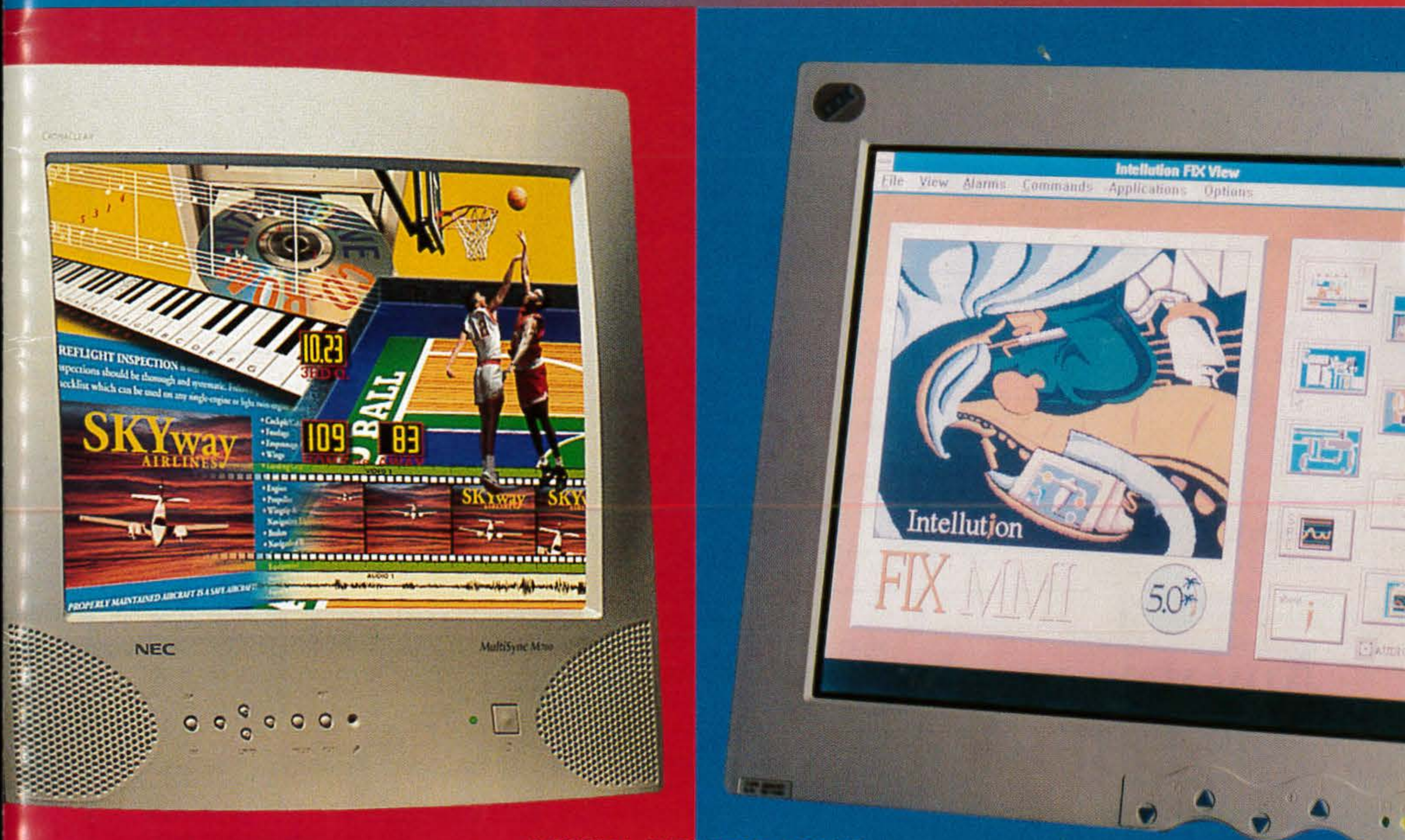
The Official Monthly Publication of the Society for Information Display

INFORMATION DISPLAY

JANUARY 1997
VOLUME 13
NUMBER 1

THE WAR FOR THE DESKTOP BEGINS



ANNUAL MONITOR ISSUE

Inside:

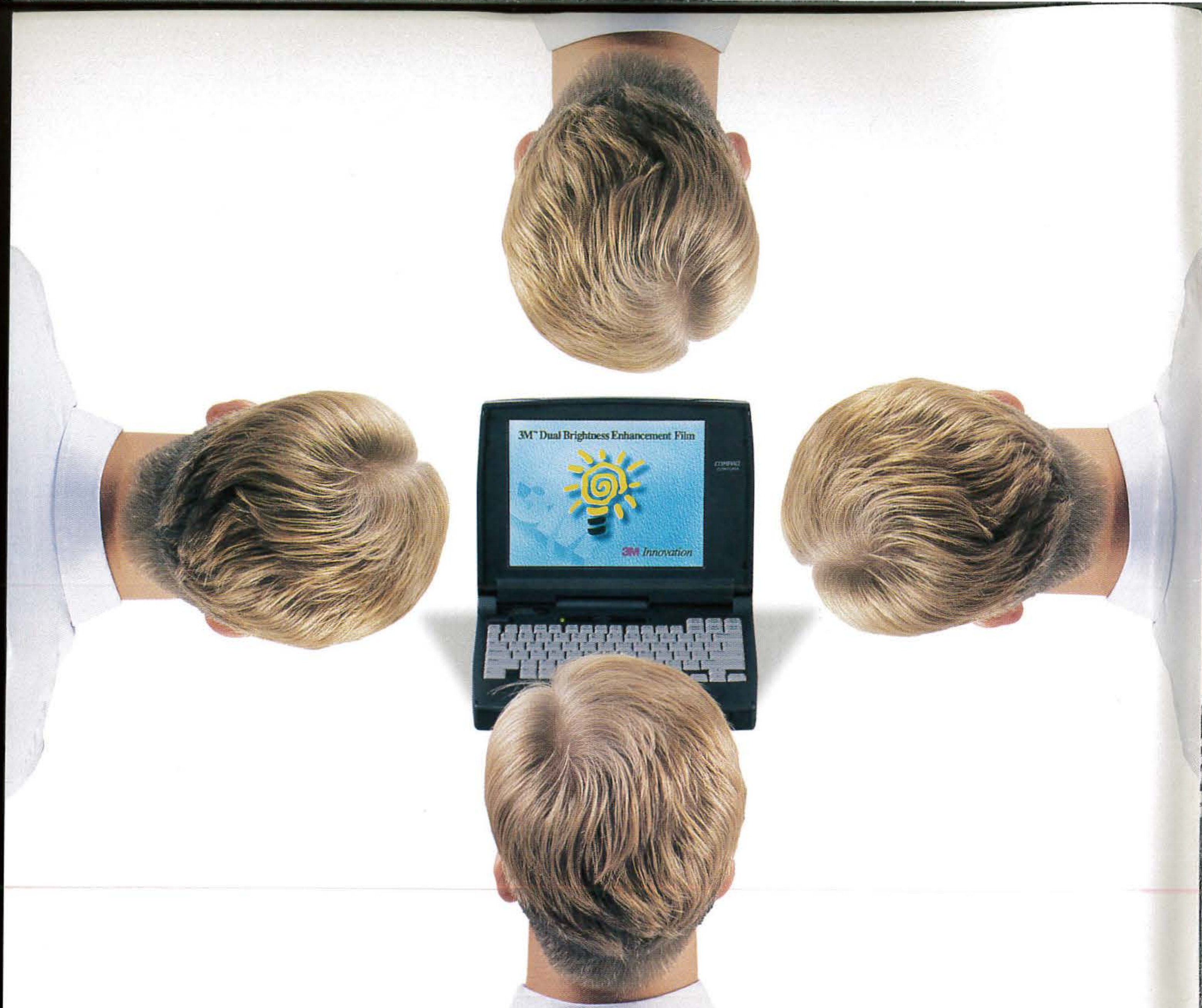
Stanford Resources' Monitor Market Survey

Time-manipulated 3D Video

Mitsu's "Modular Displays"

Designing for Electromagnetic Compatibility

EuroDisplay Report



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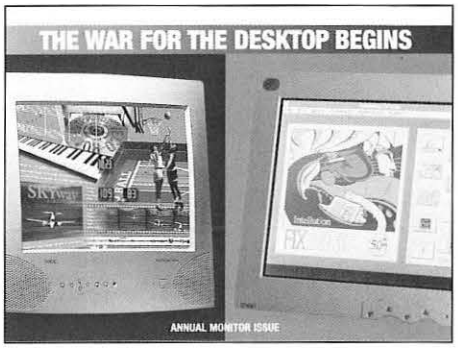
3M *Innovation*

COVER: The war for the desktop between CRT and FPD monitors will begin in earnest. FPDs bring the whole range of flat-panel virtues to what promises to be an epic technobusiness conflict that will go on for years. The IBM Italo LCD monitor (right) uses IBM's 16.1-in. TFT-LCD – the largest TFT-LCD that is commercially available as we go to press. CRT-based monitors dominate the market, and we are still seeing innovations in their design. NEC's M700 17-in. CromaClear™ monitor (left) uses a new shadow-mask design that is a cross between delta and Trinitron™ practice, and produces a very high MTF. The monitor also contains speakers for multimedia applications.



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Next Month in
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- Miniature Displays
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- Lisbon Seminar Review
- SMAU '96 Report
- EuroDisplay/EID Report

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INFORMATION DISPLAY

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editorial

Plasma Displays at Thomson. At Thomson/Matra? At RCA/Daewoo?

On October 10th, I visited the plasma-display-panel (PDP) development and manufacturing facility of Thomson Tubes Electroniques (TTE) at Moirans, France, just outside Grenoble. Despite considerable activity on the technology and manufacturing fronts, Thomson personnel were understandably distracted by an impending decision expected from the French Government the following week: selecting the private-sector bidder to which it would sell Thomson.

Thomson, S. A., is the largely government-owned international electronics giant that consists of two major parts: Thomson CSF (professional and military electronics) and Thomson Multimedia (consumer electronics). Thomson Multimedia includes RCA (the best-selling TV manufacturer in North America), Telefunken, SABA, and Ferguson, and also produces consumer electronic products under the Thomson brand name. Thomson CSF owns 87.5% of TTE, the 2500-employee industrial and military CRT and microwave-tube maker that has twice the CRT output of Thomas (U.S.) or Brimar (U.K.), according to Gérard Dhiver, Director of Marketing for visualization products. This makes it the world's largest producer of industrial and military tubes. With several factories in Europe, one in China, and having incorporated AEG's factory in Ulm, Germany, last May, TTE also has a substantial PDP development program for high-resolution industrial and military panels in Moirans. In addition, TTE is working to develop a 42-in. PDP for television under a development contract with Thomson Multimedia.

Thomson's new owner will buy a profitable professional and military electronics division and a consumer electronics division that is not profitable, although Dhiver was quick to point out that Thomson Multimedia does make money on operations. (It's the division's debt service that causes the bottom line to be printed in red.)

As has been widely reported in the trade and business press, Thomson's expected purchaser is the Lagardère Group, which includes the French aerospace company Matra. The plan is to form a company to be called Thomson Matra which would operate Thomson's industrial and military businesses and spin off the consumer electronics business to the Korean electronics giant Daewoo. The French Prime Minister has suggested a process for Matra's acquisition of Thomson, which must be approved by the appropriate E.U. body in Brussels and by the French commission that oversees privatization. If all goes well, the purchase could be approved early in 1997 - or perhaps even earlier - according to Ernest L. Stern, Chairman of Thomson Components and Tubes Corp. in the U.S.

All of this creates many interesting display-related combinations, but let's stick to PDPs - which is what this editorial was supposed to be about. The Korean electronics majors have made no secret of their interest in PDP technology. TTE's own PDP program resides on the non-consumer side, but remember the development contract with Thomson Multimedia. TTE would be very happy to continue and expand that contract, and I'm guessing Daewoo would look favorably on that prospect, too. TTE began work on AC-PDPs 30 years ago, I was told by Jacques Deschamps, Manager for Plasma Display Panels, and sold

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Model RSM 2200 — Features

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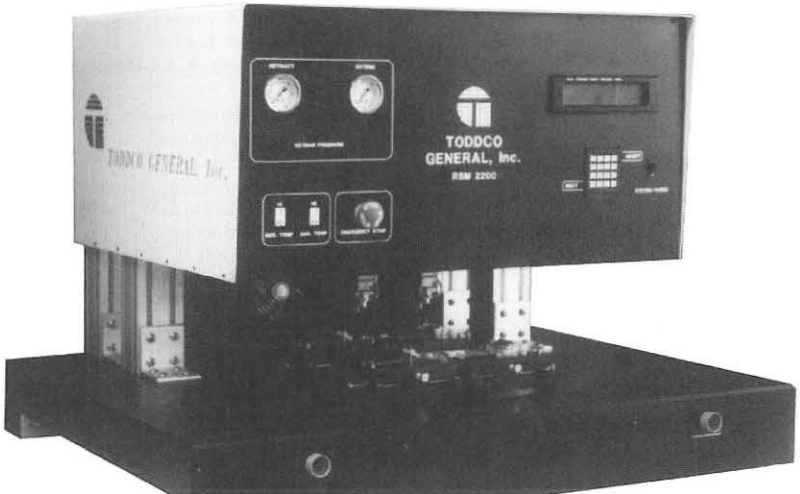

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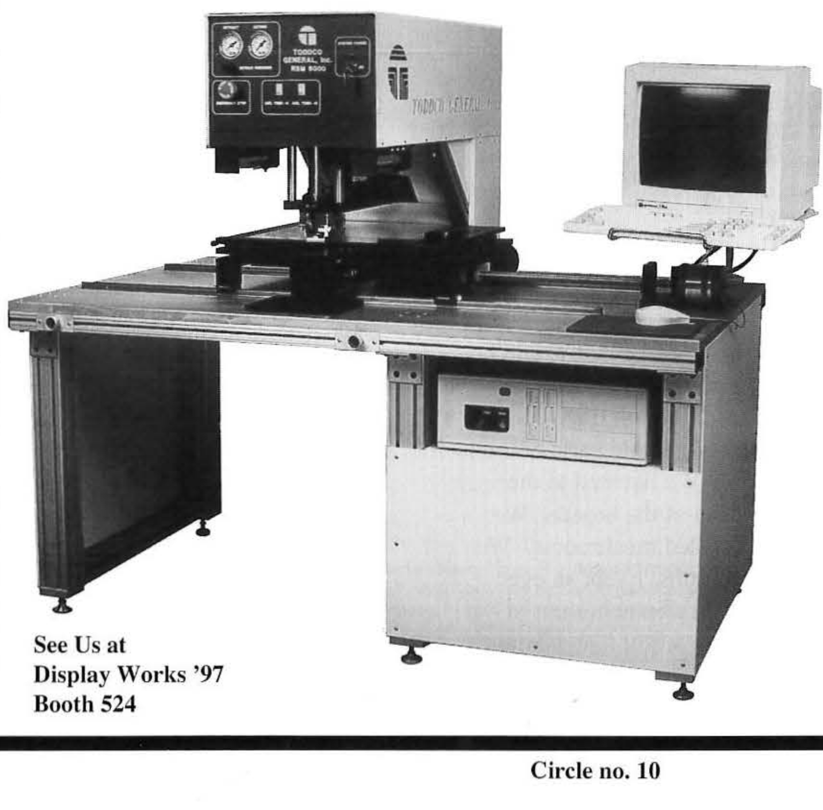

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Circle no. 10

The Blind Trust Walk ...

by Aris Silzars

Right away I could tell I wasn't going to like this. Instantly and vividly I could recall certain events from years ago in grade school. I remembered how I hated games like pin the tail on the donkey and others that required one to be blindfolded - especially when the other kids laughed as I wandered off in the opposite direction from where the donkey was stuck on the wall. Yet here I was, well into adulthood, once again about to be subjected to this kind of humiliation. Or, at least, so I thought.

How did I get myself into this? Easy. It was another outdoor management training and team-building "opportunity." You know, the kind with pole climbing and bungee jumping. However, the exercise we were about to do would have none of the exhilaration of contemplating the results of impacting the rocky ground 60 feet below if the safety harness failed - an exceedingly small probability but still likely greater than epsilon.

Nevertheless, the buildup by the training staff added a sufficient level of mystery that one definitely did not feel at ease or have much sense of control regarding the events about to take place. With our safety helmets and harnesses snugly about us, we followed our instructor into the woods on a crispy-cool and very colorful autumn morning. When we reached a clearing, we were told that we would be divided into two groups. "And then what?" I immediately wanted to know, although I didn't actually ask the question.

Once the two randomly selected but evenly populated groups had been formed, one group was told that they would all be blindfolded and led through the woods by someone from the other group. Luck was with me. It appeared that I had ended up in the group that was going to be doing the leading. Great! I wouldn't have to be blindfolded after all.

As the newly appointed leaders, we were told that we were to give the blindfolded ones as many diverse and interesting experiences as we could devise in an approximately 15-minute period while taking great care that our charges did not fall down or hurt themselves. The second firm rule was that we would not be allowed to say anything or, in fact, utter any sound at all. We were also not to identify ourselves to our blindfolded colleagues.

Otherwise, we should make the experience as creative and informative as possible by utilizing any or all of the other senses of touch, hearing, smell, and taste.

Once I had made gentle elbow contact with the blindfolded one that would be my responsibility, I became very focused on making an all-out effort to give my charge an enjoyable and varied experience. As we moved through the woods, I gave gentle guidance by little nudges on the arm and other suitable parts of the anatomy. We felt trees and branches. We smelled moss. We listened to the crunch of leaves underfoot. We tried to sense the direction of the breeze. We felt the warm sun and the cool shade. We picked and smelled mushrooms. We explored some unidentified berry bushes. While doing all this, I kept an ever watchful eye on the safety of my companion. I moved sharp branches out of our path. I made sure that there were no slippery spots. I was careful that we didn't

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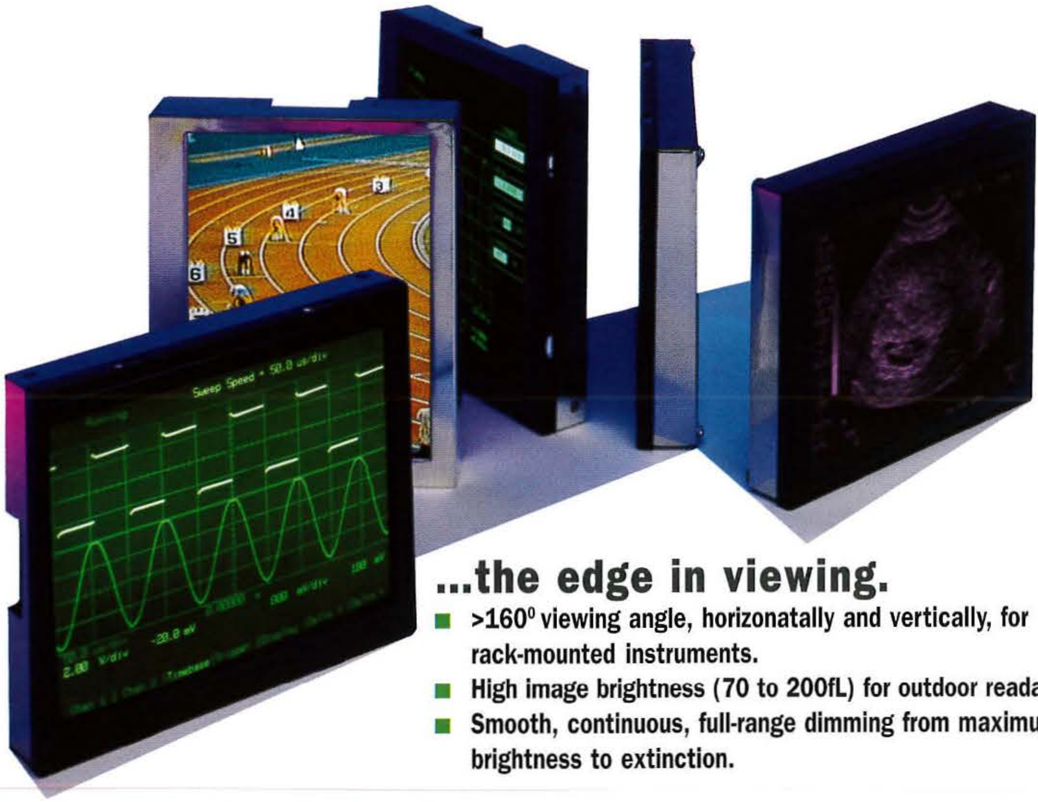

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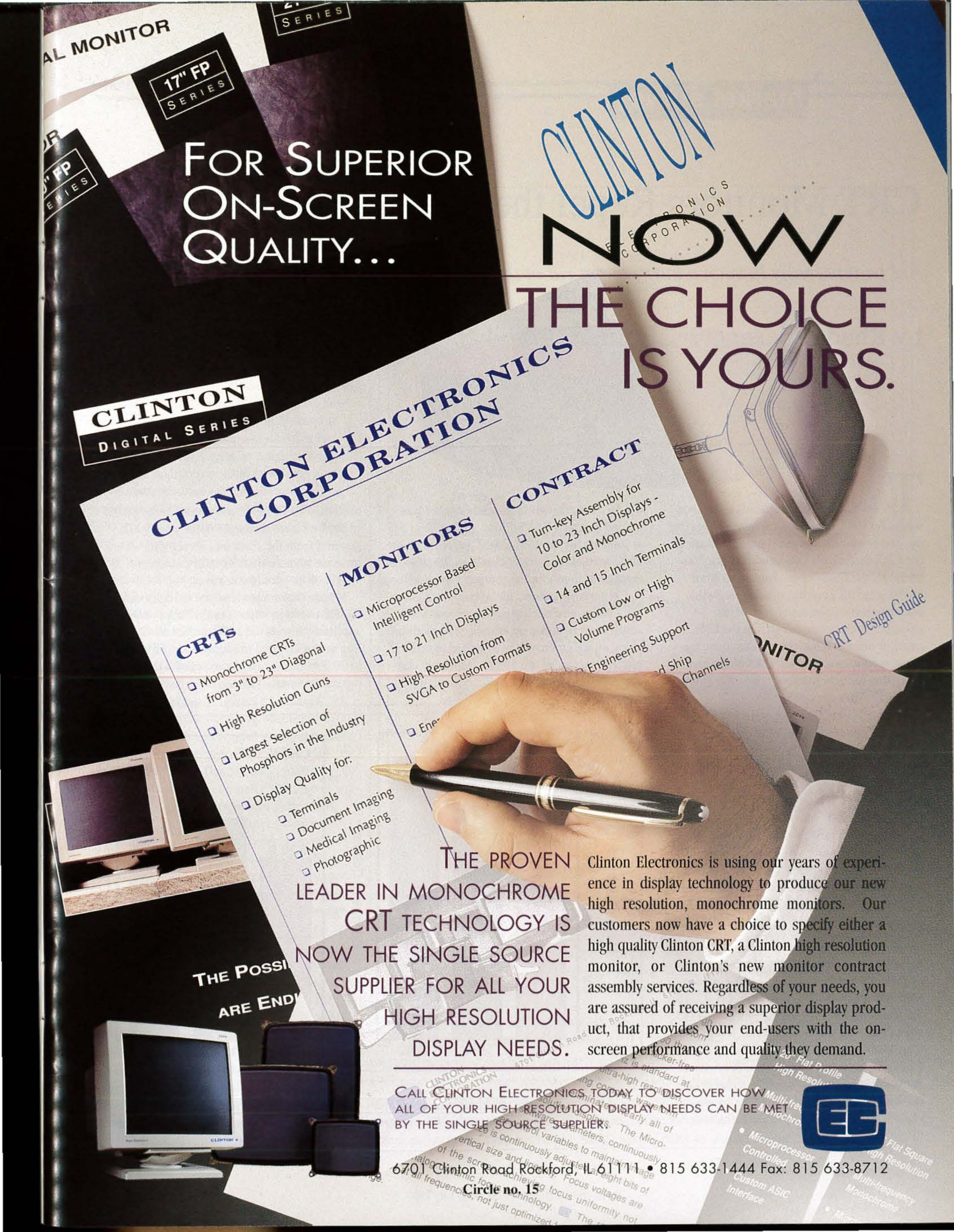

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Circle no. 15

CRT Monitors Repel the FPD Challenge

Are people really in such a hurry to get rid of their CRT monitors?

by Rhoda Alexander and Brian Fedrow

THE ONSLAUGHT of flat panels as replacements for CRT-based data displays is heating up, and predictions of the imminent death of the CRT data display abound. Despite this pressure, the CRT-based display-monitor industry is still growing steadily, and end users continue to be satisfied with the price/performance equation that the CRT monitor offers. Firms are still announcing plant expansions, new CRT developments, and plans for new monitor products every day. In nearly every applications category, the demand continues for color monitors with higher information content, higher screen resolution, higher screen refresh rate, lower power consumption, and improved shielding.

The worldwide market for all color and monochrome CRT display monitors - excluding those used for consumer TV - reached more than 64.5 million units in 1996. The aggregate world unit growth will be steady through the remainder of the 1990s, with a 4.8% compound annual growth rate (CAGR) over the 1996–2002 period, bringing the market to 85.2 million units in the year 2002 (Fig. 1). In 1996, the world monitor market was valued at nearly $21 billion. A CAGR of 5% is forecast for the 1996–2002 period, with the 2002 market reaching $28 billion, largely due to sales of monitors for computer applications.

Continuing demand in the computer industry - the largest applications segment - will result in an ongoing opportunity for monitor sales, although growth is expected to trail off moderately in the late 1990s. Monitors consumed by the computer industry totaled 56 million units in 1996, which represents 86.9% of total monitor demand. In the year 2002, demand from the computer sector will increase to more than 77 million units, or 90.4% of the monitor market.

Within the computer segment, color desktop PC monitors represent the largest sub-application, with the 1996 market of 47.3 million units expected to increase at a 7% CAGR to 70.9 million units in the year 2002. Desktop monitors are typically sold "bundled" with

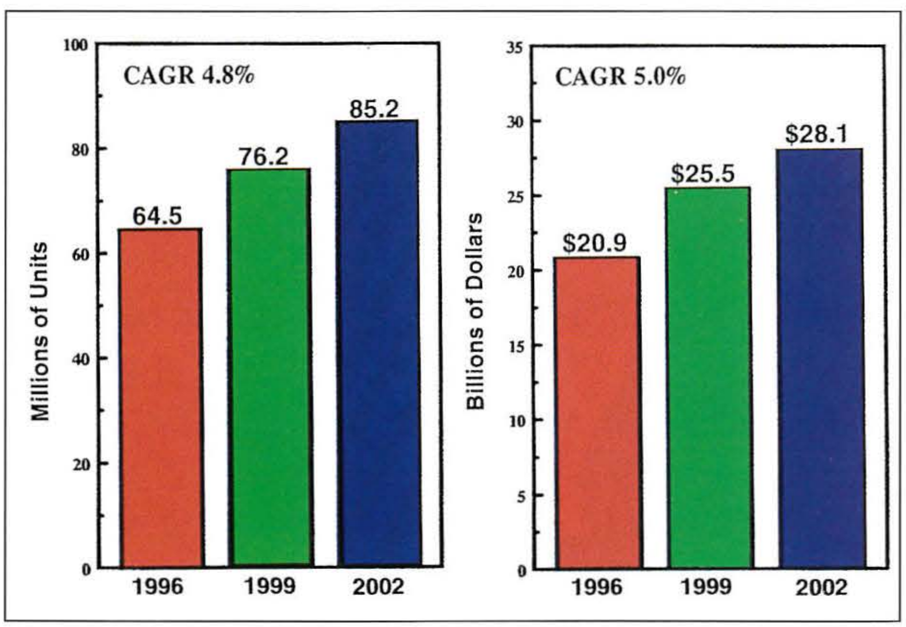

Fig. 1: The aggregate world market for all color and monochrome CRT display monitors – excluding those used for consumer TV – will reach 85.2 million units and $28.1 billion by the year 2002.

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CPUs or, less frequently, as an independent purchase for replacement or upgrade.

Since the early 1990s, makers of desktop PC monitors have continued to cut manufacturing costs through methods such as offshore production, reductions in component count, and innovative product design, while simultaneously increasing screen size and adding important features such as power management and shielding.

With the advent of highly portable computers, the demise of the traditional desktop PC has been predicted repeatedly. Firms are now even starting to introduce "portable desktop PCs," which feature a liquid-crystal display (LCD) as the main display in a lighter-weight system. In addition, in 1996 a growing number of manufacturers have accelerated the introduction of flat-panel monitors based on LCD technology with screen sizes up to 20-in. on the diagonal.

For now, the flat-panel monitor is more hype than substance - at least as far as pushing CRT monitors off the desk is concerned. The substantially higher cost associated with current flat-panel monitor offerings inhibits penetration in price-sensitive markets where space-saving is not critical.

Initial flat-panel monitor sales have been strong in such areas as financial, medical, industrial, and point-of-sale applications, where the benefits of compact size and portability outweigh cost concerns. Pricing and availability of small flat panels, combined with recent shortages of small CRTs, have created a shift in product-design philosophy for the non-computer applications categories - industrial, communications, business/commercial/retail, transportation, and military. None of these applications segments is expected to experience significant overall growth on the CRT side during the forecast period, although some growth for CRT monitors in larger screen sizes is likely.

For computer applications, overall user satisfaction with the price/performance ratio of CRT technology has been historically high and has improved even further in recent years. End users have enjoyed the benefits of the increased competition in CRT monitor markets in recent years, which has resulted in lower prices and improved performance.

Despite increases in raw-materials and production costs, CRT monitor pricing, particularly in the color segment, has consistently declined in recent years. But early in 1995, display prices started to climb at the OEM level, triggered by product shortages and increases in CRT costs. These product shortages - particularly in the 14- and 15-in. color segments - plagued OEMs throughout most of the year before easing in late 1995 and early 1996.

As supply improved in early 1996, prices began falling. Cost-competitiveness will remain the inherent advantage of CRT monitors over any flat-panel challengers during the remainder of this decade. This will be based on the ability of the CRT products to maintain a fairly steady decline in prices despite tempo-

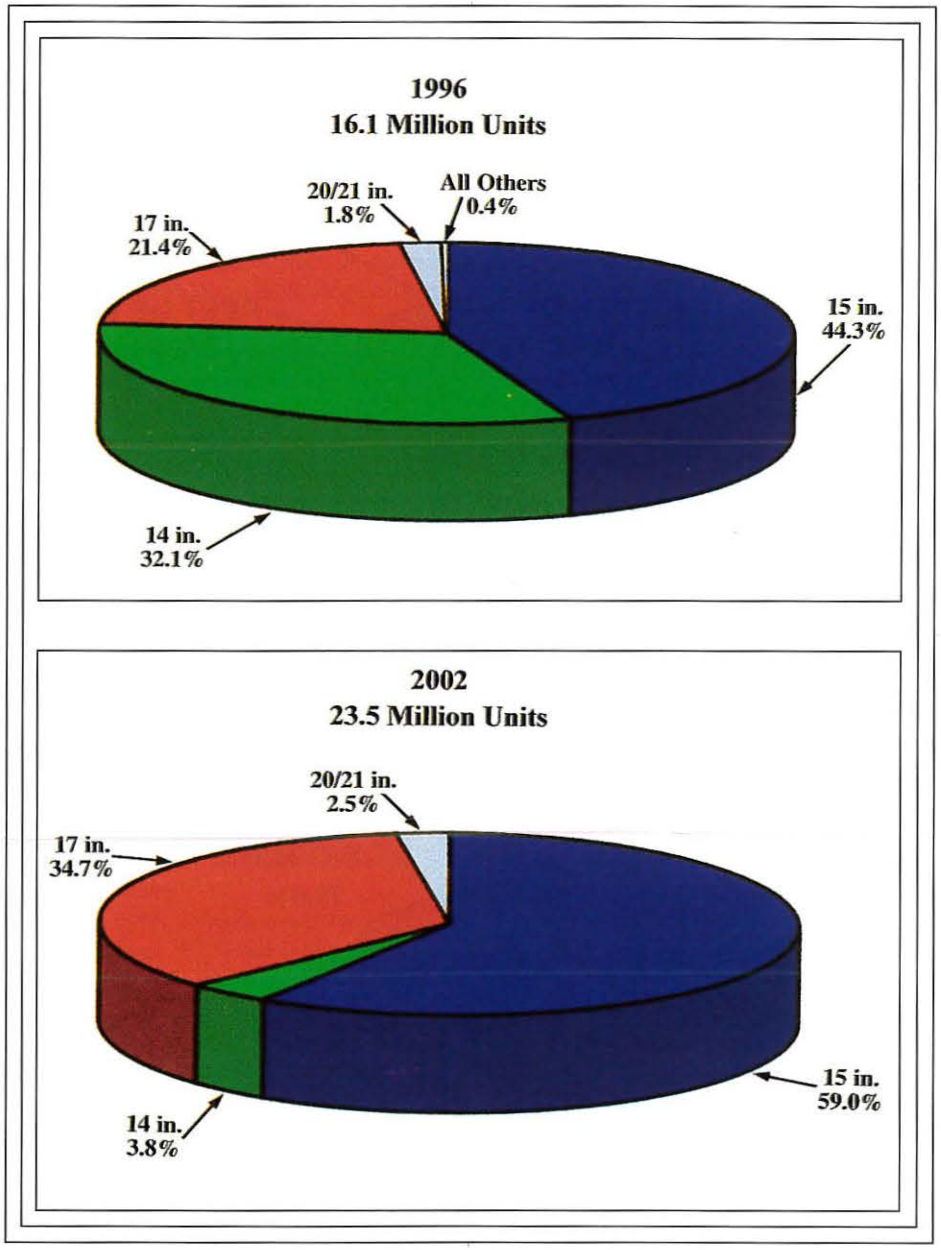

Fig. 2: *The 1996–2002 regional sales forecast of color desktop PC monitors shows substantial overall growth. Although North America and Europe are still expected to consume the majority of desktop PC monitors during the forecast period, the strongest growth rate for all monitors will occur in "other" regions outside of North America, Europe, and Japan.*

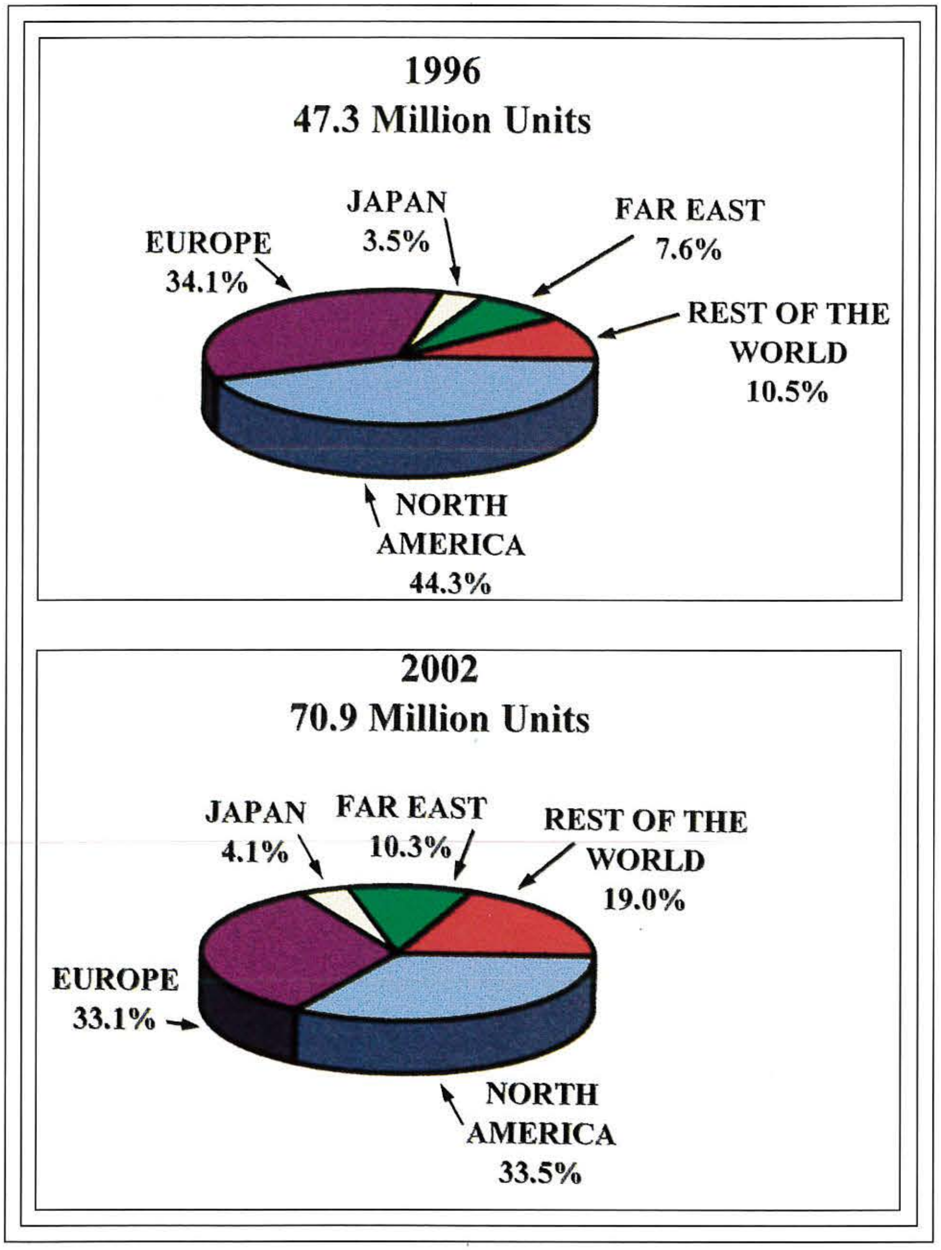

***Fig. 3:** In Europe, a strong trend is under way toward screen sizes of 15 and 17 in. and away from 14 in. But even in the Far East and the rest of the world, the current emphasis on 14-in. monitors will be succeeded by a rapid growth in the sale of 15-in. monitors by the year 2002.*

rary market conditions and threats from new technologies.

In the computer segment, there continues to be a rapid decline of the market for monitors with screen diagonals less than or equal to 14 in. because of the growing volume of "mid-size" monitors. Both CRT and monitor manufacturers have pointed toward the 15- and 17-in. color monitor markets - specifically for consumption in the desktop PC market - as the most profitable areas. Growth will remain in double figures (15.4%) through the year 2002.

The 15-in. monitor category (39.4% share in 1996) is now nearly equal to the 14-in. monitor category (40.5% share) in the worldwide color desktop PC application. The 17-in. category will actually experience the highest growth rate during the forecast period: unit consumption of 17-in. monitors is expected to reach nearly 22 million units in the year 2002 at a growth rate of more than 18%.

Regional consumption patterns are influenced by population size and education, economic development, installed PC equipment base, and availability of alternate technologies. The 1996–2002 regional sales forecast of color desktop PC monitors shows substantial overall growth. Although North America and Europe are still expected to consume the majority of desktop PC monitors during the forecast period, the strongest growth rate for all monitors will occur in "other" regions outside North America, Europe, and Japan (Fig. 2). The growth rate through the year 2002 in the Far East is expected to be 13%, and the growth rate in the rest of the world will be 18% during the same period.

Demand for low-priced color monitors is growing rapidly in these developing regions, stimulating production within nations such as China and India. Most of the monitors currently produced in these countries are being consumed internally. This makes tracking of actual consumption extremely difficult, particularly in China, where information is not readily available.

In regions of the Far East and the rest of the world where consumption is increasing, the current emphasis is on expanding the entry-level markets for 14- and 15-in. color monitors. In 1996, the 14-in. market in these regions will account for 71.2% of color desktop PC monitor sales, nearly double the share that is expected for either the U.S. or Europe. By the year 2002, 15-in. monitors will have displaced 14-in. monitors and will account for approximately 75% of sales in the Far East and the rest of the world.

Despite the strong growth rates in the Far East and the rest of the world, consumption of computer monitors in North America and Europe will represent the largest volume markets throughout the forecast period. The European region can be divided into two distinct markets. Much of the demand from Western Europe will be for larger-screen higher-resolution high-performance monitors. Demand for "ergonomic improvements" in Western Europe has driven many of the recent innovations in monitor design. Eastern Europe and the former Soviet Union, with their depressed economies, represent markets for low- and medium-resolution color monitors (Fig. 3).

The United States will continue to be the largest consumer of color desktop PC monitors in North America. The 15- and 17-in. monitor markets are expected to be the largest growth areas as many users upgrade from 14-in. models to take advantage of graphical environments such as Windows. Recent 14-in. product shortages stimulated additional growth in larger-screen markets as systems manufacturers adapted their bundles to include larger-screen monitors. U.S. vendors, such as Dell, Compaq, and Gateway 2000, offer both 15- and 17-in. monitors as part of standard systems.

Unit growth in the 20- and 21-in. color desktop PC monitor segments is not expected to match the explosive growth seen in the 15- and 17-in. markets. The combination of physical size and higher prices for 20- and 21-in. units limits customer demand despite the benefits inherent in a larger screen size. Worldwide growth for 20-in.-and-larger color desktop PC monitors will be moderate through the year 2002, with a total unit share of around 3% throughout the forecast period.

In contrast to the desktop PC monitor segment, the workstation monitor market is dominated by the larger-size monitors, particularly 20-in. Trinitron-based models. Although they represent only a small fraction of the entire computer monitor market, color workstation monitors have shown steady growth throughout the 1990s, and a CAGR of 7% is forecast for 1996–2002.

The customer base for workstations is largely composed of users from computer-aided design/manufacturing/engineering (CAD/CAM/CAE) and computer-assisted software engineering (CASE) environments. Electronic publishing, business graphics, financial services, film/video editing, and office automation applications represent a much smaller portion of the workstation market.

Several other important issues will face the monitor industry throughout the remainder of the 1990s:

- Multimedia
- Universal Serial Bus
- Safety
- Power management

Multimedia integrates text, graphics, sound, video, and animation within computer systems. After years of hype, multimedia applications are finally taking off, and this segment is expected to experience significant growth in the next few years. Multimedia monitors do not currently represent a large portion of the total monitor market, although several companies introduced them in 1996. Approximately 5–10% of the monitors shipped in the U.S. in 1996 were multimedia-capable; the trend is expected to grow as the technology becomes less expensive.

The hot new feature for 1996 and 1997 is expected to be support for the universal serial bus (USB) – a new enhanced-performance serial bus that permits peripherals to be "daisy-chained" to each other so that many peripherals can be attached to a single USB port on the system unit and operate simultaneously. USB support involves having multiple ports on peripherals, device recognition, and linking capability. Several leading vendors have already incorporated this feature into their 1996 product offerings, and most of the Far Eastern firms are planning to introduce USB products in 1996 or 1997. Already supported by over 300 different software and hardware vendors, USB is expected to fuel growth in PC-telephone integration, gaming, and multimedia by simplifying connectivity issues for users.

In the 1980s, concern about low-level very-low-frequency (VLF) and extremely-low-frequency (ELF) electromagnetic emissions originated in Scandinavian countries. The Swedish Department of Labor introduced a set of standards known as MPR-II which established guidelines for the measurement of electrostatic, magnetic, and electric field levels, and specified well-defined limits for emissions. A more rigid standard was adopted by the Swedish Tjanstemannens Central Organization (TCO) in 1991. The new standard tightened the measuring distance from 50 cm all around the monitor to 30 cm in front of the display and 50 cm elsewhere.

Today, all major monitor manufacturers offer displays that are MPR-II-certified. Manufacturers selling in the European market typically offer TCO-compliant displays as well. Demand for TCO-compliant displays in the U.S. market has been minimal, and even within the European Community demand varies considerably from country to country. TCO is a standard requirement in Scandinavian countries and Germany, an increasingly popular option in England and France, and virtually unheard of in Italy.

Sales of MPR-II-compliant displays have increased significantly in the past 3 years: more than two-thirds of U.S. color desktop PC monitors sold in 1996 were MPR-II-compliant. The price premium associated with TCO compliance will inhibit sales of these units in the United States unless vendors are willing to absorb the added cost.

Like many recent innovations in the CRT monitor market, power management has now become standard on nearly all color desktop PC monitors. Most manufacturers who have implemented power-management solutions have far exceeded the U.S. Energy Star standard and include a low-power state of 5 W or less to comply with the DPMS standard or even the more stringent Nutek standard.

End users often overlook the recent improvement in CRT monitor technology because these developments occurred seamlessly over a short period. Nonetheless, manufacturers and end users have their eyes focused on the coming flat-panel revolution, and it would certainly be hard to argue against a thinner, lighter-weight product that offers more portability with similar performance. Today, 10–16-in. color flat-panel displays for use as monitors are in demand, but their high prices – \$2000–10,000 for a plug-and-play monitor – limit their use to special applications. All major LCD makers and end users recognize the potential of these devices to replace the bulky desktop CRT monitor, but until the prices come down for displays with an actual viewing screen size of 14–15-in., the impact on the mainstream computer monitor market will be small.

It is expected that the major impact of flat panels on the computer monitor market will not occur until the early 21st century. In the meantime, FPD technology developers will continue to follow developments in CRT monitors, which remains a continuously moving target. ■

Displaying the Network

When your computer is a network, your display may be an intelligent modular tiling capable of displaying a 100-million-pixel image rendered from network-transmitted data.

by TakaHide Ohkami

MANY APPLICATIONS are now being developed to use the digital data that is increasingly available on computer networks that are becoming faster and faster. Many people share data for collaborative work, learning, or entertainment, and display systems are expected to play a vital role in the flexible presentation of various forms of visual data in a collaborative environment.

Although we have seen many innovations and improvements in display systems over the last few decades, they continue to be passive I/O devices that are either controlled by computers or designed into consumer products as integral components. Advancing technology will soon make it feasible to build an intelligent display system with information-processing capability: a system that will be able to provide new functionality, including support for a large number of pixels (10–100 million) and network connectivity. Such a display should acquire first-class citizenship in a network environment, as opposed to the second-class status displays have today (Fig. 1).

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Dr. Ohkami thanks Laszlo Belady and Tohei Nitta for their support of this work, and William Freeman for his helpful comments. This article is based on "Modular Display: An Approach to Intelligent Display Systems," a paper presented at SID '96 in San Diego, California.

Our research goal is to investigate the architecture for just such an intelligent display system, which we believe should be scalable with respect to the number of pixels and modular for flexibility in system implementations.

Groupware Applications

As we have become increasingly sensitive to the importance of computer support for human collaboration, investigators in a new field called "computer-supported cooperative work" (CSCW) have begun to explore a variety of groupware systems. Presentation of visual information is a key to these systems.

We are interested in display systems for groupware applications to help people work, learn, and play together. Since current display systems are designed mainly for personal use or for use by a very small group of people - in terms of number of pixels - many current groupware applications are supported by a collection of display systems. Some examples of these application areas are

- Video/TV studio
- Plant/traffic control center
- VLSI design room
- Automobile design room

In these areas, people work together using a collection of different display systems, each dedicated to a particular set of images. In the future, we expect to see applications such as a large-scale virtual-reality environment in which people collaborate with each other in front of a wall-sized high-resolution tiled screen.

This sort of collaborative application requires many more pixels than do applications intended for use by a single person or a small group. In addition, displays designed for these applications must accommodate different types of visual data coming from multiple sources through the network.

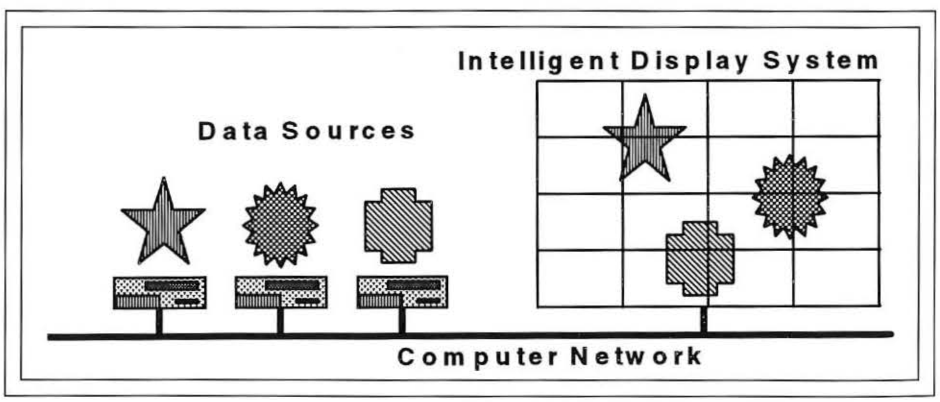

Fig. 1: *An intelligent display system with information-processing capability could provide support for 10–100 million pixels on a tiled screen and provide network connectivity.*

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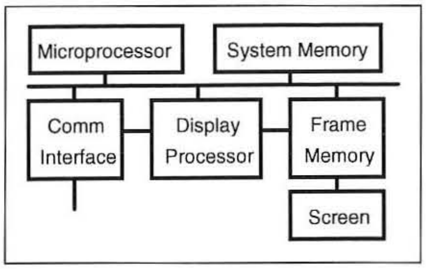

Fig. 2: A display module would provide each component screen with a microprocessor for information processing and a frame memory for holding display data.

Estimating Pixel Requirements

If an asynchronous-transfer-mode (ATM) network is used exclusively to transmit visual data to a display system with a tiled screen, we can estimate the number of pixels required to present images rendered from the transmitted data. We have made such an estimate based on the fact that first-generation ATM networks have a bandwidth of 155 Mb/s, with future generations expected to operate at 622 and then at 2488 Mb/s for transmission of raw pixel streams, NTSC and HDTV video streams, and graphics polygon streams. In our estimate, we assumed that each data stream is transmitted over the network in compressed form and that data streams of different types are compressed in different ways. Since each data stream requires a fixed number of pixels for its image frames, we can compute how many data streams of each type can be transmitted at the same time over the network. We can then determine the total number of pixels required to display the image frames rendered from all these transmitted data streams.

The details of this calculation can be found in the paper presented at SID '96 on which this article is based. The calculation results in the number of pixels a display must have (with appropriate assumptions for frame rate) to render data streams of various types pumping through first-, second-, and third-generation ATM networks. These results are summarized in Table 1. The maximum pixel requirements are 9.13, 36.51, and 146.03 Mpixels for ATM bandwidths of 155, 622, and 2488 Mb/s, respectively.

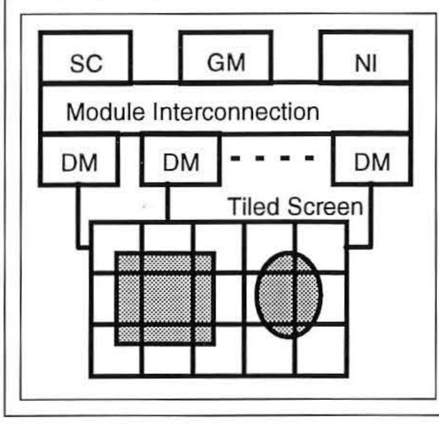

Fig. 3: A possible structure for the modular display system connects the display modules (DMs) via the module interconnection network, which also connects a system control (SC), a global memory (GM), and a network interface (NI).

Scalable Modular Architecture

Most current displays support less than 6 million pixels. To support more pixels, high-resolution displays must be connected together for tiling because it is not feasible - either economically or technologically - to develop a single screen with that many pixels.

We believe that the likely functional and pixel requirements of the growing groupware applications can be satisfied by an intelligent display system, and we believe it will be viable to develop such a system by incorporating information-processing capability into the display.

We characterize the intelligence of a display system with the following features:

- Supports 10–100 million pixels.
- Uses a tiled screen of any size and shape.
- Handles multiple data streams and stream types.
- Dynamically formats screen content.
- Connects to a network with a high-level data interface.

These features are derived from the display's information-processing capability because

- Visual data must be dynamically routed to frame buffers.
- The system configuration has to be parameterized.
- Different data streams and stream types have to be handled in different ways.
- The formatting of screen content should be independent of stream type.
- A network protocol has to be provided to process encoded data in real time.

We could build such a system by attaching a number of traditional display monitors to a supercomputer with a network interface, but this approach is neither very scalable nor modular for different system configurations. Instead, we propose a scalable and modular approach - which we call "modular display" - that uses display modules, each containing a microprocessor and a frame buffer for its own screen (Fig. 2).

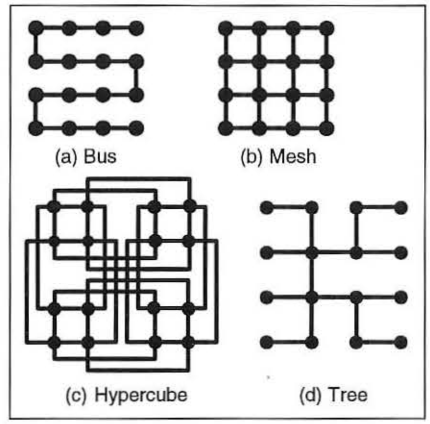

Fig. 4: The four possible types of networks for interconnecting the modules are (a) bus, (b) mesh, (c) hypercube, and (d) a binary tree with internal nodes collapsed into leaf nodes.

The proposed display system consists of a system control (SC), a global memory (GM), a network interface (NI), display modules (DMs), and a module interconnection network (Fig. 3). The global memory buffers data from the network and stores preprocessed data. The module interconnection network connects all the system components for communications and load balancing. Data stored in the global memory are distributed through the interconnection network to the display modules for display.

Interconnecting Display Modules

One of the key issues in the proposed architecture is the module interconnection network for data routing and load balancing. If we connected the global memory to each display module with a one-to-one link, we could use a powerful computer that performs all the operations and sends the appropriate data to the display modules. This is the supercomputer approach, which uses the interconnection network to distribute data only. We want to distribute operations as well.

Raw RGB pixel images require no special operations. If they are compressed, operations

Table 1: Pixel Requirements (Mpixels)

Data Stream Type	ATM Bandwidth (Mops) 155	622	2488
Raw RGB Pixels P_p (C=1/1)	0.20	0.78	3.13
Raw RGB Pixels P_p (C=1/40)	7.83	31.30	125.20
Composite NTSC (NTSC1) P_v	0.43	1.74	6.95
Component NTSC (NTSC2) P_v	0.23	0.90	3.61
MPEG-2 Encoded HDTV P_v	9.13	36.51	146.03
2-D Polygon Specs P_g (F=10)	5.87	23.47	93.90
2-D Polygon Specs P_g (F=30)	1.96	7.82	31.30

C=Compression rate, F=# frames/second

Note. For a given available ATM bandwidth (in megabits per second, Mb/s), each type of data stream has a particular pixel requirement (in millions of pixels). This requirement is the number of pixels needed to display the images rendered from each data stream transmitted over the network.

for decompression are required on the way. NTSC video streams require transformation operations from YIQ or YCrCb to RGB. HDTV video streams encoded by MPEG-2 require complicated MPEG-2 decoding operations. Graphics polygons need to be rasterized to produce RGB pixels. In order to efficiently distribute these operations over display modules, we need to find good parallel algorithms that match the module interconnection network well.

One of the challenges for good algorithms is where to generate pixels from encoded data. It will significantly affect the system's balancing of loads because many operations to route the pixels generated from encoded data to the remote frame memories may consume system resources. What makes the problem harder is that some data-stream types - including graphics polygon streams and HDTV streams encoded with MPEG-2 - do not reveal the destinations of pixels without decoding.

We have done a preliminary study to compare four types of interconnection networks: bus-based, mesh, hypercube, and tree networks (Fig. 4). Here is a summary of the study's results:

- The bus-based network provides a very simple solution for general connectivity of a small number of display modules, but it does not scale well with a large number of display modules because of the limited network bandwidth.
- The mesh network uses a fixed number of links and can balance loads well among neighboring modules, but cannot route data efficiently.
- The hypercube network can route data and balance loads in a relatively efficient way, but requires many links for a large number of modules.
- The tree network requires fewer links but more steps in routing than the hypercube network.

Since our preliminary results indicate no clear winner among these networks, further investigation is required.

Other Technical Challenges

There are several other important issues to be addressed for system implementations:

- A network protocol that can handle different stream types in real time and control different data sources connected to the computer network.
- A method for dynamically formatting images from multiple data streams and presenting them as specified by the user in a type-independent way.
- The organization of hardware and software for the display module, especially for flexible frame-buffer management.
- An application programming interface that would allow the convenient programming of a system for different applications.

Prognosis

Combining a display with a computer is not a new idea. What we are proposing here is not a traditional display system with its performance and flexibility improved by the integrated computer. Rather, we are proposing a display system with the new functions that will make it a first-class citizen in a network environment and will satisfy the requirements of collaborative groupware applications.

Although cost-effective implementations of the modular display will require solutions for many technical issues, we hope this article will stimulate the research efforts needed to bring intelligent display systems closer to reality. These are the systems we need to support a very large number of pixels. These systems, which will be able to present images rendered from data transmitted over the high-speed computer network, will enhance the ability of human beings to work collaboratively with many data sources - and, even more importantly, with each other. ■

Designing for Electromagnetic Compatibility

The easiest way to suppress EMI is to design it out from the beginning, which may include using a conductive optical filter to block the EMI-transparent display opening.

by Randal Barber, Gaylene Pryor, and Eric Reinheimer

IN THE PAST, it was not unusual for companies to select product components early in the design process and address the issue of electromagnetic-interference (EMI) compliance just before production. Sometimes schedules slipped and sometimes expensive redesigns were necessary. But in today's competitive marketplace, more companies are evaluating the EMI performance of components as an early and important selection criterion.

Designing for electromagnetic compatibility (EMC) involves vendor selection based on EMC expertise as well as component selection based on low emissions. Companies have learned it is a far better strategy to design electromagnetic compatibility in and remove what is unnecessary than to scramble to fix EMI problems at the end of a project.

EMI has been an issue in all product categories for many years, and continues to be. The European EMC Directive (89/336/EEC) went into effect in January 1996, so distributors and customers now require the CE proof-of-compliance mark for electronic products sold in the 15-member European Union. In the United States, FCC EMI regulatory compliance remains a requirement for selling most electronic products.

Thorough EMC testing is designed to keep noisy or susceptible instruments out of real-world systems, where consequences can range from process failures to personal injuries.

The Display Challenge

High-information-content (HIC) displays are inherently high-frequency components. Today's VGA displays typically require data and clock signals between 12 and 30 MHz. Higher-resolution displays require faster - and therefore noisier - video signals. Cabling these signals to the display without radiating EMI requires some planning.

Most instruments use a conductive enclosure - a Faraday cage - to block electromagnetic emissions from leaving or entering the product. The display, of course, requires an opening in the Faraday cage - an opening that usually causes more EMC problems than emissions from the display itself. The problem is that circuitry behind the display radiates EMI that escapes through the display opening. In general, commercial displays are well designed, and do not themselves generate excessive EMI.

Conductive optical filters that transmit visible light and block radiated EMI are available to seal the display opening, but these filters must be properly attached to the enclosure. This is particularly important because long narrow gaps between the conductive case and the conductive optical filter can form slot antennas that radiate EMI.

Displays have special requirements, such as impact protection and contrast enhancement - or contrast preservation. Front-surface reflection must be managed for the best display image. The best conductive optical-filter sys-

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The authors thank William Kimmel of Kimmel Gerke Associates Limited and Roland Gubisch of Inchcape Testing Services for review of the technical EMC information and regulatory requirements.

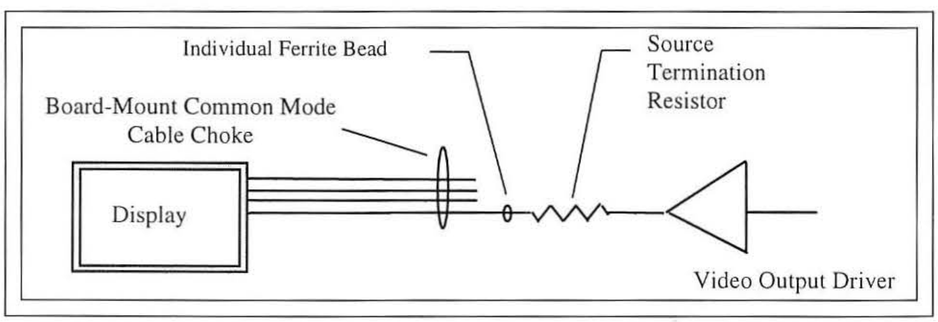

Fig. 1: *Source-terminating resistors, individual ferrite beads, and common-mode cable chokes are all important techniques for suppressing electromagnetic interference (EMI).*

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What Is an Ohm/Square?

Conductive thin-film coatings are characterized by their sheet resistance, measured in ohms per square ($\Omega/\square$ or Ω/sq. or ohm/sq.) with a special-for-the-purpose four-point probe that establishes a current flow through the thin film between the outer two points of the probe and measures the voltage drop between the inner two points. Manufacturers specify the sheet resistance of their thin films as being less than or equal to a particular $\Omega/\square$ value, so it is important to determine the actual sheet resistance of tested filters.

tems are designed with a thorough understanding of the tradeoffs between display viewability and EMI attenuation.

Controlling Video EMI

Controlling the rise times of data and clock signals are important elements in designing for electromagnetic compatibility. Individual ferrite beads placed in series with the video-signal source will keep high-frequency single-source (differential-mode) noise off the cable and reduce radiated EMI (Fig. 1). Designers should choose a minimal value for the ferrite beads.

As usual, there's a tradeoff: video-bandwidth requirements limit rise-time reduction. If during EMI testing the beads prove unnecessary, they can be replaced with zero-ohm resistors.

A board-mount or free-mount cable choke is used to eliminate common-mode EMI. The board-mount cable choke has better shock and vibration characteristics. The choke should be located near the cable exit, and all signal traces - including grounds and any cable shield - should pass through this inductor.

Cables can act like antennas unless they are properly terminated. Most displays do not terminate the signals at the display end of the video cable, so the user should source-terminate video signals on longer cables. Placing a series resistor equivalent to the characteristic impedance of the cable at the output of the video driver will minimize high-frequency ringing on the cable. Video signals on the display cable should be source-terminated, but not grounds.

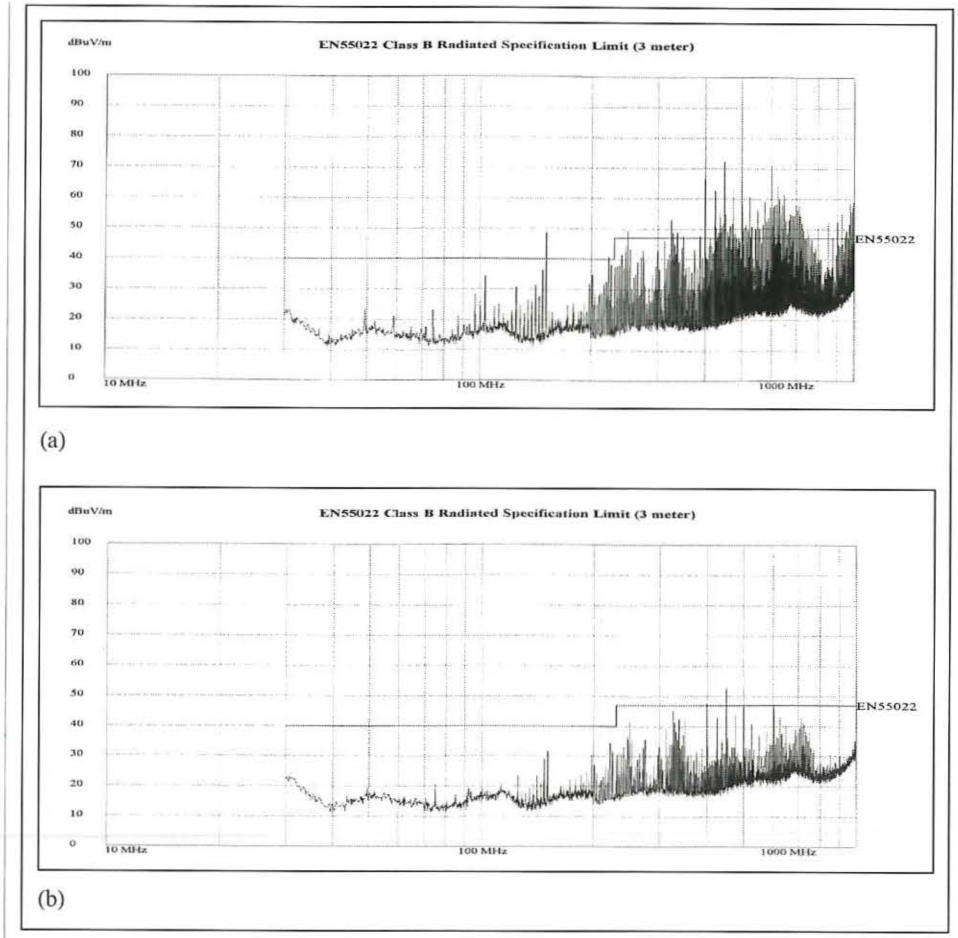


Fig. 2: (a) A frequency scan of an EMI source behind a non-conductive optical filter shows substantially more EMI than (b) a scan with a 15-$\Omega/\square$ conductive optical filter.

Cable routing can adversely affect radiated and conducted emissions. Designers should avoid running the video cable next to other cables, especially backlight inverter cables. Video noise can be induced in adjacent cables or adjacent cables can transfer noise to the video cable. Designers should also avoid running the video cable next to the enclosure to ensure that noise from the video cable is not coupled to the enclosure.

Keep the video cable as short as possible. Longer cables radiate noise, degrade video signals, and are more in need of proper termination. Low-voltage differential signal (LVDS) inputs are now available with some displays. LVDS inputs preserve the integrity of video signals over longer cables and reduce EMI emissions.

In single-enclosure systems, the video cable is usually unshielded unless testing reveals cable radiation is a major source of noise. But if the video driver and the display are in different enclosures, the connecting cable must be shielded. Then, the shield is typically connected to chassis ground on both enclosures. In cases where the cable between the enclosures is extremely long - more than 100 ft. - an ac (capacitor-coupled) ground connection is used to eliminate low-frequency ground loops.

Signal ground should connect to the enclosure (chassis ground) at only one point to minimize ground loops. Some display manufacturers connect signal ground to the display mounting frame. This can introduce noisy ground loops best eliminated by insulating

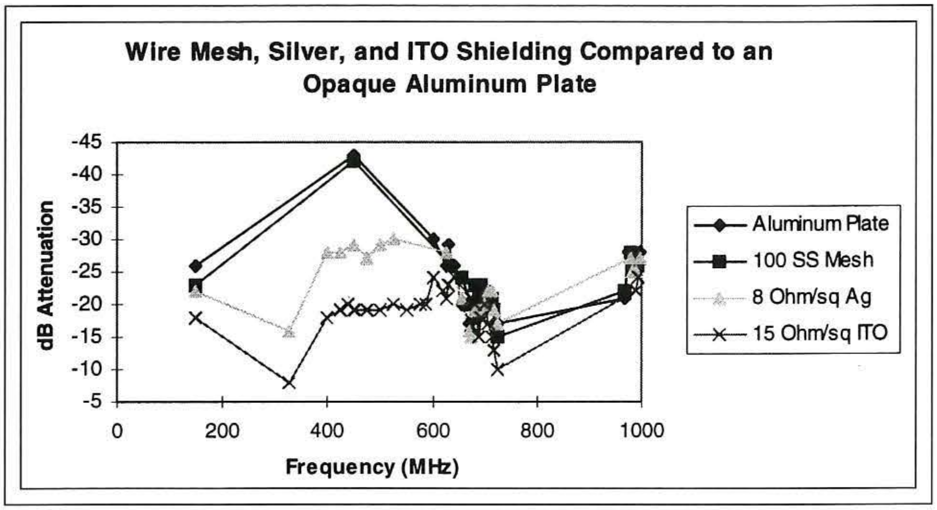


Fig. 3: These plots show the attenuation (in dB) for each conductive filter tested relative to a non-conductive filter. The plot for the aluminum plate shows the maximum possible attenuation that can be achieved by a conductive optical filter.

the display from the conductive enclosure. Indeed, insulating the display mounting frame from chassis ground often reduces high-frequency noise, regardless of the display manufacturer's dc frame grounding.

Shielding the Display Opening

To seal the display opening against EMI, one can use conductive optical filters incorporating metallic materials such as indium tin oxide (ITO), thin silver, thin gold, or wire-mesh screening. But these should be avoided if possible, as they add cost and reduce the light output from the display.

An internal metal EMI shield behind the display can often substitute for a more expensive conductive optical filter. If the thermal requirements of the display and the product footprint allow, it is wise to design in an internal EMI shield to suppress non-display emissions.

Choosing a Conductive Optical Filter

If a conductive optical filter is required, its optical characteristics should be balanced against the required EMI attenuation. The light transmission of an optical filter is always reduced by an EMI shield, which may increase the contrast ratio. If a display has sufficient brightness, increased contrast is desirable. If, on the other hand, a display already has good inherent contrast, a shield with the minimum conductivity (and maximum light transmission) should be specified.

Adding conductivity to an optical filter adds glare (surface reflections) and further reduces light transmission. The indices of refraction of ITO, thin silver, and thin gold are not well matched to the index of refraction of air, so display contrast is compromised by reflections at the air interface. Index-matching coatings can be applied over ITO, silver, and gold to improve contrast, and conductive wire mesh can be blackened to reduce reflections.

Because conductive films are applied to the display side of the filter, front-surface hardcoats, anti-reflection treatments, and impact protection are unaffected. Adding a conductive film to an optical filter is like purchasing an accessory. The front surface, material, and

European Regulatory Requirements and Organizations

CE mark: A label that warrants the product meets all applicable European regulatory requirements, including the EMC directive, for the country in which the product is sold.

CENELEC: European standards association that ratifies specifications for EMC directive compliance. In general, these specifications harmonize with pre-existing CISPR and IEC specifications.

EN55022 Class A: The CENELEC specifications for electromagnetic emissions based on CISPR 22. They apply to equipment not connected to an ac mains branch that also serves residential units.

EN55022 Class B: The CENELEC specifications for electromagnetic emissions based on CISPR 22. They apply to residential equipment and are more stringent than EN55022 Class A.

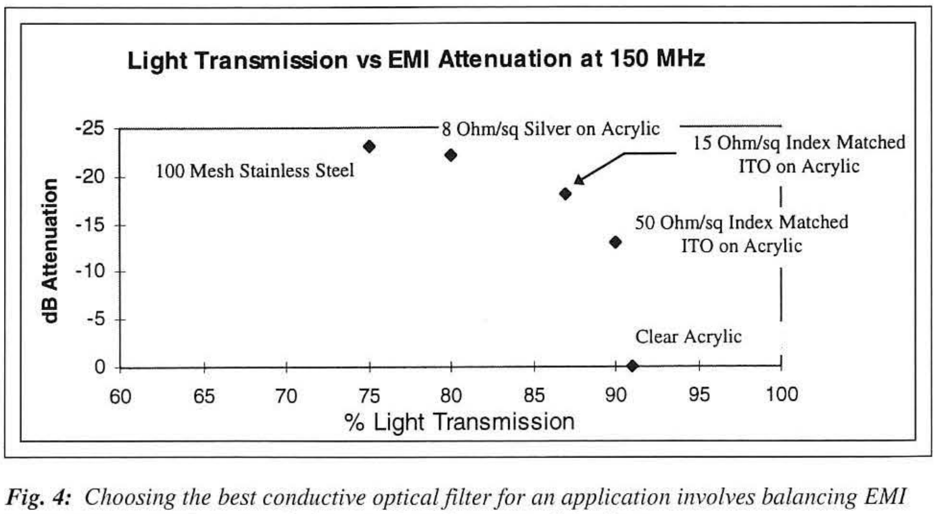


Fig. 4: Choosing the best conductive optical filter for an application involves balancing EMI attenuation requirements with the optical performance of the filter.

More European Regulatory Requirements

CISPR 22: ITE (Information Technology Equipment), the computing-equipment emissions standard.

CISPR 11: ISM (Industrial, Scientific, Medical) emissions standard.

IEC 601-1: Incorporates CISPR 11 immunity and safety standards for electromedical devices.

IEC 601-2: The expansion of IEC 601-1 which specifies standards for specific medical equipment.

- IEC 801-2 EMI Immunity (conducted ESD)
- IEC 801-3 EMI Immunity (radiated)
- IEC 801-4 EMI Immunity (fast transients)
- IEC 801-5 (DRAFT) EMI Immunity (surge voltages)

MDD 93/42/EEC: The European Medical Device Directive presenting medical-equipment guidelines were effective in January 1995 and will be mandatory in June 1998.

thickness of the filter are unaffected, and the proper conductivity - and consequent light loss - can be specified without affecting the mechanical design of the system.

Wire-mesh EMI filters - which use a metal screen sandwiched between two panels - provide the best EMI attenuation available, but they have much more impact on optical performance than other approaches. About 25% of the light emitted by a display is lost to a mesh filter, and these filters produce moiré interference patterns when matrix (flat-panel) displays are placed behind them. However, these moiré patterns can be minimized by rotating the mesh to an optimal angle. Designers should consider the relationship of pixel size to mesh opening size when evaluating wire-mesh filters. Choosing the best conductive optical filter involves selecting a knowledgeable vendor who can supply a variety of conductive optical filters and then finding the best balance between EMI attenuation and optical performance during EMI testing.

Fig. 5: *Installing a conductive optical filter.*

Evaluating EMI Attenuation

We have tested a variety of conductive optical filters (and other materials) by placing a battery-powered EMI source inside an aluminum enclosure with a display-sized opening. The opening was filled with plates of various materials; first, with a non-conductive acrylic filter, then with an opaque aluminum plate, and then with a variety of conductive optical filters. EMI gaskets were used to block potential slot antennas around the perimeter of each filter. Emissions between 30 and 5000 MHz were measured at a qualified EMI test site. An EMI scan with a non-conductive optical filter [Fig. 2(a)] shows substantially more EMI than a scan with a 15-Ω/❑ conductive optical filter [Fig. 2(b)].

For each conductive filter we tested, we calculated the attenuation in decibels (dB) at each frequency as the dB V/m field strength of the unit with the conductive filter minus the dB V/m field strength with the non-conductive filter (Fig. 3). The general roll-off in attenuation at 600 MHz shows there are EMI factors - enclosure failure- in this system unrelated to shielding the display opening. So, in this system, emissions reductions above 600 MHz are best achieved by eliminating their source or by enclosure redesign.

The aluminum-plate scan shows the maximum reduction in EMI emissions that can be obtained by adding a conductive optical filter. EMC engineers commonly run this test to determine whether adding any sort of conductive optical filter will reduce emissions to an acceptable level.

Many of the EMI problems solved by conductive optical filters are spikes in the 80–150-MHz range. In this range, the shielding effectiveness of ITO, thin silver, and wire mesh are closer than they are at higher frequencies. Choosing the best conductive optical filter involves balancing EMI attenuation requirements with the optical performance of the filter (Fig. 4).

Readers who would like a *very* quick refresher course in practical dB interpretation can refer to Table 1.

Making the Connection

Conductive optical filters only attenuate EMI when properly connected to a conductive enclosure. Long thin openings between the filter and the enclosure must be avoided: these gaps act as slot antennas and radiate EMI. Periodically bridging the gap with copper-beryllium finger stock will eliminate slot antennas, or the opening can be completely sealed with a conductive material. Completely sealing the opening not only keeps EMI from exiting the enclosure, it also keeps dust and moisture from entering.

U.S. Regulatory Requirements

FCC Class A: FCC Class-A compliance is required on equipment designed for office and industrial use. Medical devices are exempt from this requirement.

FCC Class B: A more stringent emissions requirement than FCC Class A, it requires labeling on equipment designed for home use. Medical devices are exempt from this requirement.

Mil-STD-461D: Required for certain military applications, it contains both emissions and immunity limits. Emissions limits more stringent than FCC B. Some commercial U.S. companies have adopted this as an internal standard.

MDS-201-0004: A suggested safety and EMC standard for U.S. medical devices published by the U.S. Food and Drug Administration's Center for Devices and Radiological Health (FDA CDRH) in 1979.

UL1950: Electrical safety standard for computing devices.

UL2601: Electrical safety standard for medical and dental equipment, replacing ***UL544.***

When a conductive optical filter is installed, conductive thin films like ITO and thin silver are applied to the rear - the display side - of the optical filter (Fig. 5). The conductive rear surface of the filter is connected to the conductive paint by copper foil backed with a conductive adhesive. A bracket with compressible foam (not shown) secures the filter in the opening.

Table 1: Attenuation in dB *vs.* Percent Reduction

dB	% Reduction
-6	50
-20	90
-30	97

$dB\mu\ V/m = 20 \log(V_{out}/V_{in})\ \mu V/m$

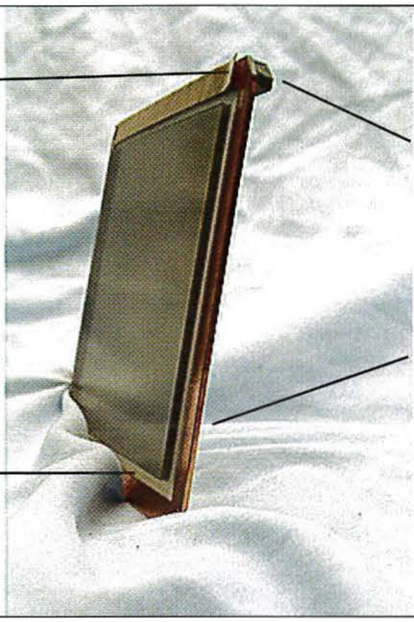


Fig. 6: *This conductive optical filter is fully prepared for nearly drop-in installation. The system manufacturer decided to transfer as much of the assembly to the filter vendor as possible.*

It is possible to design a filter that quickly and easily drops into an instrument (Fig. 6). In this case, the manufacturer decided to transfer as much of the assembly to the filter vendor as possible. The conductive optical filter pictured in the figure has a machined step around the perimeter. The height of the step matches the thickness of the enclosure wall so that the front surface of the installed filter is flush with the front of the enclosure. Copper tape with conductive adhesive is attached to the ITO on the rear of the filter, wraps around the edge, and fills the step. When the step is pressed against the enclosure, the copper tape connects the ITO on the rear of the filter to the conductive enclosure.

The mechanical connection to the ITO does not rely on the conductive adhesive. Strips of soft foam, *i.e.,* foam with low durometer readings - are applied to the rear perimeter of the filter. A bracket, which is not shown in the figure, presses against the rear of the filter, compresses the foam, and holds the conductive optical filter in contact with the conductive chassis.

The display does not contact the filter. If it did, the shock and vibration specifications of the display would be reduced in proportion to the force compressing the low-durometer foam. Contact between filter and display might also produce Newton's rings, which could seriously degrade display usability.

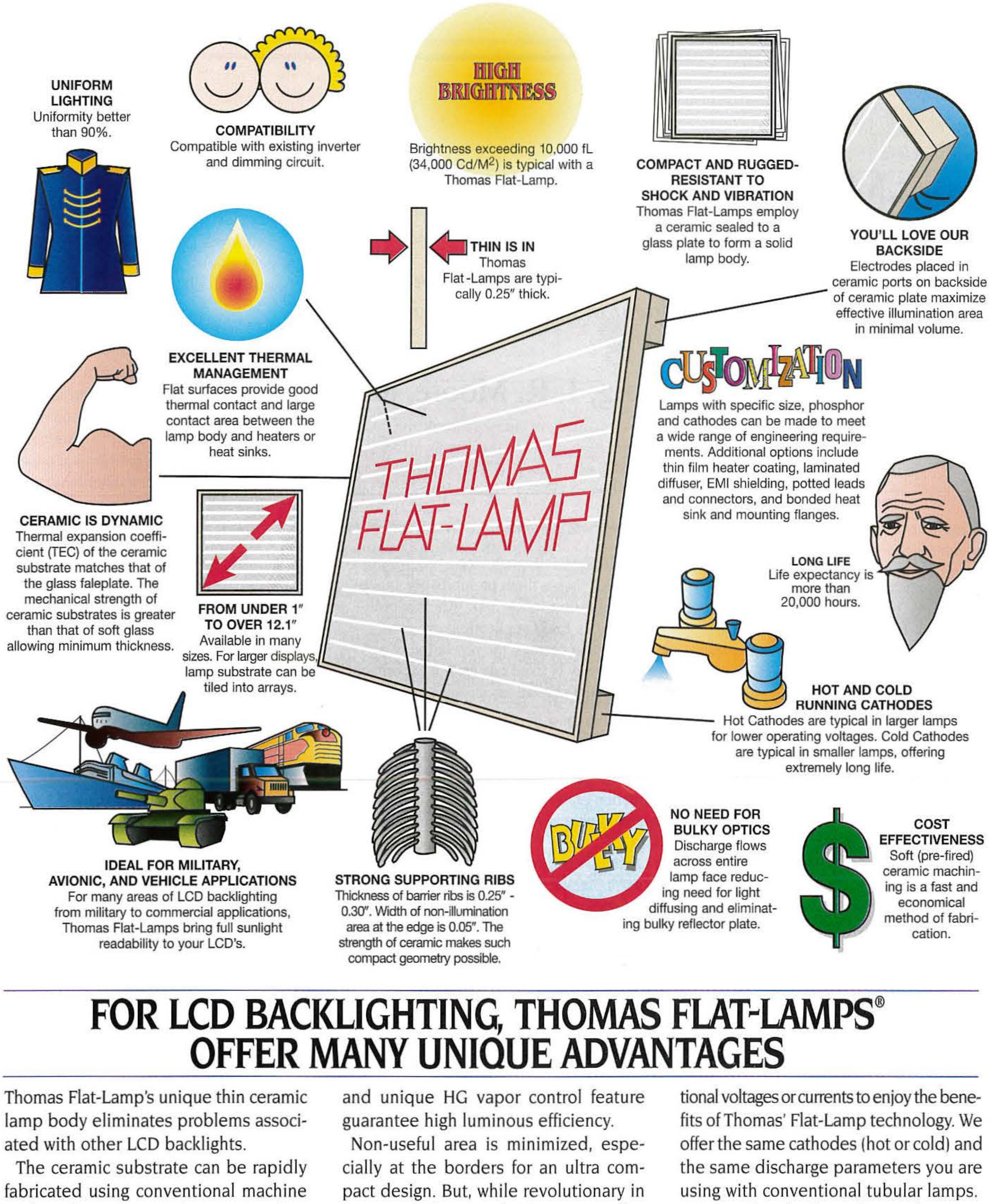
Summary

1. We strongly recommend that companies with new products plan for electromagnetic compatibility. It is more effective to remove EMC components during testing and/or subsequent cost reduction than to delay product introductions while redesigning for compliance.

2. Display systems utilize high-speed video signals, so proper cabling is required to control EMI. Most display-related EMC problems are caused by noise entering or escaping through the display opening.

3. Connecting an optical EMI filter to a conductive enclosure requires good mechanical design.

4. ITO, thin silver, thin gold, and wire-mesh optical EMI filters are available to shield display openings in conductive enclosures. Since all conductive optical filters reduce light transmission, specifying the minimum conductivity and the optimum anti-glare treatment will yield the best optical performance. ■



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THOMAS ELECTRONICS

Circle no. 17

Time-Manipulated 3-D Video

A high-quality 3-D display developed at Cambridge University uses a CRT – and no glasses, lenticular screen, or head-tracking.

by A. R. L. Travis, S. R. Lang, J. R. Moore, and N. A. Dodgson

TRUE THREE-DIMENSIONAL (3-D) images – such as those encapsulated in a hologram – can be pixelated by making multiple two-dimensional (2-D) perspective views of the 3-D image. In principle, the number of views required is approximately the field of view (in radians) times the depth of field (in pixels). In practice, however, one view per degree seems to satisfy the human eye. Nonetheless, the extra dimension requires a 3-D image to have an order of magnitude more pixels than a 2-D image.

Three-dimensional images can be projected by lenticular displays and holograms. Both approaches provide extra pixelation through high resolution – the former with subpixels beneath each microlens and the latter with pixelation fine enough to form diffraction gratings. Lenticular displays require that each lenslet and its subpixels be precisely aligned. Such precision is difficult with scanning displays such as CRTs because the alignment cannot be fixed. Matrix displays can be glued to the rear of a lenslet array, but the yield of matrix displays falls with increasing resolution, which makes them prohibitively expensive for high-resolution 3-D. Another problem, as far as R&D applications are concerned, is that because the pixelation of a matrix display is fixed one cannot experiment with different pixelations as one can with a CRT.

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Since precise alignment is not necessary to display holograms, scanning displays can be used. But the resolution required to create a diffraction grating is very high, so high that a supercomputer is needed to drive such displays.

Lenticular displays and holograms provide the extra pixelation of a 3-D image by having higher resolution than a 2-D display. An alternative is to use a higher frame rate. With this approach, a 2-D display is made visible to a single direction at a time, and a single view is made visible to each direction. If this process is repeated sufficiently quickly, the whole seems continuous to the human eye (Fig. 1).

The advantage of this approach is that increasing frame rate is sometimes easier than increasing resolution. This is true because the chance of failure rises with the number of components. Therefore, the manufacturing yield of conventional matrix displays is lower than that of CRTs, and the manufacturing yield of high-resolution matrix displays is lower than that of conventional matrix displays. But if a high-frame-rate display is to be used, a method of making the display visible from a single direction is necessary.

With liquid-crystal displays (LCDs) this is simple: one merely shines parallel rays of light through the display. And liquid-crystal (LC) materials that switch at the necessary frame rates do exist, but they require a narrower cell gap than is provided in conventional LCD production lines. It has been hard enough to get useful yields even on conventional production lines; commissioning a new line for a device without a demonstrable market is out of the question.

One solution is to track the head movement of the viewer so that only two views are needed – or, for several viewers, two views each. The frame rate need now only be double that for a 2-D display – or be multiplied by twice the number of viewers for a multi-viewer display. But one is now hostage to the vagaries of human inconsistency. Moderately reliable head-tracking devices have been demonstrated, but a fail-safe head-tracking device presents a substantial challenge.

One of the few display technologies that is cheap and also has a high frame rate is the

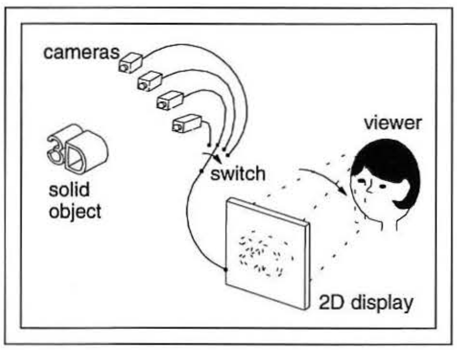

***Fig. 1:** A 2-D display synthesizes a 3-D image by presenting successive views of the original, each to a different zone.*

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CRT. What is less obvious is how one can make a CRT visible from only a single direction because CRTs are emissive and optically incoherent. The technique we are using at Cambridge University is to spatially filter the optical Fourier transform of the CRT image.

Optical Fourier Transforms

In its most popular form, a Fourier transform converts time to frequency and vice versa. An optical Fourier transform converts position to spatial frequency. It transpires that the complex amplitude of light in one focal plane of a lens is the optical Fourier transform of the complex amplitude of light in the other focal plane. This is demonstrated by the way a lens treats light coming from a single position in its focal plane (Fig. 2).

A spot source of light in one focal plane of a lens is collimated into parallel wavefronts. If the instantaneous amplitude of these wavefronts is plotted as they intersect the other focal plane, one records a sinusoid of amplitude. The more acute the angle at which the wavefronts cross the second focal plane, the higher the spatial frequency at the intersection. The lens therefore converts the position of light in one focal plane to the spatial frequency of light in the other.

It is a property of Fourier transforms that if one takes the transform of a function twice in succession, the negative of the original function results. The same holds true with optical Fourier transforms. If one passes an image through two lenses in succession, one has taken its optical Fourier transform twice over. The image therefore reappears in the second focal plane of the second lens, but upside down (Fig. 3). The advantage of this procedure is that it is now possible to filter the Fourier transform of the image.

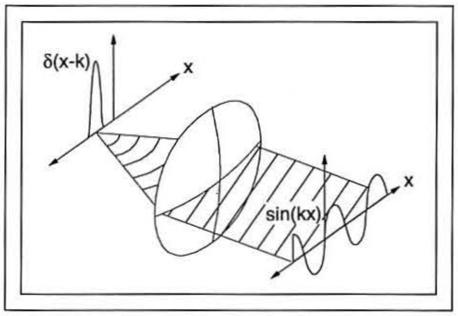


Fig. 2: A lens performs an optical Fourier transform by converting the position of light in one focal plane to spatial frequency in the other.

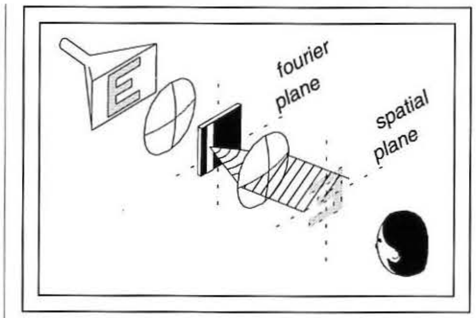


Fig. 3: Two lenses execute two optical Fourier transforms, which produce an upside-down image of the CRT. A slit in the Fourier plane restricts the image's field of view.

The Fourier transform of the image lies in the focal plane shared by the two lenses. If a slit is placed in this Fourier plane, rays of light still get through to reconstitute the image in the spatial plane. But because position in the Fourier plane transforms to direction in the focal plane, the rays all leave the system traveling in the same direction. It follows that the image in the final focal plane can be seen from only one direction.

The Optical System

The 3-D display developed at Cambridge comprises a pair of lenses, a CRT, and an LC shutter (Fig. 4). It turns out to be both unnecessary and inconveniently bulky to have a conventional optical Fourier system. Instead, the conventional layout is modified in two ways:

- The CRT is moved backwards by a distance equal to one focal length. The advantage of this is that the image of the CRT is now adjacent to the second lens, which consequently needs to be no bigger than the CRT image.
- The LC shutter is moved backwards, also by a distance of one focal length. An image of the LC shutter is now formed where a third lens would go if we were to have a third optical Fourier transform. In fact, it is the viewer's head that goes here. The second modification ensures that each of the viewer's eyes sees a single complete view. This is not a particularly important refinement, but without it the eye may see a composition of different views, with slight discontinuities arising at the borders within the composition. Otherwise, the discontinuities are eliminated by providing more views, which is desirable because the compositions are inherent to the formation of a true 3-D image.

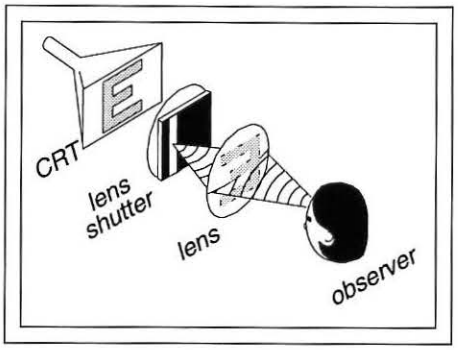


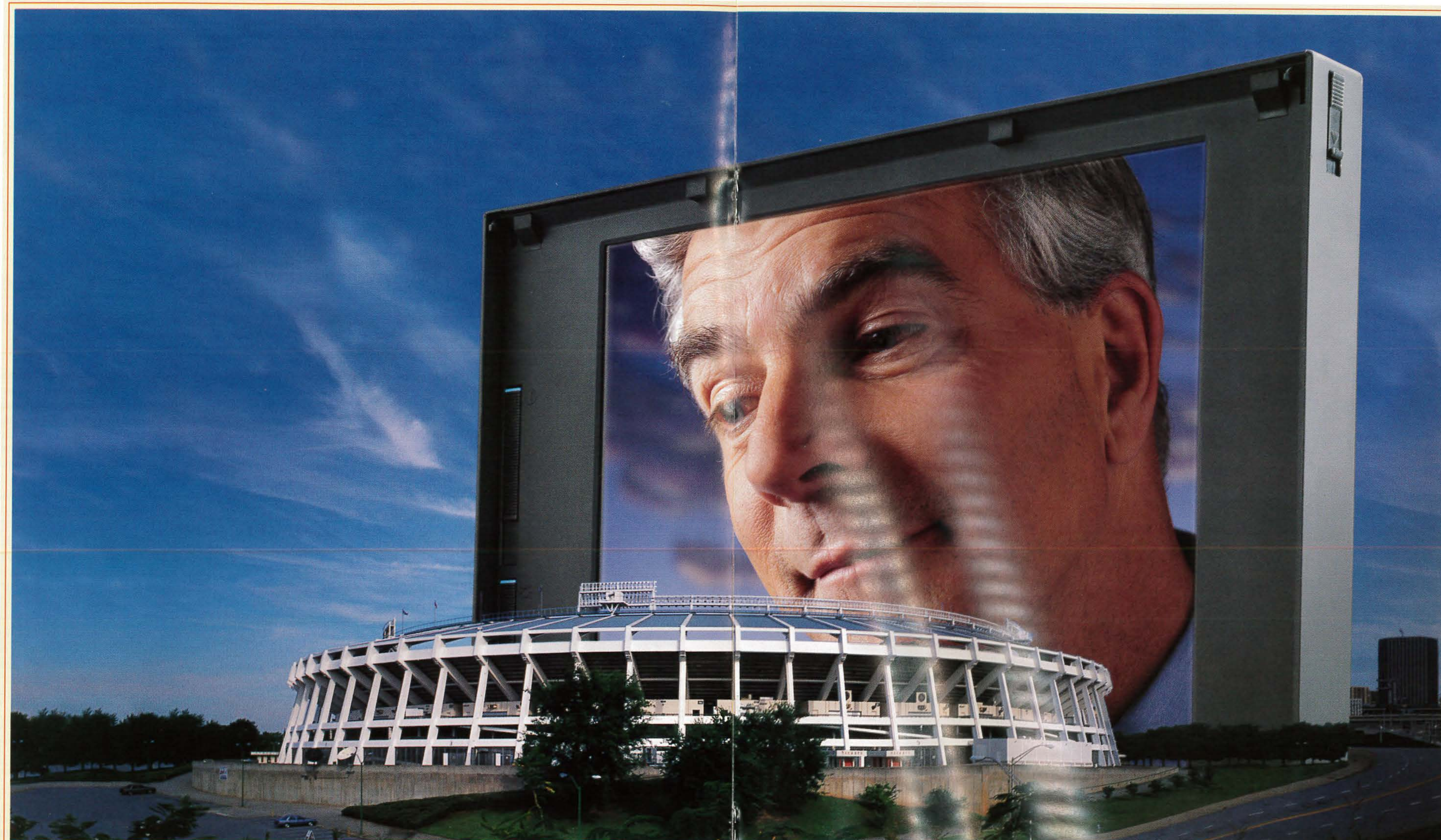
Fig. 4: The 3-D display comprises a CRT, a pair of lenses, and an LC shutter.

Why Bother?

The advantage of using a CRT with time-sequential views is that the display is completely flexible. Both the CRT and the scanning shutter are reset by synchronization pulses, so any number of views of any pixelation within the limits of the display can be chosen simply by altering the position of the synchronization pulses. We have demonstrated television resolution, and we have screened images comprising up to 16 views. In addition, the interface is flexible. A conventional frame store designed for a high-resolution CRT display can be adapted to a 3-D display simply by making it emit an extra synchronization pulse to control the shutter.

A final degree of flexibility is provided by the system optics used to control view direction. Different fields of view or screen sizes can be set up simply by shifting the position of the lenses in the display or by swapping the second lens for a different Fresnel lens.

The combination of a CRT and Fourier optics is fundamentally robust. The optical system can be assembled with none of the precision that is required to collimate light on a pixel-by-pixel basis. Furthermore, each of the display elements is robust. That this is so for CRTs and lenses is well known, but the LC shutter also has good resistance to shock. Versions of this display have been flown to a variety of destinations without mishap.



Our LCD's *have grown.*

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In the two short years since we entered the market, Samsung has become one of the world's leading TFT LCD manufacturers.

As you may know, we already offer a line of TFTs 20% brighter and with 30% more color saturation than the closest competitors.

We'll be following up soon with more products that are—well—larger than life. Including a 13.3" XGA notebook panel, and XGA and SXGA panels actually designed for desktop monitors—in a whopping 14" and 15.1".

And hey, with the desktop impending, can the coliseum really be far behind?

Onward and upward, guys.

SAMSUNG SEMICONDUCTOR

STILL A *Generation* AHEAD.

The remarkably high frame rate available with a CRT is particularly useful. It is possible to display a sufficient number of views to different positions so that there is no need to track the positions of viewers' heads in the room. This eliminates occasional hiccups in viewing. Of course, it is also possible to experiment with head-tracking systems if one wishes to do so.

The quality of the display's image is good because the whole image is processed by the lenses, which eliminates the striation or clutter associated with lenticular screens or grids. The display does not present any of the cues that might remind viewers that - whatever the quality of the 3-D image - it is being presented on a 2-D screen.

Conclusions

We have developed a 3-D video display at Cambridge University that uses an inherently flexible and robust technique to produce a 3-D image of particularly good quality. The display is intended as a research-and-development testbed, and we believe it will make progress considerably more rapid for those experimenting with 3-D systems. ■

conference report

Canon Describes Thin-Film Electron-Emitting Structure at EuroDisplay

Thin-film emitters, polymer conductors, and advances in reflective color displays were part of the news at Europe's premier display event.

by Ken Werner

FOR THE FIRST TIME, the International Display Research Conference (IDRC) - referred to as EuroDisplay when it is held in Europe every third year - was combined with a major trade show, the annual UK-based Electronic Information Displays (EID). The joint event, held September 30 - October 3, 1996, at the Metropole Hotel and Conference Centre in Birmingham, England, featured a solid technical program, a lively trade show, and a better-than-anticipated attendance.

EuroDisplay registration was 518, well over the anticipated 400 plus. Traffic through the trade show was estimated at over 400 per day, and most exhibitors pronounced themselves highly satisfied. (For a full report on EID, see Bryan Norris's article in next month's *ID*.) And attendance at the International Active Matrix Workshop that kicked off the program on September 30 was close to 200.

The Workshop, which featured a high proportion of tutorial presentations and emphasized participant interaction, opened with a paper from D. B. Meakin and his associates [Applied Komatsu Technology (AKT), Kobe, Japan]. Meakin said that all of the technological pieces for AMLCD design and manufacturing are in place. The challenge is to make the business profitable. He noted that the sale of TFT-LCD panels has risen to about 8.5 million units in 1995, and was projected to rise to 14.4 million in 1996, 21.2 million in 1997, 29 million in 1998, 40 million in 1999, and 56 million in 2000.

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

"With second-generation lines," said Meakin, "industry achieved occasional profitability and began to show its potential." The significant advance, in addition to substrate size, is the change from in-line to single-substrate process equipment. Meakin concluded with four points:

- We need simplified device architecture to reduce costs.
- We need better throughput and process control. Specifically, more precise etching would permit thinner a-Si layers and faster process time.
- The TFT-LCD business is growing rapidly.
- Profitable business conditions can be achieved now, with the desktop business being very important to attaining this goal.

In answering a question from the floor, Meakin said that AKT is currently recommending the optimization of third-generation lines rather than the early development of fourth-generation lines. He noted there is talk in the industry of standardizing on fourth-generation glass sizes of up to 1 m square.

In "The Status of AMLCDs Using Two Terminal Devices," S. J. Battersby (Philips Research Labs) said that both SiN_x thin-film diodes (TFDs) and Ta_2O_5 metal-insulator-metal devices (MIMs) have adequate ON-OFF states. MIMs can be made with a two-mask process for ITO top contacts and with three masks for metallic contacts. They are, however, somewhat slower than TFDs, have characteristic curves that are less steep, and have on-voltage non-uniformities that result in imprecise gray levels. This combination of characteristics makes MIMs well suited for low-cost active-matrix displays with a limited number of gray levels, while TFDs can be used for high-performance devices.

Both classes of devices are attractive for fabrication on plastic substrates because they can be processed at low temperature. Diodes made from diamond-like carbon (DLC) or SiN_x have been processed at 150°C, and Ernst Lueder of the University of Stuttgart (Stuttgart, Germany) has processed Ta_2O_5 MIMs at room temperature. Early demonstrators of plastic-diode displays have been produced at Philips and the University of Stuttgart.

Ken Werner

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Ken Werner

In "Overview of Polysilicon Technology," H. Ohshima of Seiko-Epson (Suwa, Japan) observed that poly-Si has performance characteristics adequate for displays up to 70 in. on the diagonal. High-temperature (hi-temp) poly-Si has performance characteristics equivalent to LSI, but it requires a hi-temp substrate, so it is only suitable for small light valves. The low-temperature (lo-temp) infrastructure is not yet mature, but performance is equivalent to hi-temp and the technology will be suitable for all sizes of displays. Lo-temp processing at less than 600°C is well established, and processing at less than 450°C has recently been demonstrated. This is highly significant because at less than 450°C, poly-Si processing is compatible with that of a-Si. "Hi-temp," said Ohshima, "will be the dominant technology for non-direct-view displays because the transistors can be made smaller than for lo-temp." The main issue for lo-temp will be acceleration toward mass production at 300–450°C. "This is an essential technology for the future of microelectronics."

In "Organic TFTs - State of the Art and Prospects," R. H. Friend and C. P. Jarrett of the University of Cambridge (Cambridge, England) emphasized the strengths of organics: versatility in selecting component layers, wide choice of extrinsic dopants, and suitability for large areas through solution processing. The organic layers that are deposited from solution can be used to fabricate thin-film FETs, electroluminescent (EL) diodes, and photovoltaic (PV) diodes.

One problem with organics is low conductivity. A solution is to use sublimed films. These are highly crystalline, and are now producing laboratory mobilities in the range of 0.02–0.07 cm^2/V-s. ON-OFF ratios range up to 100,000. All FETs are p-type except for those made of fullerenes. To date, there has been little use of organic devices in circuits except for an FET NOR gate and a ring oscillator made by Philips. Photo-oxidation stability is a problem with organic materials, so it is necessary to passivate devices against moisture and oxygen. In answer to a question from the audience, Friend emphasized that organic devices are clearly still in R&D mode, with most activity devoted to device characterization and development.

D. Straub and E. Lueder from the University of Stuttgart presented their analytical SPICE model, which permits the accurate simulation of poly-Si TFTs in both digital and analog circuits. The model is closely linked to physical parameters, including geometry, V_{th}, mobility, and trap density.

In "Fabrication and Performance of Integrated Drivers," C. Reita (Thomson CSF, Orsay, France) observed that integrated drivers (IDs) save on materials (and thus on cost), save space, reduce layers, and reduce interconnects. However, IDs increase density and may decrease yield, so their use must be evaluated in the context of total system cost. He concluded that IDs are essential for cost reduction and that device design must be matched to technology. "The system on glass is the goal, but not for today," said Reita. That's particularly true because no established technology exists for IDs - not yet.

EuroDisplay Keynotes

"Who Dares to Challenge the CRT?," the title of the keynote address given by James Smith (Philips Display Components), turned out to be more contentious than the address itself. After recapping the CRT's well-known technical, cost, and marketing strengths, Smith got into some less-familiar territory.

CRTs are likely to maintain their cost advantage overall for some time to come, in part because a CRT plant costs about $300 million and an LCD plant's cost may approach $1 billion. Nonetheless, Smith presented Philips' projections of the cost ratios between LCD and CRT monitors that should make LCD makers smile. According to Philips, the cost ratio for 14-in. monitors will go from 3:1 in late 1996 to 2:1 in 2000; to 1.5:1 for 17-in. monitors; and perhaps to parity for 21-in. monitors!

Part of Smith's upbeat analysis stems from CRTs being mature and profitable over the entire business chain, with R&D spending continuing at about 25% and with continued investment in production expansion. Substantial growth is anticipated in low-cost CRT-based TV receivers in developing countries, where small increases in per-capita income should translate into large increases in TV sets per household.

In the second keynote address, E. P. Raynes (Sharp Laboratories of Europe) looked at "Flat Panel Displays into the Next Millennium." Sharp's projection of the LCD market in the year 2000 is £10 billion (about $15.5 billion), compared to £4 billion in 1995. The split between STN- and TFT-LCDs was about even in 1995, but TFT is expected to dominate in 2000. After the recent dramatic reductions, prices have now stabilized, Raynes said.

Raynes predicted, naturally, that LCDs will be strong in laptop-computer and desktop-monitor markets, but he also discussed application in television receivers with screen diagonals between 20 and 40 in. Displays for this application may be single TFT panels, but they may also be composite panels tiled from two or more individual panels. For some time, Sharp has been exhibiting a 28-in. panel tiled from two 21-in. displays, and during the week of EuroDisplay, Raynes said Sharp would be demonstrating a 40-in. version with four tiled displays at the Japan Electronics Show.

In "Plasma Display Panels," Jacques Deschamps (Thomson Tubes Electroniques, Moirans, France) commented that, although the plasma-display panel (PDP) was invented in 1964 (at the University of Illinois) and a variety of monochrome devices were made during the 1970s and 1980s, PDPs really started to take off in the 1990s with the advent

Ken Werner

English road signs are large and detailed, but even with their help neophytes are still likely to make unintended detours while negotiating England's notorious "roundabouts" – traffic circles.

Ken Werner

The Metropole Hotel flew its ISO 9000 flag proudly, and some EuroDisplay attendees were surprised to find that hotels – as well as display-manufacturing plants – can receive ISO 9000 certification.

of color. Deschamps predicted that by the year 2000 the manufacturing cost of a color PDP would drop to $40 per diagonal inch, equally divided between the glass plate and driver electronics.

In the year 2000, a television panel with a luminance of about 100 fL should require an input power of no more than 250 W. Although some image quality and efficiency issues still need to be addressed, there should be a market for several million units - mostly for television receivers - by the year 2000.

K. Ishii and a large group of co-authors from NHK (Tokyo, Japan) and Matsushita (Osaka, Japan) reported on the latest version of NHK's DC-PDP specifically designed for HDTV. The panel offers a screen resolution of 650 TV lines and a luminance of 150 cd/m^2. The new glass plate has a high strain point, which results in greater dimensional stability and permits the introduction of a highly accurate photolithography process. The new panel has 80-μm line spacing, and sandblasting is now used in a new panel-fabrication method. The authors stated that the new panel "has sufficient luminance and life for practical use."

In the invited paper, "Digital Light Processing™ for Projection Displays: A Progress Report," Larry Hornbeck spoke of the advantages of digital displays and outlined DLP progress. Gray levels are now up to between 256 and 1024, there is a 62% pixel optical efficiency, and the fill factor is 90%. Hinge memory and adhesion failure were early problems that have now been solved with extensive development. Reliability has been improved with better hinge material, spring-tip architecture, and bipolar reset.

Business projectors using TI's 270-lm single-chip projector are now on the market. Late in 1996, products with the two-chip 300-lm SVGA engine will be available. The second chip will be for the red image only, while the color wheel will provide field-sequential color for green and blue. This design is intended both to extend lamp life and to enhance the red component - desirable because typical projection lamps emit less strongly in the red. This will be followed, at the end of the year, by a three-chip engine for professional and home theaters, with a standard 500-W xenon lamp producing more than 1000 lm and an optional 1.5-kW lamp producing 3200 lm. In the exhibit area, Texas Instruments was impressively exhibiting its wares.

In a personal conversation, A. J. van Dalfsen of Philips told *Information Display* that a Philips plasma TV set built around a Fujitsu 42-in. PDP was being exhibited during the week of EuroDisplay at the Japan Electronics Show. The set will be introduced in Europe during the spring of 1997 at a price of DM20,000 ($15,000).

In "Trends in the Development of Low-Power Color LCDs for Personal Information Tools," Yutaka Ishii and his colleagues from Sharp (Nara, Japan) observed that 12 million personal information tools (PITs) are expected to be sold in the year 2000, up from 3.3 million in 1995. (In some quarters, the term "PIT" seems to be replacing the now-tarnished "PDA.") Monochrome displays have been used in traditional PITs, but four colors will increasingly be used for basic PIT applications, and 512 colors or more will be used for graphics applications.

Displays with and without color filters (CFs) are being developed. Among the CF types, there are displays with and without polarizers. Sharp is developing a display with a low-cost MIM-like TFT structure, phase-change guest-host LC layer producing 4–8 colors, and low-density electrodes for greater brightness. The display consumes only 100 mW, has a 5:1 CR, and features an optical response of 80 ms - fast enough for moving images. Sharp is also developing a 512-color reflective TFT display for PIT and mobile-computing applications. T. Ishinabe, T. Uchida, and their colleagues at Tohoku University (Sendai, Japan) described a design concept for a bright, relatively fast, full-color, reflective LCD using an optically compensated bend (R-OCB) cell. James Larimer (NASA Ames Research Center) said he feels the Tohoku approach is significant.

Jean-François Peyre (PixTech, Rousset, France) gave an invited talk entitled "Impact of the Driving Scheme on Field Emission Displays Performance." In addition to describing three different scanning techniques, four ways of attaining gray scales, and the parameters affecting power dissipation, Peyre projected that a 40-in. color FED with high-voltage anodes should consume about 55 W. Best performance, said Peyre, will be obtained with maximum anode voltage, minimum emission voltage, and minimum capacitance. Since current PixTech displays feature a low-anode-voltage design, this comment set off some speculation as to whether we should expect a sea change in PixTech's design philosophy.

In his invited paper, "Addressing of STN Displays," Terry Scheffer (InFocus Systems, Hilo, Hawaii), noted that dual scanning of STN displays - which produced a critical improvement in drive margin - was made possible by advances in interconnection technology that allowed connections to be made at a 100-μm pitch, permitting interdigitation of connections. Now, dual-scan STN-LCDs can be made with screen resolutions up to XGA. Multi-line addressing (MLA), the long-awaited improvement in STN-LCDs that reduces response time and crosstalk, will be commercialized in 1997, said Scheffer. Test marketing had begun prior to EuroDisplay. Currently, four-line addressing seems to be the best compromise and he expects continued cost reduction through system integration, *i.e.,* off-loading some functions from the driver electronics onto the system processor.

Ken Werner

A classic British cab queues up outside the Metropole Hotel in Birmingham.

Ken Werner

If there were a EuroDisplay long-distance terrestrial commuting award, it would probably go to Vassili Nazarenko, Director of the Ukraine Chapter (left), and Alexander Smirnoff, Director of the Belarus Chapter (right), who drove the red 4 × 4 in the background 2700 km from Minsk, Belarus, to Birmingham, England.

Rank Brimar announced the sale of its specialized high-performance CRT and associated drive-electronics business to a new company, Brimar Limited, effective immediately. Brimar, Inc., a wholly owned subsidiary of Brimar Limited, will supply sales, marketing, and customer support in North America from its existing offices. Digital Projection, Inc., the company spun off from Rank Brimar to develop and market high-performance projectors based on TI's DLP™ technology, will remain under the Rank Brimar umbrella.

Best Poster Papers Selected on Site

In an interesting innovation, an awards committee picked three best poster papers while the poster session was in progress. In order of paper number, the first winner was "Improvement of Backlighting Method by Means of Light Pipe Polarizer" by M. Suzuki and his colleagues at Sekisui Chemical (Kyoto, Japan). The paper described the development of a very efficient edge-lit polarizer light pipe. By stacking polycarbonate plates at 45° to the normal to employ Brewster's condition, the plates produce highly s-polarized light.

The second winner was "A PDLC Device Having All-Plastic Transparent Electrodes," by Eli Harlev and his associates at Al-Coat (Ness-Ziona, Israel). The authors described the use of the conductive polymer polyaniline to replace ITO in a PDLC device. The electro-optic characteristics of the device were virtually identical with the two different electrode materials, and polyaniline has the advantages of mechanical flexibility, low cost, and environmental stability. The authors had developed a solubilization procedure that yields homogenous, defect-free coatings of the polymer on substrates.

The third winner was by H. Seki and colleagues from Hachinohe Institute of Technology (Aomori, Japan) and Tohoku University (Miyagi, Japan). "A New Reflective Display with High Multiplexibility and Gray Scale Capability" described a display consisting of a scattering film, a quarter-wave plate, a vertically aligned cell, and a reflector. The display exhibits high multiplexibility and gray-scale capability.

One surprise at the EID show I will not make you wait until next month to learn about was a reflective color module from TECDIS (Châtillon, Italy). The 240 × 100-pixel ECB module displays three colors plus neutral, with remarkable color saturation and brightness for this type of display. The modules will be available for about £26 in quantity in the second quarter of '97.

In a press conference, Merck described its reflective polarizer film that reduces polarizer losses in a backlit LCD display from 55–65 to 30%. It combines a wideband cholesteric film with a quarter-wave film, passes half the light incident on it, and circularly polarizes it in the right-handed sense. The remaining light is reflected and circularly polarized in the left-handed sense, after which it is depolarized by scattering and subject to multiple partial transmissions. The advantage compared to traditional polarizers is that much less light is lost to absorption in the polarizers. The company is clearly excited about the product and feels it will substantially increase the luminous efficiency of backlit LCDs. Plans to introduce the film and exhibit it at EuroDisplay were canceled because the film was not quite ready for introduction according to Merck's Patrick Nolan. Instead, the company was planning to introduce Transmax™ at LC International (Japan) in November.

Something Really New

Perhaps the most intriguing technical paper of the conference was "Flat-Panel Displays Based on Surface-Conduction Electron Emitters" by a large group of authors from the Canon Research Center (Kanagawa, Japan). In a special author interview, senior author Kunihiro Sakai and Sotomitsu Ikeda showed a videotape of a 3.1-in. full-color prototype FED using their new emitter. They reported that at a drive voltage of 13.5 V and an anode voltage of 6 kV the prototype display – which has 80 × 80 × (RGB) pixels – produced a luminance of 640 cd/m^2.

The emitter is made by gradually increasing the pulses of current through a thin conductive film until a gap appears across the entire film perpendicular to the current flow. Once the gap is formed, applying the appropriate driving voltage causes electrons to be emitted perpendicular to the plane of the conductive film. The Canon group believes the mechanism for gap creation is melting. This might appear to be a poorly controlled process, but photomicrographs show gaps that seem highly consistent, and color and brightness across the display shown in the videotape was also consistent. This point was commented upon in a discussion among FED experts at the author interview, including Webster E. Howard (FED Corp.), Ted Fahlen (Candescent), and Tom Credelle (Motorola). Chizuka Tani of NEC said privately that he thought the Canon contribution was the best paper at the conference.

Onward

The combination of EuroDisplay and EID was a success, and conversations with exhibitors indicate that this success is likely to benefit next year's EID when it is held as a standalone event. IDRC '97 and the International Active Matrix Workshop will be held at the Sheraton Centre Hotel in Toronto, tentatively from September 15–18, 1997. (The Workshop may be moved from the 15th to the 19th, or the organizers may decide to have 2 days of workshops in addition to the 3 days of IDRC.) In 1998, IDRC will be held in Seoul, Korea (under the name Asia Display), and will return to Europe in 1999, when it will be held at a site in Germany. ■

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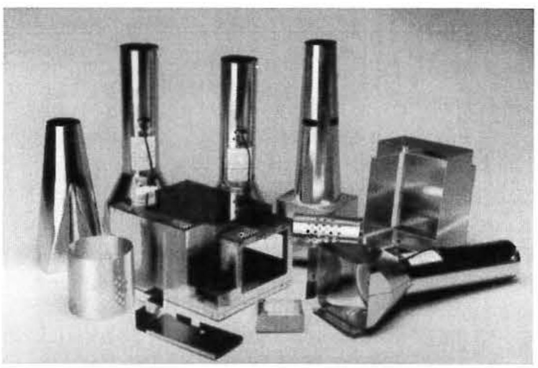

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Circle no. 29

editorial

continued from page 2

its first monochrome panels to the military in the late '70s and early '80s. The group's color R&D program began 10 years ago, with research and feasibility studies being the core of the effort through 1993. In 1994 the group moved to its current location and constructed 1000 square meters of clean-room space.

The group is currently in the final stages of developing a color 19-in. military workstation PDP with 1024 × 768 pixels and 0.4-mm pixel pitch, with the work being funded by the French military. Prototypes are scheduled for Q1 96, with production by Q2 97. Prototypes of a 19-in. 1280 × 1024 unit with 0.3-mm pixel pitch are scheduled for Q4 96, with production in Q4 97. TTE's high-resolution color panels for military and industrial applications require much smaller discharge cells than consumer-oriented PDPs, which makes the tailoring of the discharge physics and the design of the cells much more demanding.

Under the development contract from Thomson Multimedia, TTE is working on consumer-TV PDPs from 22 to 42 in. New clean-room space is currently under construction, and I saw new plastic-wrapped processing equipment - clearly designed for processing 42-in. plates - waiting for installation. Deschamps said he expected to be processing 42-in. plates in November of 1996 and to have a 42-in. TV demo with 576 × 768 triads in Q2 97. After that, the decision to proceed further will depend on Thomson Multimedia - and its new owner.

Back to TTE's own military/industrial work. Following the 1280 × 1024 19-in. model, TTE is planning on a 1280 × 1024 24-in. model with 0.4-mm pixel pitch (prototype Q2 97; production Q4 97) and a 1280 × 1024 40-in. model with a 0.7-mm pixel pitch (prototype 1998/99; production 1998/99).

Thomson's panel structure is very similar to the typical monochrome PDP structure - with one sustain electrode, not two like Fujitsu's structure. The hi-res ac displays with 0.3-mm (100-μm) pixel pitch have 0.1-mm pitch between subpixels and a 40-μm gap. At the back (the side away from the viewer) of each cell in all of the hi-res displays, there is a window in the phosphor over the column electrode.

Designing and fabricating hi-res PDPs that are fast enough to support large numbers of gray levels is a challenging exercise. Unlike the Japanese practice with consumer PDPs - where photolithographic processes are energetically avoided - Thomson must use many photolithographic processes to achieve precise and repeatable dimensions in small cells. Interestingly, Deschamps feels a process depending heavily on photolithography can be inexpensive enough for consumer applications, too. If true, this could lead to TV panels with higher luminous efficiencies than the current 1.0 lm/W for ac panels, which is acceptable now but not for the long term.

The speed limitation in hi-res PDPs stems from the speed at which the discharge progresses once it is initiated. TTE is optimizing its cell structure and discharge physics with improved 2-D simulation software developed at the University of Toulouse. The software models cell excitation, plasma formation, and speed of ignition.

TTE's tube business is international, with 39% of its sales in North America, 44% in Europe, and 12% in Asia. (Small percentages are in South America, Africa, and the Middle East.) TTE is energetically reaching out to the U.S. military/industrial market, where it will probably compete with the hi-res AC-PDPs of Photonics Imaging - which now has prototypes in customers' hands - and perhaps with the hi-res AMLCDs produced by the dpiX/Planar partnership.

Although TTE's immediate interest is their military/industrial PDP business, one can not help but be intrigued by the thought of an RCA/Daewoo/Thomson plasma television receiver. In the current era of me-too Fujitsu-like AC-PDP architectures, Thomson's approach could give Daewoo an interesting way of distinguishing their products.

– Ken Werner

Information Display Magazine invites other opinions on this and related subjects from members of the international display community. The opinions expressed in this editorial do not necessarily reflect the opinions of the editor or publisher of *Information Display Magazine*, nor do they necessarily reflect the position of the Society for Information Display. Your comments and suggestions are welcome. You can reach me by e-mail at kwerner@netaxis.com, by fax at 203/855-9769, or by phone at 203/853-7069.

calendar

Display Technology

Display Works 97: Display Manufacturing Technology Conference (DMTC). Co-sponsored by SID, SEMI, and USDC. Contact: Mark Goldfarb, Palisades Institute for Research Services, Inc., 1750 Jefferson Davis Highway, Suite 500, Arlington, VA 22202; 703/413-3891, fax -1315.
January 27-31, 1997 San Jose, CA

Fourth Asian Symposium on Information Displays (ASID). Co-sponsored by SID (Asia Regions); IEEE Electron Device Society (Hong Kong Chapter); Technical Group on Electronic Displays, Institute of Electronics, Information and Communication Engineers (Japan); and Technical Group on Information Displays, Institute of Television Engineers of Japan (Japan). Contact: H. S. Kwok, Dept. of EE, Hong Kong University of Science and Technology, Clear Water Bay, Hong Kong; fax +852-2358-1485, e-mail: eekwok@usthk.ust.hk.
Feb. 13-14, 1997 Clear Water Bay, Hong Kong

SID International Symposium, Seminar & Exhibition (SID '97). Contact: Mark Goldfarb, Palisades Institute for Research Services, Inc., 1745 Jefferson Davis Highway, Suite 500, Arlington, VA 22202; 703/413-3891, fax -1315.
May 11-16, 1997 Boston, MA

The 17th International Display Research Conference and Workshops (IDRC '97). Co-sponsored by SID and the Advisory Group on Electron Devices (AGED) in co-operation with the IEEE Electron Devices Society. Contact: Ralph Nadell, Palisades Institute for Research Services, Inc., 201 Varick Street, Suite 1006, New York, NY 10014; 212/620-3341, fax -3379, e-mail: rnadell@newyork.palisades.org.
Sept. 15-19, 1997 Toronto, Canada

Fifth Color Imaging Conference: Color Science, Systems & Applications. Co-sponsored by IS&T and SID. Contact: IS&T, 7003 Kilworth Lane, Springfield, VA 22151; 703/642-9090, fax -9094.
Nov. 16-19, 1997 Scottsdale, AZ ■

Edited by JOAN GORMAN

Largest XGA STN-LCD module

Sharp Electronics Corp., Camas, Washington, has announced the North American introduction of the industry's largest high-definition XGA-format color STN-LCD module. The goal in developing the 21.4-in. color STN-LCD was greater functionality in a more compact, power-efficient package. The display is designed for simultaneous multi-tasking on multiple screen frames while meeting stringent power and space requirements. The new display features reduced shadowing around displayed characters and graphics and a 140° horizontal viewing angle, a full 60° greater than previous models. The display's optical characteristics include a luminance of 250 cd/m^2, a response speed of 300 ms, and a contrast ratio of 30:1. Power consumption is 28 W. Samples will be available in February 1997.

Information: Sharp Electronics Corp., 5700 N.W. Pacific Rim Blvd., M/S 20, Camas, WA 98607. 1-800-642-0261, 206/834-2500, fax: 206/834-8903.

Circle no. 1

XGA LCD projector

Polaroid Corp., Cambridge, Massachusetts, has introduced the Polaview 220 projector featuring digital light processing (DLP) technology. The Polaview 220 is a true SVGA projector supporting 800 × 600-pixel resolution and delivering a 240-in.-diagonal on-screen image with a brightness of 400 ANSI lumens that matches the resolution and brightness of an image on an SVGA monitor. With the wireless built-in turbo remote, the presenter can move freely around the room and control projector operation up to 50 ft. The unit provides multimedia capability through simultaneous connection of up to two computers and two video sources, plus total interactivity and instant switching between sources. The Polaview 220 is compatible with a broad variety of computer and video systems. The U.S. suggested list price for the Polaview 220 is $10,900.

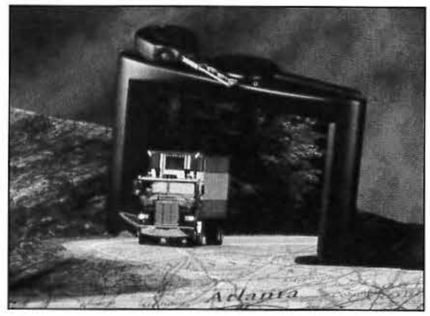
Information: Polaroid Corp., Digital Imaging, 565 Technology Square, Cambridge, MA 02139. 1-800-816-2611 ext. 970 or 716/256-4436 ext. 970. ■

Circle no. 2

"Complete" automotive AMLCD module

Philips Flat Panel Display Co., Eindhoven, The Netherlands, has introduced the LDE052T, a 5.1-in. active-matrix color LCD module designed to provide the high performance, ruggedness, and reliability necessary for automotive applications. The LDE052T is "complete" because its smoothly contoured plastic case can be mounted in a variety of locations on or in front of the dashboard without OEM redesign. With its advanced backlight, the module offers a maximum luminance of 300 cd/m^2, brighter than any standard LCD module on the market today. The 50,000-hour lifetime of the backlight is more than five times as long as any conventional backlight. The module also features an extra-wide viewing angle which allows images on the screen to be easily viewed by both driver and passengers. Depending on user requirements, the unit can be equipped with an analog RGB (NTSC/PAL) interface for fleet management or a digital 1/4 VGA (320 × 240) interface to meet the latest digital requirements of the automotive industry. The unit's range of options meet the diverse requirements of automotive and industrial users, and include loudspeaker, audio amplifier plus volume control, infrared RC receiver, CVBS (PAL or NTSC) input with color and contrast control, single 9–16-V power-supply input, and PWM-controlled backlight dimming. For inquiries, please indicate FPD-003.

Information: Philips Components, Marketing Communications, Bldg. BAE-1, 5600 MD, Eindhoven, The Netherlands. +31-40-272-27-90, fax: +31-40-272-45-47.

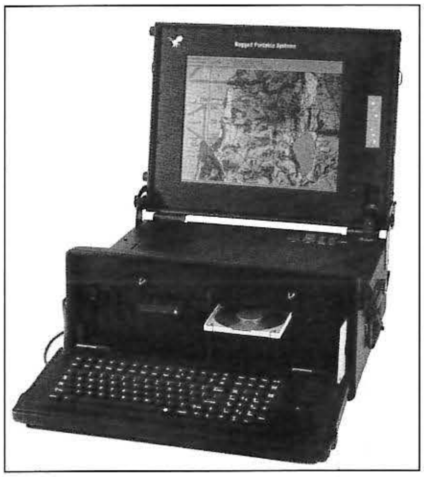


Circle no. 3

One-man tactical workstation

Rugged Portable Systems, Orange, California, has introduced the RPS Eagle, a ruggedized portable SPARCstation™ designed to satisfy the most demanding processing requirements of shipboard, airborne, ground-mobile, and rapid field-deployable applications. Based on Sun Microsystems' UNIX workstations and servers, the Eagle features a 16.1-in. 1280 × 1024 color AMLCD with adjustable brightness and contrast, allowing night-vision-goggle operation. The one-man near-real-time tactical workstation includes an ergonomic, user-friendly moisture-proof Sun-type removable keyboard with integral pointing device, two removable 3.5-in. 9.0-Gbyte hard drives, and two fixed 5.25-in. peripheral bays which can support any combination of CD-ROM, 4-mm DAT, 8-mm DAT, MO-drive, or COMSEC KIV-7. All of the Eagle's major components are upgradable and expandable.

Information: Larry Aguilar, Rugged Portable Systems, 3745 West Chapman Ave., Orange, CA 92668. 714/939-6233, fax: 714/939-6234.



Circle no. 4

Slim XGA monitor

PixelVision, Acton, Massachusetts, has announced the PV114XG, a compact high-resolution 14-in. LCD monitor designed for information-intense markets such as finance, medicine, and aviation. The 3-in.-deep monitor is intended to replace traditional 15–17-in. CRT monitors, saving space and energy while minimizing eyestrain, reducing glare and reflection, and eliminating radiation, all inherent ergonomic problems with CRTs. The PV114XG displays a resolution of 1024 × 768 and can replace any CRT monitor without hardware or software upgrades. The monitor features a palette of 2 million colors and on-screen menu controls that feature both numeric and graphic settings for precise, user-friendly adjustments. The PV114XG comes with a desk stand and an enclosure made of scratch-resistant anodized aluminum with an electrostatically applied baked-on finish for durability. The PV114XG is available immediately at a U.S. list price of $5950.

Information: Alice Poltorick, PixelVision, 43 Nagog Park, Acton, MA 01720. 508/266-7516, fax: 508/264-9446.

Circle no. 5

Rugged real-time-window FPDs

BARCO nv, Kortrijk, Belgium, has announced a new family of ruggedized flat-panel displays, in 10.4-, 13.3-, and 16-in. screen sizes, that provide a real-time window which can be displayed while a current application is running. The window is resizeable and can be repositioned according to the user's application. The displays can automatically convert the generator resolution of the incoming image source to the fixed panel resolution, allowing the user to easily connect any type of generator source without hardware modifications. The new displays were designed to withstand harsh environments and meet the stringent requirements encountered in aerospace and defense applications. The panels can display up to 1024 gray scales and millions of colors, and can optionally provide soft keys around the bezel for customized applications. The brightness of the display exceeds 200 nits with a contrast ratio of 10:1. An additional automatic light-control feature allows the operator to lock onto a fixed brightness and contrast ratio regardless of constantly changing ambient lighting conditions.

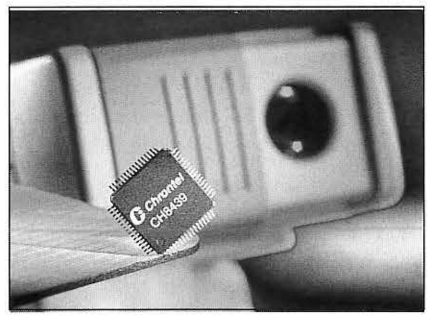
Information: BARCO nv, Th. Sevenslaan 106, B-8500 Kortrijk, Belgium. +32-56-233-450, fax: +32-56-233-460.

Circle no. 6

Video and graphics multiplexer

Chrontel, Inc., San Jose, California, has introduced the CH8439, a multiplexer allowing video and graphics to be displayed on the same screen. The multiplexer supports displays with pixel resolutions up to 1280 × 1024 and features a palette of 16.7 million colors. The CH8439 accepts full-bandwidth analog RGB graphics and controls the mixing of digital video inputs using a programmable analog color key and high-performance genlock. Chrontel's proprietary leakage-suppression technology enables the CH8439 to support full color-key control while limiting graphics bleedthrough to less than one pixel. The multiplexer features dual analog wideband drivers, YUV-to-RGB color space conversion, and a serial programming interface for video-attribute control. The CH8439 series is available immediately in 64-pin PQFP and is priced at $9.75 in quantities of 1000.

Information: Ken Lowe, Chrontel, Inc., 2210 O'Toole Ave., San Jose, CA 95131-1326. 408/383-9328, fax: 408/383-9338.



Circle no. 7

Video test-pattern generator

Video Instruments, Xenia, Ohio, has introduced the Model 3200, a video test-pattern generator that provides full remote-control capability for selection of format, format edit/build, pattern selection, video level, sync level, as well as other operating modes including pulse polarity via the RS-232 serial port on the rear panel. The front panel contains only the 12-key keypad used for all operations displayed on a four-line LCD. The Model 3200 provides basic video test patterns for performance tests of displays which operate at virtually any format/scan rate. Patterns are derived from logic, not by digital-to-analog conversion, and therefore are instantly available when selected. The Model 3200 lists for $3950.

Information: Video Instruments, P.O. Box 33, Xenia, OH 45385-0033. 1-800-962-8905, fax: 937/376-2802.

Circle no. 8

LCD-measurement system

ELDIM, Caen, France, has introduced the EZContrast AX 160D fully automated LCD-measurement system designed for instant testing of any LCD panel up to 22 in. on the diagonal. The system can measure luminance, contrast, and color coordinates as a function of viewing direction. It can also plot V/T curves for any viewing direction, analyze gray-level inversion, evaluate color shift, as well as perform uniformity testing. The AX 160D includes the new EZMotion XYZ tables, suitable pattern-generation drivers (video, RGB, and digital), and automation and analysis software. The performance levels include a ±80° incident-angle range, a 0–360° azimuth-angle range, a measurement step down to 0.2°, and a measurement time of 3–4 sec for full luminance measurement at an accuracy better than 3%. The full nine-point measurement speed is less than 3.5 min.

Information: Kathleen Helm, ELDIM, 4 rue Alfred Kastler, 14000 Caen, France. +33-2-31-94-76-00, fax: +33-2-31-47-37-77.

Circle no. 43 ■

Circle no. 30

continued from page 4

mix up smell with taste. I provided gentle reassurance through my touch and presence. We moved at a slow pace but we covered a lot of territory.

All too soon, the signal was given for us to quietly and slowly reassemble at the clearing. On a signal from the instructor, the blindfolds were removed so that everyone could see the one in whom he had so completely placed his trust. There were cheers and hugs all round. A few had been able to identify their guides, but most had not. Yet, a strong bond had been formed in just those few minutes. Quite an interesting and, for me, surprising result.

Unfortunately for me, the exercise wasn't over yet. We would now get to change places and be blindfolded while some unidentified person from the other group would now lead each of us through the forest. Knowing the routine didn't seem to help much; I still didn't want to go through with it. I have always hated having any of my senses not fully functional or having that feeling of not being in control. However, peer pressure being quite the motivator, the blindfold went on and I stood in dark and lonely anticipation, waiting for someone to take me by the arm and guide me around. At least, given the rules of engagement, I felt pretty sure he would not push me off a cliff or purposely run me into a tree.

The feel of a gentle, although anonymous, hand on my elbow felt somewhat reassuring. My experiential "tour" was about to begin. The darkness felt like a large expanse of three-dimensional space - maybe like an empty universe. I felt lonely and lost. But then almost imperceptibly my other senses began to intrude on this emptiness. In fact, in a very short time, they simply overwhelmed it. The smell of the cool autumn breeze coming off the river seemed so full of energy. The leaves underfoot made incredibly loud crunching sounds. I was sure the sounds had color in them. The feel of the autumn air on my skin brought forth images of forests, mountain meadows, and streams. The touch of the moist earth, moss, grasses, rocks, and tree branches all brought forth vivid mind-pictures. I had a new sense of the forest and of nature. There was a bond with the earth that I had not felt before. With each step, I felt more at ease and more secure. My tenseness disappeared and was replaced by a childlike trust in my guide. Through this person's touch, I could feel the care and intense interest he was demonstrating in my well-being. I no longer had the curiosity to know his identity. I simply trusted.

"What a neat deal," thought I to myself. This person is totally responsible for my safety and well-being. Even if I try to do something stupid, he will do everything in his power to keep me safe. After all, if I get hurt he will be blamed and look bad to the rest of the group. Not only that, he is in a little bit of a friendly competition with the other leaders-of-the-blind to provide the most interesting experience so that during the debrief, I can mention all the neat things I was shown. To my total amazement, for the first time in my life I had discovered that being blindfolded under certain conditions can be easier and more fun than having to be responsible for someone else who is similarly sense-deprived.

After we reassembled in the clearing and finished sharing our reactions and individual experiences, our trainer proceeded to lead us through the lesson that was supposed to come from this exercise. According to our instructor, we would now have a much better understanding of how, in a work-related team environment, we can gain great benefits from helping and supporting each other. For example, if we have information that someone else needs in order to get a job done, we should enthusiastically provide it. We should also learn to ask for help from and rely on our team members, and generally support each other and help guide each other, to the greater benefit of the entire team. And, we should each take full responsibility for the success of the entire team.

This all sounded pretty darn good to me – as it apparently did to everyone else. There were understanding head nods all around, as well as lots of enthusiastic comments about how everyone would now apply this learning back at work.

I sure didn't want to do anything to upset such a positive state of affairs. However, something in my head was not fully accepting these "obvious" conclusions. I couldn't get rid of the nagging feeling that I had just learned something quite different than was intended by the instructors. The conclusion that wouldn't go away was that once I had accepted my subservient position, being led and being taken care of was much easier than being the leader. Isn't it kind of nice to know that whatever happens to us is someone else's problem and that we are being taken care of and protected from harm? Sure sounds like that special time when we were children and our parents took responsibility for our care and safety. It may also remind you of the behavior of people in some of our larger institutions – at least before the days of downsizing. Is it harder to grow up than we think?

Now, before you decide that none of this could possibly apply to you because you are already all grown up, you are in a smaller and more entrepreneurial work environment, or your giant corporation is so cleverly organized that no one can avoid taking responsibility for his actions, let me tell you about one of my real-life experiences.

Some time ago, I took over the management of a relatively small engineering group of about 15 people who had previously been led by a manager with quite a dominating personality. This manager had good technical skills and had thought of himself as a pretty clever and inventive fellow. In fact, he was so innovative that he changed the direction of the group's technical activities on an almost daily basis. The engineers in this group had learned that the path of least resistance was to listen to this manager's ideas carefully and then follow his instructions without challenge. The first benefit of this behavior was that they did not have to risk suffering the emotional stress of being told by their clever and articulate boss that their ideas weren't really very good. The second benefit was that by following each day's instructions, which were freely and regularly offered, the outcome was not their responsibility. It always became the responsibility of their outspoken boss – and since he took credit for everything anyway, and could put a positive spin on just about any result, that was just as well.

It took several months of encouragement before I could get members of this group to offer anything more than token ideas. And even then, they kept expecting me to tell them what was wrong with their proposals, to offer up the "right" answer, and to make the final decision on how we would proceed. Then it took more effort and more months before I could get them to agree to take responsibility for the outcome of the designs and experiments they were developing. The kind of comments that came back to me through other sources in the company went something like this: "I like it that Aris is involving us in the decision making, but I sure wish he wouldn't push so hard for us to tell him how we plan to solve the problems." "Why can't he just tell us what he wants done next?" "I can see that in the long term, this may be better for all of us, but it sure is harder right now."

It took more than six months before this group began to feel that they really were the ones with the authority and responsibility for making the technical decisions, and that ultimately they would have to accept responsibility for the outcomes. Even though that had actually always been the case – since the company needed well-designed products to succeed – having a dominant boss who acted as though he could do it all had deprived these highly capable engineers of the awareness that they were critically important to the company's success.

Most definitely, for them, taking responsibility was not the path of least resistance. However, once they fully understood what was expected, they were able to contribute at a much higher level. The results were quite evident in the quality and quantity of the new product designs. Unfortunately, this story has a really horrible ending. The group was subsequently taken over by another boss, even more dominant than the one before me, and within days they reverted right back to their earlier behaviors. It's hard enough to grow up in the first place. Does it also have to be so hard to hang on to our gains?

I think there must be a little bit of Peter Pan in all of us. On occasion, when we least expect it, that "wish-upon-a-star" to return to our younger days can hit us. We revert to the time when we could count on Dad and Mom to take care of us and keep us safe and sound.

And is that really all that bad? I think not, if we recognize it and learn to manage it. It only becomes a problem in a work environment when we want to have the authority and freedom to make all the interesting decisions, but then want someone else to take responsibility for the results – especially the not-so-good ones. But then, you certainly wouldn't ever catch me doing anything so childishly irresponsible, would you?

For further interaction on this topic or others of your choosing, you may contact me directly by phone at 206/557-8850, by fax at 206/557-8983, or indirectly through Jay Morreale at Palisades Institute, 201 Varick Street, Suite 1006, New York, NY 10014. ■

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

letters

To the Editor:

Re: "The First Flat Panel" by W. R. Aiken, June 1996, p. 28.

I remember the flat tube pretty well, and it was not the first heads-up display as claimed. The first production HUD was on the Vigilante bomber, which first flew in 1958. It had the HUD for use when performing the LABS maneuver.

The predecessors of this display were the gun-sights which date back to WW II. Commercial aircraft HUDs were first promoted by Bendix in 1965 and included a stereo version. These were never much of a success, but here at McDonnell Douglas we have had provisions for HUDs in every aircraft since about 1967. These are now coming into the fore with Alaska Airlines and Southwest Airlines.

– Erv Ulbrich
Senior Principal Specialist – Avionics
McDonnell Douglas Transport Aircraft
Long Beach, California

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11 **97**

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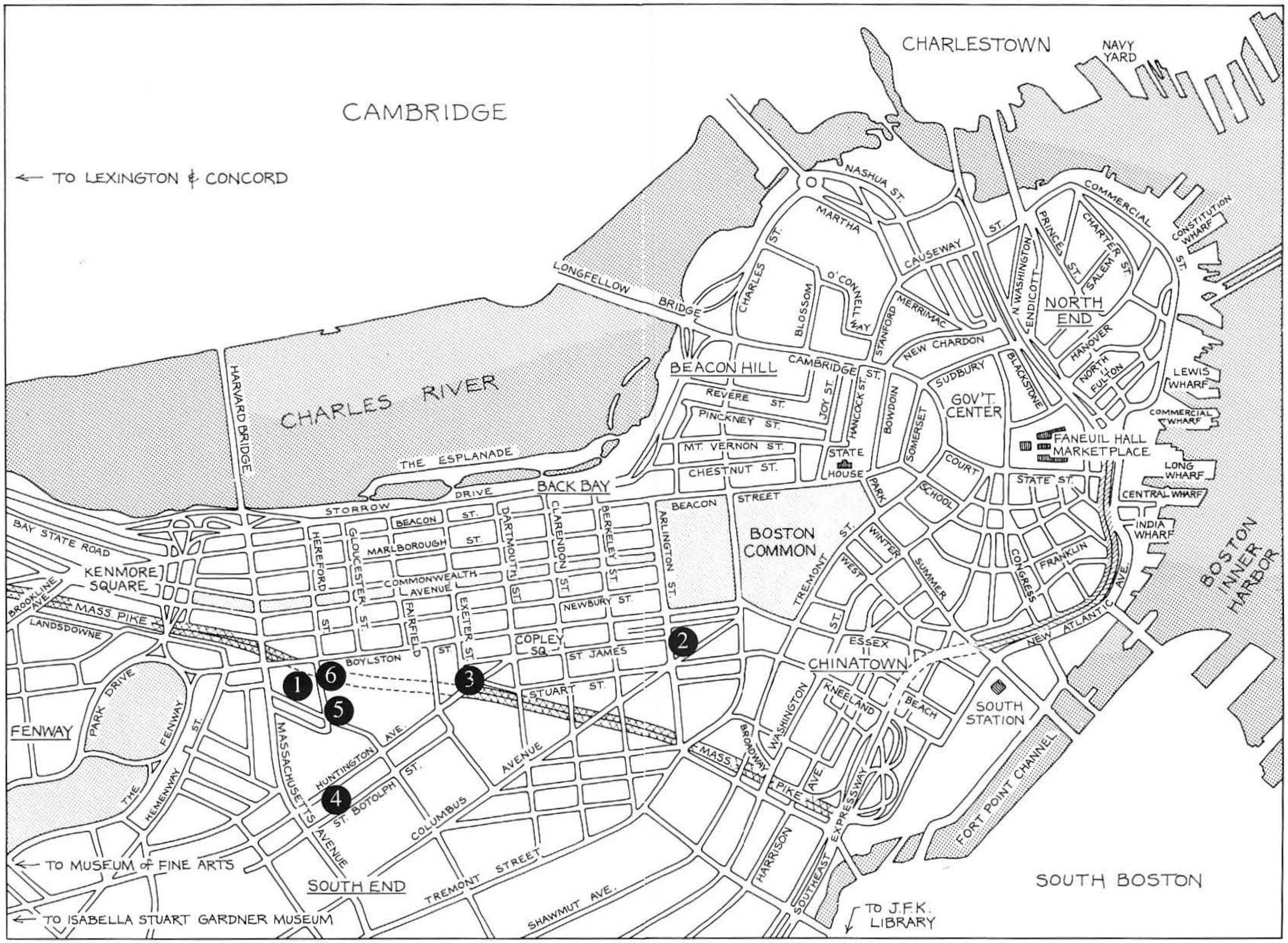
  - Co-sponsored with IS&T.

DISPLAY WORKS 97

San Jose, California
January 27–31, 1997

Convention Center and Convention Hotel Map List

1. Back Bay Hilton
2. Boston Park Plaza Hotel & Towers
3. Copley Square Hotel
4. MidTown Hotel
5. Sheraton Boston Hotel & Towers
6. **John B. Hynes Convention Center**



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SID Conference Calendar

Next Show!

Display Works 97
Manufacturing Technology Conference

The 2nd edition of Display Works and the Third Display Manufacturing Technology Conference will be held at the San Jose Conference Center. This event is sponsored by SID, USDC, and SEMI.

Display Works 97 will feature:

- An exposition
- Manufacturing technology conference
- Business conference
- Standards meetings
- Educational programs
- Networking events

29 JANUARY 97

Display Works 97

SAN JOSE, CALIFORNIA
JANUARY 29 – 30, 1997

An international conference addressing all aspects of Display Manufacturing including:
- Flat Panel and CRT Manufacturing
- Display Materials
- Manufacturing Equipment
- Cost Reduction and Yield Improvement
- Industry Forecasts
- Investor Presentations
- International Standards

11 MAY 97

SID '97

BOSTON, MASSACHUSETTS
MAY 11 – 16, 1997

- SID's MAJOR ANNUAL EVENT
- An International Symposium, Seminar, and Exhibition – Featuring:
  - Technical Sessions – Poster Session
  - Author Interviews – Evening Panels
  - Short Courses – Applications Seminars
  - Technical Seminars – Applications Sessions
  - Product Exhibits.

15 SEPTEMBER 97

17th International Display Research Conference

TORONTO, CANADA
SEPTEMBER 15 – 17, 1997

- An international conference on display research and development aspects of:
  - Display Fundamentals, Display Devices
  - Hard Copy & Storage, Input Systems
  - Integrated Devices and Applications
  - Image and Signal Processing
  - Color Perception, Human Factors

16 NOVEMBER 97

Fifth Color Imaging Conference: Color Science, Systems & Applications

SCOTTSDALE, ARIZONA
NOVEMBER 16 – 19, 1997

- An international multidisciplinary forum for dialogue on:
  - Creation and capture of Color Images
  - Color Image reproduction and interchange
  - Co-sponsored with IS&T.

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