FLAT-PANEL ISSUE

Information DISPLAY

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SID

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The Goal is to Accept All Signals and Display High-Quality Images

- *Smart Integration in FPDs*
- *Single-Board Computers*
- *Head-Mounted Displays*
- *Computex Taipei Report*

COVER: Integrating discrete display-interface functions into a single chip can reduce parts counts and manufacturing costs of a computer or multimedia monitor while improving image quality, extending reliability, and adding new user features. The goal is a moderately priced product that accepts all applicable signal types and displays high-quality images.

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- Fluidic Self-Assembly
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- Future of Laser Glass Cutting
- Display Developments in Russia
- Phosphor Requirements

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Information DISPLAY

OCTOBER 1999
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editorial

Snapshot of Cuba

Despite his impeccable revolutionary credentials, Ramiro Valdés Menéndez has the appearance of a Spanish nobleman. With his lean build, cropped hair, and neatly trimmed gray beard, he could be the genuine hidalgo of which Don Quixote is the caricature. But, although Valdés has embarked on a crusade, he is no tilter at windmills.

Ramiro Valdés Menéndez is a Commandante de la Revolución - one of the commanders who fought under Fidel Castro in the Cuban revolution that brought Castro to power 40 years ago. This is a title of great prestige in Cuba, and it appears on Valdés's business card. But he is also President of the Grupo de la Electronica, a division of the Cuban Ministry of Mechanical, Metallurgical, and Electronic Industry (SIME) with 10,300 employees. On the humid morning of Wednesday, July 14th, Valdés assembled a small group of his senior executives to give a presentation to an even smaller group of foreign visitors. The visitors - in Cuba to attend the 4th Ibero-American LCD Workshop, organized by the Ibero-American Program of Science and Technology for Development (CYTED), and SIME's own Electronica 99 - were, in addition to myself, Professor Carlos I. Z. Mammana, Director of the Institute of Microelectronics (IM) at the Technological Center for Informatics (CTI), Campinas, Brazil, and Coordinator of CYTED's Microelectronics Sub-program; Professor Alaide Pellegrini Mammana, Director of the Information Display Laboratory at IM/CTI in Campinas, and Coordinator of CYTED's LCD Network; and Professor Petri Vuorimaa of the Telecommunications Software and Multimedia Laboratory at the Helsinki University of Technology, Helsinki, Finland.

The message Valdés went to such pains to deliver to his small group of foreign visitors was Cuba's readiness - indeed, enthusiasm - for rejoining the global technical and economic community. Here are some extracts from his informally presented comments (as translated by a senior member of his staff).

> We want to locate the areas in which we can work together. R&D is very important to us. We are a small country. Relationship with the world market - primarily with the U.S. - ended with the revolution. For this reason, we established a relationship with the socialist countries. It was a supportive relationship, but R&D was not so advanced, and not targeted to the world market. The communications, informatics, and computer industries suffered as a result. With the collapse of the socialist countries, even this was lost. Since 1995, we have been building up our technological areas and have reorganized them within the government. The Grupo de la Electronica was formed to implement technology in telecommunications, informatics, and computers. When the group was established in 1996, *[the companies that came under its control]* had sales of $60 million and no exports. *[Figures are given in Cuban pesos, or MP. Subsequently, economic figures were equated at 1.44 MP to the U.S. dollar. – Ed.]* Sales were $306 million in 1998, and we anticipate $380 million in 2000. Exports will be $4 million in 1999, and we anticipate $8 million in 2000.
>
> It is a matter of the highest priority for us to maintain and extend this activity.... We must have technological development to introduce technology into industry. This must be a systematic, multi-disciplinary approach, and it

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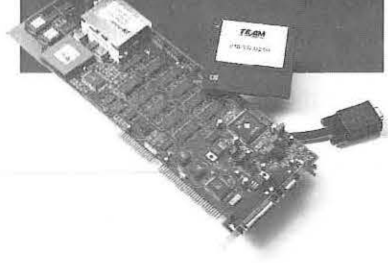

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Circle no. 2

the display continuum

A Great Cup of Coffee ...

by Aris Silzars

"Here, let me make you a cup of coffee." Gianni motioned us to follow him as he got up from behind his desk and walked over to the kitchen counter that was an extension of his modest windowless office. On the counter stood a number of commercial-grade espresso machines of varying levels of complexity and production capacity. A large coffee grinder was positioned between the espresso machines and the stainless-steel sink. An adjacent refrigerator completed the equipment array. "Let's use this small machine that I think will suit your needs perfectly. However, please note that the coffee holder and steam wand are of the same heavy commercial-grade design as in the larger coffeehouse machines." Thus began our adventure into the world of coffee making and espresso machines.

As Gianni continued his demonstration, first came the precise grinding of the recently roasted coffee beans, followed by the careful tamping of this now wonderfully aromatic powder into the fine-mesh metal filter basket. Next came the steaming of the milk that, with a slight repositioning of the steam wand, could be used to create either a cappuccino or a latte. From Gianni's running commentary, I finally learned what the difference is between the two. With each step, Gianni continued his tutorial covering the range of topics from the importance of filtering the water, to the need to control the coarseness of the coffee grinder, to how to adjust the quantity and stiffness of the milk froth, to yet other subtleties, since forgotten, for the process of making repeatably excellent cups of espresso, cappuccino, or latte.

I don't think it would have meant much to Gianni, but I wanted to congratulate him for his excellent understanding of manufacturing process control. I'm sure he wouldn't have known how to respond to my comments regarding "process windowing" or "statistical process control," but intuitively he was doing exactly that. He knew what the "incoming inspection" criteria were for each of his ingredients. He knew at each step what to look for to know that his process was in control, and if anything went wrong, he knew how to relate a particular symptom back to its cause.

Of course, the concluding step in the demonstration was the taste test. As Sally and I each sampled a cup of the product, we had to admit that Gianni had indeed made the best coffee we had ever tasted. As we migrated back to Gianni's modest and paper-cluttered desk, he proceeded to tell us the rest of the specifications of the machine and then wrote out the quotation.

Well, things are never totally perfect. The price was somewhat higher than we wanted to spend. We told Gianni that we would go home and make some measurements to see if the machine would fit our kitchen counter. While in itself this was a true statement, there was an agenda item left unspoken - the one concerning the price.

Perhaps by now you may be wondering, "How does one stumble onto a small business selling espresso machines from a one-room office in a nondescript office building, among car dealers and other merchants with big flashing signs, on a busy arterial, more than twenty miles from Issaquah?" By using the Internet, of course. Being the very thorough person that she is, Sally had started the

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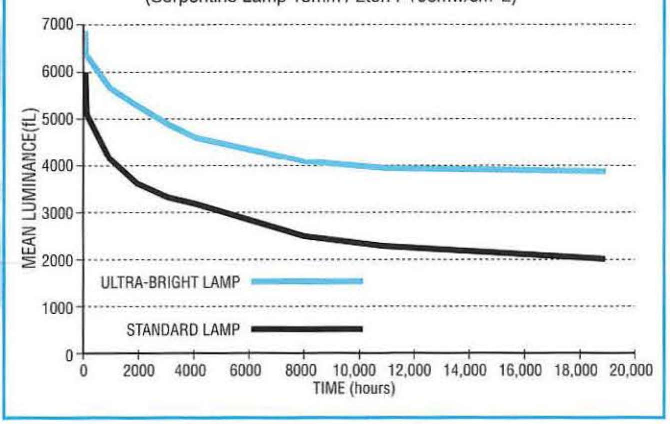

ULTRA-BRIGHT™ vs. STANDARD LAMP MAINTENANCE

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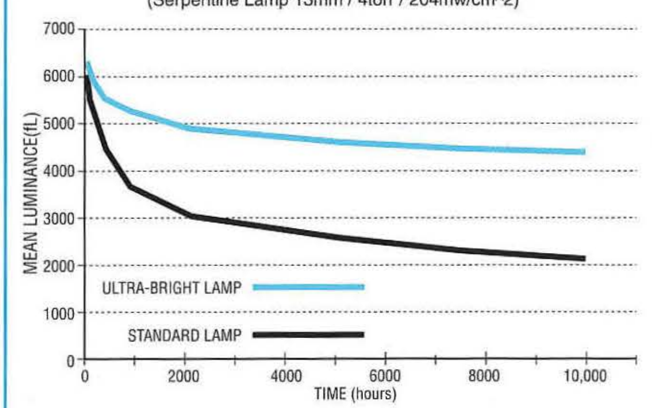

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Smart Integration in Flat-Panel Displays

Using large-scale integration to combine many interface and controller functions on one chip reduces the parts count and improves manufacturability, but there are risks.

by Doug Bartow

FLAT-PANEL DISPLAYS (FPDs) are taking the computer market by storm; the sales growth rates for LCD monitors (LCMs), graphics projectors, and plasma displays are reminiscent of the early days of personal computers (PCs).

To remain competitive in a fast-growth arena, manufacturers can't stand still. They must constantly work to improve their products by lowering costs, improving image quality, extending reliability, and adding new user features. Most of all, manufacturers must enhance the manufacturability of their products, making them easier and less expensive to produce. One key to achieving all these design objectives is to use "smart integration" in the display interface.

Integration of discrete functions into a single chip can reduce parts counts and manufacturing costs - a strategy that has certainly worked for PC manufacturers over the past dozen years. But displays require smart integration because there are significant technological challenges to surmount when combining display-interface functions. Designing high-performance analog and high-speed digital circuitry into an integrated design requires experience in specialized mixed-signal design techniques. An integrated-interface product needs to satisfy cost- and size-reduction goals without sacrificing image quality or manufacturability.

The typical LCM presents many opportunities for integration (Fig. 1). Among them are

- Combining analog interfaces with digital interfaces to provide "legacy compatibility" with over 1 billion PCs in the world today, and still be "digital-ready" for the future.
- Combining interfaces with graphics-controller functions - the primary image-related circuitry in an FPD.
- Reducing the number of interconnects and simplifying board layouts to reduce distortions that affect image quality.
- Adding new features such as USB hub and USB client functions to flat-panel interfaces at little added cost.

Integrating the Analog Interface

Interest in the new digital flat-panel interfaces continues to grow, but the analog interface is still the predominant choice for LCMs sold today. Integrated analog interfaces such as Analog Devices' AD9884A and Philips' TDA8752H have combined all of the traditional analog functions required for a flat-panel interface in a single chip (Fig. 2). This first step in integration has led to lower costs, improved image quality, and simplified board layouts.

Integrated analog-interface chips are being manufactured in high volumes using either mixed-signal CMOS or BiCMOS wafer-fab processes. These high-performance processes are required if the chips are to meet the flat-panel-interface application requirements of high-speed (>100 MHz) analog-to-digital (A/D) converters with linearity specifications (INL/DNL) of typically ±0.5 LSB and input

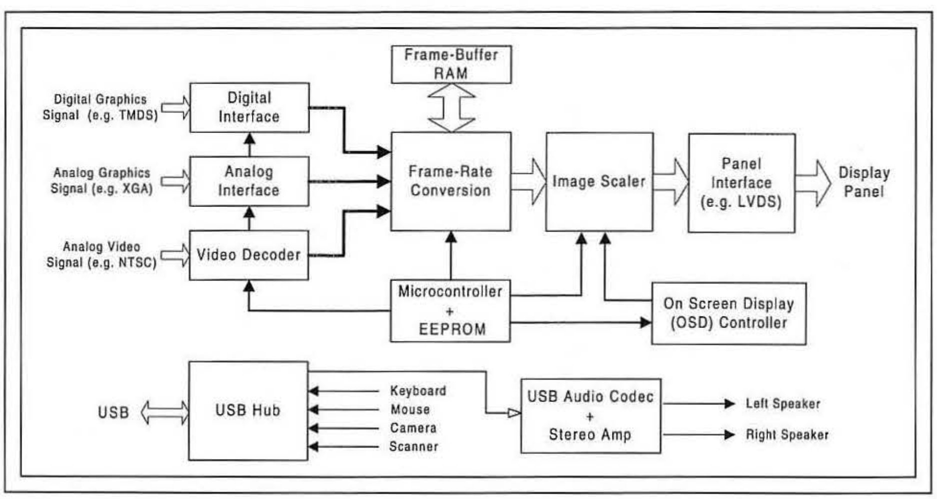

Fig. 1: The system block diagram for a typical flat-panel monitor presents many opportunities for system integration.

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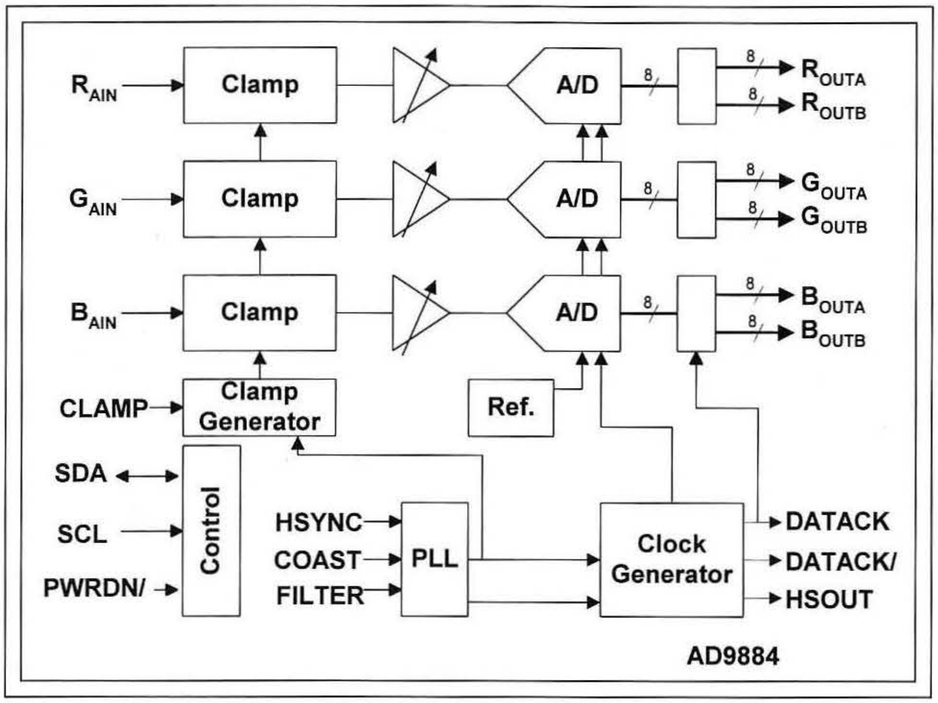

***Fig. 2:** Integrated analog interfaces such as Analog Devices' AD9884A combine in a single chip all of the traditional analog functions required for a flat-panel interface.*

bandwidths of >200 MHz. Standard CMOS wafer-fab processes do not provide the mixed-signal characteristics required to implement high-performance analog signal processing and A/D converters.

Adding the Digital Connection

The next logical step in the integration of flat-panel interfaces combines both analog and digital interfaces on a single chip. This makes it easy to offer legacy-compatible displays that are also digital-ready for the future. More than one billion PCs in the world today have analog RGB display outputs; the analog interface in an LCM ensures that consumers can use their new monitor right out of the box.

A digital interface in the same monitor may encourage consumers to choose a digital connection when upgrading their graphics card or computer system. It is widely accepted that most PC users keep their monitors for 5–7 years, and typically upgrade their PCs several times to take advantage of higher-performance technology before buying a new monitor. Dual-interface monitors allow users to continue to get a long useful life out of their displays.

Both the new Digital Display Working Group's (DDWG's) Digital Video Interface (DVI) v1.0 standard and the Video Electronics Standards Association's (VESA's) Plug and Display standard allow for such dual-interface monitors. Both of these direct-address display standards specify connectors, cables, and electrical characteristics that support dual-interface monitors. Both standards also specify transition minimized differential signaling (TMDS) as the digital interface.

The AD9887 Integrated Interface

The AD9887 is the world's first integrated dual interface for FPDs (Fig. 3). The analog interface is based on the AD9884A Analog Interface Design and operates at up to 140 MHz for SXGA displays. The digital interface uses TMDS to also provide up to SXGA (112 Mpps) image resolution. These interfaces share the same outputs, thereby saving 48 pins compared with a two-chip analog/digital interface design. The chip also provides automatic detection of the interface connected to the monitor, as well as an option that allows the user to select the interface over a serial data connection.

The chip is available in two grades: AD9887-100 for XGA displays and the AD9887-140 for SXGA displays. This choice permits designers to select the most cost-effective solution for their display. The AD9887 is now sampling, with production release set for December 1999.

Cutting Down on Interconnects

The image quality available from an FPD is largely dependent on the design and layout of the monitor interface board. One of the advantages of higher levels of integration in displays is that fewer interconnects between devices can lead to higher image quality. It has been notoriously challenging for display manufacturers to craft their interface boards with "noisy" digital circuits positioned next to noise-sensitive phase-locked loops (PLLs) and A/D converters, and still yield acceptable image quality. David Mentley, vice president of Stanford Resources, said monitor companies "spend a lot of money, time, real estate, and effort to get an analog interface that works without artifacts, and not all of them are successful." Higher levels of interface integration promise to simplify board designs and produce image quality superior to that available in older discrete-component board designs.

Integrating Control Functions

Early graphics-controller products (also referred to as scalers or zoom scalers) such as the Genesis gmZ1 typically contained only the image-scaling function and required that other flat-panel-monitor electronic functions be handled by separate peripheral chips. Frame-rate conversion, a frame buffer, an external PLL, a microcontroller, an OSD controller, and EEPROM chips were required to complete a display board.

Second-generation graphics controllers such as the Macronix 88282 and the Sage Cheetah 2 integrated both scaler and frame-rate-conversion functions on a single chip. Third-generation graphics controllers such as the Pixelworks PW364 controller have integrated all the digital circuit functions on a single chip, resulting in higher image quality, lower cost, and simpler board layouts.

Boarding the Bus

LCMs offer a smaller form factor, which leads designers to consider integrating even more user features into this kind of display. With USB quickly becoming the preferred communications connection for PC peripherals, it is natural to place USB hub and client functions

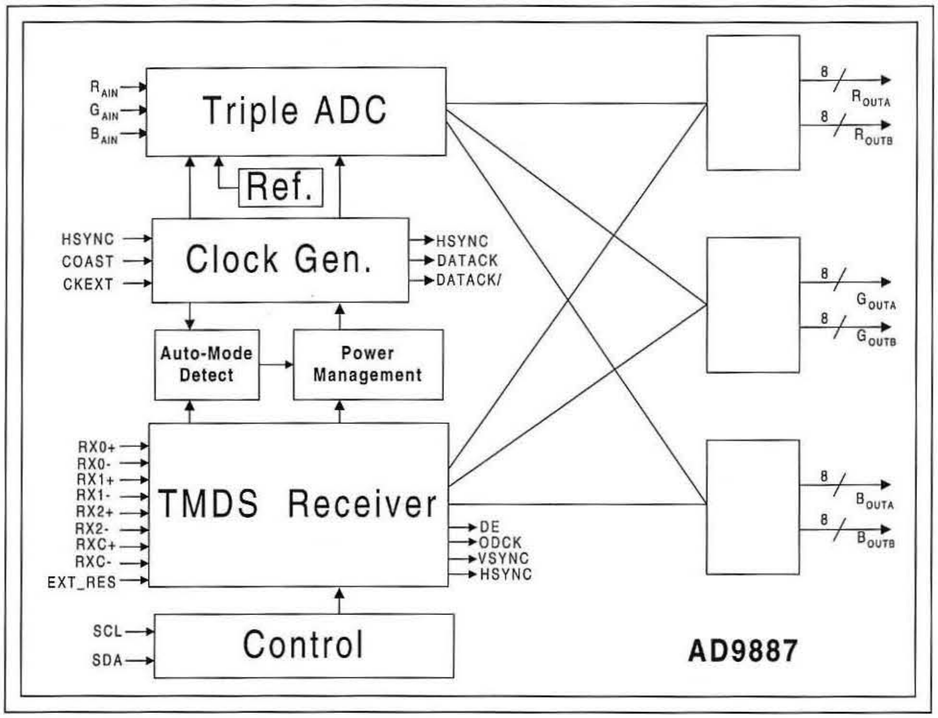

Fig. 3: The AD9887 is the world's first integrated dual – both analog and digital – interface for flat-panel displays. It supports an SXGA screen resolution in either digital or analog format.

in a desktop LCM. The USB 1.1 data rate of 12 Mb/s is sufficient for a wide range of PC peripherals, such as telephones; digital cameras; keyboards; mice; digital joysticks; tablets; wireless base stations; cartridge, tape, and floppy drives; digital speakers; scanners; and printers. The higher bandwidth of USB 2.0 (products will be available in the second half of 2000) will permit higher functionality in PC peripherals, including higher-resolution video-conferencing cameras, next-generation scanners and printers, and fast storage units. The higher data rate (>120 Mb/s) of USB 2.0 will also open up the possibilities of exciting new PC peripherals.

Nearly all of the LCMs on the market today featuring USB hubs have the connectors and associated circuitry located in the monitor base. But the VESA Flat Panel Physical Mounting Interface Standard (FPPMIS) describes a standardized mounting scheme for detaching the monitor base and attaching LCD panels directly to wall and arm mounts to maximize desktop space. To comply with FPPMIS, USB hub circuitry and connectors must migrate onto the monitor electronics board located on the back of the LCD panel. Consistent with smart-integration design strategies, flat-panel-interface products will soon integrate USB hub functions on-chip to comply with FPPMIS, save board space, and further reduce overall monitor cost.

A Question of Complexity

Some graphics-controller manufacturers are designing and producing integrated analog interface/graphics controllers on a single chip. These integrated products are primarily focused on the XGA (100 MHz or less) screen resolution, and promise lower costs and simplified board layouts. Although they emphasize a "single-chip implementation," they often still require one or more external PLLs, microcontrollers, OSD (on-screen display) controller, EEPROM memory, and other external circuitry. These integrated analog-interface/graphics-controller products are typically limited to the scaling of lower-resolution images. Frame-rate conversion is either not available or requires an external frame-rate controller and external frame-buffer memory.

To be cost-effective, this integration strategy requires the use of either a 0.25- or 0.35-μm digital CMOS fab process since the majority of the die area is made up of digital gates. Embedded DRAM processes are being used in some cases to integrate large frame-buffer memory on-chip with the graphics controller, but are not well suited for implementing high-performance analog functions.

To optimize high-performance analog circuitry, a mixed-signal CMOS fab process is needed. Because mixed-signal processes are not commonly used and designers with high-performance mixed-signal experience are still rare, the analog performance - visible as degraded monitor image quality - of these early integrated products suffers when compared to stand-alone analog-interface products.

Test for Success

Integrated-interface/graphics-controller products are true mixed-signal devices that require 100% high-speed mixed-signal electrical testing to ensure the highest-quality performance. Mixed-signal test solutions for A/D converters are now nearly as complex as the chip design itself.

Digital designers are well versed in the development of digital test programs in which test vectors are usually input into automatic-test-pattern-generator (ATPG) software to develop a digital test pattern. Joint Test Action Group (JTAG) boundary-scan and internal-scan techniques are also used to verify 98% or more fault coverage in the digital circuitry. Existing digital logic testers are frequently used to test these digital circuits.

But high-performance mixed-signal circuitry requires "at speed" testing to verify electrical performance. Testing high-speed analog circuitry requires both a test-development engineer to develop code and unique test hardware to make precision measurements of jitter, signal-to-noise ratio (SNR), and linearity of the A/D converters. High-performance mixed-signal test platforms such as the Teradyne Catalyst and the LTX Fusion combine the capabilities of testing high-performance analog circuitry and the high-speed high-pin-count digital circuitry contained in an integrated device. Integrated-interface products that are not rigorously tested using high-performance mixed-signal test platforms may have critical variations in their performance as a result of normal distributions in wafer fab processing.

An "out-of-spec" component can cause serious problems for LCM manufacturers with demanding product schedules and limited engineering resources. For example, consider an interface product with a lot-to-lot variation in a critical parameter that affects only 10% of the lots tested. Should the supplier not be able to screen out all these offending units, the monitor manufacturer would be forced to add additional testing to 100% of its monitors - which adds cost to the finished products. Prudent designers are now asking more questions about how integrated-interface products are being tested to ensure they receive only product of the highest quality.

Moving to the Next Level

Smart integration is the key to increasing the success of LCMs and other direct-address display products. The reduced parts counts can improve image quality, cut costs, reduce size, and make the products easier to manufacture. But the resulting components are highly complex. Unless the components are properly designed and thoroughly tested, attempts at higher levels of integration can produce disappointing results. Engineers need to look beyond product specifications to make sure they have a component that they can count on for their display designs. ■

Are Head-Mounted Displays Going Anywhere?

Just as most of the growth of LCDs has been in new applications, the early growth of consumer-friendly HMDs will be in enabling new packaging of traditional systems and new systems that could not exist without them.

by Tom Holzel

ONE OF THE QUICKEST WAYS to turn any end user off is to replace mundane display equipment that still does a first-rate job with second-rate technology notable chiefly for its novelty. For example, active-matrix LCDs (AMLCDs) have been used to replace the CRTs displaying television programs on commercial aircraft. While the packaging and power advantages of the AMLCDs are enormous, the viewing experience remains distinctly second-rate.

Another novel display technology that has been attempting to muscle its way into our limited attention bandwidth is the head-mounted display (HMD). In this class of devices, a virtual image that appears to hover about 18 in. in front of the viewer is projected directly into the viewer's eyes. Is this another LCD-like "improvement" on the CRT viewing experience? There is no question that the packaging of most HMDs is far smaller than that for the direct-view CRT, and sometimes even smaller than that for the slender direct-view LCD. So in that sense, yes, HMDs can offer packaging advantages. But how does their image quality compare to the direct-view screens of CRTs and LCDs?

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Immerse or Augment?

HMDs fall into two basic types: immersive or augmented. An immersive HMD essentially replaces a viewer's natural vision with an electronic one; an augmented HMD adds information to the relatively unobstructed view of the user.

Immersive displays generally require that the viewer be shut off from the real-world view. This arrangement is often preferred for video games, as well as for virtual-reality devices that allow a viewer to, for example, visualize himself walking - or more likely flying - about an artificial terrain. These displays are often binocular and wide-angle, and require high resolution to create an adequate illusion. Stereoscopy is possible. The apparatus to create such images is generally bulky and covers the head and eyes. Motion sickness can become a problem for some users.

Augmented displays merely create small windows of information in the field of view that lets a user see data while viewing the real world. Generally, the user of an augmented

Minding Your HUDs and HMDs

A head-up (not "heads-up") display (HUD) is a fixed optical system first used in fighter aircraft - and soon to appear in a Cadillac. By projecting a virtual image into the eye of the user, it can be used in a fighter as an electronic boresight that allows a pilot to center the aircraft on a target while still maintaining critical visibility of the surrounding environment. In a Cadillac, a Raytheon-built night-vision sensor will show an image well beyond the range of the vehicle's high headlamp beams.

The difference between HUDs and HMDs is that the former is fixed, and the viewer's eyes must be focused on the sweet spot where the virtual image is visible. The HMD, on the other hand, is attached to the head - or to a helmet; the acronym originally stood for "helmet-mounted display" - so as to move with the viewer's head. This keeps the image centered in the user's field of view.

Other significant differences are that a fighter pilot's HUD images are generally formed on a stroke-written CRT with image luminance as high as 40,000 fL, which can produce a contrast ratio of 2:1 against sunlit clouds. The HUD is generally a large and complicated device, but it is mounted behind the cockpit bulkhead, and thus has the advantage that the pilot doesn't have to wear any of it.

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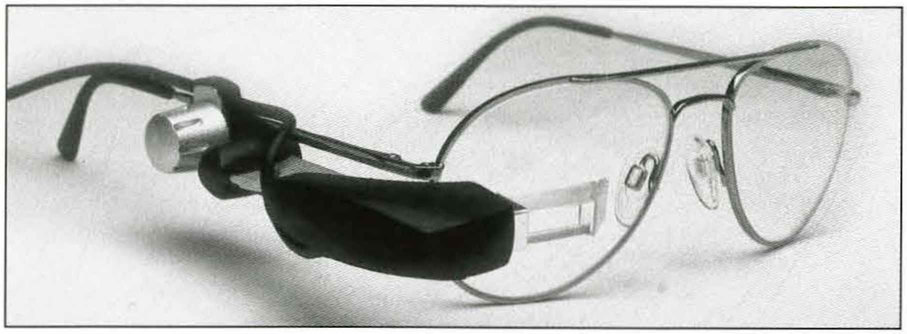

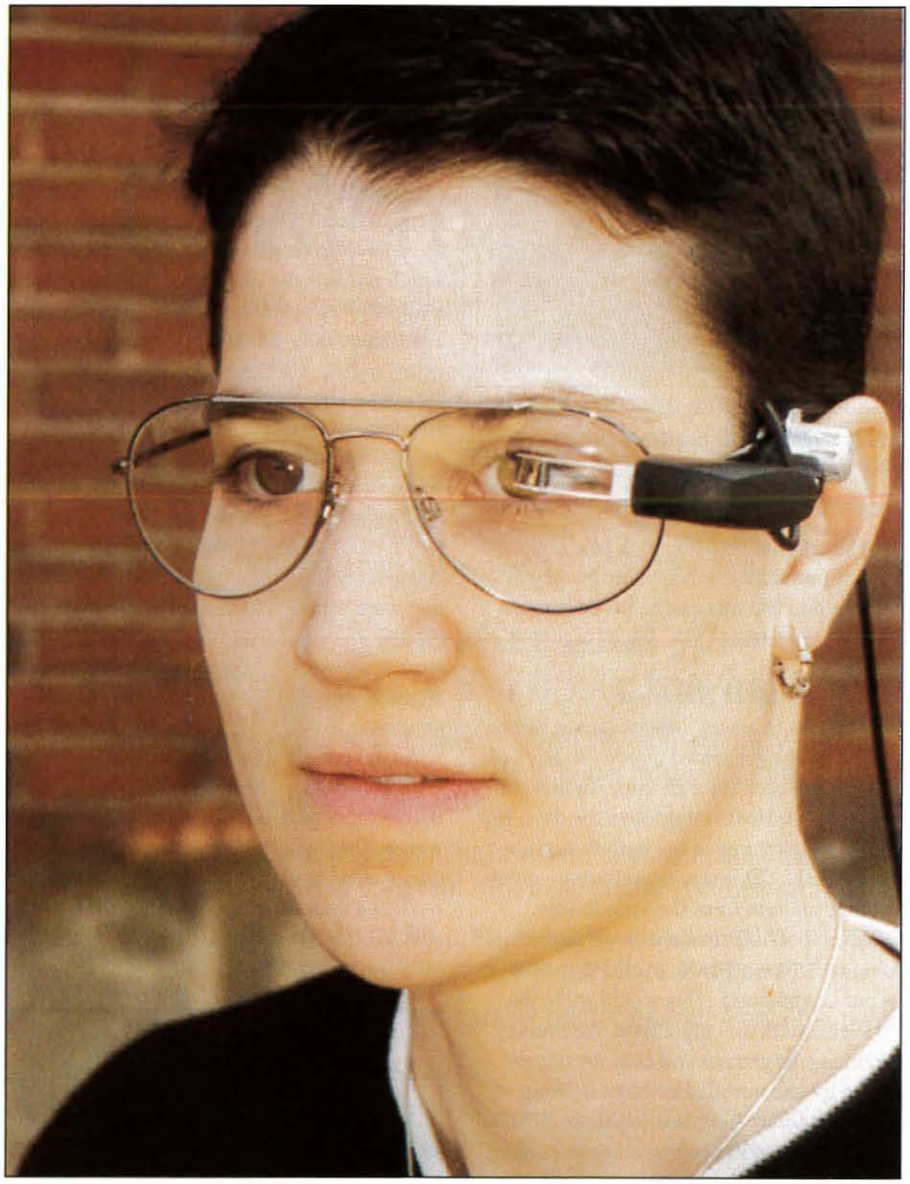

MicroOptical Corp.

Fig. 1: The clip-on version of MicroOptical Corporation's EyeGlass Display (EGD) is light, surprisingly comfortable, and transparent, but intrudes slightly into the side view.

display, while performing a task that requires viewing of the real world, also benefits from being able to glance at supporting data, warnings, *etc.* Augmented displays have a narrower field of view (typically 10–12°) than immersive displays.

Depending on the particular task, QVGA is a perfectly adequate resolution for a simple data display of, for example, speedometer and oil-pressure readings, heart and respiration rates, an oscilloscope waveform without accompanying text, and many sonoscopes.

VGA is needed to read windows-formatted text and icons, maps and circuit diagrams, and dismounted-soldier FLIR imagery. SVGA requires the widest viewing angle, although practical uses for that resolution have not been demonstrated yet. Product designers do not anticipate that users of augmented displays will spend hours reading dense text or poring over massive spreadsheets, applications in which SVGA resolution would indeed be greatly appreciated.

It must be emphasized that a primary benefit of augmented displays is that natural vision is not appreciably obstructed. Thus, a helicopter pilot or a soldier peering at a FLIR image does not lose precious peripheral vision, which is necessary to warn the user of lateral movement. A race driver will not miss sensing another driver trying to pass, and an anesthesiologist will not be prevented from noticing the skin color or movement of the patient that is being monitored electronically.

While HMDs may offer viewing quality suitable for auxiliary information in some applications, in others they offer superior viewing performance. Helicopter pilots flying nape-of-the-earth missions at night quite naturally wish to avoid flying into treetops and church steeples. Current infrared (IR) goggles are huge contraptions that often block forward "natural" vision. But viewing in the IR spectrum is not enough. Computer data is needed as well. For example, night-vision (NVIS) goggles do not have the resolution to detect power lines that can snatch a helicopter out of the sky. So power lines are detected by radar and merged into the pilot's NVIS-goggle view.

Packaging Is Crucial

One feature common to many HMDs is their ungainliness. Fighter pilots refuse to wear any head-mounted excrescences that might brush the lip of their cockpits if they must be

MicroOptical Corp.

Fig. 2: *Many users of the integrated version of the EGD prefer that the combiner cube be positioned high in the field of view so that the view down and horizontally forward is completely clear.*

catapulted out in an emergency. Nearly half of ejectees suffer some sort of injury anyway - generally to the back, or to an arm or a leg that did not quite clear the cockpit. The possibility of having a device attached to the head catch on something on the pilot's trajectory out is too horrifying to contemplate.

Also, at the 9 *g*'s of gravity experienced in a tight turn, bulky HMDs can exert painful added torque on a pilot's neck. Even in normal use, the sheer inertia of large HMDs may prove annoying no matter how well the device is fitted to the user. Civilian users may object to being ridiculed in public because of a cyborg contraption that appears to be attacking the head.

But let's get back to the original question: Is the virtual image as good as that of a life-sized direct-view display? The simple answer is that in most optimal viewing environments, no it is not. The primary reason is that the optics that would be required are prohibitively expensive at this time. This means HMDs will *not* replace laptop screens in the near future except where their use provides temporary or situational benefits, such as a high degree of portability, privacy, or low power consumption. But this can be the case more often than expected.

When an HMD Is Necessary

What happens to a user's 14-in. laptop screen when the passenger seated directly in front of the user leans back for a snooze? In that situation, a clip-on HMD might save the day. But once the seat "returns to the upright position," the full-sized LCD image is preferred - unless streaming sunlight ruins the viewability.

It's even possible to conceive of airlines passing out clip-on HMDs just as they now pass out headphones. This would solve the LCD seat-installation nightmare, the privacy issue, image brightness and contrast issues imposed by uncontrolled ambient lighting, and the tilted-way-back seat problem. HMDs are more efficient to operate, so power consumption is reduced as well.

The MicroOptical Corp. differentiates its unique HMDs by calling its devices EyeGlass Displays (EGDs). The name derives from the fact that EGDs are not attached to the head or a helmet, either attaching to conventional eyeglasses as a clip-on model or being integrated (nearly invisibly) into the eyeglass frames themselves.

The clip-on EGDs have the advantage that the eyeglass wearer supplies his or her own prescription lens and mounting apparatus. Those not requiring corrective lenses must wear plano-lenses - a strong safety feature. The clip-ons can also be shuttled from one user to another, but while transparent, they do intrude slightly into the side view (Fig. 1).

The integrated eyeglasses must be fitted by an optician to ensure that the combiner element is correctly located and facing the pupil. This version gives completely clear vision in all directions (Fig. 2). The tiny combiner cube may be transparent (50%). Being out of focus, it quickly becomes unnoticed. Many users have preferred the combiner cube, which projects the image into the eye, to be in a slightly "up" position, so that the view down and horizontally forward is completely clear.

Leaping the Ergonomic Hurdle

Head-mounted displays have long been an engineering solution unwilling to solve an ergonomic problem. With the advent of lightweight and invisible (or really cool-looking) EGDs, we expect that many product designers will find they have had problems that were waiting for this solution. In certain products now using direct-view displays, the large screens may be replaced by EGDs, or bundled with them to provide a choice of either.

As the optical viewing systems of HMDs - even non-EGD HMDs - improve in quality, become less expensive, and become lighter in weight, they will be able to compete with direct-view displays in many applications. And, in a number of applications, they will be able to offer a superior viewing experience. ■

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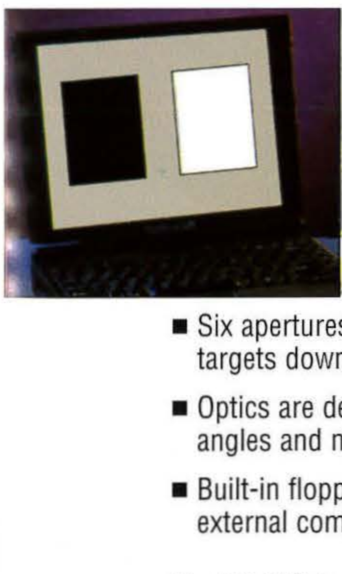

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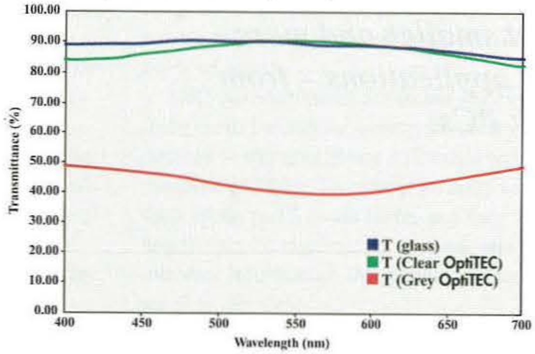
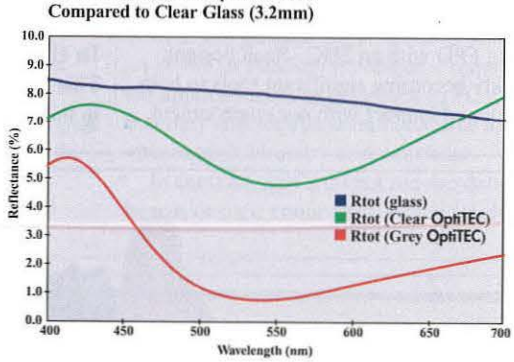
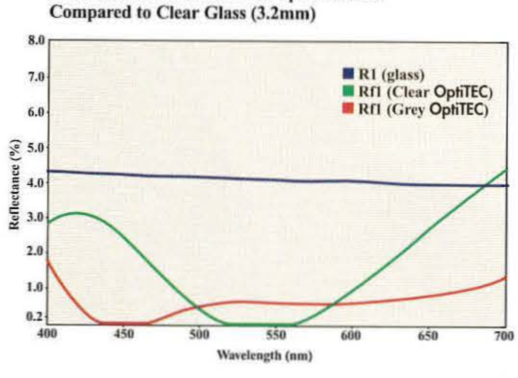


Total Reflectance of OptiTEC Glass Compared to Clear Glass (3.2mm)



Front Surface Reflectance of OptiTEC Glass Compared to Clear Glass (3.2mm)



Pilkington OptiTEC Anti-Reflective Glass Performance Data

Product	Total Reflectance	Total Transmittance	Sheet Resistance
	(%)	(%)	(ohms/square)
Clear **OptiTEC**	<5.3	89.5 +/–1.0	<250
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Single-Board Computers: Expanding Applications for Flat-Panel Displays

As single-board computers (SBCs) get smaller and more powerful, they are appearing in more applications – from industrial controllers to sub-notebook PCs.

by Fred B. Salloum

THE Internet has changed everything. We now view information differently and expect to have access to it anytime, anywhere. Consumer and industrial applications rely on new devices in addition to traditional computers to deliver information in new ways. Liquid-crystal displays (LCDs) - often in combination with touch-screen technology - play a visible role in these new products.

A fourth component, single-board computers (SBCs), is necessary to make information, people, and flat-panel displays (FPDs) work together in the broadest range of applications. These devices can be found in many places where one might not expect to find a computer:

- Automotive navigation systems.
- Systems that track grain-harvest details in a combine.
- Home-security systems.
- Glucose-monitoring devices that reduce the need for repeated injections.
- Golf carts that can provide an overview of the ninth hole's sandtraps or send refreshment orders to the clubhouse.

These devices exist today, and all share a common attribute; they combine a visually appealing FPD with an SBC. Such designs are quickly becoming significant tools to help us control and interact with our environment.

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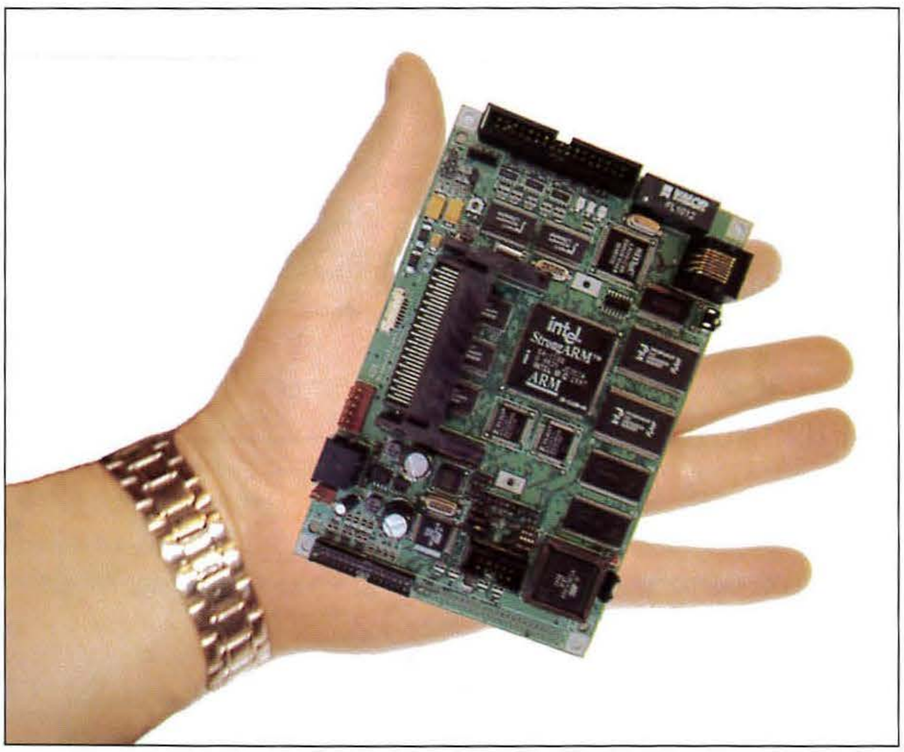
In the Beginning

This communications revolution got its start in industrial process control, where operators



Applied Data Systems, Inc.

***Fig. 1:** Single-board computers (SBCs), such as this ADS Graphics Client, can pack in powerful processing and communications features, and connect to a wide range of displays.*

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on manufacturing floors ran heavy-duty machinery for making industrial and consumer products. New technologies made it possible to achieve greater efficiency by providing better control of the machinery. The term "man-to-machine interface" (MMI) became a buzzword, and the combined use of touch screens, LCD flat panels, and SBC solutions grew rapidly. Operators were able to obtain specific details such as production-run quantities, pressure limits, and temperature levels for the process in real time.

The MMI improvements have allowed the individual to interact with a machine at levels never previously thought possible. Instead of human operators having to monitor the systems to see if they are climbing above predefined limits, an SBC can monitor them. Should a problem occur, the SBC can notify the operator - perhaps with a flashing red light - and possibly fix the problem before the operator even has to look into it. The result is greater efficiency, fewer human operators, and more consistent and reliable operations.

A Growing Role for SBCs

Over the past 15 years, the personal computer has evolved from a machine the size of a desktop to a wireless device that fits neatly into the palm of the hand, communicating with other computers from SBCs to mainframe systems. Computers now "talk" to one another as easily as people talk over the phone, although computers can transfer information at much higher rates. These exchanges can take place across a versatile range of connections, including wired networks, telephone lines, radio waves, and infrared light.

SBC-based systems are in use for everything from barcode-scanning inventory devices to the ubiquitous automatic teller machine (ATM). They help farmers seed their crops and harvest them, and they help health-care workers store, process, and transmit vital information through sophisticated medical devices.

SBC Advantages

One popular device on the market is the PC104. These are complete PC-level computers that can provide the processing power of an 80486 or Pentium processor if required by the application. The drawback to PC104s is that they still require daughterboards to provide support circuitry and interfaces.

In contrast, SBCs do not require daughterboards or their connectors, which results in a more integrated product with fewer components that is easier and less expensive to manufacture. For example, if an application requires an Ethernet network interface, it can easily be made part of the SBC design.

SBCs are cost-effective to produce, and can easily be reconfigured for specific size and shape requirements. Often, the SBC is smaller than the FPD, which gives designers great flexibility in creating new products. While active-matrix LCDs (AMLCDs) remain too expensive for many SBC applications, the lower-cost passive-matrix LCDs provide an affordable solution.

Processing Power

A key component of any SBC is its microprocessor. These tend to be designed for minimal power consumption and for support of a wide range of operating systems.

One popular processor is the Intel StrongARM chip. This reduced-instruction-set computing (RISC) device provides the processing power required to handle sophisticated applications. The chip also has the added advantage of including an LCD-panel controller with software-configurable registers. As a result, the device can be reprogrammed to work with a 3-in. monochrome low-resolution passive-matrix panel or a 15-in. SVGA color active-matrix panel in just minutes. The StrongARM draws less than 200 mW, and there are plans for future generations to draw as little as 30 mW. This frugal power consumption extends battery life in handheld devices. Hewlett-Packard's Jornada palm-top computer is one product based on the StrongARM processor.

In addition to its processor, an SBC must have an operating system (OS). Most applications do not require as complex an OS as DOS, Windows, or the Macintosh OS, but instead can rely on an embedded OS - one that can be stored on a chip within the device. Microsoft's Windows CE is a popular choice for many devices, in part because it is relatively easy to port applications from the regular Windows OS. Other choices include OS-9 from Microware, VxWorks from WindRiver, and Nucleus from Accelerated Technologies. For Web-access applications, it is possible to run Java applications with OS-9 or VxWorks.

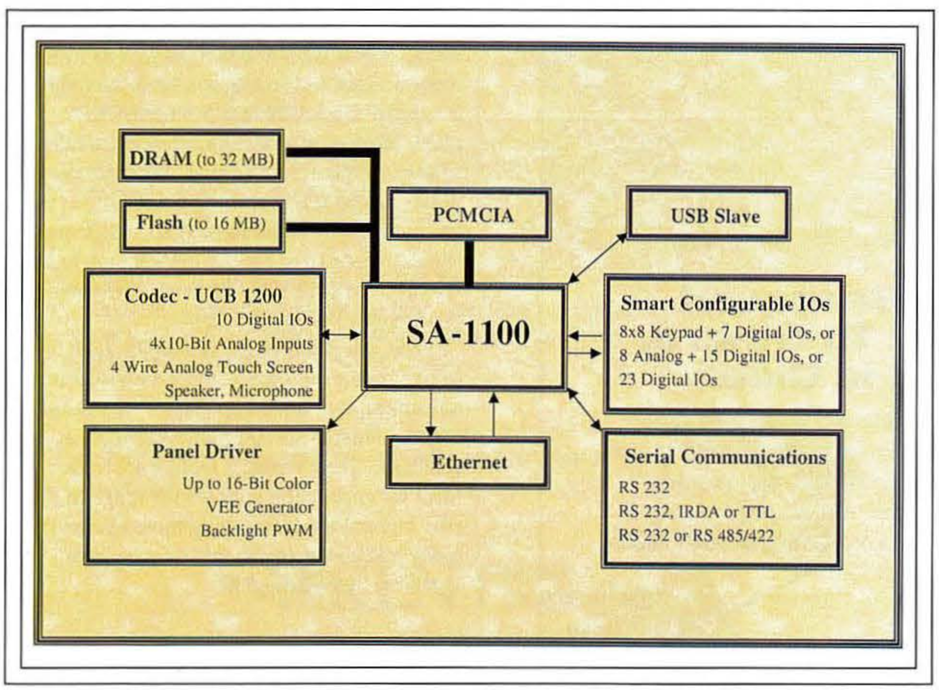

Fig. 2: This block diagram of the ADS Graphics Client indicates the high level of integration on a single board, from Ethernet and keyboard to PC card and display interfaces.

Anatomy of an SBC

The new Graphics Client from Applied Data Systems (ADS) provides a good example of

Circle no. 15

Circle no. 16

display applications

an SBC's capabilities (Fig. 1). The device is only 4 × 6 in. and less than 0.75 in. thick. The one board contains all the circuitry and connectors needed for coupling a variety of input and output components. The actual feature set can be varied to meet specific applications requirements.

The board's block diagram indicates the wide range of support features available on a typical ADS Graphics Client board (Fig. 2). One can easily connect a microphone, speaker, keyboard, numeric keypad, 10BaseT Ethernet, USB, or serial devices. The board also supports Infrared Data Association (IrDA) connections and a PC card (PCMCIA) slot, as well as digital and analog sensor inputs.

Perhaps most interesting are the board's display-support features, which include a programmable digital interface with 8-bit color depth (4092-color palette) that can be configured to work with passive- or active-matrix panels at resolutions from quarter-VGA (320 × 240 pixels) to XGA (1024 × 768 pixels). The board also provides the power and control for a backlight, including the ability to turn it on and off. There is even circuitry to support touch-screen analog inputs.

Small Wonders

SBC technology will help make it possible to expand our access to information in new ways. Still images and text, as well as full-motion video and sound, can be delivered by inexpensive systems smaller than their displays. One may be able to get news, weather, sports, and other information while standing in the checkout line at the supermarket, at the gas pump, or in an elevator. Of course, one should be prepared for this information to be interspersed with advertisements and other product-marketing information.

Their low cost, design flexibility, high level of integration, and small size give SBCs an advantage over other approaches when creating a product to solve a particular applications problem. Their versatile feature set is also ideal for connecting with a wide range of display technologies, including those available today and new displays that may become available in the future. ■

Take a Trip to "Technology Island"

In LCD panel and monitor production, Taiwanese manufacturers are planning to hold most of the cards for a winning hand. Computex Taipei is where the plans unfold.

by Bryan Norris

TAIWAN, OR "TECHNOLOGY ISLAND," as it is pleased to hear itself dubbed, is the world's third-largest IT supplier, with an output valued at US$33.7 million in 1998 (up just 2% over 1997). High-technology products took a 42% share of Taiwan's total exports and accounted for 57.1% of the GDP in 1998. And according to the Marketing Intelligence Center (MIC), "the island's IT industry expects another 14.6% growth in 1999." So one couldn't find a more appropriate location for Computex Taipei, which is claimed to be Asia's largest IT exhibition.

And the exhibition, held June 2–5, 1999, certainly did not disappoint. Its organizers – the China External Trade Development Council (CETRA) and the Taipei Computer Association (TCA) – were proud to report that the show attracted a record number of exhibitors – 912 (97 from abroad). The number of overseas visitors was also the highest ever, with "more than 18,000 overseas buyers from 89 countries." (Show press statements optimistically equate "visitors" to "buyers.") Top overseas contingents were from Japan, Korea, and the U.S.A., with the numbers from Korea up 68%, Poland 100%, and Hungary 514%! The big names count.

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The pre-show information on the Computex Web site looked discouraging from a display point of view since the number of monitor exhibitors was down from 1998. Of this year's 912 exhibitors, 47 Taiwanese companies were listed as supplying color CRT monitors (compared with 64 last year) and 69 as selling LCD monitors (compared with 60 in 1998). Eight suppliers indicated that they still offered monochrome models, and five suppliers were showing large-screen models, which included some home-grown plasma units this year.

But all of the top suppliers were present – including such well-known names as ***Acer Peripherals*** (Fig. 1), ***ADI, MAG, Sampo,*** and ***Tatung*** – and proudly showing off their own leading-edge display-technology products. Among the overseas exhibitors, ***Likom*** (Malaysia), ***Power Industry*** (Canada), ***Samsung*** (Korea), ***Toshiba*** (Japan), and ***ViewSonic*** (U.S.) were promoting their displays. One supplier went for the shrine look to win favor with the people attending – and perhaps with the gods! (Fig. 2)

Prominent monitor suppliers were again occupying a large room each in the Taipei International Convention Center. (This building lies across the road from the main exhibition hall in the Taiwan World Trade Center). The monitor suppliers here were ***Compal, GVC, Mitac, ProView, Tatung, Teco, Action (Axion), Top Victory (AOC),*** and ***Clevo,*** a PC assembler showing LCD monitors. ***Chuntex (CTX)*** was also exhibiting, but was not actually at the official show (although listed in the catalogue). Instead, CTX opted for a more cost-efficient location: a suite at the Howard Plaza Hotel (which is not a place one usually thinks of as Taipei's low-rent district). A number of other monitor suppliers were occupying rooms at the Grand Hyatt Hotel next door.

But one had to be a bit careful when looking for some of the well-known names in the monitor industry this year since a number of companies had decided on an identity change. The brand name ***Amaga,*** for instance, had reverted to its original name of ***Shamrock,*** and ***Operlence*** is the new brandname to replace ***Cheer.*** And the Taiwanese brands ***AOC*** and ***Smile,*** which are well known in Europe, at home go under their company names of ***Top Victory*** and ***KFC,*** respectively.

Vital CRT Statistics

The move to larger screen sizes was reflected in the CRT products on display in Taipei during the show week. There was a marked upward trend in the proportion of 19- and 21-in. models being promoted by suppliers. Of the 325 models listed, 13% were 14-in. (compared with 15% last year), 26% were 15-in. (29% last year), 32% were 17-in. (30% last year), 14% were 19-in. (8% last year), and 6% 21-in. (5% last year). The remaining models were 10-, 16-, 24-in. and above, and monochrome monitors.

As one would now expect, many of the brand-new models boasted excellent specifi-

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CETRA

Fig. 1: All of the top suppliers were present at Computex Taipei, including such well-known names as Acer Peripherals, ADI, MAG, Sampo, and Tatung.

cations. Over half had TCO '95 or the latest TCO '99 certification (as standard or optional), a third came with multimedia options, and nearly a quarter were USB compliant. The trend toward multi-language on-screen displays (OSDs) continued, with a third of the new models having 4–6 language OSDs.

Short Is Smart, Flat Is Chic

Multi-language OSDs are cool, politically correct, and make good marketing sense. But when it comes to CRT-monitor features, it's the latest tubes that grab most of the attention. Seventeen of the new offerings employed "super-flat" tubes, while 13 utilized short-depth tubes. Models using the new 0.25-mm stripe-pitch FD Trinitron® Pure Flat (PF) tubes from Sony were on the stands of ***ADI*** and ***MAG,*** and other models were being shown by ***CTX*** off-site.

ADI unveiled its new PF MicroTron series, which includes a 15-in. (GD570T), a 17-in. (GD790T), and 19-in. (GD910T), all complying with the TCO '99 standard. The company boasted that the 30–70-kHz 15-in. was the first 15-in. "pure flat" monitor available on the worldwide market. The GD790T has a horizontal scan frequency of 30–86 kHz, and the GD910T is capable of running up to 110 kHz, and can thus offer flicker-free images at an ultra-high resolution of 1792 × 1344 at 75 Hz.

To complement its existing Trinitron® range, ***MAG*** showed its range of models using the FD Trinitron® tubes, which comprises a 15-in. model (570FD), two 17-in. (786 and 796FD), and a 19-in. (810FD). The 17-in. models should be available in Q3 '99, and the 15- and 19-in. in Q4 '99.

CTX previewed its forthcoming PF Trinitron® models: a 15-in. model, three 17-in. (the 30–85-kHz PR705F/T, plus the 30–95-kHz PR710F and PR711F), a 19-in. (the 30–110-kHz PR960F), and a 21-in. (the 30–125-kHz PR1400F).

Acer Peripherals' new 30–95-kHz "AcerView" 99g NF uses the Mitsubishi 19-in. DiamondTron™ Natural Flat tube, has a maximum resolution of 1600 × 1200, a USB port, and OSD, and complies with TCO '99. This tube is also being used by ***AmTRAN*** in its new AT1099A, a model destined to be sold by numerous (European) OEM clients.

And seven companies showed new 19-in. short-depth models, namely, ***ADI, Bridge, CTX, Lite-On, Relisys (Teco), Sampo,*** and ***Smile.*** Bridge and Smile also had short-depth 17-in. models on display.

Back to Basics

While it is always interesting to talk about the models that employ the latest tubes and technology, Taiwanese makers also remember that many of their markets still demand more basic fare. Therefore, the show is host to the full spectrum of CRT monitors available. A typical example was the booth of ***Taiwan Video Systems (TVS)*** (Fig. 3), which showed a complete range of displays, from CCTV and 10-in. color monitors to an LCD model. In fact, a total of eight exhibitors displayed 10-in. color monitors, and another eight still had monochrome monitors at the show. Two sup-

CETRA

Fig. 2: One exhibitor went for the shrine look to win favor from attendees – and perhaps the gods!

pliers – ***Chun Yun*** and ***Fancy (Fan Shaing)*** – were continuing to cater especially to high-end information-display markets with a range of large-screen models (24 in. and above).

Bridge had decided to cater to more aesthetically minded buyers by introducing a range of colored 17-in. CRT monitors. Eerily reminiscent of another company's offerings, the BM17 has a white/grey bezel with colored cases and buttons in orange, purple, blue, green, and red. And just in case anyone should think that any similarity to another company was entirely unintentional, the brochure for the BM17 featured the five colored monitors in a flower pattern, with the logo "iMonitor."

Supply-Shy LCDs

There were at least 38 exhibitors showing LCD-monitor displays, and other exhibitors had LCD units for use in non-monitor applications such as point-of-sale (POS) terminals. Of the 142 models we noted, 25% were less than 14 in. (compared with 41% last year), 9% were 14 in. (19% last year), 49% were 15 in. (35% last year), 8% were 17 in. (0% last year), and 9% were 18 in. (5% last year).

The shortage of panels created an odd situation: active promotion of 18-in. LCD monitors (LCMs) was being done only by ***Acer*** (two models), ***AmTRAN*** (three models), ***ADI, Top Vision, Vicam,*** and ***ViewSonic*** (one analog and one digital model). Of the 18-in. models seen last year or this year at the show, only ViewSonic's had already been launched into the marketplace.

There were 12 17-in. pre-production LCM models on display, all, of course, using the Samsung 17-in. panel. On ***Samsung***'s own large stand was an impressive array of TFT-LCD modules and panels. Samsung currently offers 14- and 15-in. XGA and 17- and 18.1-in. SXGA modules for monitor applications. The company's brochure also promises 21.3- and 30.0-in. modules for Q1 '00. (Samsung has been showing prototypes of both displays and early production samples of the 21.3-in. model on the show tour, most recently at SID '99 in May. Rumor has it that Samsung was offered $30,000 for the 30-in. prototype at SID, and that the offer was refused.)

Stars of the Show

On ***Samsung***'s stand, perhaps the star exhibit of the show was a 24-in. UXGA panel, but with no specified production date. Also of particular interest, an SXGA+ 15-in. panel was on show with a resolution of 1400 × 1050, although there was no further information about it.

But in a room in the nearby Grand Hyatt Hotel, an IBM SXGA+ (1400 × 1050) 15.0-in. model – the ITSX93 – was available for close examination. It was extremely thin and lightweight, with a typical luminance of 150 nits. The image clarity was outstanding. The

CETRA

Fig. 3: Taiwan Video Systems (TVS) was typical of the Taiwanese makers who know that many of their markets still demand basic monitors, and therefore produce a wide range of products. In TVS's case, the range was from CCTV and 10-in. color monitors to an LCD model.

viewing advantages of using such a high-resolution panel were demonstrated to best effect by showing an XGA window surrounded by a border with the normal Windows '95 computer icons viewable.

But for sheer boldness and presence, one couldn't really beat ***Acer Display Technology***'s new P420SN 42-in. color plasma-display panel (Fig. 4). With its 42-in. diagonal, the panel couldn't help but attract a lot of attention from passers-by. The PDP module features a luminance of 350 nits and a contrast ratio of 400:1. Rather than use the now-quite-common 16:9 wide-screen format and a VGA-equivalent resolution, the Acer panel has a standard 4:3 screen format and SVGA resolution. Acer's press release claimed that the P420SN was the "very first Taiwanese-made color plasma-display panel."

CETRA

Fig. 4: Acer attracted attention at Computex Taipei with its new 42-in. PDP, the "very first Taiwanese-made color plasma-display panel." First shown in prototype form at the Asia SID (ASID) conference in March, the panel has an aspect ratio of 4:3, 350-nit luminance, and SVGA screen.

"Made in Taiwan"

It seems that being Taiwanese-made is now definitely something to be proud of. Yet, it doesn't seem so long ago that the label "Made in Taiwan" was synonymous in the minds of Western buyers with cheap imported goods. But other Asian labels - such as "Made in China" and "Made in Thailand" seem to have taken over the "low-cost" mantle, and Taiwan has long since lost any stigma in the minds of consumers. The burgeoning IT industry in Taiwan must have played a part in the makeover of Taiwan's image, lending as it does high-tech credibility and respectability to the island's manufacturing activities. Not that Taiwan's IT industry is resting on any past achievements.

Looking at the computer sector in particular, the 1999 production capacity for notebooks is set to rise by 35% to 8.2 million units; desktop PCs by 31% to 16.4 million units; and motherboards by 19.6% to 66.2 million units. The production capacity for monitors is predicted to grow in volume by 13.9% to 56.9 million monitors in 1999, and in value by 3.2% to US$7.8 billion.

In the first quarter of 1999, 13.5 million CRT monitors were made by the Taiwanese manufacturers, the majority of these in offshore plants. Only 10% of those produced were 14-in. models; over 36% were 15-in.; and nearly 48% were 17-in.! Just over 5% of the total were 19-in. models and 0.3% were 21-in. units - a radical move into the market for larger computer-associated screens.

Grow Your Own

These days, the business of producing CRT monitors in volume is beginning to take a back seat. It is clear that many of the Taiwanese monitor producers see their future primarily as makers of LCD monitors rather than CRT models. This is particularly true of those also manufacturing notebook PCs.

The importance of the notebook industry in Taiwan cannot be underestimated and is the main reason why a source of locally made LCD panels is of paramount concern. The combined demand for both notebooks and LCD monitors lies behind the considerable amount of money - 150 billion NT (approaching US$5 billion) - being invested by Taiwanese companies in LCD production facilities and know-how, often in partnership with foreign firms.

There are a number of Taiwanese suppliers, most in partnership with another company, currently committed to setting up LCD-manufacturing facilities: ***Acer Display/IBM, Chimei Optoelectronics/Fujitsu, Chunghwa Picture Tubes/Advanced Display Inc. (ADI), Hannstar Display/Toshiba, Prime View International, Quanta Computer/Sharp,*** and ***Unipac Optoectronics/Matsushita.*** Once all the planned production facilities are up and running, which should happen by the end of 2000, Taiwan will become the third-largest panel-producing country, after Japan and Korea. Let the good LCD times roll.

It was initially expected that the Taiwanese panel producers would concentrate on the smaller-screen panels, but their prime target seems to be the 15-in. segment! ***Chunghwa Picture Tubes (CPT),*** the most advanced Taiwanese panel supplier, began shipping its first few thousand mass-production 15-in. units in May. When a second production line comes on-stream in 2000, CPT will have a final monthly panel capacity of 20,000 (15/14-in.) units, most intended for the notebook market. Incidentally, CPT's partner ADI is itself a partnership of Mitsubishi and Asahi, and Mitsubishi intends to buy 30% of CPT's LCD output. And CPT is a subsidiary of Tatung, which showed a 15-in. LCM at ASIS '99 in March that used a Mitsubishi LCD similar to those CPT has now started to manufacture itself.

Acer Display Technology will be meeting its target to supply its first 15/14-in. panels in August. The company intends to build up to over 6000 units a month in 1999 and to 30,000 a month when a second line comes into production in 2000. And not to be outdone, ***Chimei*** plans to have three product lines, one with a final capacity of 15,000 and two with a capacity of 20,000 panels a month. These three product lines will come into operation by Q4 1999, 2000, and 2001, respectively. (Some of the AmTRAN 15-in. preproduction LCD monitors on show had Chimei panels in them!)

So growth with diversity is definitely the theme for the coming year among Taiwan's monitor suppliers. Not to be outdone, Computex Taipei has its own plans for expansion in the new millennium. The 2000 exhibition, to be held June 5-9, will be even bigger, with 300 more booths in a new Exhibition Hall built for the purpose on an adjacent site. ■

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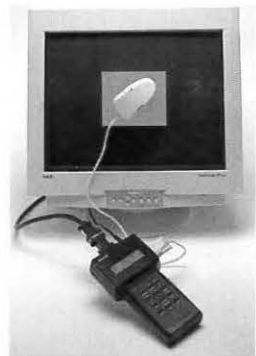

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continued from page 2

must use commercial organizational tools. Technical and financial resources must be allocated. We must DO this. This is for today, not for tomorrow. Things are changing, and we want you to know about the possibilities and opportunities. We invite your suggestions and your ideas for the mechanics of implementation. (Acknowledging the philosophical change that these statements represent, Valdés said with a smile, "Some of this may sound sacrilegious, but we must do it.")

In a subsequent electronic slide presentation, Group Vice President Daniel Fernández López informed us that the Grupo de la Electronica contains 32 state-owned companies and, to my surprise, 10 companies in a separate system of private companies *(sistema empresarial privada),* five of which are in Cuba and five in other countries. There are now programs in various stages of execution in a variety of areas, including solar cells, digital-television development, ecological vehicles, industrial automation, telecommunications devices, microcomputer parts, and Internet-focused information systems.

From conversations with members of the Grupo de la Electronica, non-Cubans familiar with developments in Cuba, and my own observations on this very brief visit, I present you with the following snapshot of Cuba taken on a hot, sunny, and humid day in mid-July of 1999.

Cuba remains a desperately poor country with a reportedly ill-managed agricultural system that seems to provide a limited variety of foods. With only a few exceptions, the areas of Havana I visited (with absolutely no restrictions - just hail a taxi) ranged from being shabby to being in a state of dangerous disrepair. But the increasing openness of the country to tourism in the last few years is providing hard currency, and some of it is being used to restore both historic buildings in the old city of Havana and apartment blocks in residential areas. I also saw two instances of new apartment construction.

An Hispano-American, who has family in Cuba he visits regularly, told me that 4 years ago things seemed completely hopeless in Cuba. Now, there is optimism. A black-market cigar seller in the old city was more cautious. "Some things are better for ordinary people," he said. "Some things are worse." But tourist dollars were very much in evidence - and not excluding the cigar-seller's pocket.

Although there was a healthy sprinkling of tourists throughout the old city, few of them were from the U.S. - although numbers have been increasing over the last year, perhaps to 30,000 or so. I was repeatedly taken for being French or German by taxi drivers and vendors in the market in the old city.

Despite Cuba's poverty and crumbling infrastructure, it has a great strength: a high-quality system of 47 universities that have produced a substantial scientific and technological work force. There are over 62,000 science and technology workers, according to the Grupo de la Electronica, nearly 29,000 of whom are high-level (university-trained) specialists. There are 30,000 informatics-related specialists, 200 with a Ph.D. in electronics. There is one university graduate for every 15 inhabitants and, according to UNESCO, 1369 scientists per million inhabitants.

A Mexican electronics professor who has Cuban exchange students said they were motivated and well-prepared. A group of English majors (five, I think, but I might have missed one) from Cuba's Santa Clara University provided translation services at Electronica 99. I was impressed by their combination of seriousness concerning their assignment and good humor in what must have been a high-pressure situation. Indeed, this combination characterized the educated Cubans I met. They were typically efficient and knowledgeable, which was quickly accompanied by warmth and good humor once a personal relationship was established.

Private-sector business people from Brazil and Sweden told me that the Cubans had proved themselves good partners over the last three years, being honest, efficient, and prompt, and showing in the arrangements they made an understanding of the need of private-sector companies to make money.

During the time I was in Havana, I was told that the President of the U.S. Chamber of Commerce was also there. This information was communicated by Angel Lorenzo Turuceta, SIME's international relations specialist and official problem-solver for Electronica 99 attendees. He was obviously pleased.

Cuba's need and desire to partner with companies from around the world, including U.S. companies as soon as U.S. law permits, offers attractive - if modestly sized - opportunities for technology companies in a variety of areas, including electronic displays. Cuba's combination of technical sophistication, limited resources, and awareness that its special economic and political situation creates a need (and opportunity) for some unconventional solutions can make those opportunities challenging and rewarding for creative companies that listen to their customers.

- KIW

I would like to acknowledge, gratefully, the independent information and insights pro-

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

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SID news

* * * OBITUARY * * *

Koichi Miyaji Remembered


Koichi Miyaji

Dr. Koichi Miyaji, former President of the Shibaura Institute of Technology and founder of the Japan Chapter of the Society for Information Display (SID) in 1975, passed away on September 5, 1999, at a resort hospital in Nagano prefecture.

Dr. Miyaji was elected a Fellow of the SID in 1977, the second Japanese citizen to receive this honor, and in 1990 became the first Japanese recipient of the Beatrice Winner Award (now the Lewis and Beatrice Winner Award) for his invaluable contribution in establishing the Japan Chapter of SID. Dr. Miyaji served as conference chair of the first and second Japan Display Conferences in 1983 and 1986, respectively. He thus has been given credit for creating the present Japanese display community.

Dr. Miyaji was always deeply interested in fostering display technology. He attended almost all of the SID Japan Chapter meetings and gave us proactive opinions. He attended SID '99 last May in San Jose with his beloved wife Sachiko.

Dr. Koichi Miyaji was also a world-renowned dance critic, writing under the pen name Toshio Hayakawa. In fact, he was much more famous as a critic than as a display engineer. He was asked to write many critical articles in newspapers, monthly magazines, and books. Many world-famous dancers, such as Margot Fonteyn, were eager to hear his opinions on their performances, and they would wait for his arrival at Kennedy Airport when they heard Mr. Hayakawa was coming to New York.

The Japanese, Asian, and global display communities deeply feel the loss of Koichi Miyaji. Our sympathy is extended to Sachiko, their two children, partners, and grandchildren.

Please be kind enough to pray for a moment that his soul may rest calmly.

- Akito Iwamoto
SID Regional Vice President
Asia Region

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process of learning all about espresso machines by not only looking in specialty stores but also doing a search using our computer. She quickly learned that most of the specialty stores weren't so special after all. Most of the clerks didn't know the products they were selling, the products were not all that great, and at least here in Seattle (Latteland?), the prices ranged from too high to exorbitant.

In doing her research, she found many Internet sites that claimed to cater to coffee connoisseurs. Some were much better than others, and investigating them allowed Sally to identify the better machines, with their corresponding distributors and sales offices. Also, once the models of most interest to us were identified, it was easy to find the lowest prices being offered by the mail-order (Internet-order?) houses.

By the time we visited Gianni, there were three or four brands of machines that, from their specifications and prices, seemed to meet our needs. Clearly, one of them was Gianni's machine. Unfortunately, Gianni's price was – also just as clearly – too high. An East Coast dealer offered the same machine on the Internet for about 20% less, and there would be no sales tax to pay, only shipping. Among the other machines under consideration, some had interesting features and would possibly provide better overall value.

Naturally, we tried to be very scientific about our decision. But after our visit to Gianni, each selection discussion ended the same way: "Wow, that was sure a great cup of coffee that Gianni made for us!" Specifications be damned, that was coffee with a memory. Not only that, we liked Gianni as a person, and as an extra inducement, he had promised to put us on his delivery route for the same delicious coffee beans that he had used for our demonstration.

But, what to do about the higher price? A more than 25% differential (including the sales tax) was clearly more than we wished to pay for one great cup of coffee and a friendly personality. On the other hand, we did not think it would be fair to Gianni to just disappear and, using the knowledge he had so graciously imparted to us, buy the same machine from someone else. It was time for some honest discussion.

We called Gianni and explained the situation. We told him what price was being quoted by the large mail-order house over the Internet. We also told him that we would very much like to buy from him and would also use him as our coffee supplier in the future. To our pleasant surprise, and without too much fussing, Gianni agreed to match the lower price. He said that this left him very little profit but that perhaps our future coffee business would help to make up for some of the lost revenue.

Are we happy with our purchase? Absolutely. We're still refining our process-control skills, but our cups of coffee are almost as good as Gianni's and at $0.25 for each cup instead of the $3.00 at the typical upscale Seattle espresso shop, we are already well on our way to recapturing our investment.

In completing this "search and acquire" transaction, we made use of the Internet, retail outlets, and a specialty distributor. The Internet got us started and provided plenty of general information on the important features of these products, and we were able to do a presorting of what would meet our needs and to obtain detailed technical and price information on each model. However, we could not examine the quality of construction or try out the operation and feel of each machine. The Internet got us started but could not meet all of our needs.

This is not a temporary situation that will soon be fixed with more sophisticated software, search engines, or faster computers. ***It's an inherent limitation of the Internet, just as it is with mail-order catalogs. The Internet can never replace a showroom or a live product demonstration.*** (For this same reason, the SID International Symposium and Exhibition is going to be around for many years to come.)

The retail stores should have been able to meet our need to examine the operating features of each machine. But what we found instead was a limited number of models, typically of inferior quality, and sales personnel who couldn't tell us much more than the prices and available colors. None of the personnel in these "specialty" shops were able to give us a knowledgeable demonstration of the products they were selling. And even that would have been a long way from tasting a real cup of espresso made with each machine. In just a few weeks of relatively modest effort, Sally had become more of an expert on espresso equipment than these sales people.

Is it the strong economy that has caused stores to hire people who don't know and don't care about the products they are selling? If there is no customer service, for what purpose does the store exist? If it's simply to warehouse products until someone walks in and makes a purchase, then the Internet will win on convenience and price each and every time. (By the way, have you tried to find a parking spot in downtown Seattle, or any other large city, recently and would you like to know how much they charge once you do find one?)

Then, there was Gianni. With his enthusiasm and knowledge, and with his willingness to take the time and effort to show us what could be done, he captured our attention and our loyalty. He distinguished himself from the others. He made for us the two greatest cups of coffee we have ever tasted. How could we not give him every opportunity to meet our needs? The Internet led us to him and the Internet gave us negotiating leverage, but the sale was made by Gianni demonstrating the true meaning of customer service: having product knowledge, being willing to share it, and being willing to invest some effort in building a relationship with a potential customer.

Today, the Giannis of this world seem to be part of a vanishing breed. But, I think that instead of placing them on the endangered species list, the Internet will cause the opposite to happen. The stores with the uninformed clerks will be the ones that will not survive. The Internet and mail-order (Web-order?) companies will soon cause them to go under. What will replace them will be "centers of expertise" - relatively small enterprises based on providing what the Internet will not be able to provide. The Internet will facilitate the communications links that will allow these expert-based businesses to thrive in spite of competition from the large retail-chain stores. We will discover the benefits of these centers of expertise and the Internet will conveniently allow us to find them. How can we make intelligent product choices otherwise, especially for those products that are new to us, or for those that we wish to select with extra care?

As we discussed in last month's column, we technologists are just now beginning to understand the benefits and the limitations of the Internet. The financial community will take much longer to catch on. The Internet cannot do it all. I like e-mail, but not all the time. What I like is that it is almost free - for now. But some of the time I would rather make a personal call than compose a message on my computer screen. I would most likely use the telephone and fax even more if they were also almost free. Of course, e-mail is especially convenient when you are spanning many time zones and when you are sending messages to multiple recipients. The ability to avoid direct confrontations would, by some, also be considered an e-mail benefit. Thus, the Internet becomes another communications tool to add to the ones we already have.

The Internet has given us virtually instant and worldwide access to information and products. It is breaking down the few remaining barriers to a true world economy. Anyone now can find the best and cheapest source of a product anywhere in the world. There are few remaining local price anomalies. Merchants and buyers now use the Internet to instantly establish what everyone else is doing. That can be both a positive and a negative. It is now much harder to find localized bargains, but also easier to find a product's fair market value - which is especially important for those dealing in collectibles.

The Internet will encourage the revival of smaller businesses, which will be able to provide their customers with the information and services that cannot be obtained any other way. And just as with a cup of coffee, have you ever been truly wowed by a display from an examination of its specifications sheet? I think, for most of us, seeing and believing aren't so different from tasting and imagining. Therefore, I salute you, Gianni, for showing us the future of retailing, real customer service, and how it can work interactively with the Internet.

In keeping with the theme of multiple paths and multiple choices, this column always provides you with several convenient ways to communicate. You may reach me by e-mail at silzars@ibm.net, by telephone at 425/557-8850, by fax at 425/557-8983 and by mail at 22513 S.E. 47th Place, Issaquah, WA 98029. ■

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

The new Temescal® FCE-7000 from BOC Coating Technology is very big news: In fact, if you're looking for high-volume FED flat panel deposition with lowest cost of ownership and incredible flexibility, it just doesn't get much better than this...

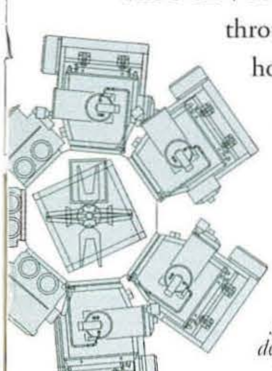
To start with, there's BOC's world-class e-beam technology – which gives you the best uniformity, highest rates, longest life and largest source inventory, to cite just a few of its merits.

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

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

Highest throughput. Lowest cost of ownership.

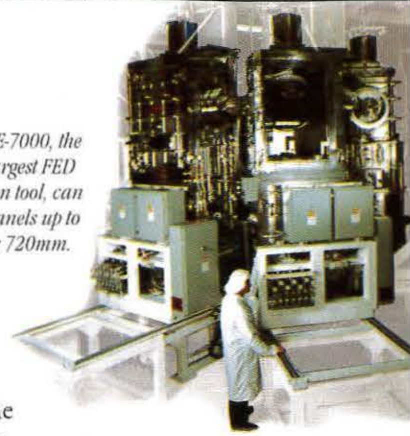
The FCE-7000 is a proven production tool that generates throughput speeds of from 10 to 60 panels per hour – and even up to 70 and 75 on certain processes. And when you combine that kind of throughput with high production quality levels, you get a very attractive return on your investment.



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

And this system also reduces downtime and requires less maintenance.

Plus, it provides more advanced automation and higher materials utilization. So you can see how it achieves the lowest cost of ownership of any flat panel deposition system in the industry.



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

A full spectrum of solutions.

BOC has been producing coating systems for more than 35 years now.

So they can provide not only high-throughput production systems, but also prototype R&D and intermediate systems, as well.

They can also provide you with an unmatched repertoire of process and system knowledge and managed engineering expertise.

So, even if your process is not yet fully developed, you can depend on BOC to help you answer the questions, negotiate the risks and get where you want to go.

Bottom line, it means smarter solutions – from the big performance guys, BOC. Call them and see for yourself...

Temescal, a part of BOC Coating Technology, 2700 Maxwell Way, Fairfield, CA 94585. (707) 423-2100. Fax: (707) 425-6071.

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