FLAT-PANEL ISSUE

Information DISPLAY

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SID

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Are Anti-ferroelectric AMLCDs Ready to Challenge TN- and STN-LCDs?

- Creating Dynamic HMIs
- How FLC Devices Work
- Electronic Developments for FEDs
- FLC '97 Report
- SMAU '97 Report

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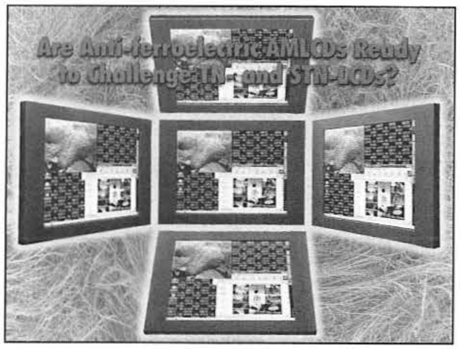
COVER: Toshiba's 15-in. TFT panel using chiral smectic-A anti-ferroelectric materials was demonstrated via video at FLC '97. The display "has breathtaking performance. With this development, smectic materials can start to challenge the nematic hegemony," reports Bengt Stebler in the article beginning on page 20.



Credit: Toshiba
(Photo supplied courtesy of Paul Surguy)

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Next Month in
Information Display

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- Marketing rugged displays
- SID '98 preview
- CIC5 report
- EID '97 report

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INFORMATION DISPLAY

FEBRUARY 1998
VOL. 14, NO. 2

editorial

Japan: "We Must Learn from the U.S."

Shortly before attending the International Display Workshops in Nagoya in November, I found myself at a reception on the top floor of a company office tower in Tokyo, speaking with the General Manager for International Planning of a major Japanese electronics company and the Tokyo Bureau Chief for *Forbes*. The GM agreed with the man from *Forbes* that if two banks merge in New York, one of their office towers will be empty in a few months, but when two banks merge in Japan, both buildings remain full of people.

"Why?" asked the man from *Forbes*. "The answer is here," said the GM, tapping his index finger on his forehead - meaning in the Japanese mind. Laying people off is simply something that large Japanese companies don't think they can do. "If Fujitsu or Mitsubishi were to fire 10,000 people today, I would fire 10,000 tomorrow - but I will not be first."

The executive went further. Although individual Japanese companies may do well, he does not see the political will in Japan to make the hard decisions that could ultimately get the economy on track. "People have lost confidence in government," and although manufacturing is efficient, white-collar productivity is very low.

Seemingly everyone in Japan recognizes there is a serious problem and does not hesitate to talk about it. And it's interesting to see where at least some members of the Japanese governmental establishment are looking for solutions. In a keynote address delivered at the International Display Workshops in Nagoya on November 19, 1997, K. Suzuki, Director of Technology Development at the Japanese Ministry of Posts and Telecommunications (MPT) - who was filling in for Akio Motai, the MPT's Deputy Vice-Minister for Technology Policy Coordination, who had been scheduled to deliver the address - spoke very openly about information and telecommunication technologies policy in Japan.

Japan is in a serious economic situation, he said, with low growth in formerly key industries and a very high cost of doing business. The MPT is looking to info-communications - the combination of information technology and telecommunications - as the key to reforming Japan's economic structures.

Suzuki gave U.S. President Bill Clinton more credit as a visionary technology planner than he usually gets at home, speaking admiringly of Clinton's vision for a National Information Infrastructure and his goals of developing a next-generation Internet and a global communications structure. Suzuki noted that the annual growth in info-com industries is 23.3% compared to 9.6% for industrial growth overall. The MPT wants to institute a digital infrastructure for Japan, including optical fiber to every Japanese home by 2005.

Among other initiatives are promotion of new businesses through competition, merit-based pay, and an environment conducive to labor flexibility. The MPT wants to encourage more open research, and Suzuki spoke approvingly of the new Yokosuka Research Park, which includes both Japanese and non-Japanese companies. He also spoke of establishing ATSI - the Asia-Pacific Telecommunications Standards Institute - to be modeled after ANSI in the U.S.

Suzuki spoke admiringly of the U.S. portfolio of info-com companies, which is five times the size of Japan's, and implied that the lively economy in the U.S.

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INFORMATION DISPLAY

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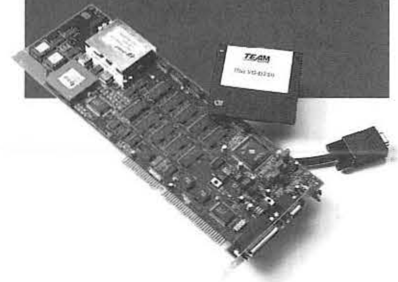

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Circle no. 12

the display continuum

Planting Tulip Bulbs in February ...

by Aris Silzars

As the keynote speaker finished his talk, a colleague whispered in my ear, "Didn't we hear this same talk ten years ago?" I smiled and nodded vigorously in agreement. A keynote speaker at a major technical conference repeating ten-year-old material? Didn't anyone on the technical-program committee screen this talk?

The opening session had followed pretty much the standard format for technical conferences, with the obligatory introductions of the conference and program chairmen and the usual polite but content-free welcoming remarks. And then, as again dictated by tradition, came the introduction of the first keynote speaker. This was followed by the customary warm, welcoming round of applause.

Yet, in spite of this all-too-predictable commencement, the first day's opening session of a major technical conference is always, for me, the most exciting. Maybe it's because it triggers memories of past first days at school each fall - times of anticipation and excitement before the newness of the experience has worn off. I especially like the keynote sessions because they often provide a nice overview of where our industry is headed.

This keynote speaker's intent had been just that - to tell us what new opportunities we could expect over the *next* ten years for displays and dashboard electronics in the automotive industry. And this he did rather eloquently by first describing the stringent automotive criteria for ruggedness, temperature range, brightness, contrast, viewing angle, long life, and low cost. Next, he suggested candidate technologies covering the predictable gamut of vacuum fluorescent displays (VFDs), active and passive LCDs, with a brief mention of EL and some future-looking projections for FEDs. The closing remarks re-emphasized that cost and styling issues are the most important determinants for which new display technologies may get used.

And yes, indeed, the problem was that, unbeknownst to this speaker, we had been seeing and hearing most of these same projections in other talks by automotive-industry experts over the *past* ten years - a decade rich in display-technology progress, but in which the automotive industry's display-usage projections had changed hardly at all. Had the automotive industry fallen into some kind of previously undiscovered time-warp singularity, a singularity where time moves at about one-tenth earth speed?

Back (... to the future?) in 1986, I too had predicted some modest progress in the area of automotive electronics and displays. I thought that surely by 1996 we would see some new implementations of electronics in automobile dashboards. But reality could not be denied. Last year I had to admit that this was my biggest technology forecasting miss of the last decade. And, darn it, I was trying so hard to be conservative - and *was,* compared to every other futurist!

Why are we consistently so far off in our expectations when it comes to electronics in automobiles? Even industry insiders mislead us by promising a migration to electronic dashboards that never happens. At least it hasn't happened in the last thirty years. Shouldn't automobiles be one of the great opportunities for new flat-panel-display technologies? Well, shouldn't they? ...

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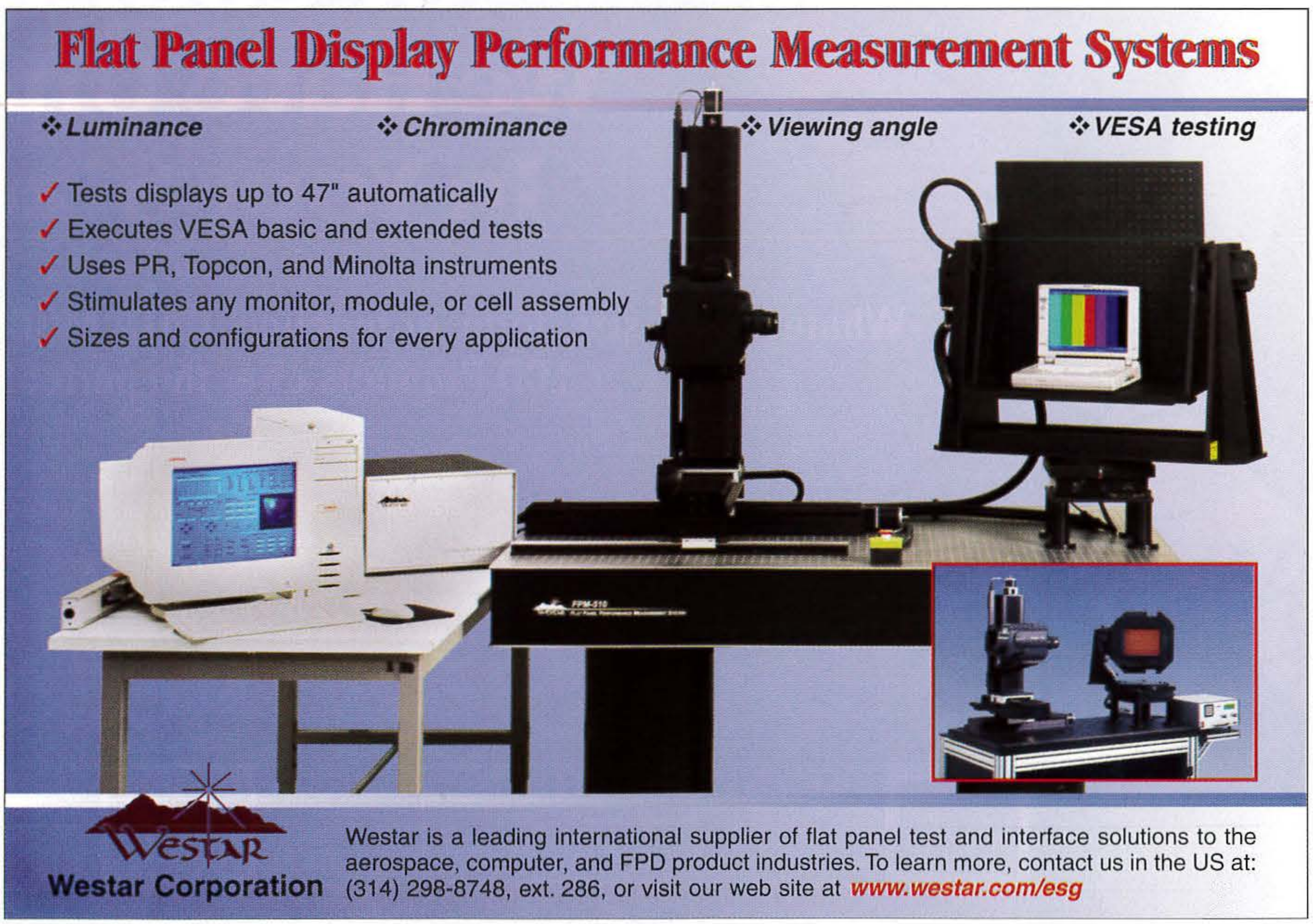

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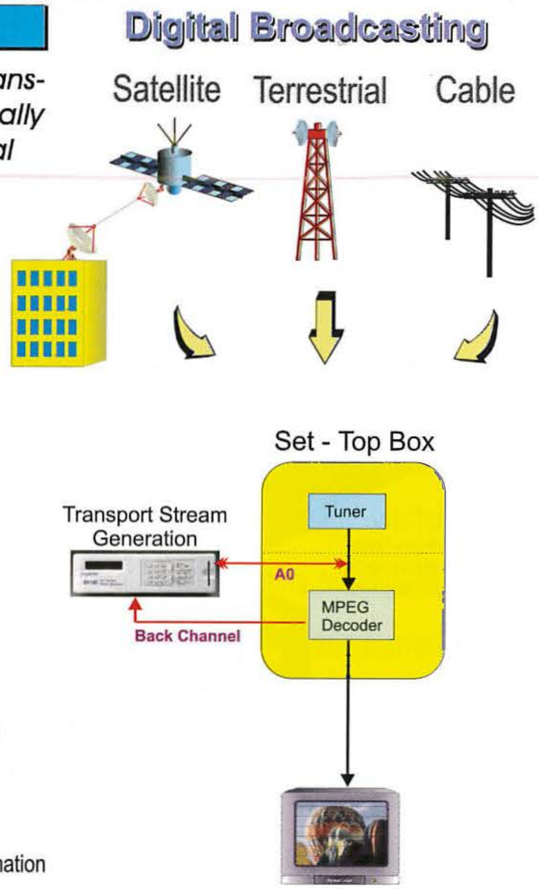

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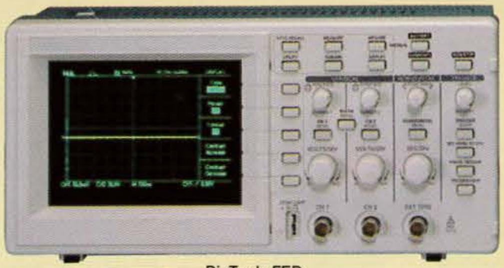


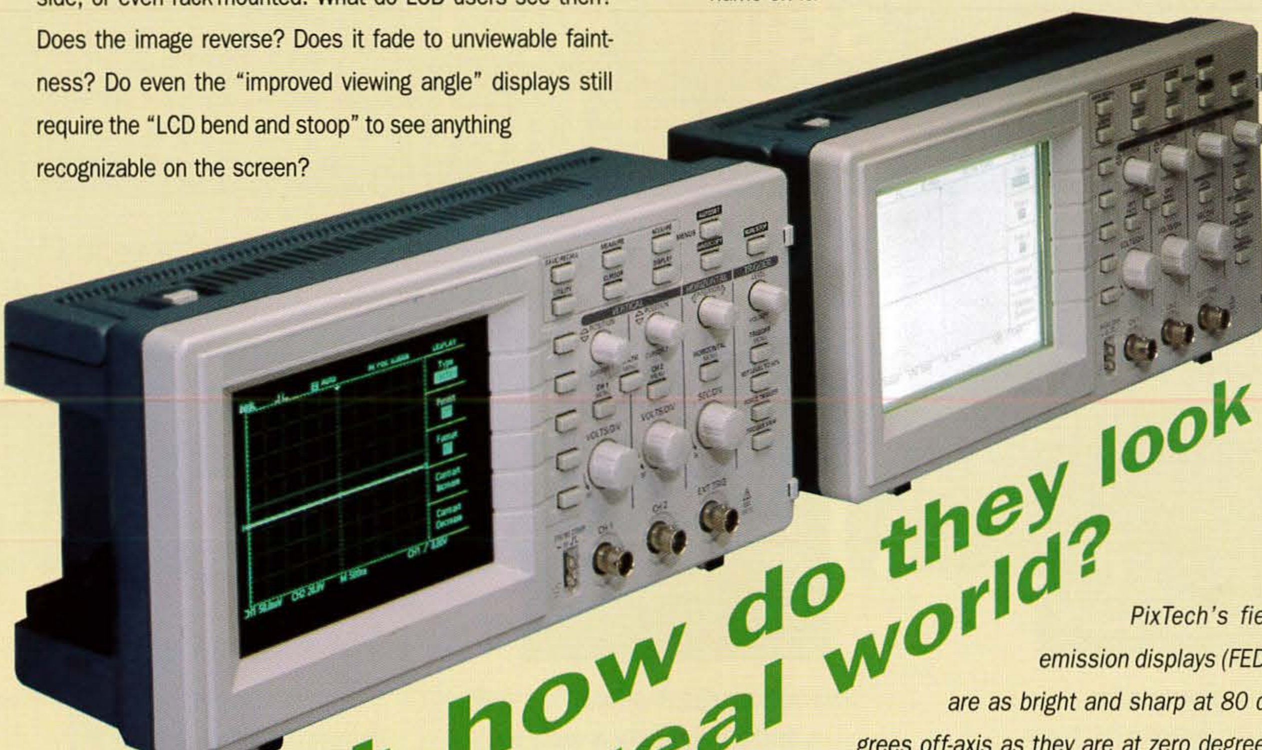
PixTech FED

Standard LCD

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

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

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



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Circle no. 19

Electronics Development for Field-Emission Displays

Combining amplitude-modulation and pulse-width-modulation drive schemes gives FED-panel designers the best of both worlds.

by Robert T. Smith

THE FIELD-EMISSION DISPLAY'S (FED'S) electron source makes a flat CRT possible. The flat-CRT display is composed of a large number of electron emitters in an addressable matrix. Each addressable location of the matrix corresponds to a display pixel that is in close proximity to the phosphor screen. Therefore, the flat CRT does not need a deflection system.

Unlike CRTs, which use raster addressing, FEDs can use line-by-line addressing. This results in dwell times much longer than those produced by the flying spot of a conventional CRT. The longer dwell time permits lower pixel current for a given brightness, thus eliminating the problems of beam divergence and phosphor saturation that occur in high-brightness CRTs.

The electronics for the FED have several functions. The standard analog video signals must be converted to a form appropriate for driving the FED. And ultimately, the drivers must accurately control the charge that impacts the phosphor screen.

Much of what has been written about FEDs concerns the physical structure of the display and ways of fabricating the emitters. But as more FEDs approach commercialization, it has become important to think about the various ways of controlling the delivery of charge to the screen and to determine which technique is best suited for a particular situation.

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FED Basics

The potential barrier at the surface of a metallic conductor binds electrons to the bulk of the material. This potential barrier is called the work function, and is defined as the potential difference between the Fermi level and the height of the barrier. For an electron to leave the material, the electron must gain an energy which exceeds the work function. This can be accomplished in a number of ways, including thermal excitation (thermionic emission), electron and ionic bombardment (secondary emission), and the absorption of photons (photoelectric effect). Fowler-Nordheim emission or field emission differs from these other forms of emission in that the emitted electrons do not gain an energy which exceeds the material work function.

Field emission occurs when an externally applied electric field at the material surface thins the potential barrier to the point where electron tunneling occurs, and thus differs

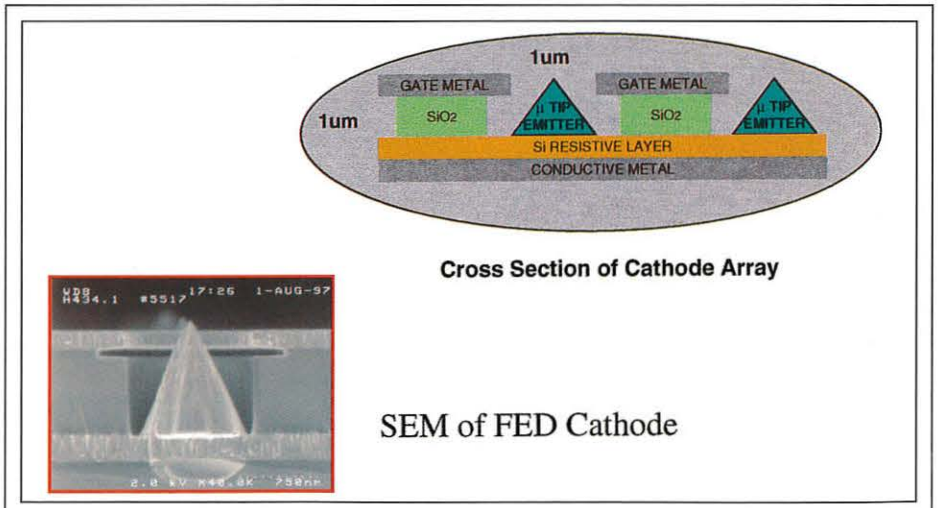

Fig. 1: The FED is a sharp point with a connecting electrode, a dielectric layer, and an isolated extraction gate in close proximity. A voltage between the gate and the point generates a high field, which allows electrons to be liberated through tunneling.

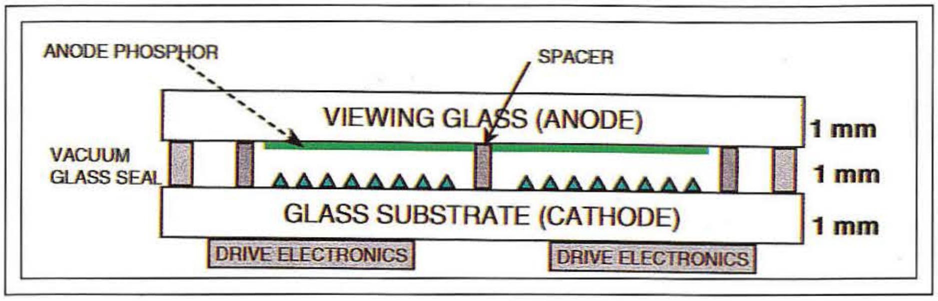

Fig. 2: *An FED must be enclosed in a vacuum package to prevent destruction of the cathode by ionization, the formation of plasmas, and arcing.*

greatly from thermionic emission. Since there is no heat involved, field emitters are a "cold-cathode" electron source.

One needs to apply an electric field on the order of 30–70 MV/cm at the surface of a metallic conductor to produce significant tunneling current. For example, if an electrode is placed 1 μm from the surface of a conductor, it would take 1000 V between the electrode and cathode to induce significant current flow. Obviously, a flat-panel display (FPD) that is addressed at 1000 V is of little use. Therefore, "field enhancement" is used to lower the necessary addressing voltages.

The FED is a sharp point, or whisker, with a connecting electrode, a dielectric layer, and an isolated extraction gate in close proximity (Fig. 1). If a positive potential is applied between the gate and cathode, a uniform electric field is produced in the dielectric. But the presence of the emitter produces a compression of the equipotential lines at the tip, and thus a high electric field. This is field enhancement.

Field enhancement is a geometric property and is strongly dependent on the sharpness of the tip. Note that the dielectric must hold off the un-enhanced field, so field enhancement is essential for operation of the FED. With field enhancement, a reasonable voltage applied to the extraction gate results in electron emission at the point.

The Vacuum Package

From the foregoing brief description of field emission, one might suppose that the emission of electrons into a gassy medium might be a problem because ionization, the formation of plasmas, and arcing would cause destruction of the cathode. It is for this reason that the FED – like the CRT – is a vacuum device. To make a display, a vacuum package is needed (Fig. 2).

The cathode is composed of row and column conductors separated by an insulating layer. These layers are deposited on an insulating substrate, such as glass. The locations where the rows and columns cross define a pixel. The row conductors serve as the extraction gate, and the column conductors connect to the cathodes.

The anode is the phosphor screen and is composed of the phosphor powders, which are deposited within a black matrix. The entire anode is covered with a thin aluminum layer, which bleeds off the electrons that bombard the screen. The cathode and screen, along with spacer materials, are aligned, sealed, and evacuated to complete the vacuum package.

Electron emission from each pixel is controlled by a forward bias between the gate and cathode. Once released from the confines of the bulk material, the emitted electrons are accelerated toward a phosphor screen. The voltage applied to the screen must be higher than the gate voltage or the emitted electrons. The screen (anode) voltage must also be high enough so that most of the electrons' energy remains once they penetrate the aluminum layer covering the phosphor particles.

A typical current–voltage response for an FED pixel with a resistive ballast layer is shown in Fig. 3. The resistive layer eliminates current runaway, which could otherwise lead to a damaged cathode panel. Non-uniform pixel emission is also improved – but not eliminated – by using the resistive layer.

The Display System

To complete the FED system, various subsystem components are needed to control operation of the vacuum package (Fig. 4). Other than the vacuum package, the subsystems include the video controller, panel controller, and row and column drivers. The component subsystems will differ depending on whether the input is analog or digital.

For an analog composite video signal containing red, green, and blue (RGB) information and timing signals, a video controller is used. The controller samples the analog signal, digitizes it, and separates it into RGB components. Horizontal and vertical timing information is also extracted from the composite input. The video controller then presents the digitized video information to the panel controller in the form required by a standard digital video interface specification. This standard specifies digital RGB data up to 18 bits in parallel, horizontal and vertical sync, a pixel clock, and a data valid signal. Other processing that may be required in the video controller are gamma correction and adjustment of color saturation, brightness, and contrast.

In order to keep the FED compatible with other FPD technologies that accept digital input, the panel controller must accept the standard digital-interface signals and extract the signals necessary to drive the FED row and column drivers. In most cases, the signals appearing at the digital interface are used directly by the row and column drivers, and the functionality of the panel controller is minimal. However, depending on the drive approach used and on the design of the drivers, some functionality may be required on the panel.

Line-by-line addressing is used to display an image on the FED. Typically, the row connections are the FED gates, and the columns are the FED cathodes. The rows are scanned sequentially from top to bottom. As each row is selected, the columns are used to modulate the current in the pixels of the selected row.

The voltage applied across the pixel is the difference between the row-select voltage and the column voltage. For white level – a current level that produces "white" on the screen – a pixel current between 1 and 10 μA is needed, depending on factors such as brightness, phosphor efficiency, and anode voltage. For a typical FED, a gate-cathode voltage of approximately 80 V is required to achieve full white brightness. The pixel OFF current for black level is 50 V or less. The modulation voltage used to control the intensity of each pixel is the difference between the white and black levels, or about 30 V (Fig. 3).

As a result, the row-select voltage is not required to switch to 0 V for the OFF state and the row driver can be referenced to a dc offset. Rise and fall times for the row and column signals in the FED determine the maximum scan rate and gray scale of the display – and, therefore, the highest possible resolution. The high-voltage output devices in the driver must be sized to supply enough transient current to support the required scan rates for the display.

From a functional standpoint, the row driver is a very simple circuit that provides only a row-select signal as the display is scanned from one line to the next. The column driver presents gray-scale image information to the pixel and differs from the row driver both in functional complexity and bandwidth performance.

Gray Scale

There is more than one way to modulate the pixel intensity with the column driver, and there are tradeoffs with each approach, including power consumption, susceptibility to cathode defects, ability to drive the required load, and display uniformity. The leading approaches are amplitude modulation (AM), pulse-width modulation (PWM), and a mixed AM/PWM approach. Each of these approaches can be used with column drivers configured as either voltage or current sources.

Current *vs.* Voltage

If gray scale is achieved by modulating a voltage source, we must confront the problem of non-uniform pixel emission. The problem arises because, if we modulate a voltage source, all pixels must emit the same current at a given voltage. Individual emitters do not emit uniformly under these conditions, so uniformity is attained by having each pixel consist of many individual emitters. Uniformity is attained statistically.

This approach works, but at the expense of a larger pixel, which increases capacitance (reducing bandwidth and increasing power) and will limit the smallest pixel pitch that can be attained in an FED.

The other option is to control emission with a dependent current source. Here, as the row is selected the column voltage is allowed to float to a value corresponding to the current set in the dependent current source. The only requirement is that the row-select voltage be high enough to accommodate all possible currents in all pixels of the display. Because a current source is used, the need for redundancy in the pixel design is greatly reduced, which reduces capacitance. Unfortunately, since current is limited to the emission level – which happens to be much smaller than the charging current – the column's voltage-slewing ability can be compromised and become a bandwidth-limiting factor.

Pixel leakage, the most common cathode defect, also affects the drive electronics. Except for a dead short between rows and columns, a voltage-drive approach would not be affected by leakage. But even low levels of leakage in a pixel will cause intensity distortions when a current-drive approach is used.

Amplitude Modulation

Intensity variation of the pixel by AM can be accomplished with either voltage or current drive to the columns. With either approach, the column driver forces a level proportional to the pixel brightness, which is held for the entire row-select time. Design of the AM column-driver circuit is relatively simple, but it must maintain high accuracy, particularly at low emission levels. The FED has an exponential response, so 256 gray levels require accuracy in the millivolt – or nanoampere – range at low luminance levels. Transient power is minimized because the voltage excursions from one row-select time to the next are minimal.

With an AM voltage source, the display will suffer from non-uniformity at low luminance levels. The ballast resistance of the pixel produces uniform emission only if a significant voltage drop occurs across the ballast. At low emission levels this voltage drop is small, so pixel emissions tend to become very non-uniform.

Pulse-Width Modulation

Pixel intensity can also be modulated in time. The pixels are operated at a constant current by either a voltage or current source. During a row select, the pixel is on for some fraction of the line time. Dark pixels are not turned on at all and white pixels remain on for the entire row-select time. Gray scale is achieved by varying the ON-time of the pixel between these two extremes.

Since the driver is digital, the output accuracy can be substantially relaxed from what it is in AM approaches. Unfortunately, transient power is maximized because the same voltage transitions occur whether the pixel is at a low or high luminance level. In addition, the slew rate is dependent upon the required number of gray levels and can be quite high. Pulse widths on the order of 100 nsec may be required.

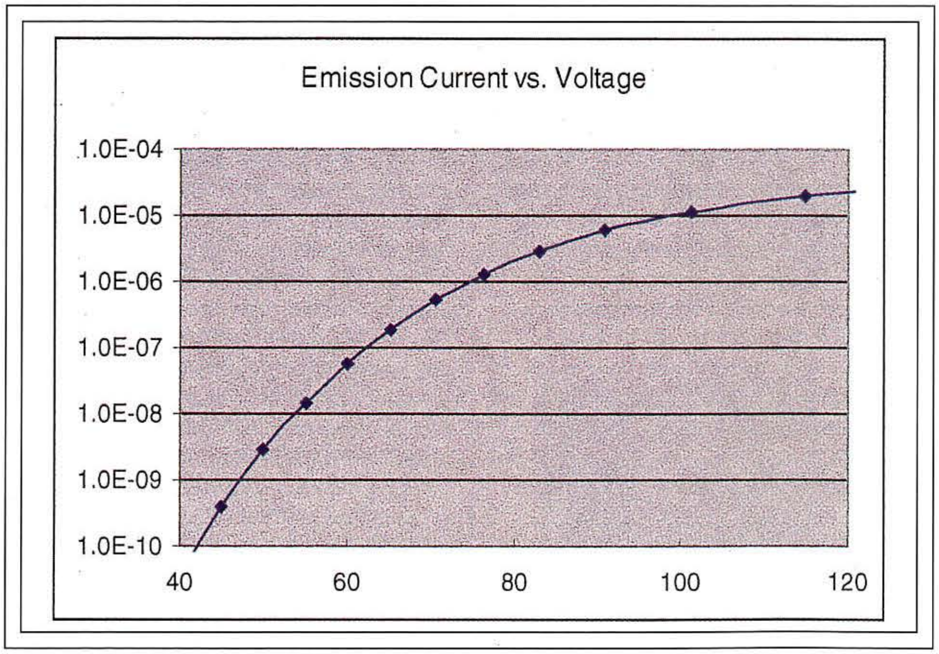

Fig. 3: *This is a typical current–voltage response for an FED pixel with a resistive ballast layer, which eliminates current runaway.*

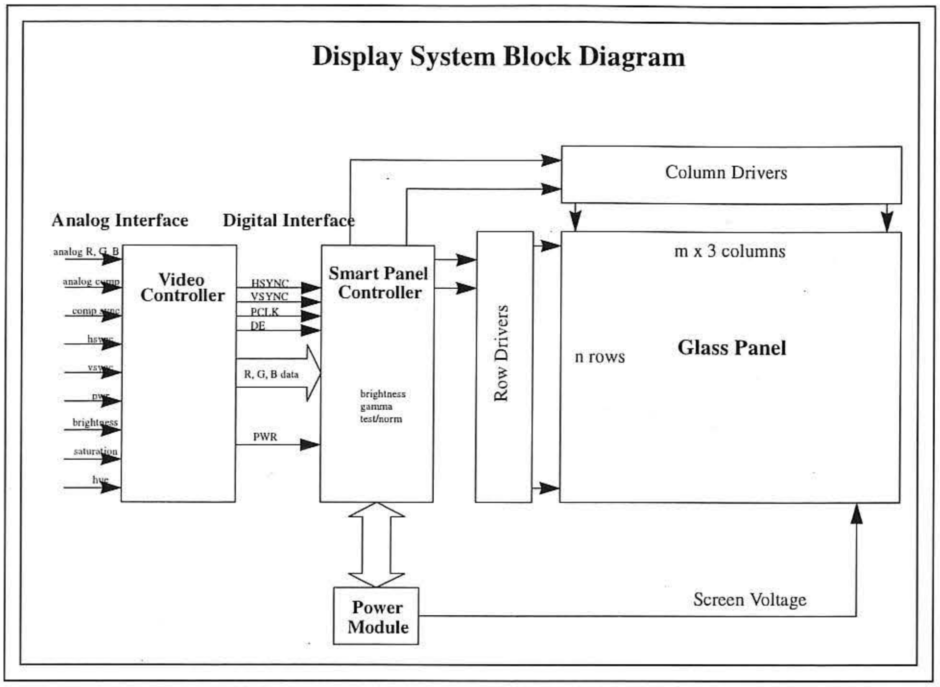

Fig. 4: To complete the FED system, a video controller, panel controller, and row and column drivers must be added to the vacuum package. The component subsystem will differ depending on whether the input is analog or digital.

AM/PWM

A combination of AM and PWM has distinct advantages over the PWM-only approaches. The main problem with PWM is the very short pulse widths needed for low-luminance pixels. Very short pulse widths require very fast rise and fall times and very high charge currents. AM/PWM relaxes this requirement by splitting the video data byte into N nibbles. N current sources with currents scaled to the proper magnitude are operated in PWM by the appropriate nibble. The resulting current pulses are summed at the column connection. This reduces the number of discrete time increments per row-select time from 2^n to $2^{n/N}$, where n equals the number of video bits.

This AM/PWM approach can be applied with voltage sources as well. Consider the possible values of emission current from the pixel. For the case of N = 2- and 8-bit video, there are four possible values, one of which is the OFF-state. This can be implemented as a voltage driver with four possible output states corresponding to each of the three possible emission currents and the pixel OFF-state.

Where Are We Now?

The FED holds the promise of providing a very high-quality CRT-like image in a thin, low-power package. The video controllers that have been developed for the LCD industry apply equally to an FED, and there are existing IC processes that would support the row and column driver needs for FEDs. (In addition, custom drivers have been developed.)

At Motorola we have demonstrated that a cost-effective electronics drive system can be designed that is compatible with existing flat-panel electronics and can provide up to 8 bits of gray scale. With these developments, easy integration of FEDs into new products should be straightforward. Prototype FEDs from several manufacturers are available, and mass-production is expected in 1998.

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Creating Dynamic HMIs for Modern Display Systems

How can we economically design and maintain human–machine interfaces that must often outlive the hardware and software platforms they are built to run on?

by Paul A. Bennett

PHYSICAL DISPLAY DEVICES, such as cathode-ray tubes (CRTs) or active-matrix liquid-crystal-display (AMLCD) panels, present information to a system's users. The physical display screen is the most tangible element of a display system, but from the user's perspective it fades into the infrastructural background. What really matters to a system's user is the data the system presents to him or her. Human-machine interfaces (HMIs) are designed to optimally present data to users performing complex tasks.

HMIs are typically found in special-purpose computing environments, rather than in general-purpose environments like PCs. HMI elements tend to be dynamic, changing their appearance as a result of changes in data.

The appearance of HMIs tends to be closely related to their function, often as software alternatives to the electro-mechanical instrumentation they are increasingly replacing. Examples of HMIs include such things as displays in aircraft "glass cockpits" (Fig. 1), screen displays for a variety of medical instruments, and new electronic instrumentation packages for vehicular use.

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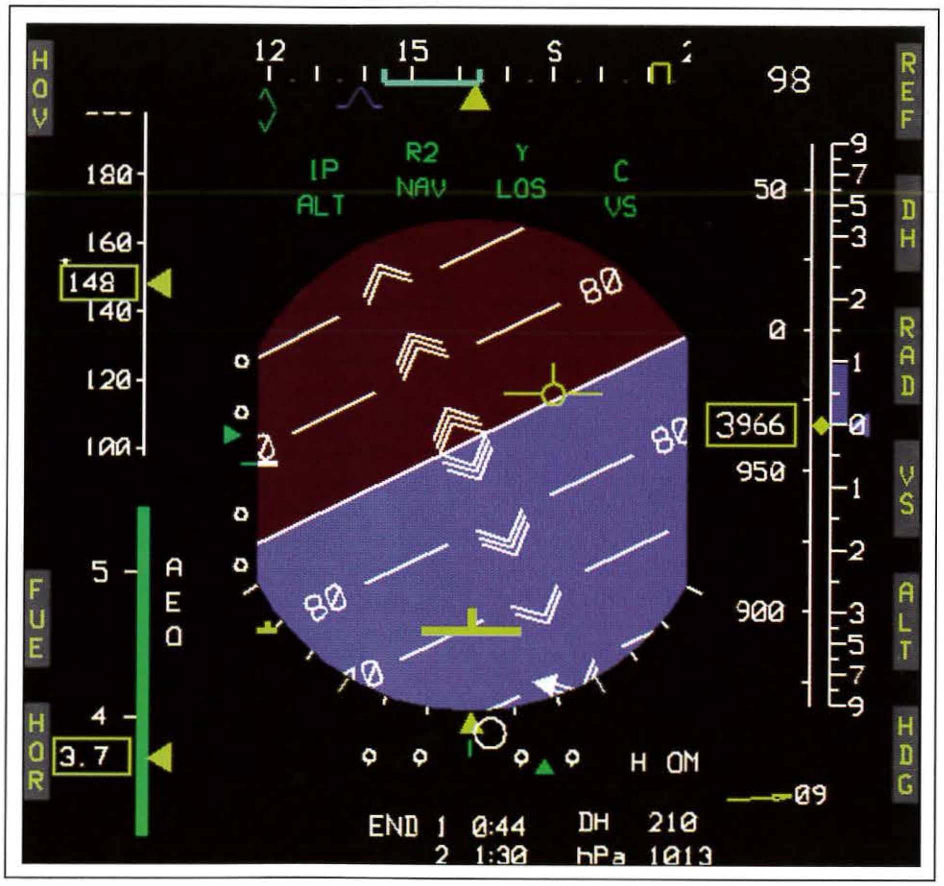
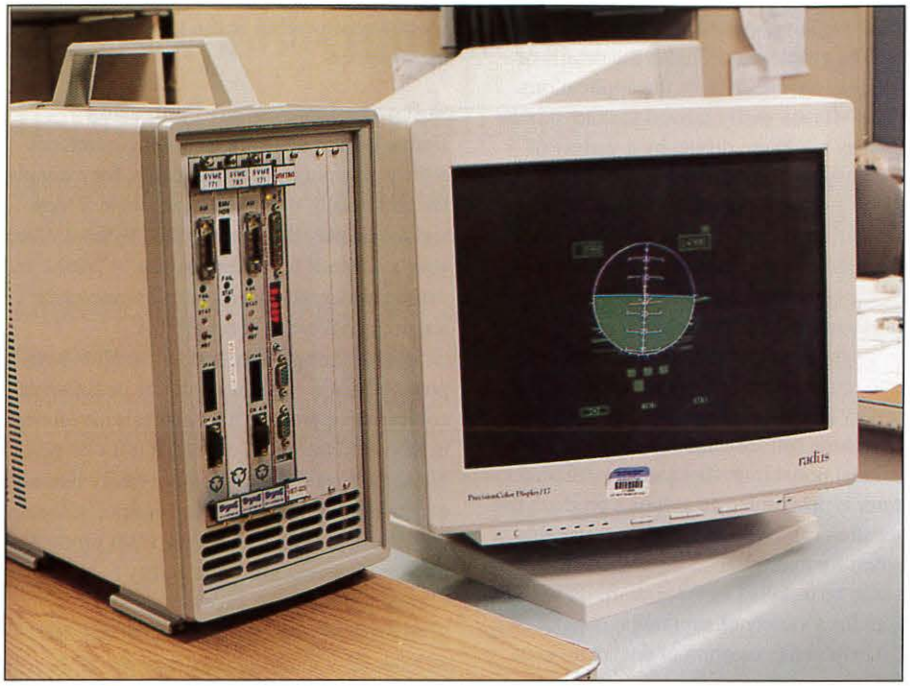


Virtual Prototypes, Inc.

***Fig. 1:** Complex human–machine interfaces (HMIs), such as this primary flight display, require extensive development and more efficient development methods.*



The Boeing Company

Fig. 2: A typical avionics display driven by embedded VME hardware.

Building HMIs

The generation of the images one sees as the HMI must be programmed along with the other behaviors of the system, such as controlling devices and retrieving data from them. The traditional approach to building HMIs has been to laboriously hand-code programs using text editors. These programs are then turned into executable programs by a suite of software-development tools that includes a compiler, assembler, linker, and debugger.

HMIs have tended to become more complex over the years as greater demands are made of human operators and of the HMIs designed to assist them. This increasing complexity has led to the development of a variety of tools for reducing the risks involved in developing HMIs for today's high-quality displays.

Until recently, however, the problem with HMI prototyping tools has been that prototyping was all they did. A user would develop a graphical prototype of the HMI to be built. A team of programmers would then be sat down in front of the prototype and told, "Build that!"

This approach to HMI development resulted in wasting most of the effort that went into building the HMI prototype because the HMI had to be developed all over again, usually by hand-coding it in some high-level language such as C. In the normal course of these projects, someone would discover an emerging market requirement, or that something had been overlooked, or that standards had changed - but only after a significant investment in code had been made. Then, the code would have to be thrown out or substantially modified. No wonder HMI projects developed a reputation for being perennially late.

Software Portability

The continuing development of computing hardware and software technologies has also influenced the development of HMIs. Today's leading-edge hardware may not be available for purchase 5 years from now, and software technologies evolve with similar rapidity. This creates a real problem for companies that must develop, maintain, and evolve their products over a period of years. Avionics systems, for example, are frequently installed in aircraft that fly for decades. Customers must be confident that manufacturers will be able to support these systems for the life of the aircraft, even if today's generation of hardware is no longer available.

Software portability thus becomes one of the most important issues related to the development of HMIs for long-lived systems. HMIs developed today must be deployable on virtually any present or future computing platform and on any present or emerging display technology.

Developing Software for HMIs

Fortunately, a new generation of software tools has been developed that is revolutionizing the development of HMIs. These virtual prototyping tools - which include VAPS, a product of my own company, Virtual Prototypes, Inc. (VPI) - have been developed to help companies interactively design, develop, build, test, and deploy HMIs for a wide variety of applications and platforms in a graphical, interactive, point-and-click fashion.

Users begin by drawing the graphical elements of their application. As the graphical elements are developed, they can be assigned functionality from among a large number of behaviors known to the virtual prototyping system. This converts the static graphics of a traditional prototype into dynamic objects. Objects thus become, for example, dials, lights, knobs, or switches, depending on the developer's requirements.

In the VAPS implementation, each type of object has characteristic data entry or exit points called "plugs," which can be connected to channels that transport data between the objects and between processes. The visual representation of object plugs and of channels allows for data connections to be performed in a point-and-click fashion. Event-based logic can also be defined in a point-and-click fashion.

Once the graphical, behavioral, data-manipulation, and logical elements of an HMI have been developed, they can all be tested in an integrated, interactive fashion within the virtual prototyping development environment, where the HMI will behave exactly as it will in the final product. Should changes be required, the various elements of the HMI can be edited iteratively and retested.

In our VAPS implementation, once the HMI has been developed to the user's satisfaction, the system can output the ANSI C code that exactly implements the HMI. This code, generated from the HMI, can then be cross-compiled to a wide variety of computing, graphics, and display environments, including real-time operating systems (RTOS) and ruggedized embedded systems (Fig. 2).

The secret to an application's portability lies in the software architecture implemented uniquely by VAPS (Fig. 3). The specifics of an HMI developed by a user are encoded in the generated C code which occupies the top layer in the architecture.

The next lower layer consists of VAPS libraries which implement the functionality called for in the specific HMI the user has developed. This layer is essentially application-invariant, but has been cleverly constructed so that, when the final application is constructed by the linker, only the code required for the specific application is included in the final product. At its lowest interface, this layer makes graphics calls that are implemented by the Graphics Porting Library layer beneath it.

Cross-Platform Portability

The Graphics Porting Library layer can be used to port the VAPS graphics to a new graphics applications programming interface (API) that occupies the next lower level, immediately above the firmware and hardware on which the graphics will be executed.

This architecture allows an HMI application to be moved to a new computing environment by changing only one layer, the graphics porting layer, which is independent of the specific application. In the VAPS system, once the graphics library has been ported to a new graphics API, any VAPS application can be rehosted to that platform in a matter of minutes. Such short iteration times facilitate the continual improvement of an HMI's quality without negatively impacting product deadlines. The graphics API hides the details of the display hardware from the applications. Thus, HMIs are easily moved to many kinds of display hardware driven by a variety of computing platforms, including PCs, UNIX workstations, and ruggedized VME or other embedded hardware. The possible display devices include traditional CRTs in a lab or AMLCD panels in aircraft or vehicles.

Because virtual prototyping systems make it easy to rehost an application to a variety of computing environments, it is now possible for a number of groups within an organization to use the same software and benefit from cross-functional portability. For example, if a manufacturer is developing an avionics product, the application can be turned into an executable program for execution on the embedded system that is to be installed in the aircraft, on a UNIX system for a variety of simulation uses, or on a PC to help in the creation of documentation.

Arrangements can be made so that all concerned users are automatically provided new versions of the executable software on the platform that is appropriate for their work. This might be done weekly or as specific milestones are achieved, enabling everyone in the organization to be working with the same software, automatically generated from the same specification.

Developing HMIs in this way gives a much larger number of people an early opportunity to work with the HMI software than would otherwise be the case. Problems can thus be spotted much earlier in the product-development process.

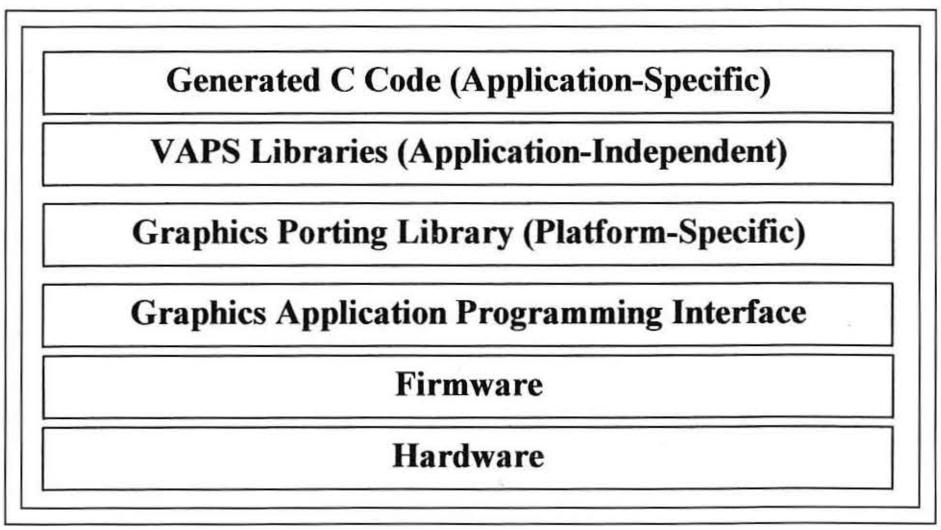


Fig. 3: Structure of a virtually prototyped HMI deployed using VAPS.

Software-Investment Protection

Hardware and software technologies are constantly changing. Graphics cards, for example, are continually evolving, as are their drivers and the display devices attached to them. Last year's X/Motif becomes this year's Win32 and maybe next year's Java. Display-resolution requirements are in constant flux.

Storing the specification for an HMI independently of a specific hardware or software environment protects a customer's investment in HMI software. Of course, it must be possible to convert the specification easily into an executable for whatever hardware or software environment is chosen for the HMI product's next implementation. The ability to generate C code provides this capability.

In the VAPS system, one can define and edit the HMI visually, then store the HMI specification in a platform-independent way. The C code that implements a specific HMI is treated as an enabling step that bridges the gap between the HMI specification and the execution platform. The approach minimizes the investment required to move HMI software to a new platform. Investments in HMI software development are thus preserved while the way is paved to inexpensive product improvement as the need arises.

Conclusion

HMI designers are constantly improving the advanced data-display and control mechanisms for their products. In addition, computing and display technologies are constantly evolving, sometimes faster than complex HMIs can be built. Therefore, ease of development and software portability have emerged as paramount requirements for the development of complex HMI projects.

These characteristics are provided by VAPS, which facilitates high-quality and timely implementation of the HMIs required in large projects, allowing them to be brought to market rapidly while minimizing the risk arising from the HMI software-development process. Indeed, HMI virtual prototyping systems change the way in which HMI development is done, increasing the efficiency of an organization by encouraging more parallelism in the HMI development workplace. ■

FLCs COME OF AGE

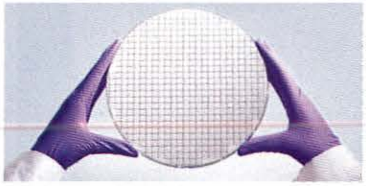
High resolution, full color, video-capable miniature displays are now shipping.

*Displaytech is the **only** licensed company in the world producing ferroelectric liquid crystals on VLSI.*

Both front and rear projection systems are leading applications for Displaytech high resolution displays, now in production. Full 24-bit color is delivered in a convenient, flexible circuit package, shown actual size.

MARRYING THE PROVEN TO THE REVOLUTIONARY

Micro display and projection applications capitalize on advances in CMOS processing and recent Displaytech FLC breakthroughs. Low-cost, mirror-surfaced integrated circuit chips provide high quality, active matrix backplanes to which ultra-thin films of high speed FLCs are applied. Displaytech devices combine the latest CMOS improvements with state-of-the-art FLC materials — resulting in displays that are designed to be small, exploiting high-volume, low-cost manufacturing methods. These no-compromise, fully digital displays are ready for design integration into demanding product applications.



Wafer-based CMOS manufacturing assures cost efficiencies with established production methods. As a reflective medium for Surface Stabilized Ferroelectric Liquid Crystals (SSFLCs), this marriage has proven a superior construct for micro displays.

ULTRAFAST SWITCHING

Using standard CMOS voltages, FLC materials provide microsecond switching. This incredible switching speed enables 24-bit color at full video frame rates.

Displaytech ChronoColor technology delivers crisper, cleaner full screen images without scrolling or reformatting — from a panel measuring just 10.4 mm (0.4") diagonally.

COLD STORAGE WITH HOT PERFORMANCE

Over twelve years of intensive research have yielded FLC materials usable from -5 to +70ºC (-40 to +85ºC storage).

Actual screen enlargement of a VGA ChronoColor Display. With full color on every pixel, ChronoColor technology eliminates subpixelation artifacts common with active matrix LCD triads. High fill factors exploit the full CMOS active area with no black matrix. Images are smooth and colorful, text is comfortable and continuous.

READY FOR PRIME TIME CONSUMER APPLICATIONS

Displaytech production-ready ChronoColor™ Displays combine key features required for near-eye and projected applications: excellent image quality, high efficiency, lightweight construction, easy design integration, and low cost. FLCs provide significant technical advantages for battery-powered, portable, full color displays with applications in handheld devices (PDAs and digital cameras), eyeglass-mounted display systems, and more. Contact Displaytech at 1.800.397.8124.

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conference report

Canon Shows New-Generation FLCD at FLC '97 in Brittany

After years of difficulties, Canon may have gotten the big-screen FLCD solution right.

by Bengt Stebler

IN 1987, Christian Destrade and his co-workers at the University of Bordeaux called the liquid-crystal community to the First International Conference on Ferroelectric Liquid Crystals. This initiated a series of conferences that celebrated its tenth anniversary last July, when the Sixth International Conference on Ferroelectric Liquid Crystals (FLC '97) was held in France once again. (Intervening meetings had been held in Göteborg, Boulder, Tokyo, and Cambridge, UK.)

The venue this time was the École Normale Supérieure de Télécommunications in Brest, Brittany, with organization by Professor Jean-Louis de Bougrenet and his team from the school's optics department.

Although the scientific program was dominated by research papers, it was complemented by a number of live demonstrations of FLC applications in spatial light modulators, optical correlators, and other optical devices. Several papers discussed the exciting progress in smectic FLC displays, including developments at Canon, Denso, Toshiba, and Displaytech.

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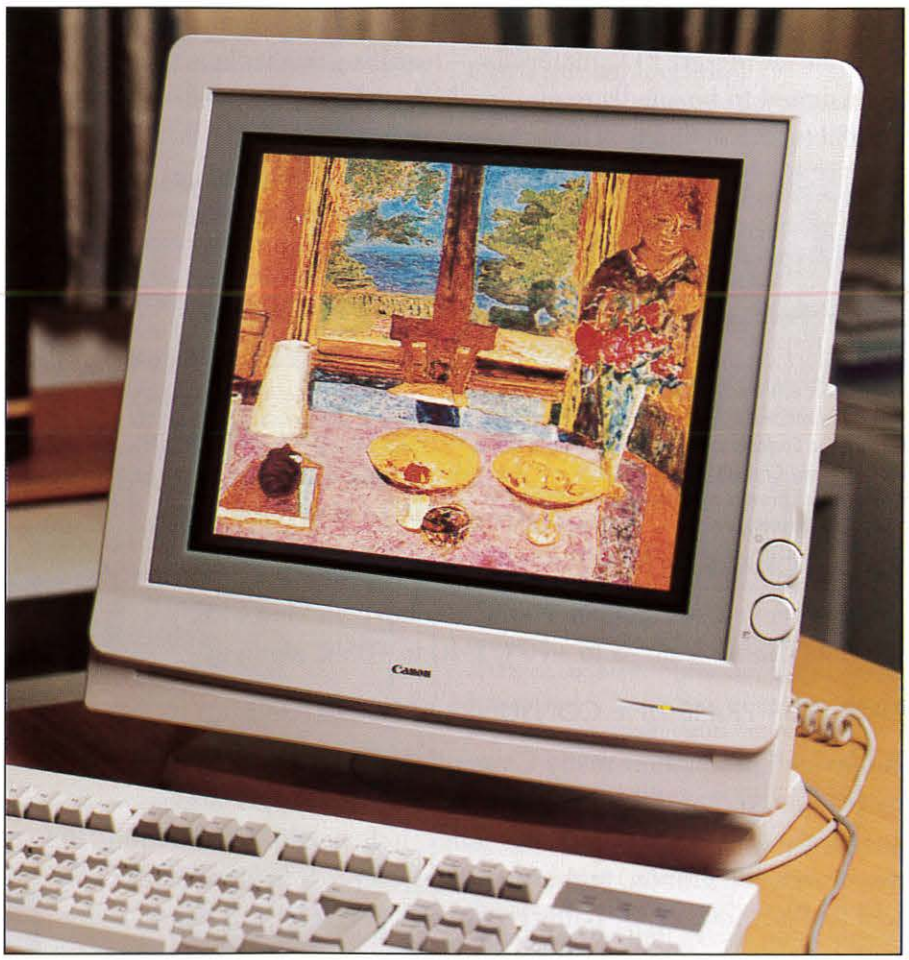

J. O. Yxell

***Fig. 1:** Bonnard's* Dining Room Towards the Garden *(1933), as shown on Canon's first-generation FLC screen. The FLC's complete absence of flicker is ideal for showing art because the screen looks much like a printed page.*

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Commercial Development of Ferroelectrics

It appears that there are four ways in which ferroelectric liquid crystals are being used for commercial displays. These are the passive-matrix bistable FLCD, the passive-matrix anti-ferroelectric LCD, the active-matrix AFLC, and the active-matrix silicon-backplane FLCD. Table 1 summarizes the companies that are involved - to a greater or lesser extent - in developing these displays.

Table 1: Summary of Display Companies and Their Interests

Company	FLCD Passive Matrix	AFLCD Passive Matrix	Silicon Backplane	AM AFLCD
Canon	X			
Casio		X		
CRL	X		X	
Displaytech	X		X	
GEC			X	
Nippondenso		X		
Samsung Display Devices	X			
Sharp	X	X		
Toppan	X			
Toshiba	X			X

The chemical companies supporting the development and production of materials for research and commercial production were also present. The leading company in ordinary FLC materials is Hoechst, which was giving away copies of their 1997 catalogue at FLC '97, while in AFLCs, Chisso seems to be the main supplier. ROLIC, a smaller FLC-material supplier, was also present.

Some electronics companies have developed their own materials: Toshiba for the active-matrix AFLC display, Canon for its passive-matrix FLCD, and Displaytech for its silicon-backplane device.

- Paul Surguy

This table and the accompanying text originally appeared in a slightly different form in Stanford Resources' monthly newsletter Electronic Display World, *Vol. 17, No. 8.*

Large FLCDs

In 1995, Canon brought the first smectic display to market. This 15-in. color display used a cell gap of only 1.1 μm and the quite extreme pretilt of 18° at the alignment surface. It used a so-called C1 chevron-layer structure (see accompanying article by Paul Surguy), and each one of the 1280 × 1024 pixels could have 16 different color states via subdivision into four subpixels.

A spatial dithering technique called error diffusion is used to compensate for the low number of colors, and produces a reasonably good rendition of color shades (Fig. 1). The FLC materials used are a factor of 2 from video speed, which means that they produce moving pictures only across half the screen or when scanning 512 lines.

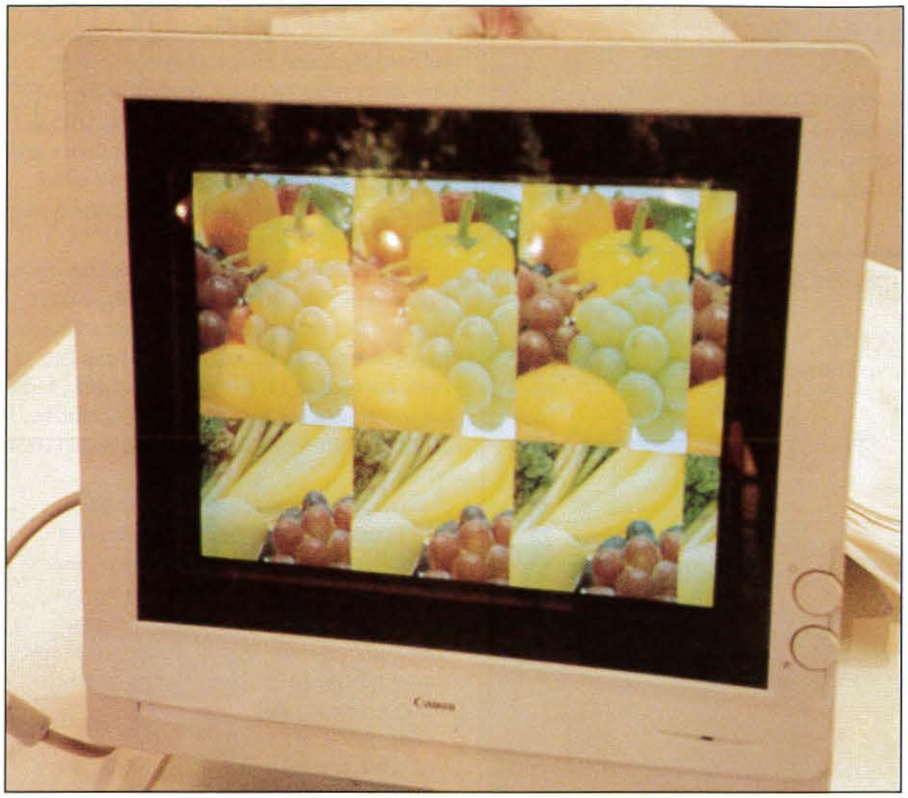
For several years FLC researchers have been awaiting the advent of smectic-C* materials, which are characterized by a temperature-independent smectic-layer thickness. Such materials would make quasi-bookshelf (QBS) structures instead of folding the LC layers into the chevron structures that make the lives of display designers exceedingly complicated. It now seems that smectic-C* materials have finally been engineered with a sufficiently broad temperature range to be able to replace chevron materials. This has important consequences because the QBS structure has a much higher transmittance and also allows zero pretilt. This improves the viewing angle to the hemispherical one typical for all in-plane-switching LCDs.

To show the impact of these new materials, Canon brought a demonstrator to the conference - essentially the old panel, but with some important modifications. The cell gap had been doubled to 2.0 μm, the aspect ratio had been designed for HDTV, and the screen resolution had been increased to XGA level (1024 × 768).

Each pixel is composed of three RGB stripes measuring 100 × 300 μm, each of which is subdivided in turn into four subpixels. This gives 16 different states per color and 4096 different color shades per pixel. The 2-μm gap will greatly simplify manufacturing relative to the panel that is currently being manufactured.

The glass plates with the new FLC material had been inserted in the old frame and were addressed by the same drivers. Because there were not enough drivers for the increased number of pixels, one picture is repeated more than three times over the full screen (Fig. 2). Nonetheless, the demonstrator succeeds in showing that FLC is capable of gray scale even if - on a fine scale - each subpixel has only two states. For this reason, Canon calls the technology "Digital Full Color." The close-up (Fig. 3) and macro close-up (Fig. 4) of the screen further illustrate how the halftones - though generated graphically - are already quite satisfactory. The new chevron-free materials allow an update frequency of 18 Hz in a gap of 2 μm. Dual scan is required for video.

The variety in the similar, but still different, QBS smectic technologies under development in other Japanese companies are equally fascinating. Professor A. Fukuda described how, after years of developing small anti-ferroelectric panels for the automotive industry, Denso Corp. finally decided to aim at large desktop panels. The company now has a prototype with a 17-in. diagonal, video speed, and the easily achievable gray scale characteristic of the anti-ferroelectric symmetric driving scheme. The company hopes to begin large-volume manufacturing in two years - the same time frame as for Canon's new panel.



Bengt Stebler

***Fig. 2:** Canon's prototype has new, chevron-free FLC materials. Reflections are from light bulbs in the ceiling.*

Bengt Stebler

***Fig. 3:** This close-up of the screen in Fig. 2 shows that the generation of halftones is satisfactory although there are no gray levels in the binary-mode FLC.*

At the other end of the size scale, Displaytech, Inc. (Boulder, Colorado, USA) showed their delightful full-color VGA video-speed active-matrix microdisplay using FLC on a reflective crystalline CMOS backplane. In this ChronoColor™ device, 4 bits of gray are generated in the time domain for every color. Although the optical viewer of this 8-mm-square display is still a little primitive, the potential of the device is immediately clear, not only for virtual reality but also for small high-resolution video displays, which are being developed for mobile phones of the future.

Perhaps the most fascinating presentation at FLC '97 was given by Dr. K. Takatoh from Toshiba Corp. on applications of FLC and AFLC materials to AMLCDs. Here is also an example of a rather sensational kind of materials development. If an electric field is applied perpendicular to the optic axis of a chiral orthogonal smectic material, the optic axis will tilt out. This is the electroclinic effect, which has found some uses in the QBS geometry but has been hampered by the very small value of available tilt.

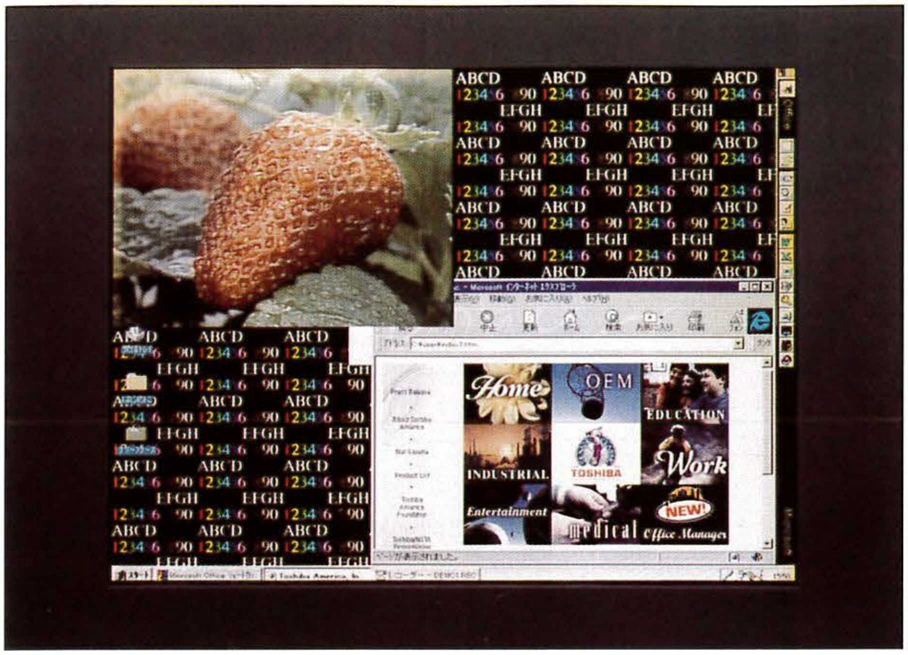
Recently, however, Mitsubishi Corp. has synthesized new materials with a tilt that is an order of magnitude higher - and achieved at a lower voltage. Part of the secret seems to be that these materials are disordered to an extent that is quite unusual in smectics. How the molecules are organized in detail was not revealed, but it looks as if the long molecular axes are tilted completely at random, giving a smectic-A structure similar to a model proposed long ago by the crystallographer A. de Vries at Kent State University.

In Japan these new materials go by the name "thresholdless anti-ferroelectrics," but scientists in the West conjecture them rather to be chiral smectic-A because of the symmetry of the phase. With regard to their very large electroclinic coefficient, one conference participant coined the name "magiclinic materials."

The Toshiba 15-in. TFT panel using these materials in a 2-μm-wide cell gap has breath-

Bengt Stebler

***Fig. 4:** In this macro close-up of the same screen, each of the individual 300 × 300-μm pixels can be seen.*



Toshiba (Photo courtesy of Paul Surguy.)

Fig. 5: The Toshiba 15-in. TFT panel using chiral smectic-A anti-ferroelectric materials demonstrated via video at FLC '97 had breathtaking performance.

taking performance (Fig. 5), as was demonstrated on a video – although an actual display was not shown. With this development, it seems that smectic materials have finally reached a maturity where they can start to challenge the nematic hegemony in passive as well as active displays.

Common to all these smectic technologies is the superior viewing angle from the perfect in-plane switching, the very high speed (in principle, already permitting time-sequential color), and the perfect separation of color and gray shades. (This is in marked contrast to twisted-nematic (TN) displays, in which changes of gray level always influence the hue to some extent.)

Also common to the smectic technologies has been the fact that the panels cannot support pressure – thumb pressure, for instance, which may change the cell gap – without destroying the QBS structure. Fortunately, spacer technologies are now available that render a display rigid, so the know-how is keeping pace with the challenges presented by these promising materials. ■

calendar

Display Technology

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How Ferroelectric Liquid-Crystal Devices Work

Understanding the operation of the various FLCDs presented at FLC '97 makes their advantages and disadvantages clear – and may even make it possible to pick winners and losers.

by Paul Surguy

Ferroelectric liquid-crystal (FLC) phases were known to exist in the mid-1970s, when researchers discovered that chiral liquid-crystal molecules form tilted smectic phases, such as the smectic-C phase.

The lack of symmetry in the tilted and layered smectic-C phase, coupled with the lack of symmetry in the chiral molecules, gives rise to a permanent electric dipole. In the bulk of such a material the molecules twist from layer to layer, forming a helix in such a way that the permanent dipole averages to zero in the bulk. However, in "Ferroelectric Liquid Crystals: A Review," *Molecular Crystals and Liquid Crystals*, Vol. 40 (1976), Bob Meyer speculated that if the helix of a smectic-C FLC could be suppressed by making the FLC layer very thin, then a macroscopic ferroelectric dipole should exist and this might have some interesting bistable properties (Fig. 1).

As shown in the figure, the molecules lie at an angle θ to the plane of the layers and can rotate around a cone. The two stable states

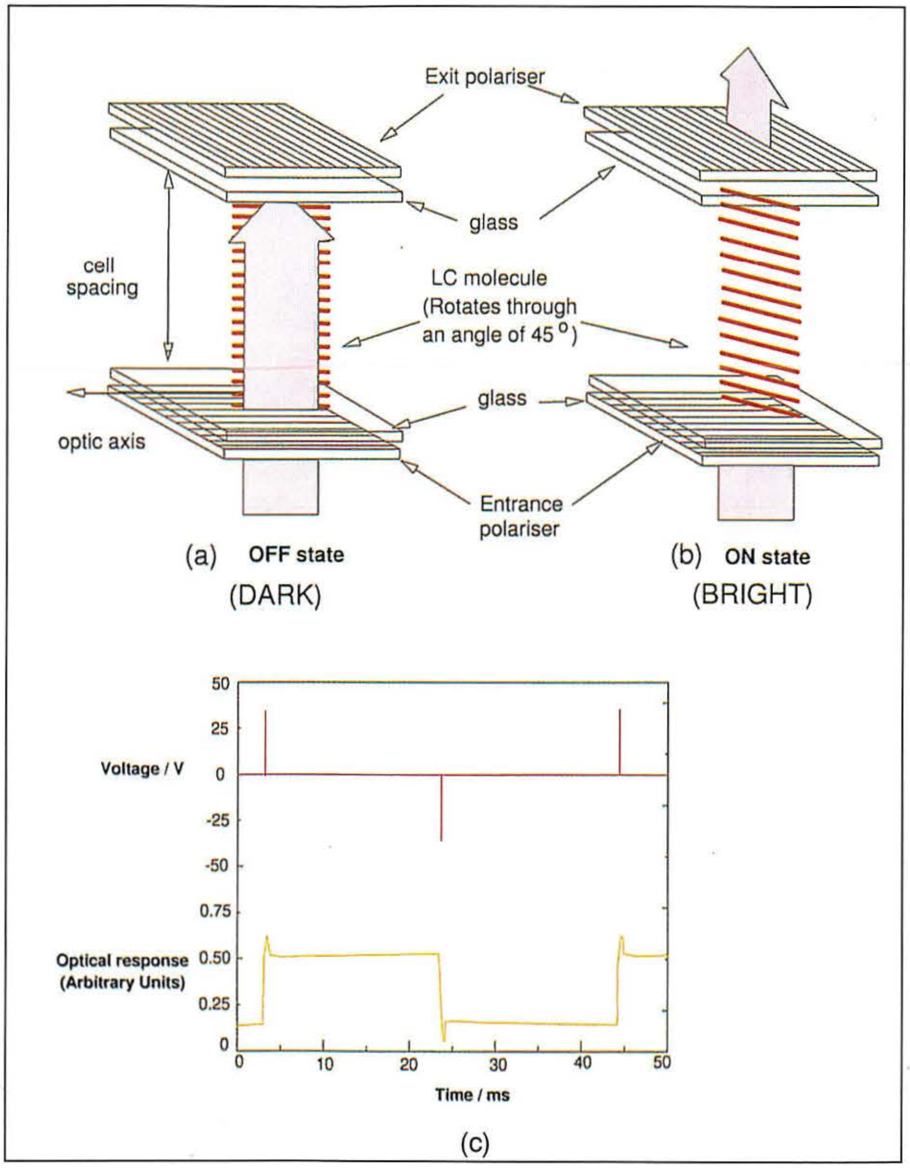

***Fig. 1:** Although their operating principle differs from that of TN-LCDs, FLCDs also have (a) a bright transmitting state and (b) a dark non-transmitting state. The optical response to alternating polarity pulses (c) clearly shows the bistability of FLCDs.*

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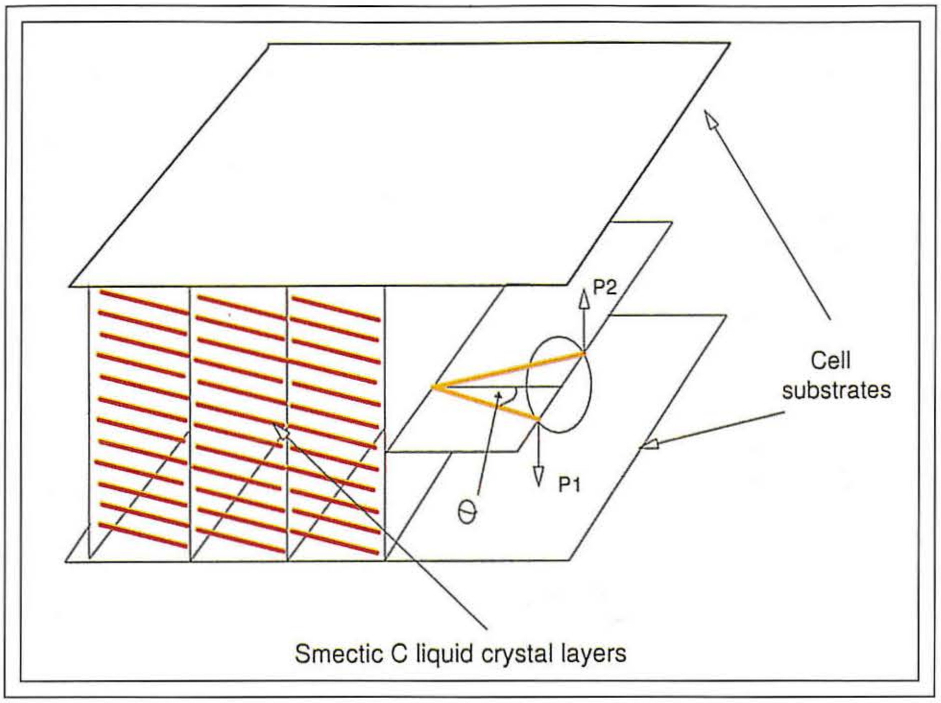


Fig. 2: Like other LCDs, the FLCD modulates the intensity of polarized light passing through it, in this case by acting like a classical half-wave plate – but one whose optic axis can be reoriented by an applied field. Light enters the FLCD through an entrance polarizer, with the light's polarization direction either parallel or perpendicular to the optic axis. The light passes through the FLCD unchanged and cannot emerge from the exit polarizer. Applying a pulse of suitable polarity reorients the FLC molecules so that the optic axis makes an angle of 45° to the incoming polarized light, which is then transmitted.

are on opposite sides of the cone and in the horizontal plane. The orientations of the ferroelectric dipoles of these two stable states are labeled P1 and P2.

Like other LCDs, the FLC device (FLCD) modulates the intensity of polarized light passing through it. The basic principle of operation is that of a classical half-wave plate with an optic axis that can be reoriented by an applied field. Light enters the FLCD through an entrance polarizer, with the light's polarization direction either parallel or perpendicular to the optic axis (Fig. 2). The light passes through the FLCD unchanged and cannot emerge from the exit polarizer, which is perpendicular to the entrance polarizer.

Applying a pulse of suitable polarity reorients the FLC molecules so that, ideally, the optic axis makes an angle of 45° to the incoming polarized light - which sets the angle 2θ–45°. The light is then transmitted according to the equation for polarized light travelling through a half-wave plate.[1] A pulse of opposite polarity would switch the FLCD back to the original state [(Fig. 1(c)].

This is an idealized model of the FLCD since, in practice, the surface molecules don't move as the bulk switches. As a result, there is twisting and bending of the structure, and so-called chevron structures can also arise. But the model does represent a sufficiently good approximation for considering display applications.

Advantages and Disadvantages of FLCDs

The obvious advantage of the FLC effect is the existence of two stable and optically distinguishable states which can co-exist with zero applied electric field. This bistability enables information to be written on a ferroelectric display and be maintained indefinitely without consuming any further power. The same property has a particular benefit for multiplexed passive-matrix displays, in which the information is written a line at a time. In these displays, there is no need to refresh lines where the information does not change because the FLC does not decay with time.

There is, of course, a trade-off when moving images are displayed because the lines have to be refreshed at around 25–60 Hz to prevent movement artifacts. The trade-off is between the number of lines that can be written and the refresh rate, since the number of lines that can be written in a given time is limited by the switching speed of the FLC.

Switching speed is the most frequently proclaimed advantage of FLCs, which can switch in tens of microseconds at room temperature. The switching time is very dependent on the applied electric field, and the faster switching times of a few microseconds are usually only achieved with applied voltages of more than 30 V.

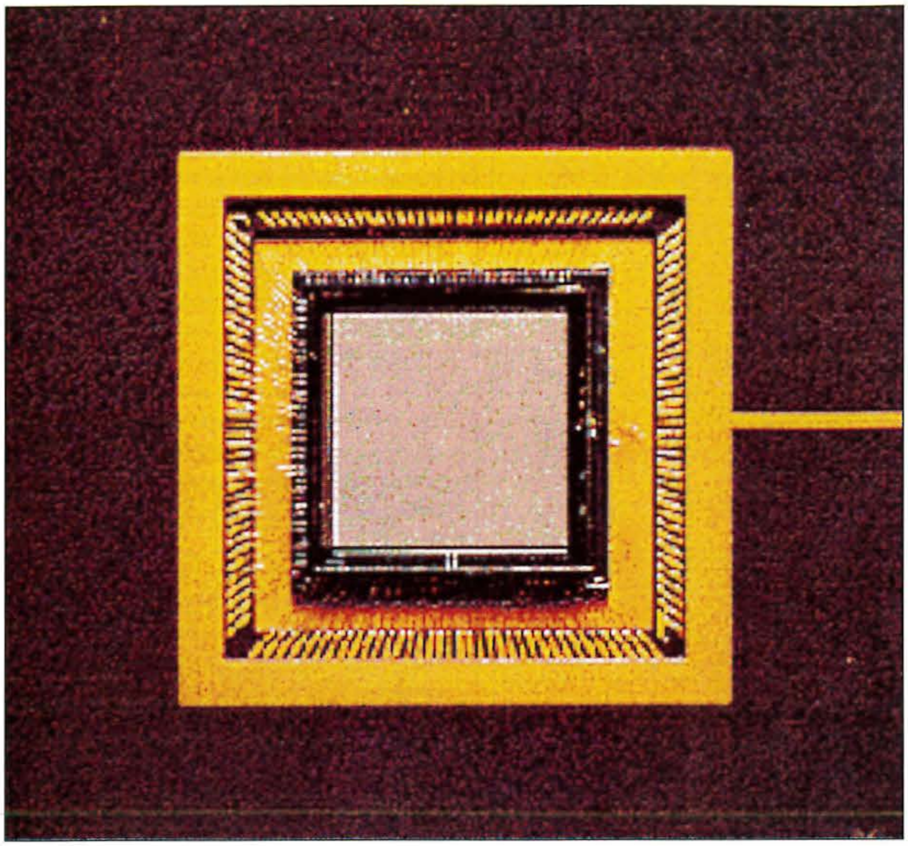
A disadvantage of the FLC effect is that it is inherently binary, which makes displaying gray shades intermediate between black and white more difficult. The usual method of obtaining gray scale involves using subpixels or multiple sub-frames to dither the black and white states in either space or time to create a spatially or temporally averaged gray shade.

In the past, concerns were voiced about the mechanical stability of the FLC structure. The structure was inherently more crystal-like than nematic LC materials, and so more subject to distortion-induced flow when the FLCD was dropped or prodded. This flow disrupts the LC structure, causing the device to fail. Recently, however, more rugged display structures have been developed, which reduce the distortions experienced in ordinary use to a level where no damage results.

At FLC '97, held in Brest, Brittany, France, a range of variants for this ferroelectric technology were discussed (see accompanying article by Bengt Stebler). Here's a summary.

Passive-Matrix Ferroelectric Displays

This original - and simplest - form of ferroelectric display is the one described earlier in this article. It was the subject of numerous R&D projects in the early 1980s, but to date only Canon has taken it to market. Canon, which developed a 16-color 1280-line 15-in. display back in 1992, presented their latest prototype at Brest - a 15-in. 1024 × 768 display using subpixels to generate gray scale. There were four binary-weighted subpixels per color, giving a total of 4096 colors, but the



CRL

Fig. 3: Silicon-backplane FLCDs are similar to active-matrix displays except that the active matrix is formed on ordinary single-crystal-silicon chips, with the FLCD built on top.

aperture ratio was low at just over 50%. Canon demonstrated the panel with only a series of still-video images because the update rate of the screen was not fast enough for a full-motion-video rate.

Although passive-matrix FLCDs were originally hailed as the best way of achieving large-area direct-view displays, they have not yet been proved in this application - mainly because of a lack of adequate means for producing gray scale.

Silicon-Backplane Devices

An important and longstanding use of FLCs has been in miniature displays based on single-crystal-silicon backplanes. These devices are similar to active-matrix displays except that the active matrix is formed on ordinary single-crystal-silicon chips, with the FLCD built on top (Fig. 3). The advantage of these displays over conventional active-matrix twisted-nematic (TN) displays is that they can be written with very high frame rates, making it possible to produce color on the display using the color-sequential technique rather than color filters.

In this technique, color is produced by writing a frame containing just the red parts of the picture and then flashing a red light [usually a light-emitting diode (LED)], then writing a frame of green information and flashing the green light, and finally a frame of blue information and flashing a blue light. This is done at a frame rate sufficiently high for flicker to be imperceptible to the observer.

Because these displays have no color filters, they generally have higher luminous efficiency. They also provide higher perceived resolution because the color is not split into subpixels. The same color-sequential principle can also be used for projection displays, with the flashing LEDs replaced by a color wheel synchronized to the display and illuminated by a projection lamp. This color-wheel technology is already used in some projectors based on the Texas Instruments Digital Micromirror Device™.

Since silicon-backplane displays are limited by the size and cost of silicon wafers - and by the size of the display that can be made with a reasonable yield at a reasonable cost - this technology is restricted to miniature displays that can be used for projection and head-mounted applications.

Antiferroelectric Displays

By far the most popular topic at Brest was antiferroelectric liquid-crystal (AFLC) devices and materials. These are very similar to ordinary ferroelectric materials and devices in that they are fast, have a wide viewing angle, and show some hysteresis - often referred to as tristable switching - so that they can be multiplexed without an active matrix. Unlike ordinary FLCs, they are not fully bistable, so they have the significant advantages of being able to display analog gray scale and being driven by ac waveforms (Fig. 4).

An interesting recent development has been the use of AFLCs in active-matrix-addressed displays. This combination of technologies promises fast-switching displays (for true video rate) with excellent gray-scale fidelity.

Low-Power and Polymer Displays

One of the attractions of FLCDs has been their potential for low-power portable displays: once an image is written on an FLCD, no power is required to maintain it. However, apart from gray scale, two other problems have restricted the use of FLCDs in these applications. One is the low contrast of approximately 40:1; the other has been insufficient ruggedness. In an attempt to overcome these drawbacks, FLCs have been incorporated into polymer networks, similar to the way in which nematic liquid crystals have been incorporated into polymer-dispersed liquid-crystal (PDLC) displays.

What of the Future?

This was one of the questions being debated in the final panel discussion at the end of the conference in Brest. The clear majority opinion was that there is a place for FLC displays - particularly in silicon-backplane devices, where high resolution, high speed, and gray

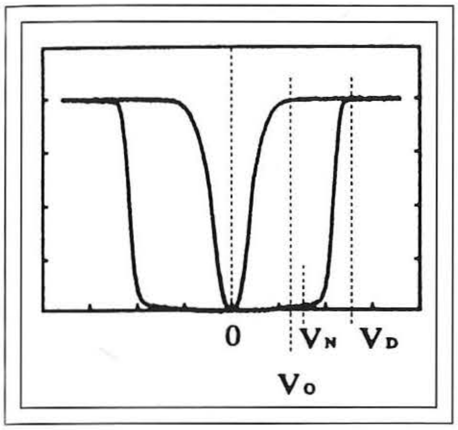


Fig. 4: Unlike ordinary FLCs, antiferroelectric LCs (AFLCs) are not fully bistable, so they can display analog gray scale. In this typical electro-optic characteristic for an AFLCD, the gray scale is selected over the voltage range V_N–V_D, V_0 being the holding voltage that maintains the selected gray level.

scale can be achieved and where there are appropriate applications in head-mounted and projection displays. As far as large direct-view displays are concerned, most attendees seemed to believe that the only route forward was to use AFLCDs on active-matrix substrates. These should be able to outperform conventional AMLCDs - which use a TN effect - in both speed and viewing angle, and thus provide the performance expected of monitors with diagonals in excess of 15 in.

Arguably, this view was confirmed by the 15-in. antiferroelectric active-matrix display that Toshiba presented - but did not exhibit - in one talk. The company said it expected to market the display in about 2 years, after the AFLC material is further developed.

When considering the longer-term future, some people suggested that the price of the silicon-backplane devices could be brought down enough for them to be used in virtual-reality games. This comment was based on the fact that the simple silicon chips used for the backplanes can be made very cheaply in large volume, and that assembly costs and liquid-crystal costs should also be relatively low.

So, for those people who are wondering what happened to ferroelectrics, the answer is that FLCs still appear to be of interest for a range of applications, including both miniature displays and large direct-view passive- and active-matrix displays, and are certainly of great academic interest. The release of high-volume products has, however, not yet been realized. Probably the best hope for the commercialization of this enigmatic technology is the silicon-backplane miniature display.

Note

[1]The equation for polarized light travelling through a half-wave plate is

$$I = I_o \sin^2 4\theta \sin^2\left(\frac{\pi d \Delta n}{\lambda}\right),$$

where I_o is the transmission through parallel polarizers, θ is the tilt angle of the FLC molecule (see Fig. 1), Δn is the birefringence of the liquid crystal, d is the cell spacing (see Fig. 2), and λ is the wavelength of the incident light. ■

SMAU '97: International - and Very Italian

FPD monitors appeared in quantity at Europe's second-largest IT show, but the force was still with CRTs in Milan.

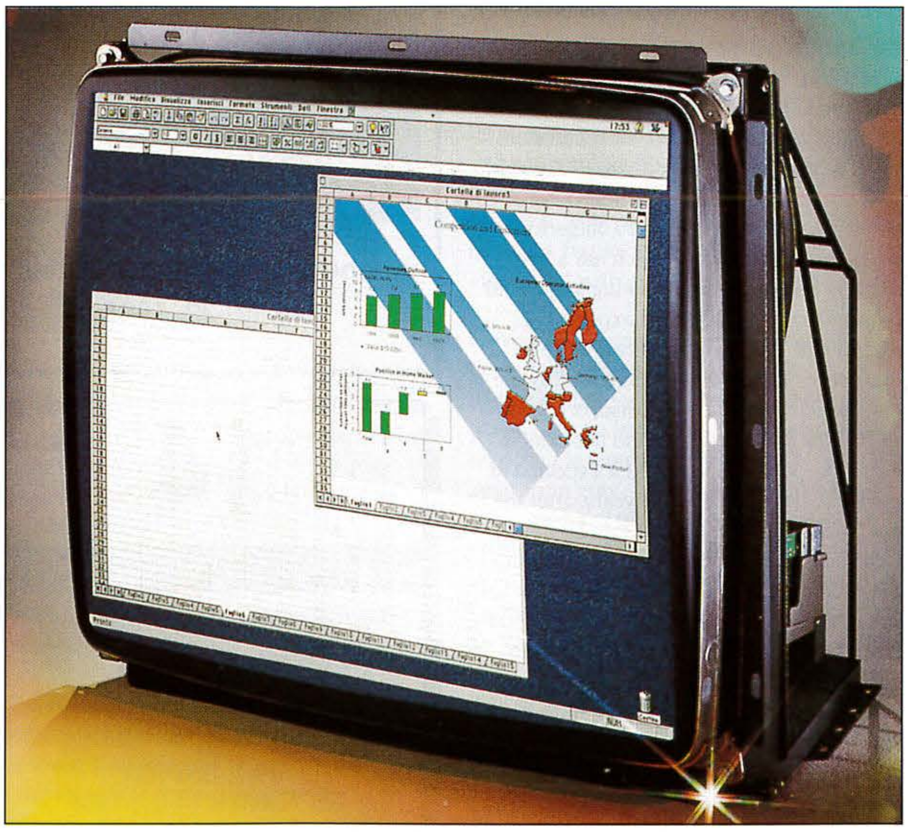
by Bryan Norris

THE International Information and Communications Technology Exhibition (SMAU) - Italy's premier information-technology (IT) trade show and Europe's second largest - was again held at the permanent Fiera Milan site, this time from Thursday, October 2, to Monday, October 6, a little earlier than usual. This 34th SMAU fair was once again larger than the previous year's. There were 2600 exhibitors (compared to 2300 in 1996), with booths occupying 86,000 m^2 (as opposed to 79,000 in 1996) in 24 (compared to 20) of the large halls.

Visitor numbers were slightly down at 357,000 compared to 387,000 last year, despite - or maybe because of - the brilliantly fine and warm weather. Also, the SMAU organizers had designated Friday and Monday as trade-exclusive days, allowing (theoretically) the general public in only on the other three days. Separate entrances gave the different types of visitors specific routes to suit their supposed interests.

The contention that SMAU is international was proved by the significant number of exhibitors and professional visitors coming from a host of countries: Australia, Brazil, Canada, China, Germany, Great Britain, Greece, India, Ireland, Israel, Japan, Malta, Morocco, Portugal, Russia, Spain, Syria, Taiwan, Thailand, Tunisia, Turkey, Ukraine and, last but not least, the USA.

But having said that, the show is unashamedly Italian, both in outlook and in the product portfolios promoted. For example,



Sambers

Fig. 1: There's not much margin in the 14-in. PC monitors still popular in Italy, but several manufacturers are finding healthier margins in public-information monitors. Sambers' EV model is being used in airport installations extending from the new Malpessa Airport in Milan to Australasia.

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Eiki

Fig. 2: Large plasma panels were being used to provide easy-to-read information on many stands at SMAU. A notable example on the Videosel stand was that from the Japanese company Eiki, which has ties to Fujitsu General.

the most popular monitor group on display was still the SVGA 14-in. with (perfectly adequate) MPR-II. By contrast, at the Orbit Show in Basel, held the previous week in neighboring Switzerland, the most popular was the high-end 17-in. with TCO '95.

To put things into a local perspective, during the second quarter of 1997, over 53% of the monitors sold in Italy were 14-in. and only 11% were 17-in. However, in Switzerland during the same period, over 50% of the color CRT monitors sold were 17-in. models and just 2.2% were 14-in.! Nonetheless, most of the new displays from the major VDU suppliers seen in Switzerland were also being exhibited in Milan, together with some unique brands from Italy itself. And there were extra products from many Far Eastern suppliers who recognize that they can sell into the much larger, although not so demanding - in terms of specifications - Italian market.

A batch of local monitor makers, introduced to you in previous SMAU show reports, contributes significantly to the expertise that Italian companies have built up in supplying the multimedia and information-display niche markets with large-screen monitors. Although ***CA&G*** still makes well over 200,000 monitors a year - mostly 14- and 15-in. models - the company continues to look to its 28-, 29-, and 34-in. public-information display (PID) monitors to provide its greatest reward.

Fimi, the local and long-established production arm of Philips, has its factory at nearby Saronno, where the Philips 28/29- and 32/33-in. (16:9) PID monitors are made. Its new PID 600 model on display at SMAU is now being installed in the Frankfurt and Brussels airports. Also still produced at Saronno are ***Philips'*** flagship product, the Brilliance 210CS Cyberscreen®, and the Brilliance 201 21-in. models, plus special monochrome and color 14-, 17-, 20-, and 21-in. monitors designed specifically for medical applications.

Seleco still offers its 28-in. units, but is increasing promotion of its projector ranges for multimedia applications. ***Sambers*** - with production up around 20% in 1997 and its phoenix-like brandname ***Hantarex*** now selling in 60 countries around the world - will make over 50,000 (mostly large-screen) monitors in 1997. Information-display models, such as the EV model (Fig. 1), are being used, for example, in airport installations extending from the new Malpessa Airport in Milan to Australasia. And the Sambers/Hantarex 42-in. standalone plasma-display panel was at last going into volume production. On numerous stands at the show, large plasma panels were being used to provide easy-to-read information, which is the natural function of these products, and a notable example on the ***Videosel*** stand was that from the Japanese company ***Eiki,*** which has ties to ***Fujitsu General*** (Fig. 2).

FPD Monitors

In addition to state-of-the-art plasma monitors, other flat-panel-display (FPD) products took some of the limelight. The measure of excitement generated in Milan by the FPDs heralds their meaningful sales in Italy, most particularly with respect to LCD standalone monitors.

The prize for the most eye-catching stand and LCD-monitor product range must go to the Italian - yes, Italian - manufacturer ***McPerson.*** The host of varied and brightly colored LCD monitors on the McPerson stand - which made the neighboring ***Compaq*** stand look positively dull - included the TFT 10.4-in. VGA, TFT and DSTN 12.1-in. SVGA "Sierra" range, and the TFT 14.5- and 15.1-in. XGA and DSTN 15.5-in. XGA "Tango" range. All were full-featured, including OSD and multimedia (Fig. 3). Established in 1993 - and initially specializing in the production, assembly, and sales of "latest-generation" notebooks and multimedia accessories - ***McPerson*** is located at Pordenone, around the coast northeast of Venice. It is claimed that the new 4000-m^2 factory there has a production capability of over 30,000 notebooks and 60,000 multimedia monitors a year!

But the CRT Still Rules

The trusty CRT monitor was still coming up trumps at SMAU, with considerable enthusiasm being generated by the latest screen size, the 19-in. On view at the show were 19-in. models from the early suppliers, notably the CM751ET from ***Hitachi*** itself on its distributors' stands, ***ADI***'s MicroScan 6P (on distributor ***Digitronica***'s stand), and ***Princeton***'s EO90 on the crowded ***Computer House*** booth.

Newcomers to this screen size, ***Nokia*** and ***Philips*** each managed to show 19-in. units with unique features. The Nokia 446Xpro has a very high horizontal scan frequency (to 107 kHz), and the Philips Brilliance 109 has an optional plug-in USB module.

Other companies showed they would soon be joining the 19-in. club by including their forthcoming 19-in. models on their price lists, although their products were not on display. ***Acer***'s 99c was to sell for Lire 1690k (US$980); ***Compaq***'s V90 was listed at Lire 1924k (US$1116); and in local PC assembler and peripherals distributor ***Intercomp***'s catalog, ***MAG***'s DJ800 was offered at Lire 2000k (US$1160).

LG Italia, now one of the major players in the Italian-branded market, was disappointed that it was unable to show off its 99i. Although the first of these models will, like all the other current 19-in. displays, be fitted initially with the ***Hitachi*** tube, ***LG*** plans to be using its own 19-in. CRT by the second quarter of 1998.

Panasonic too was forecasting that its small-footprint own-tubed 19-in. model would be available in the spring of 1998. In the displays section of the enormous ***Panasonic*** stand - which covered over half of Hall 21's floor area - a special exhibition demonstrated the company's commitment to its new range of compact tubes and, thus, monitors.

All the international monitor suppliers were naturally keen to demonstrate their other new CRT-based products at SMAU. Well-known companies such as ***LG, Mitsubishi, NEC, Nokia, Panasonic, Philips, Samsung,*** and ***Sony*** each had prestigious booths and, in addition, were also promoting their products through their various distributors.

Other international monitor houses relied on distributors to make the show visitors aware of their new models. For example, ***ADI*** monitors were to be seen on distributor ***Digitronica***'s stand, and ***Daewoo*** models were exhibited on the ***Executive*** stand. ***Eizo*** displays were prominent on exclusive distributor ***Epson***'s booth, as well as on numerous other dealer stands, and ***iiyama*** employed ***Concordia Graphics*** to promote its high-end range.

During the show, it was stated that ***Hyundai*** had formed a joint venture called DHI with its major distributor ***Data Pool.*** Meanwhile, ***Datamatic,*** which had been selling ***Samtron*** monitors very successfully in Italy for a number of years, responded to ***Samsung***'s virtual withdrawal of the brand from the marketplace by delivering increasingly significant quantities of the new Korean brand ***Hansol*** to the Italian market.

The Pan-European trend for local PC assemblers to use a branded monitor on their PCs and to sell that brand to bring in "survival" revenues was also much in evidence in Milan. ***Computer House Store*** uses - and sells - ***LG*** and ***Samsung*** monitors; ***Frael*** has ***AOC*** displays; and ***Intercomp*** appeared to be completely converted to using ***MAG*** monitors on its PCs.

It was interesting to note some peculiarly Italian aspects of the Italian monitor market. ***Acer***'s extensive stand included a large monitor-display wall, and the wide range of models offered included the "Basic 14-in." 48-kHz unit [for Lire 379k (US$220)] and the AcerView 34e and 54e 54-kHz 15-in. units [for Lire 399k (US$231) and Lire 449k (US$260), respectively]. ***Lemon Computers*** offers the "economical option" of a 48-kHz 14-in. monitor for Lire 344k (US$200), or a 64-kHz 15-in. monitor for Lire 499k (US$289), a 75-kHz 17-in. model for Lire 1019k (US$591), or a (rarely sold) 85-kHz 20-in. model for Lire 2429k (US$1409).

LG provides its 14-in. 44i for Lire 349k (US$214) and ***Samsung*** the 3Ne 31.5–38-kHz 14-in. for Lire 359k (US$248). ***Semio,*** the local supplier from Florence, was predicting that sales of its Taiwanese-made Boxer and industrial Techno brands would be up nearly 30% in 1997 over 1996, but that the percentage of its 14-in. sales would be down only some 5–10% from the 65% 1996 share.

On the other hand, all the international PC houses now boast a range of high-spec monitors. Local manufacturer ***Olivetti,*** now a subsidiary of ***Piedmont,*** no longer (publicly) offers a 14-in. model, just 54- and 69-kHz 15-in., 69- and 92-kHz 17-in., and 107-kHz 21-in. models! ***ZDS,*** still French in outlook, unveiled its new range of Korean-made moni-

McPerson

Fig. 3: *Italian manufacturer McPerson showed a full range of attractively packaged LCD monitors at SMAU, of which this is an example.*

tors at the show: one 14-in., three 15-in., and two 17-in. models. German ***SNI*** exhibited its extensive range of ergonomically and ecologically friendly monitors, which included the 13.8-in. LCD monitor already selling well in Europe (including Italy).

From the United States, ***Compaq***'s 24-in. Trinitron™-tubed P1610 and its 15.1-in. TFT500 LCD monitor were generating interest, although competing with the company's usual razzmatazz products. A fringe display product in the form of ***Apple***'s "Twentieth Anniversary Macintosh," the 12.1-in. SVGA LCD-PC (with 32MB expandable to 136MB, CD-ROM, etc.) was also attracting a great deal of attention. And, last but not least, ***MicroTouch*** used the occasion of SMAU to announce to the world an agreement with ***IBM*** to market a dual-branded range of one 14-in., two 15-in., and one 17-in. touch-screen monitors.

There was much to be learned at SMAU, which continues to prove its worth as one of the world's major IT shows. It is a *must* for all those interested in the Southern European display markets - and it provides that extra Italian piquancy. ■

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28 **98**

SEPTEMBER

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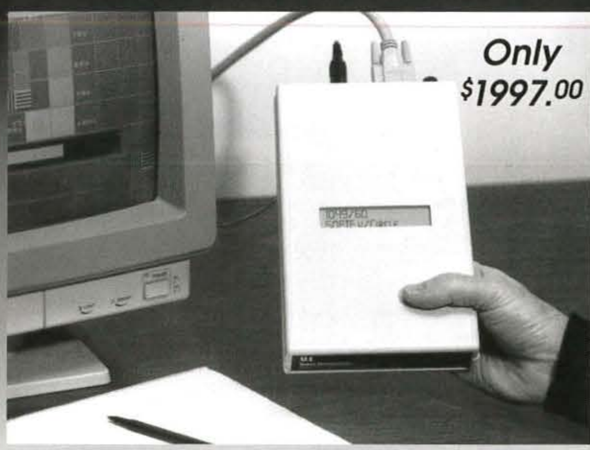


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Circle no. 32

Compiled by EDITORIAL STAFF

Highly reflective mobile color TFT-LCD

Sharp Corp., Camas, Washington, has developed and will begin mass production of the HR-TFT Super Mobile LCD. By eliminating the backlight, this new highly reflective display uses one-seventh the power, is one-third thinner, and is 50% lighter than conventional transmission-type LCDs. The display gets brighter and easier to see as the surroundings get brighter, even in direct sunlight. It achieves a 30% reflective rate of incidental light, a contrast of 10:1, and displays 260,000 colors. The HR-TFT Super Mobile LCD is capable of displaying moving images with a high-speed response rate of 50 msec, comparable to current transmission-type LCDs. Because the display uses a highly efficient reflective function for the picture-element electrode, double images, which have been a problem with transmission types, are eliminated, even when viewing the display from an angle. Production of the HR-TFT Super Mobile LCD will begin with a 2.5-in. model for use in audiovisual products in 1998. This will be followed by models of 4–6.5 in. for use in portable information tools and by 8.4-in. models for use in mobile PCs.

Information: Sharp Electronics Corp., 5700 N.W. Pacific Rim Blvd., M/S 20, Camas, WA 98607. 1-800-642-0261, 360/834-2500, fax 360/834-8903.

Circle no. 1

Two-page color SXGA FPD

dpiX, A Xerox New Enterprise Company, Palo Alto, California, has introduced the Expression 100, a 19-in.-diagonal high-resolution color flat-panel-display (FPD) module that provides a two-page viewing area, bright saturated colors, and wide viewing angle. The largest AMLCD manufactured in North America, the Expression 100 is designed to replace bulky 20–21-in. CRT monitors. Its 1280 × 1024 workstation-class resolution and Digital True Color™ technology support full 24-bit color, and its fast response times support full-motion video at 30 frames/sec – ideal for real-time video imaging applications. The wide field of view is achieved without compromising real-time video rates. Unlike CRTs, it is immune to magnetic fields, and it displays distortion-free images from center to corner. Sample units of the Expression 100 are currently available for under $10,000. Production is scheduled for the first quarter of 1998.

Information: dpiX, Inc., 3406 Hillview Ave., Palo Alto, CA 94304. 650/842-9600, fax -9808.

Circle no. 2

Multimedia pivot LCD

ViewSonic Corp., Walnut, California, has announced the VPA150 ViewPanel®, a 15-in.-diagonal multimedia pivot LCD designed for applications where space, weight, and power consumption are as vital as the need for a large, crisp display. With its unique pivot capabilities through PerfectPortrait™ software, the VPA150 is ideal for spreadsheets and graphics using the regular landscape mode. When in portrait mode, the screen height is comparable to that of a standard 21-in. monitor, enabling it to display a full 8.5 × 11-in. or A4-size page of text. Its slim 6.7-in. profile takes up 75% less space than a 17-in. CRT monitor, and its low 40-W power consumption offers up to 70% in energy savings. Weighing only 12.8 lbs., the new VPA150 ViewPanel® display is extremely portable. Its high performance is due to ViewSonic's LuCiD™ technology that combines an AMLCD with 200 nits of backlight power, supported by 1024 × 768 XGA resolution at a refresh rate of 75 Hz. Other features include OnView® controls, which guide users in making screen and LCD signal adjustments via pushbuttons and an on-screen menu; ViewMatch®, which helps users to match screen colors to printer output; and ViewMeter®, which takes out the guesswork in refresh-rate configuration. The VPA150 ViewPanel® is designed for both PC and Mac® systems. It has an estimated street price of $2195 and an MSRP of $2395.

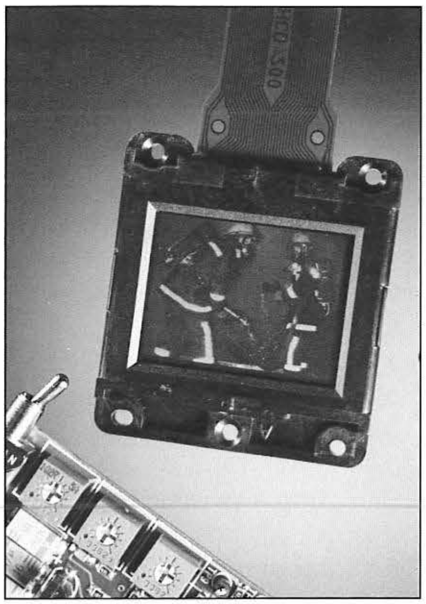
Information: ViewSonic Corp., 381 Brea Canyon Rd., Walnut, CA 91789. 1-800-888-8583, 909/869-7976, fax 909/468-3756.

Circle no. 3

Plug-and-play miniature VGA display

Central Research Laboratories (CRL), Middlesex, U.K., has introduced the VGA2+, a video-interface version of their 640 × 480 VGA monochrome miniature display. The new device retains all of the design features of the VGA1 spatial light modulator and is now compatible with CCIR (50 Hz) and RS170 (60 Hz) video input. Measuring only 34 mm on the diagonal, the VGA2+ supports a full image at full line resolution, allowing programmable image formatting, and accepts a wide input-voltage range. The device comes complete with its own interface to allow users to simply plug and play. Full specification and pricing information will be available early in 1998. Devices will be available with no minimum order quantity.

Information: Claire Harrison, CRL, Hayes, Middlesex, U.K. +44-0181-848-6444, fax +44-0181-848-6677.

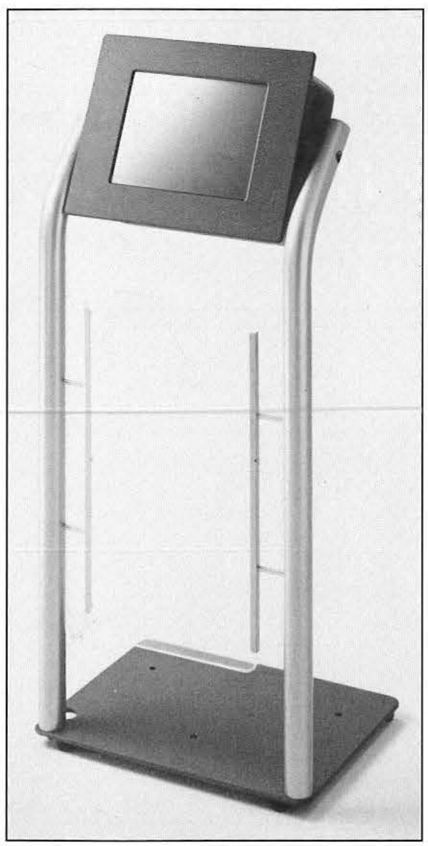


Circle no. 4

Interactive AMLCD touch-screen system

Information Display Systems, Inc., Wilmington, Delaware, has introduced the CustomTouch™ flat-panel interactive display system for public multimedia kiosks. The AMLCD interactive touch-screen system was designed specifically for multimedia operations and as an alternative to bulky conventional CRT-based kiosks. The system features a large, bright screen that users can tilt to a comfortable viewing angle. The benefits to designers of public multimedia systems include design freedom, an attractive platform that can be incorporated into many exhibit styles, and a single screen/computer unit that allows more flexible use of display space. The advantages to businesses and developers are easy integration into retail, lobby, trade-show, and other exhibits; significantly reduced costs; adaptability for multiple uses; and greater convenience for shipping, setup, and maintenance. The system's easy portability eliminates the need for lift trucks and full crews with carpentry skills or technical expertise in multimedia applications.

Information: Edward A. Wesolowski, Jr., President, Information Display Systems, Inc., 1514 Brandywine Blvd., Wilmington, DE 19809. 302/764-8602, fax 302/764-6609.



Circle no. 5

Portable video wall

Pioneer New Media Technologies, Long Beach, California, has introduced a fully self-contained multiscreen projection system suitable for retail, concourse, and hospitality locations. The 100-in. system, which boasts a smaller footprint and lower cost than conventional multiscreen projection systems, consists of four 50-in. projection-cube units mounted together in a lightweight metal-frame cabinet with a depth of only 37 in. The system features an advanced full-function video processor with optional control and interface software. When equipped with a variable scan card, the system can display data and graphic images generated by most PCs. The modular design allows for easy servicing, and the unit can be divided into two parts for convenient transportation.

Information: Pioneer New Media Technologies, Inc., 2265 E. 220th St., Long Beach, CA 90810. 1-800-926-4329, 310/952-2111, fax 310/952-2990.

Circle no. 6

AMLCDs with multisync capability

DATA MODUL, Inc., Hauppauge, New York, has introduced their BATRON 20.1-in. color AMLCD monitor that fills the need for active-matrix displays with multisync capability. Its slim profile, small footprint, and zero emissions are ideal for crowded hospital emergency rooms and financial trading areas. Eyestrain is minimized by the monitor's quick response, superior readability, and high refresh rate, resulting in flicker-free images. The sharp contrast, lack of distortion, brilliant colors, and 1280 × 1024-pixel SXGA resolution are also suitable for CAD/CAM and graphics applications. Equivalent to a 23-in. CRT, the new 20.1-in. plug-and-play LCD monitor has a power consumption of only 72 W, about 35% of that of a CRT, and an 80° viewing angle (vertical and horizontal). BATRON monitors can be customized to meet specific customer needs.

Information: Peter Mazza, DATA MODUL, Inc., 120 Commerce Dr., Hauppauge, NY 11788. 516/951-0800, fax 516/951-2121.

Circle no. 7

Flat-panel 3-D color display

Dimension Technologies, Rochester, New York, has announced the 2012XL Virtual Window™, a 12.1-in. 1024 × 768 XGA flat-panel autostereoscopic display that allows both single and full-motion stereoscopic 3-D images to be viewed in full color. The display is housed in a cabinet that boasts a footprint about 10% that of a conventional display. The 2012XL can be used with a variety of operating platforms and accepts S-Video and standard NTSC input signals. This display provides high-quality images in true three dimensions without the need to wear special glasses or use other cumbersome viewing devices.

Information: Dimension Technologies, Inc., 315 Mt. Read Blvd., Rochester, NY 14611. 716/436-3530, fax 716/436-3280.

Circle no. 8

LED automotive-lighting assembly

Hewlett-Packard Co., Palo Alto, California, has announced the implementation of its SnapLED technology in the center high-mount stop lamps of the 1998 Ford Explorer, available in showrooms now. The assembly enables automotive manufacturers to design integrated exterior tail lamps, stop lamps, and turn lamps using LEDs instead of conventional incandescent lamps. The flexibility of the LED lighting assembly allows automotive stylists to create more innovative designs while delivering lower power consumption. Unusually shaped thin tail lamps accommodating the curvature of the vehicle's body are now possible. Expensive sheet-metal tooling and assembly costs associated with the body cutouts required for incandescent bulbs are eliminated, allowing vehicle manufacturers to increase trunk space. The SnapLED assembly employs HP's TS aluminum indium gallium phosphide (AlInGaP) materials. The LEDs are so bright that they permit a reduction in the total number of LEDs required for tail-lamp and stop-lamp applications. Emitting true red-orange and amber, the super-bright LEDs are not dependent on lens color. The assembly is available now, with some standard-sized modules available for sale and sampling. Actual cost will vary based on design and will provide up to $10 savings per car compared with incandescent-bulb assemblies.

Information: Hewlett-Packard Company Inquiries, 5301 Stevens Creek Blvd., P.O. Box 58059, Santa Clara, CA 95052-8059. 1-800-537-7715, ext. 9967.

Circle no. 9

Portable spectroradiometer

Photo Research, Chatsworth, California, has announced the PR-705/715 SpectraScan®, a portable stand-alone spectroradiometer designed to quickly measure the color and intensity of light sources, displays, and reflective/transmissive samples with NIST-traceable accuracy. The PR-705 measures spectral power distributions in the visible range (380–780 nm), and the PR-715 extends the range to the near-infrared (380–1068 nm). This multiple-aperture (1–6) device is the most sensitive spectroradiometer in its class and can measure luminance levels as low as 0.003 cd/m^2 (0.001 fL). One of the key features that makes the PR-705/715 an essential tool for both R&D and QC/QA testing is its ability to measure areas as small as 0.02 mm (0.001 in.) with the highest accuracy and repeatability.

Information: Photo Research, Inc., 9330 DeSoto Ave., Chatsworth, CA 91311-4926. 818/341-5151, fax 818/341-7070.

Circle no. 10 ■

continued from page 4

"Faster, sleeker, meaner"... "Sumptuous luxury and superb performance." "Responsiveness unlike any other." "An uncommon blend of classic and contemporary design."

"Live now, you've arrived..." Ah yes, here we are at the annual Seattle Auto Show. Seven hundred cars, sport-utility vehicles, and pickup trucks, and I'm determined to look inside every one of them. The goal I have set for myself is to figure out once and for all why there has been such a lack of progress in getting electronic displays into these vehicles. And along with that I want to try to improve my accuracy for predicting what will happen during the coming decade.

I have started my self-assigned task with a preliminary calculation that if I look at ten "cars" - actually there are considerably more pickup trucks and sport-utility vehicles than traditional cars - each minute, I can cover the whole show in about the time it would take me to run a half-marathon. I won't have to cover as much distance; nevertheless, I'll have to move right along, especially if I want to allow some extra time to spend on those models which may have some really interesting displays. Fortunately, I have picked a time when the crowds are still light - but they will most likely be increasing as my tour progresses.

I move quickly from vehicle to vehicle. Most require only a momentary glance. Right away I decide to spend more time with the "concept" cars. I make the seemingly reasonable assumption that they are indicators of directions for the future. However, to my surprise, I see *less* dashboard electronics in the concept cars at this show than I remember seeing in those at shows ten years ago. Most of the emphasis appears to be on heavily sculptured shapes and what to me looks like gaudy styling. Batmobile-based inspirations are prevalent. Bright metallic colors and strangely shaped bucket seats are major trends. The dashboards are all curves and circles and other conical cross sections. But the gauges look conventional and mechanical. No flashing lights and no flat-panel displays.

I look at the new GM electric car, which is being leased in a few selected areas of the country through Saturn dealerships. I am told that the dashboard is electronic and that the display technology is LED. Since it's not turned on, I can't verify that, but the rectangular display box looks small and rudimentary.

Everywhere I look I see conventional round gauges. Finally, at the Cadillac booth I find my first electronic display. But it's the same VFD display that the top-of-the-line model has used for several years now. It's really quite a nice display, with some well-thought-out extra features, but it's only in that one model. The other Cadillac models have mechanical dashboards. The Lincoln Town Car also has a VFD that looks much like the

Cadillac's. But the other Lincolns are like the other Cadillacs - with gauges that are round and mechanical.

More fast-paced looking. By now, I'm doing better than my goal of ten vehicles each minute. Not that I'm rushing, mind you. There really isn't much interesting to see. Mostly, the cars are indistinguishable from one another. I'm beginning to feel like I am lost in a forest of giant, brightly colored metallic jelly-beans.

After a few hundred more cars, I come to the BMW booth. Aha! the gauges are conventional but the 700-series has a built-in global positioning system (GPS). Finally, an electronic display. It's a backlit LCD, just like the one I had on an Avis rental car not too long ago. Apparently, a function has come along that could not be implemented with a round mechanical gauge! The BMW implementation looks like it was inspired by one of the early James Bond movies. It's really quite nice in the way it makes the dashboard look - much classier than the Avis-installed round-post-on-the-center-console, although no different in functionality or appearance from the 5-in. display in the rental car. Well finally, I have found one example of a flat-panel-display application.

At the Mercedes booth, the only hint of electronic displays is for the odometer and outdoor-temperature displays. Not too surprising from this conservative company. But isn't the odometer rather important? Isn't that a risky place to experiment with a new technology? But then, I guess the gas or engine-temperature gauges wouldn't be any less risky.

More cars and more round mechanical gauges. I'm still having trouble accepting that the only thing new that the concept cars are offering is "batmobile" styling.

Another hundred or so vehicles blur by my now-tiring eyeballs. I think I can see the end in sight. I'm even beginning to feel about as tired as I would near the end of a mini-marathon.

One of my last stops is at the Lexus booth. Here I find another built-in GPS system, like the BMW's. It looks even better than the BMW one. The rest of the gauges are still mechanical but the lighting is impressively dramatic. The dials literally glow. Are they using supplemental soft-UV lighting? I can't tell for sure. The dashboard itself is the most impressive I've seen all day. The stereo system is described as top-of-the-line by Nakamichi, with 280 W of audio power. But in stark contrast to the dashboard instrumentation, it has one of the worst-looking segmented-LC displays I have seen in quite some time. The contrast is poor. The colors appear as a dark gray on an olive-green faintly lit background. The symbols are rudimentary geometric shapes. As a representative of the display community, I am embarrassed by what I see. Any VFD would put this LCD to shame.

And that was all there was. Why wasn't there more for us in the display community? And what about 2007? Will there be an automotive-electronics revolution and, if so, when will it happen? Perhaps, the question we must first answer is, **What problem are we proposing to solve in attempting to replace mechanical gauges with electronic ones?**

The mechanical gauges are reliable, they are inexpensive, and they provide a crisp-looking display that can be seen under all lighting conditions. Furthermore, the mechanical gauges "feel" right in an automobile that has its roots as a mechanical creation. The radio and clock can be electronic because they are considered add-ons or accessories subject to upgrading or replacement. But the gauges, they are integral to the soul of the machine - an expression of its character and personality.

Electronic displays don't yet look and feel as robust or precise as their mechanical counterparts. In fact, one of the minor hits of the show was an automobile clock with "real hands" on it. Furthermore, electronic displays don't provide any new capability in these applications. That, of course, wasn't the case in airplane cockpits, where the proliferation of mechanical indicators was overwhelming the available front-panel space and the pilots' abilities for visual information management.

And finally, we must not forget the automotive industry's overriding drive for low component costs. If mechanical gauges are even one cent cheaper than electronic ones and if they meet the minimum functional needs, then cars will continue to have mechanical gauges. It's that simple. It's like writing a mathematical equation. The answer is unambiguous.

If dashboard gauges aren't going to benefit from electronics, then what? The natural opportunity for electronic displays in ground-based vehicles lies in adding new functions such as GPS and in enhancing the already existing ones such as built-in cell phones and audio entertainment systems. Perhaps in the future there will also be voice-responsive computers combined with heads-up displays for interactivity while the vehicle is being driven. These new functions are the ones that will benefit from various new display technologies. Of course, most police vehicles already have laptop computers permanently mounted for easy driver access, as do car-rental airport vans.

Getting the traditional instrument panel - with speedometer, tachometer, fuel-level gauge, and other basics - to go electronic may indeed be **like planting tulip bulbs in February.** In many parts of our world, that is a time of year when the ground is frozen hard and the weather is cold. If you try hard enough, you may be able to dig a hole into this uninviting soil and manage to stick that bulb in the ground and cover it up. But you will most likely freeze your fingers and the bulb may never come up when spring does arrive. Trying to design and sell an electronic-display speedometer into the mainstream automotive market during the next decade may be about as difficult. The spring thaw may not occur until a lot more displays make it into cars by way of GPS, telephones, and entertainment systems. Only then, and if display costs have dropped way below what we can offer today, are we likely to see the dashboard go electronic. Can any of you see this automotive spring thaw occurring any sooner?

I know! ... Here's the answer. What we need is the electronic version of Groundhog Day. How about if each year we pick a candidate display for the automotive market. This display has to be cheaper than the mechanical gauges it seeks to replace. We will put an image of a groundhog on this display, and if the sun comes out and washes out the image so that you can't see the groundhog anymore, we will have six more years of being frozen out of the automotive market. All the news media will come. We will all dress up in fancy suits. And we will all be famous. What a splendid idea!

I fully expect to revisit this topic again in 2006 or 2007 on the tenth anniversary of the by-then-famous Electronic Groundhog Day. But if in the meantime you have some thoughts to offer regarding my prognostications, or you would like to volunteer your services to help organize this important event, you need not wait that long. In fact, I would be interested in hearing from you sooner rather than later. To respond, you can reach me by e-mail at silzars@ibm.net, by phone at 425/557-8850, by fax at 425/557-8983 or by vehicle-with-mechanical-gauges-delivered mail at 22513 S.E. 47th Place, Issaquah, WA 98029. ■

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editorial

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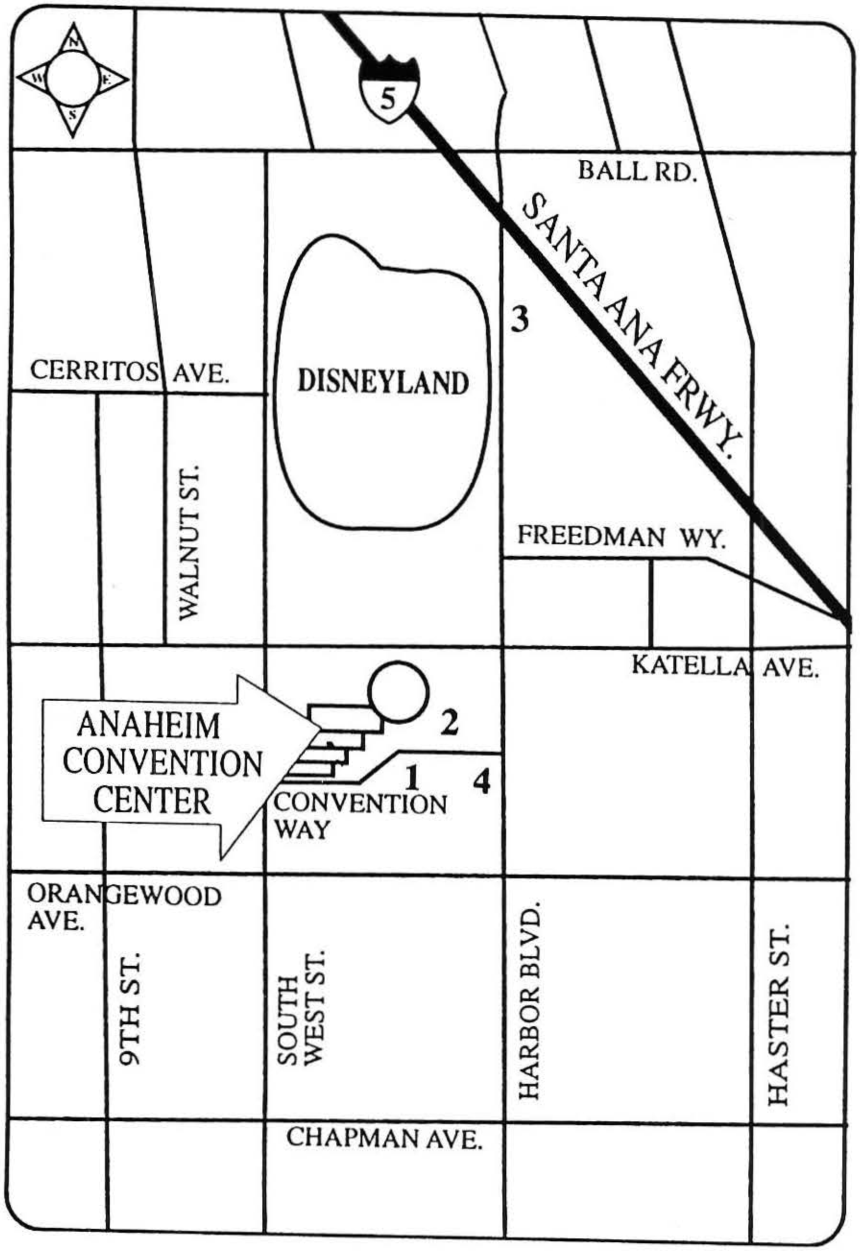
is due, in no small measure, to this portfolio. It was clear that the MPT sees a Japanese technological environment that will look more like the United States' in the future, but it was also clear that centrally directed programs in which the ministries pick technology winners will still play a very large part. That puts a tremendous burden on Japan's technocrats to make the right choices.

For an extended period that ended about 5 years ago, it seemed that the very air Japanese executives and government policy-makers breathed put them in touch with cosmic economic currents, and that they could not make serious mistakes. Toward the end of that same period, the United States seemed to have irrevocably lost its way. Now the magical air seems to be blowing over North America, and all of Asia seems to be floundering.

But one thing we know about winds is that they change. Perhaps they will be blowing Japan's way when her technocrats choose their next list of winners.

– Ken Werner

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



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