

ANNUAL DIRECTORY OF THE DISPLAY INDUSTRY

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DISPLAY

SID

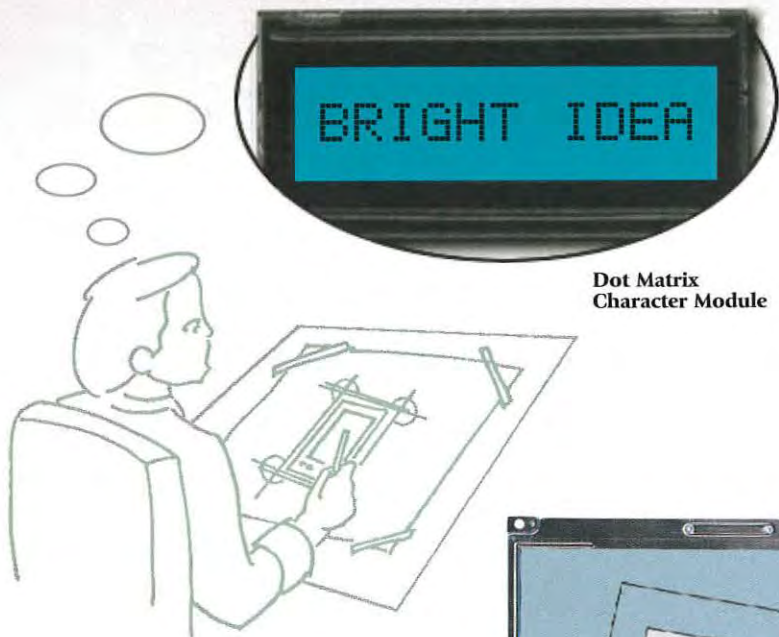
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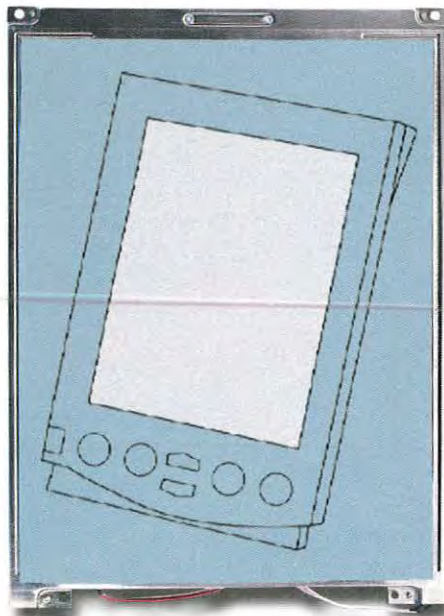
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COVER: Panoram Technologies' very-wide-format PV290 display is more than the sum of its parts. The unit comprises three 18.1-in. SXGA AMLCD panels with small mullions between them, resulting in overall screen dimensions of 43.5 x 11.5 in. Combined with control electronics, custom software, and a handsome housing with well-designed controls, the PV290 provides an unusual solution for air-traffic-control and other industrial applications. For more on the PV290, see the article beginning on page 22.



Panoram Technologies

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

Next Month in *Information Display*

- SID 2000 Review Issue
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Windows on the World

Cheap, quick, global communications and information access are recognized as necessities the world over. This is not new. The electric telegraph made next-day newspaper coverage of American Civil War battles routine in the 1860s. Clipper ships, railroads, photography, steamships, the telephone, communications and broadcast radio, automobiles, roadway express by truck, air travel, wire photos, television, satellite communications, ARPANet, cheap G2 and G3 fax, and cellular telephony were all paving stones in the road to cheaper, faster, and more varied communication over ever-longer distances. And most of them are still with us – supplemented and redefined, but not replaced, by the technologies that followed.

Among the most recent technologies are the Internet and the World Wide Web. And since they are among the most recent, we are inclined to view them as the most revolutionary. (They are surely revolutionary, but whether the changes they enable wind up being greater than those produced by telegraphy and television, or whether we will come to see them all as a continuum, remains to be seen.)

But we accurately see the Internet and the Web as critical business, educational, and social tools. Optimists see the Internet not only as a tool for making the rich and educated even richer and more educated, but also as a medium for closing the gap between the haves and have-nots. Pessimists – perhaps they are realists – see countries such as Zambia as being so mired in extreme poverty that their peoples don't have a chance of climbing on the Internet train. Therefore, unless something dramatic is done, most of the residents of such countries will fall farther and farther behind the privileged people who have computer access, computer literacy, and an Internet connection.

But these poor nations share something with the prosperous ones. They all agree that the Internet is a train to change and prosperity for those who can get on board. So what poor country would ban Internet access by an enthusiastic segment of its population? Myanmar would, according to a story from the Associated Press.

Myanmar's government is one of the world's more repressive regimes. (Aung San Suu Kyi won the Nobel Peace Prize for her resistance to that regime.) And the regime is seemingly more concerned with the threat of open communication than it is with the opportunity for much-needed economic growth.

A change of perspective: We technologists tend to have a more-or-less blind faith in the benefits of technological progress. That blind faith is not always justified. What we make, after all, are essentially tools. And tools can be used for ends that are significant or trivial, good or evil.

The Internet, for example, together with the displays that are essential to its effective operation, can help generate greater wealth for the peoples of the world. It could also, as some people fear, lead toward a homogenous, sterile, and materialistic world culture. But one thing the Internet surely does is frighten despots.

The instant global communication that provides an efficient market for goods also provides an open marketplace of ideas. One thing that despots require is control of the information media, and an open Internet defies control. It is

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Toward a Common Language ...

by Aris Silzars

Suppose you are a display engineer from Sweden waiting for a connecting flight in the international area of Frankfurt airport, and a person from Argentina approaches you to ask for directions. What language are the two of you most likely to try first? Or suppose you are a pilot of a Boeing 747 on an international flight. What language is the accepted standard for communicating with air-traffic controllers everywhere? The second question has only one answer, while for the first you might suggest English or perhaps German as possibilities. However, I think most of us would select English as the most probable answer even to this question.

Over the last fifty years, as airplane travel, the telephone, fax, Internet, and now wireless communications have increased our ability to connect with each other – anytime and anywhere in the world – the need for a common language has become increasingly important. No longer is it convenient, or timely, to have documents translated into a native language so that a response can be generated which is then reverse-translated prior to sending. More and more international business is being transacted through a combination of personal on-site interactions and electronic communications. While it is certainly possible to continue to have such meetings and correspondence using skilled translators, the most intense and productive interactions occur when a common language can be used.

What about computers and electronic data transmission? Compatible operating systems and formats become mandatory. Electronic data streams are unforgiving of even the most trivial of ambiguities. Therefore, precise standards must be established, or a common operating system must be used, to facilitate even the simplest of information exchanges.

Let us now turn our attention to SID and to our own methods for worldwide communication. Our publications and technical conferences are our primary means for facilitating interaction within the global display community. What should we do when we have a magazine with readers, or a technical conference with attendees, from almost every European country, most of the Pacific Rim countries, and from all regions of North and South America? The selection of one common language becomes a necessity. For technical societies, as well as for many businesses, English has become that common language. No one forced it on us. No government told us that it was a requirement. In fact, a few governments have worked very hard to prevent English from becoming the dominant technical and business language and/or from corrupting the “purity” of their own language. But it seems that once a common standard starts to evolve, its widespread adoption often becomes inevitable. The more it is used, the more it suppresses other choices. Eventually, it becomes acceptable to hold only local meetings, which are not expected to have international attendees, in the local (non-standard) language.

Recently, we have been able to observe this same phenomenon in computer operating systems, word processors, spread sheets, and communications protocols. The need for commonality to facilitate fast and easy data interchange has been a great boon for one company, Microsoft (in the operating systems and

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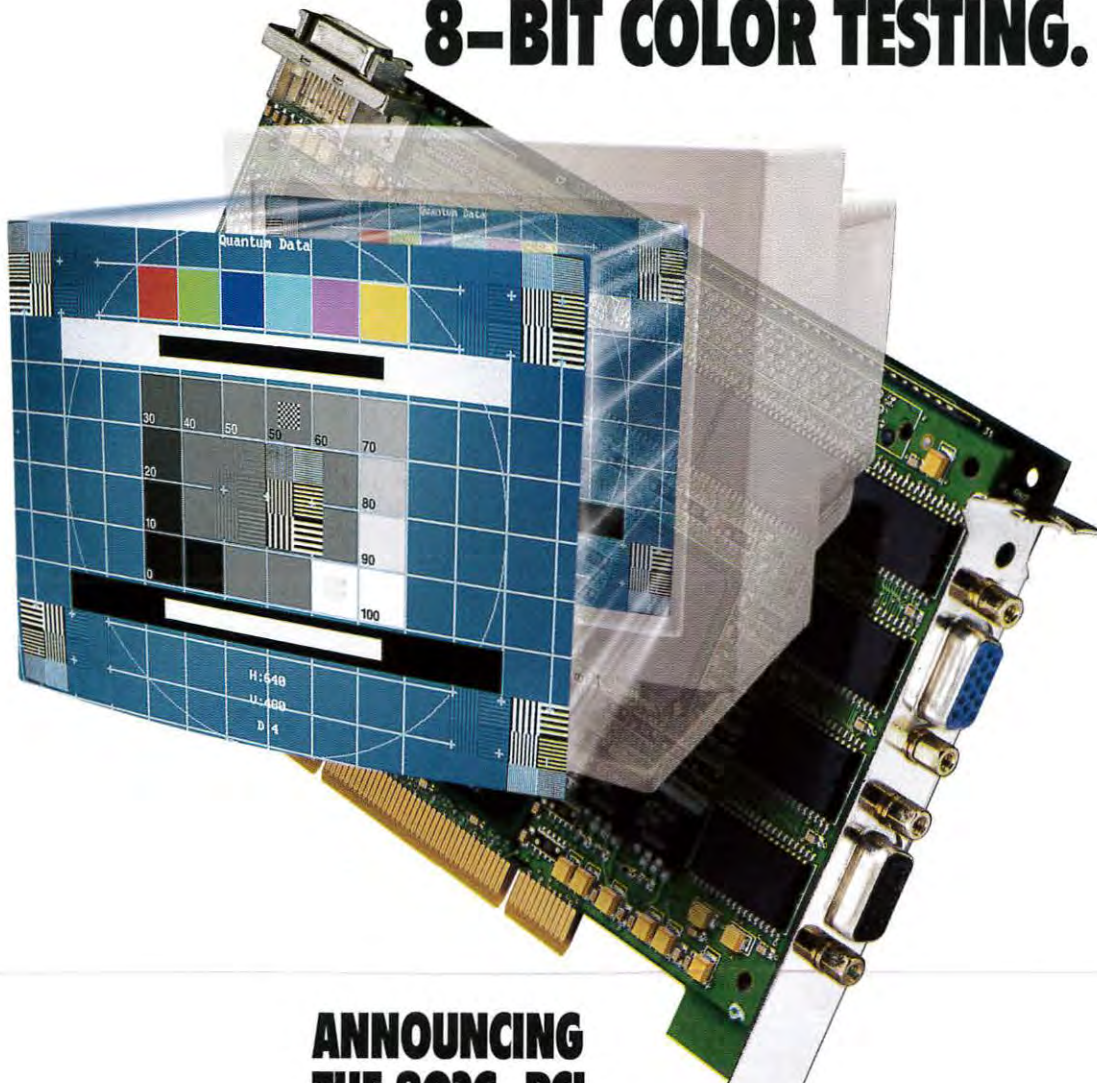
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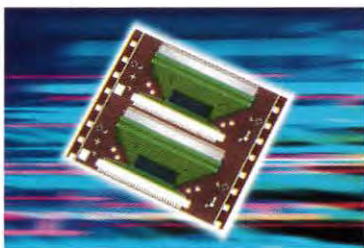
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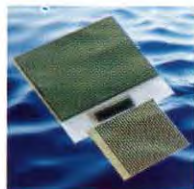
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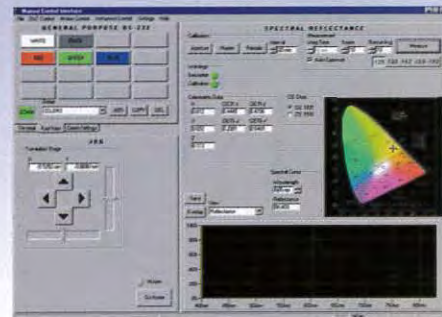
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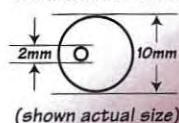
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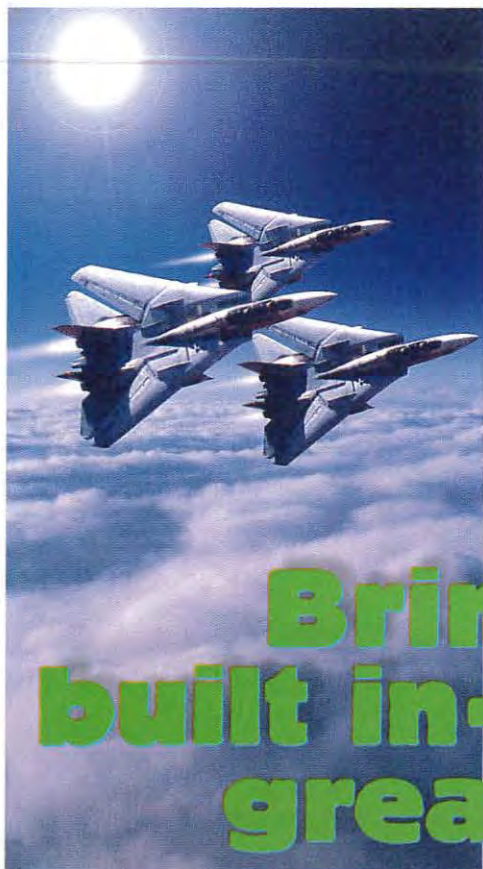
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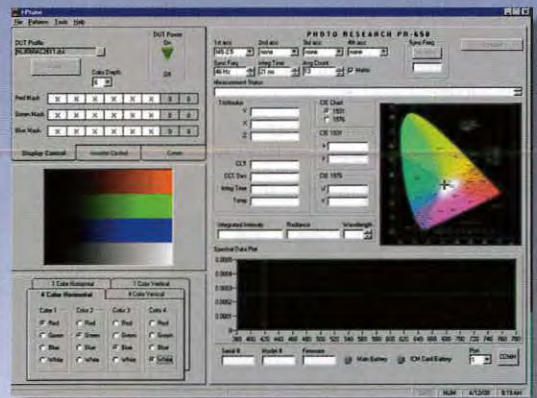
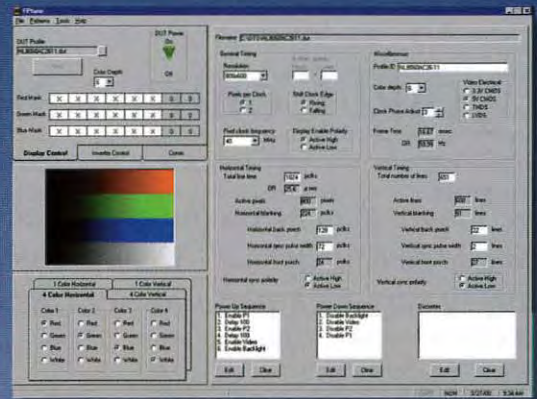
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Beyond Contrast and Luminance

There's more than meets the eye – and more than can be revealed by simple measurements – when it comes to evaluating the image quality of very-high-performance CRTs.

by Ken Compton

TYPICAL end users can be quite demanding when it comes to the quality of their data displays. But the level of fidelity needed to present word-processor text or a slide-show presentation to those typical end users is relatively low when compared with the accuracy needed for diagnostic medical imaging from x-rays and MRI scans. Because some of the information contained in these images can be extremely subtle, doctors must be able to access this information reliably in order to make accurate decisions.

Developing and supporting high-resolution monochrome displays for such applications has provided the technical staff at Clinton Electronics with valuable experience in evaluating display quality. Many of these lessons can be applied to color-CRT and other display technologies.

Resolution-Addressability Ratio

The spec sheet for a CRT display will report its maximum resolution, but this typically refers to the addressable resolution and may have nothing to do with whether or not those pixels can be accurately displayed for the viewer. The resolution-addressability ratio (RAR) is a simple way to evaluate the resolution claims for a display using just three pieces of information, two that should be available from the data sheet and a third that

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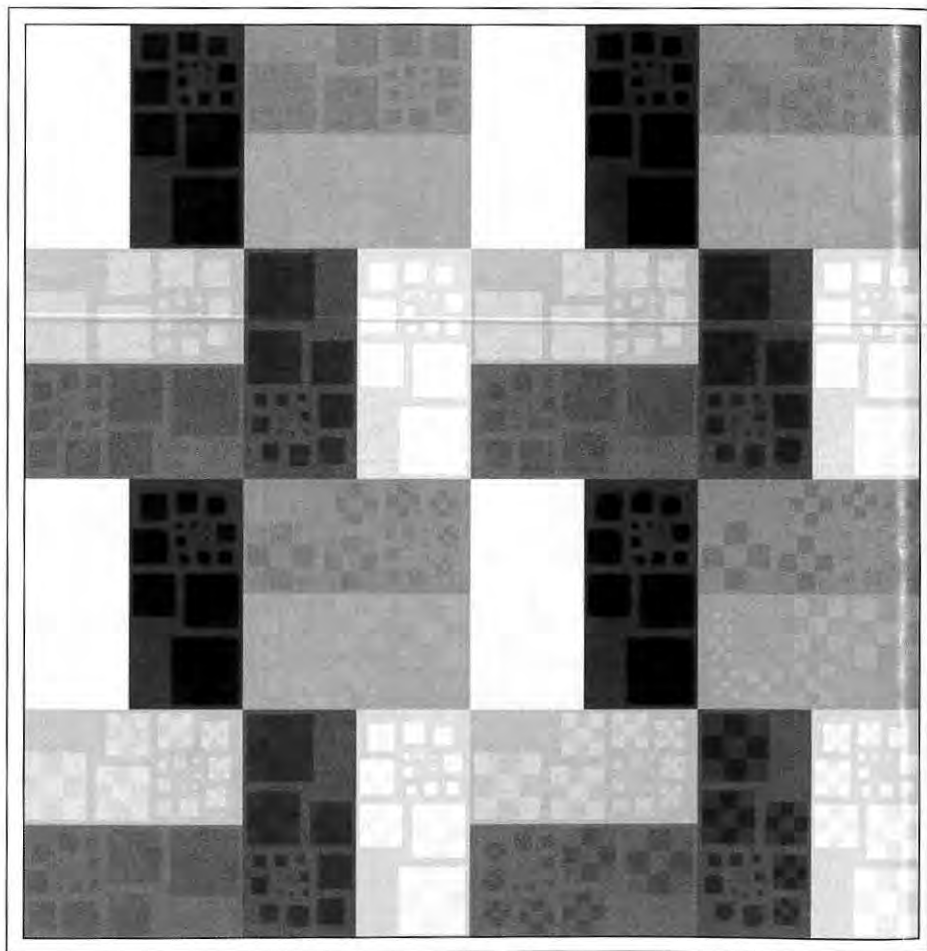


Fig. 1: The Briggs Test Pattern is a sequence of checkered patterns that takes into account the eye's ability to resolve features of decreasing size at different luminance levels with varying background luminance levels. The pattern provides an intuitive way of assessing the display's contrast modulation. (Source: Stewart Briggs, SPIE Vol. 762, "Electro-Optical Imaging Systems Integration," 1987.)

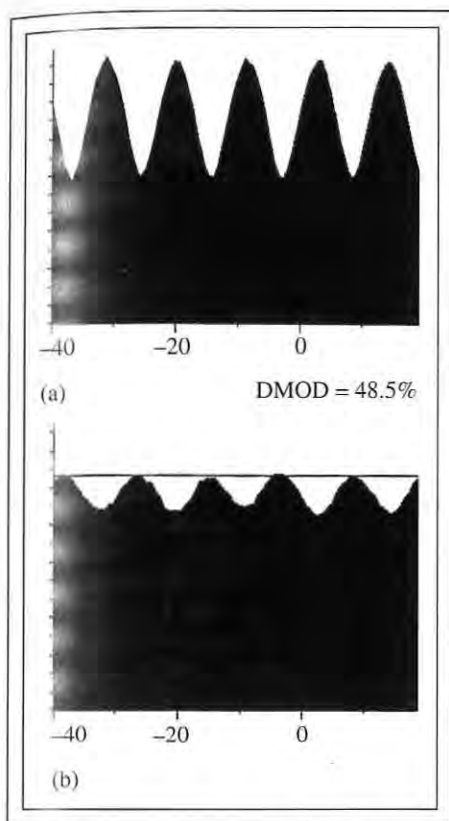


Fig. 2: Horizontal scans illustrate the depth of modulation for a 200-MHz amplifier (a) at the center and (b) at the upper-left corner of a test display.

is typically available from the vendor on request. The two easy items are the pixel format and the active video area. For discussion purposes, we will use a typical 21-in. flat square CRT in portrait orientation with a 300 × 400-mm (11.8 × 15.75-in.) video area.

The first step is to calculate the addressable pixel size. This is determined by dividing the active video area by the pixel format. A 5-Mpixel format of 2048 × 2560 pixels would yield a horizontal addressable pixel size of (300/2048) 0.1465 mm and a vertical addressable pixel size of (400/2560) 0.1563 mm. This represents the space available for each pixel.

Next, one needs to obtain the spot size of the display, which should be available from the vendor. This is typically specified at the center of the screen, and measures the size of the spot to the point where it is at 50% of the maximum luminance energy (assuming a Gaussian distribution).

Finally, these two values are compared by dividing the spot size by the addressable size. If the display in our example is rated at a 0.127-mm (0.005-in.) spot size, then the horizontal RAR is 0.87 and the vertical RAR is 0.81, which means that the spot size is smaller than the addressable pixel size. This is a best-case measurement because pixel size changes with beam current and location on the screen, which can make the actual size larger than specified.

Optimum RAR depends on the application. An RAR greater than 1.5 implies that the display cannot resolve the addressable pixels. If the RAR is too small, the pixels separate so that lines will appear to be broken. This would be seen as individual raster lines or as dots in a horizontal line. For commercial graphics, an RAR between 1.2 and 1.3 provides a smooth appearance because of the overlapping pixels, but the resulting decrease in contrast modulation makes it less acceptable for medical applications. The recommended RAR for medical applications is within a range of 0.9–1.1.

Contrast Modulation

Another important concern is contrast modulation (C_m), without which small transitions in gray tones would be lost (Fig. 1). But how does one differentiate among displays that would appear to be the same on paper when the important criteria cannot always be found in the sales literature?

Understanding the factors that contribute to C_m will help us extract the information available in the image and ascertain the additional pieces needed to complete the analysis. Three fundamental elements control how well the viewer can resolve the difference between adjacent pixels: (1) the pixels per inch or dpi, (2) the pixel diameter at the 50% point, and (3) the Gaussian distribution of the pixel down to the 5% point. For the moment, we will assume that the pixels are in focus and that video bandwidth – a critical element – is properly matched to the application and video source.

The ability to generate a bright pixel is of little importance if one cannot see a black (OFF) pixel between white (ON) pixels. Unfortunately, the industry sometimes focuses on the peak white pixel in a black field for measurement purposes, ignoring the contribution of adjacent ON pixels to an OFF or nearly OFF pixel's image fidelity. A similar

trap is the use of a full white-field luminance value divided by a full black-field value to calculate "contrast." It yields a large number that represents the video amplifier's dynamic range in a quasi-static state: either on or off like a switch!

dpi. We must start with dpi to eliminate the noise from the serious contenders. More is not always better unless there is sufficient active video area to maintain pixel spacing and C_m , or better electron optics to do the job without going to a larger active video area. The National Imagery and Mapping Agency's (NIMA's) standard format of 1408 × 1408 at 100 dpi needs a minimum 14 × 14 in. of active video area. This requires a 23-in.-diagonal CRT (14 × 18-in. screen area). A 21-in.-diagonal CRT (12 × 16-in. screen area) cannot display this format without compromising C_m (assuming the same electron optics). The pixel density would increase to 117 dpi on the minor axis, increasing the proportion of pixel overlap.

For geographic-information-system (GIS) displays, the dpi should be held between 70 and 100, but for the NIMA format specifically, the dpi should be held close to 70.

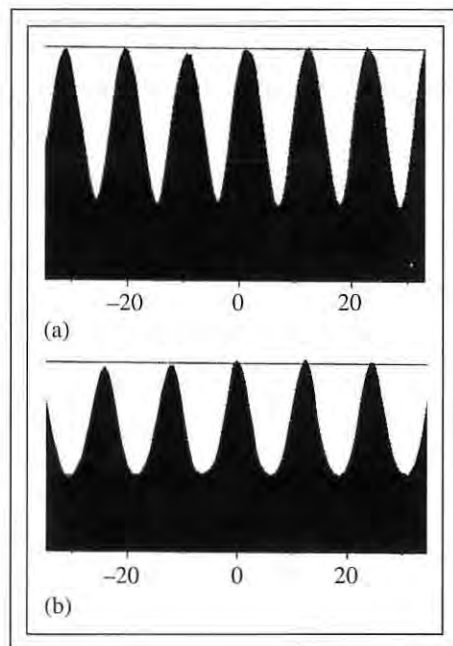


Fig. 3: Similar scans for a 330-MHz amplifier in a test display demonstrate improved depth of modulation (a) at the center and (b) at the upper left corner as a result of the increased bandwidth.

CRT technology

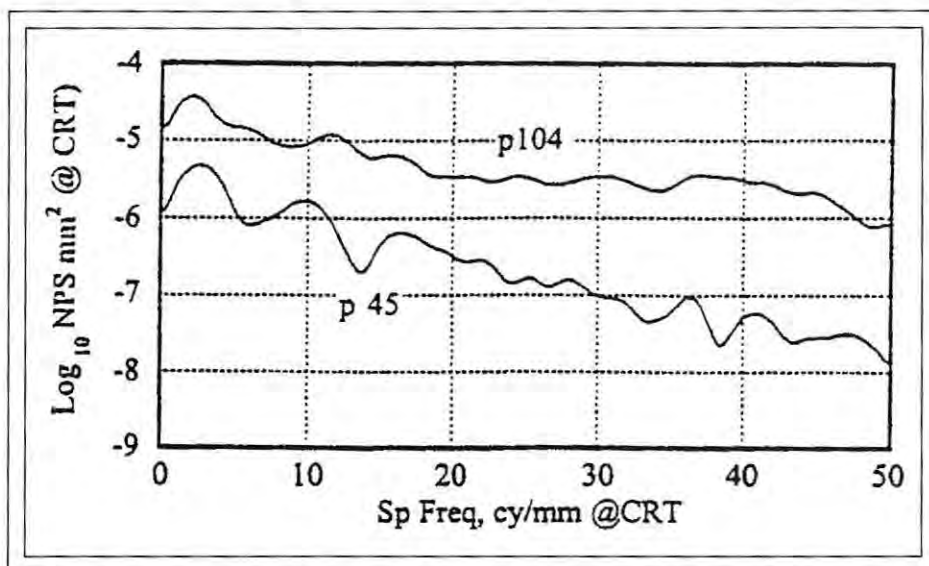


Fig. 4: P45 phosphors show lower noise levels than P104 phosphors. (Source: SPIE Vol. 3031, "Impact of Phosphor Luminance Noise on the Specification of High-Resolution CRT Displays for Medical Imaging.")

Going above or below 70 dpi moves away from the optimum visual acuity of the human eye. Another concern is the degradation of C_m as the pixels either separate into individual dots that look like newspaper halftone printing or merge together to become non-resolvable. Once a balance is established between active screen area and pixel density, the pixel itself needs to be analyzed.

Pixel Diameter. Consider the pixel diameter, or spot size, as measured at the 50% (luminance energy) point of the Gaussian distribution, which is the industry-accepted standard at screen center for medical images. Assume that the RAR for a given display specification is 1.0. The actual spot size will be larger away from the center of the screen; the deflected pixel increases in diameter with distance from screen center because the beam-landing angle is no longer perpendicular to the glass and because beam deflection produces distortion in the beam.

Without the benefits of dynamic astigmatism and focus correction, the increase in spot size can exceed 25% from beam deflection alone. Even with compensation, the fidelity of the image decreases toward the edges. The extent of degradation depends on the quality of the compensating circuits.

Gaussian Distribution. The third element contributing to C_m is the Gaussian distribution, or the cross-sectional profile, of a pixel.

In addition to the shape of the spot, we are also concerned about the flare to the 5% luminance level because the luminance energy is visible down to that point. If the 5% circle is too wide, it will overlap the adjacent pixel and reduce the C_m . It is best to consider the 5% diameter in terms of a ratio with the 50% diameter for the spot size. If the ratio starts to exceed 2:1, the adjacent black pixel will begin to disappear.

To adequately assess contrast, a black pixel must be placed in a white field. This approach takes into consideration the effects of halation – the reflected luminance energy bouncing off the two glass surfaces of the CRT, the phosphor screen, and (to a lesser extent) the aluminum behind the phosphor. (The latter is applicable to monochrome and color CRTs; color-CRT shadow masks significantly contribute to veiling glare.)

When all these factors are considered, a 0.010-in. pixel could range from 0.020 to 0.030 in. at the 5% point. When the 25% spot growth from deflection distortion is taken into account, it becomes clear why maintaining a narrow electron-beam column down to the 5% point and providing high-quality dynamic astigmatism correction is critical for high-fidelity images. A vendor of NIMA displays should be able to provide a minimum C_m value for the entire screen. The C_m represents the impact of all the above factors.

Depth of Modulation

It is not sufficient to examine a display's performance on the basis of a single pixel because this does not tax the components and masks possible effects on adjacent pixels. Alternating single-pixel lines of black and white can yield additional useful information.

A map of the luminance profile for each axis will show the ability of a display to generate a black line between adjacent white lines. The difference in luminance between the peak and valley is the depth of modulation. Displays with acceptable RARs at the 50% point but with large flares to the 5% point will show poor depth of modulation. The pixel overlaps, along with veiling glare, will contribute to the increased luminance measured at OFF-pixel locations.

Insufficient bandwidth on the horizontal axis is the cause of pixel flare, while the electron optics controls the vertical axis of the pixel and is generally more stable from center to edge. For this reason, modulation-transfer-function (MTF) measurements for the vertical axis are typically better than for the horizontal axis because the video amplifier is not a factor.

Scans of the center and upper-left corner of a high-performance CRT display with a 200-MHz amplifier show that the depth of modulation at the center is 48.5%, but that it falls off dramatically in the corner to 16.9% [Figs. 2(a) and (b)]. The flare of the 5% point, the beam-landing angle, and deflection distortions all contribute to this loss of MTF.

In contrast, scans with a 330-MHz amplifier with faster slew rates – yielding narrower pixels – show much better results. The depth of modulation at the center is 67%, with 59.6% at the upper-left corner [Figs. 3(a) and (b)]. Holding the ratio of the 5% to 50% points close to 2:1 is the key to achieving this level of performance.

The two pairs of images also illustrate that command levels greater than the depth of modulation will be filtered. The 200-MHz video amplifier is acting like a low-bandpass filter in this example because it cannot track the command level beyond the percentages noted. The image may appear to be of high quality, but the information that is missing leaves no trace.

The ON-OFF-ON line pattern used for this illustration is a worst-case test pattern for the video amplifier. But it raises the question of just how much information loss can be acceptable in a given display application.

Phosphor Selection

The choice of phosphors can have an effect on image quality in ways that may not be immediately obvious. Some of these factors are peculiar to black-and-white CRT displays, but

the effects are worth noting for all displays.

The human visual system's response to "phosphor noise" is a measurable attribute of a display system. The importance of choosing a low-noise phosphor for diagnostic applica-

tions cannot be over-emphasized because small changes in the luminance of the image can fall within the noise level of the phosphor.

Total phosphor noise is the summation of temporal and spatial effects that affect the perceived contrast of a display system. Temporal noise refers to random fluctuations at a screen location which can be attributed to the electronic signal path starting with the digital-to-analog converters (DACs) in the video card and through the video amplifier; artifacts in the digital world can also contribute. But over the nominal luminance range of a medical display, temporal noise is not a significant factor and actually decreases with increasing luminance (in terms of signal-to-noise ratio). Spatial noise is the major factor.

Spatial noise is attributed to the localized stationary graininess of the luminance output with a constant input value for a given area. Because phosphor graininess is a physical structure, it is independent of the luminance level. Phosphors that are blended from two or three components, such as P4 and P104, will exhibit a physical structure that the eye can detect as blue and greenish-yellow patches. At viewing distances greater than about 18 in., the human visual system integrates the physical structure into a solid white field.

Using a single-crystal phosphor such as P45 can minimize this source of spatial noise. The attributes of P45 make it the preferred phosphor for diagnostic displays of 2000 lines when the user can be expected to view images at close range. For lower-resolution clinical/office and intensive-care-unit (ICU) displays of 1000 lines, the blended phosphors are acceptable, although not in every case.

Studies performed since 1991 have shown that for a luminance difference to be detected, the change in luminance must be greater than the phosphor noise by a particular factor. The ability to detect differences is also influenced by the size of the target and the background luminance. For the reading physician, confidence that an abnormal structure was actually observed is very important. One study indicated that a factor of three times the noise yields a detection probability of 50%. A factor in excess of five is required to detect with 100% confidence. The size of the object also influences its detectability.

At higher frequencies, spatial-luminance noise is much lower in P45 than in P104 (Fig. 4). This is especially important on complex images. Again, the single-crystal struc-



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ture of P45 provides a better pixel profile than a blended P104/P4. When the profiles are magnified and viewed, the uneven luminance attributed to the individual components of P104 can easily be seen. A similar view of a

P45 spot profile exhibits a better fit to the desired Gaussian profile.

Quality Is Complex

A given display's ability to accurately repre-

sent subtle information in the image data is the result of a combination of complex and interrelated factors. It is not enough to simply measure spot size or full-raster contrast ratios. Only by paying attention to factors such as those described here can we be sure we have the ability to see all the information an image may contain. ■



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Displays in Action

When dentists, radiologists, and manufacturing engineers go to trade shows to look at the newest tools of their trades, they are often looking at displays – or equipment that contains some.

by Alan Sobel

IT is useful and educational to attend a trade show where displays are merely tools rather than the centerpieces of the exhibits. This is a report on three trade shows of this type: the Radiological Society of North America (RSNA), a very large annual show; the Chicago Dental Society (a new one for me); and National Manufacturing Week, an enormous annual show that is a composite of four shows and two associated expositions, mostly concerned with manufacturing products and processes.

Medical X-Rays

A continuing thread through both medical meetings was the growing use of electronic imaging, especially x-ray imaging. X-ray images are either digitized from film images or captured electronically in the first place, typically by using CMOS imaging plates. CMOS imagers typically use a phosphor to convert x-ray photons to photons at wavelengths where the photosensitive elements of the imager respond, and may incorporate further image processing on the same panel. These imaging plates can be much larger, physically, than CCD imagers. They frequently require lower x-ray doses than film, although the resolution (total number of pixels) is not as high as that of good large-sized film.

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As for displays, radiologists are accustomed to the monochrome images of film, need the extended gray-scale range it can provide, and tend to be reluctant to use image-enhancement techniques or make other changes in the way they work. On the other hand, ultrasound devices do make use of color, to distinguish among directions of blood flow, for example.

Some other forms of imagery, such as positron emission tomography (PET) and blood-flow magnetic resonance imaging (MRI) also make use of color displays.

An important advantage of digital radiology is storage. Instead of bulky and expensive film x-rays, images are stored on tape or CD-ROM. They can be accessed from any



Fig. 1: Among the more interesting displays at National Manufacturing Week was a very-wide-format AMLCD from Panoram Technologies consisting of three SXGA panels with small millimeters between them.

Panoram Technologies



Fakespace Systems

Fig. 2: At National Manufacturing Week, Fakespace Systems showed a real three-dimensional display. The company's 3-D Immersive Workbench produced excellent 3-D images of machine designs (although a mapping application is shown here).

equipped place in the medical facility, or even remotely, and can be viewed by several workers simultaneously. With a good filing system, they do not get lost – a significant issue with film images. On the other hand, the possibility that unauthorized people can look at x-rays of one's most private problems is giving patients and doctors pause.

A problem with viewing film x-rays is veiling glare. Typically, an x-ray film is clipped to the front of a very bright light box and the radiologist "reads" the back-illuminated film. If the film does not cover the entire lighted area of the backlight, the very bright light from the uncovered area can make it difficult to see small features. One company, Smart Light, has a light box that automatically dims the light in areas not covered by the film, and has mounted a long test and demonstration campaign to show – convincingly, for this viewer – the advantages of their system in improving the detectability of small low-contrast objects. Another company produced the same result with a much lower-tech approach. They sell a black neoprene sleeve, like an arm-length open-ended glove. The viewer looks through the sleeve and shapes it to cover the area of interest on the film. The same result is achieved without electronics.

The vendors of dental x-ray equipment would have you believe that CMOS imagers and electronic displays are definitely the wave of the future (my dentist still uses film), but there are problems with electronic x-ray displays. It is difficult and expensive for electronics to match the luminance and number of gray levels that are available from film. This is particularly true for chest x-rays and mammograms, and radiologists are very suspicious of electronic image-enhancement schemes. There are two reasons: defense of their turf against technicians with lesser training and questions of liability – who gets sued if an x-ray is misinterpreted?

A perhaps marginal but still interesting medical application for displays is head-mounted displays used to display movies or other distractions while the dentist is inflicting pain or the patient is avoiding claustrophobia while immured in an MRI or CAT scanner. I have met at least one dental patient who thinks this is the greatest thing since sliced bread. Vendors have been pushing it for several years.

National Manufacturing Week

The National Manufacturing Week shows covered a very wide range, from on-the-fly

examination of tiny parts coming off a production line to control of large machinery. A number of vendors showed cameras associated with frame grabbers and image processors to capture images, measure selected portions, and display the result or control the machinery to correct for deviations. Some of these camera systems feed data into statistical systems to monitor and graph process deviations. The range of sophistication runs from relatively simple systems that detect the presence or absence of something (an unfilled container, for example) to micron-level measurements.

Rapid prototyping, or three-dimensional printing, has been available for several years now, but the machinery is getting better and the output more useful. Typically, these devices work from either mechanical drawings or the output of a scanner to produce a replica, either by eroding a material or (more commonly) by building up the replica layer by layer. The resulting model can be used to check a design for errors or interference between parts, or even to generate tooling for short production runs. There is a variety of methods, including laser sintering of polymers, deposition of material by what are essentially ink jets, and control of a small milling machine.

Among the more interesting displays was a very-wide-format AMLCD from Panoram Technologies of Sun Valley, California (www.panoramtech.com). The unit on display, the Panoram PV290, comprises three panels with small mullions between them, for an overall 43.5 × 11.5-in. screen area (Fig. 1). Each panel is 1280 × 1024 pixels. The panels sit atop a stylish control console that implements individual control of each panel or the melding of two or three panels to produce a wider image. (There are other configurations as well. Making full use of the system apparently requires proprietary software.) This is a good-looking package with good-looking imagery. The company was demonstrating air-traffic-control applications, among others. The wide-screen presentation makes it possible to look at a great many moving targets simultaneously.

A real three-dimensional display was being shown by Fakespace (www.fakespace.com), now an Electrohome subsidiary. Their 3-D Workbench, using StereoGraphics Crystal-Eyes shutter glasses and CRT projectors from Electrohome's Projection Display Division

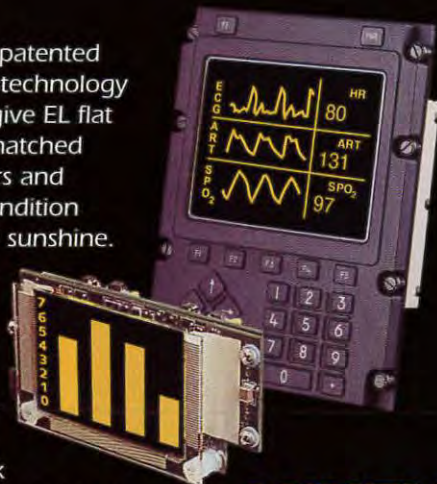
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display applications

(recently acquired by Christie Digital Systems), produced excellent 3-D images of machine designs (Fig. 2). It was possible to "grab" a portion of the mechanism, using special gloves, and rotate it to see it perform at various angles. For designers of complex machinery, this could be a real boon. Fakespace has been around for some time. The company started at NASA Ames Research Center in Mountain View, California, and has expanded to incorporate newer technologies and other companies.

Flat-Panel and Other Displays

A few years ago, the dominant flat-panel displays on industrial equipment were TFEL, chosen because of their wide viewing angle and ruggedness. Gradually, these were supplanted by color AMLCDs, and for several years the major supplier was Sharp. This year the most visible presence was NEC, with large high-resolution wide-viewing-angle displays in a variety of sizes. And, of course, CRTs are still very much with us. Surprisingly, there were very few of the newer flat-faced tubes we have seen at SID meetings and CeBIT (see the CeBIT review article in this issue).

Several vendors of touch screens were present, mostly touting immunity to dirt and surface scratches, as well as the convenience of touch inputs. Plasma displays were much in evidence as billboards and demonstration units, but few were incorporated into equipment for sale. Similarly, projectors were in wide use as product demonstrators, and most of these were quite visible in the trade show's ambient light.

Although all three of these trade shows emphasize the tools of the trade - everything from software to keep track of accounts through tiny tools for shaping dentures to control systems to handle big punch presses - it is instructive to see the number and variety of applications in which a human interface is essential. Frequently, that interface includes some kind of display. ■

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Lamps for Projection Displays

Arc lamps have a long history, and current versions are being optimized for the newest microprocessor-based projection displays.

by Robert L. Donofrio and Robert Eckel

THE PRIMARY lamp technology over most of the century-long history of motion-picture projection has been that of the carbon arc. And carbon-arc lamps have an impressive history of their own.¹ They are associated with some of the great names of 19th-century science and technology, including Sir Humphry Davy (the first carbon-arc lamp in 1802), William Staitte (an arc clockwork in 1849), Col. Rookes E. B. Crompton (the first arc-lamp-illuminated football match in 1878), and Paul Jablochhoff (1876). (Jablochhoff's "candle" arc lamp was the first arc lamp used in large numbers.)

The carbon-arc lamp was used with lantern slides and film for large-area projection, and for applications such as searchlights. Almost 200 years after their invention, carbon-arc lamps are still being used in the theater industry for stage illumination. Carbon-arc stage lighting was used to make the movies *Gone with the Wind*, *The King and I*, and *The Ten Commandments*. Metals and salts can be added to the carbon arcs via a core fill to change the color of the arc (Table 1).

There are a number of discharge lamps,

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such as the ubiquitous fluorescent tube, but we are concerned with short-arc lamps. Mercury (Hg) arc-lamp pressures can go from a low of 20 atm to high-pressure lamps with internal operating pressures of 200 atm. Each has its applications but it is the high-pressure Hg arc lamps that have short arcs. High-pressure xenon lamps and metal-halide lamps have been used in theatrical film projectors and searchlights. The metal-halide high-pressure arc lamp contains mercury with a metal-iodide fill gas.

The lamps used in today's display projection systems are the xenon, metal-halide, and mercury arc lamps. Interestingly, each of these three lamps has a color temperature in the range used in the photographic arts.

Projection-Lamp Characteristics

Brennesholtz lists the most important characteristics of projection lamps as (1) lifetime, (2) cost, (3) efficacy, (4) source size, (5) source color, (6) instant – or almost instant – on, (7) no emission lines between 470 and 510 nm and 570 and 600 nm, and (8) a safe and simple power supply.² Unfortunately, as Brennesholtz discusses in his book [*Projection Displays* by Edward H. Stupp and Matthew S. Brennesholtz, Wiley-SID Series in Display Technology (John Wiley & Sons, 1999)], metal-halide, xenon, and Hg lamps all show some form of line spectra, so the seventh criterion is hard to meet except for tungsten lamps, and line emissions can give rise to color issues.

Lamp Life. A goal for lamp lifetime is 5000 hours. Normal lamp life today is 2000 hours or better.

During the operation of an arc lamp, the cathode material is sputtered and the anode material is evaporated on the inside of the quartz envelope. This causes the envelope to darken. Stress, either shock or thermal, can cause the quartz to crack. Frequently turning an arc lamp on and off produces heating and cooling of the lamp, which initiates devitrification – the transformation from the vitreous state of quartz to the crystalline state, which appears as a cloudy region in the quartz. If this region is in the optical path, it causes the radiation from the lamp to be scattered and to increase the effective size of the source radiation.

Lamp lifetime is determined by the failure mode. If nothing else intervenes, transmission will be progressively reduced by the deposition of material on the inside of the quartz envelope. One criterion is that when lamp intensity is reduced to 70% of its initial value, it should be replaced. This is defined as the life of the lamp.

Table 1: Correlated Color Temperature of Various Arc Sources

Lamp Type	Color Temperature (K)
Solid carbon rod	3700
NaCl-cored carbon	4740
Al-cored carbon	6160
Mercury arc HP	8500
Xenon arc HP	4000-6000
Metal-halide arc HP	3200-8500

Efficacy. Efficacy is the amount of luminous flux (in lumens) produced per watt of electrical power. Luminance is the amount of luminous flux a source emits per unit solid angle per unit area of the source – not a very intuitive concept. The luminous flux delivered to the screen is determined by the product of the average luminance of the source collection optics, the transmission of the optics, and the étendue of the system. The étendue is related to the diameter of the elements in the optical system. Most of the light from a large light source, for instance, would not be captured by an optical system with a small étendue and would therefore be wasted. This is why short arc gaps are important in projection systems.

One thousand screen lumens is generally accepted as the value required for comfortable viewing with room lights on. To obtain this output with the étendue typical of today's projection systems, a high-intensity arc lamp is necessary. This is satisfied by 200-W arc lamps with arc gaps from 1 to 3 mm. Shorter arc gaps would be desirable but would reduce lamp lifetime. The Welch Allyn company has determined that the relation between arc length (L), the diagonal of the light valve, or scanning engine, (D), and the f number of the projection optics is $L = 5.51D/f$ (Ref. 3). Thus, for a 4:3 aspect ratio, a 0.75-in. (19-mm) light valve, and an $f/3.5$ lens, the optimum arc length is near 1.2 mm.

Lamp Structures

High-intensity arc lamps consist of an envelope, electrodes, seals, and fill. The envelope should be transparent, impervious to air and fill gas, and mechanically strong, a set of characteristics that limits the possible envelope materials (Table 2).

Table 2: Possible Envelope Materials

Envelope Material	Short Cut-off Wavelength (nm)
Sapphire	142
Suprasil quartz	160
Clear fused quartz	220
Ti-doped quartz	250
Ce-doped quartz	380

Note. The short cut-off wavelength is the wavelength below which no radiation emanates from the lamp.

Quartz is used in high-intensity lamps. The clear fused quartz (CFQ) that is usually used in Hg lamps solarizes, *i.e.*, it forms color centers that give the material a purple color, reducing transmission, mostly in the UV.

The envelope is usually made from quartz tubing with a wall thickness of about 1 mm. It can be formed as a simple capillary structure (Fig. 1) or with a bulb or bubble in the gap region. The usual short-arc projection-lamp shape has a bulb-like center structure, which covers part of the electrodes and the arc-gap region (Fig. 2).

Arc lamps have electrodes made of tungsten. The anode is usually larger than the cathode. The tungsten in the cathode contains thorium. The thoriated tungsten helps reduce the work function of the cathode and improves electron emission.

Seals. Two types of hermetic seals are used in the manufacture of arc lamps for microelectronics and projection applications: rod seals and ribbon seals. The rod seal consists of a tungsten rod made as thin as practical. A section of the rod is coated with a "sealing glass" that has a coefficient of expansion midway between tungsten and quartz. The quartz of the lamp body is then melted, or "sealed," to the sealing-glass bead on the tungsten rod.

In the Hg capillary lamp, the tungsten rod is approximately 0.765 mm (0.030 in.) in diameter and serves as the electrode. In the bulb-like short-arc Hg lamp, the electrode tip protrudes inward a fraction of an inch, beyond the pool of mercury at the ends of the lamp. On the outside of the lamp, the tungsten rod is connected to the lamp base or electrical contact.

The second type of seal used in the manufacture of Hg arc lamps is much more sophisticated. This seal consists of a thin molybdenum (Mo) strip or ribbon (or a group of them) that is fused into the quartz tubing. One end of the Mo strip is connected to the tungsten electrode and the other end to the electrical input. The Mo ribbons are quite thin – usually between 15.2 and 51 μm thick. The quartz sealed around the ribbon is thick enough to impart mechanical strength to that region.

Although the Mo metal has a higher coefficient of expansion than the quartz, the Mo oxide layer between the ribbon and the quartz functions as a wetting medium that produces an hermetic seal. The "molybdenum ribbon seal" is central to the manufacture of Hg arc



ARC

Fig. 1: Mercury capillary lamps are made from quartz tubing having a wall thickness of approximately 1 mm.

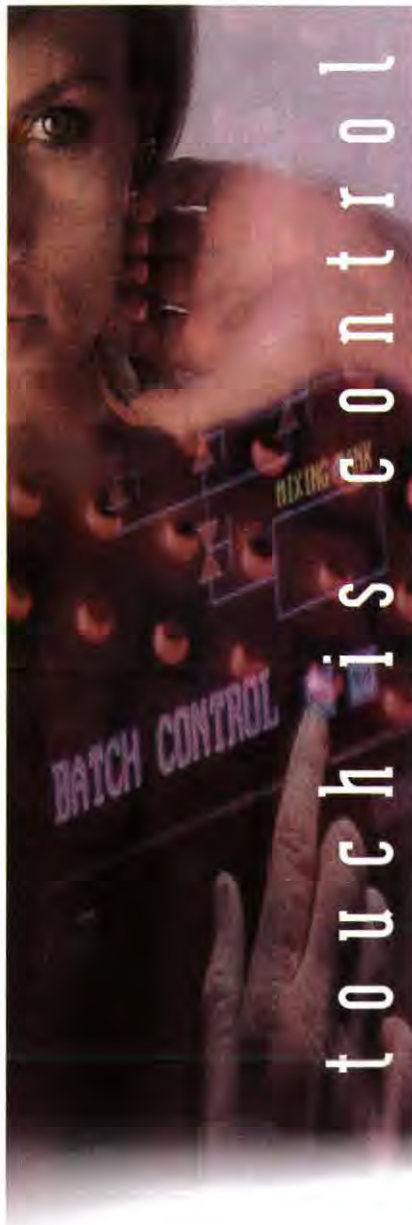
lamps. The outer-end regions of the seals in a Mo ribbon lamp must not exceed a temperature of 220°C – independent of the cold spot temperature of the bulb itself. Above 200°C the exposed Mo ribbon at the end of the hermetic seal will begin to oxidize, leading to a deterioration of the seal and eventual failure of the lamp.

Recent Developments

1995. Philips developed a metal-halide lamp and reflector system with a 100-W



Fig. 2: The typical short-arc projection lamp, such as this xenon arc lamp, has a bulb-like central structure that covers part of the electrodes and the arc-gap region (Fig. 2).



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projection technology

1.4-mm arc-gap lamp producing a luminous flux of 6000 lm. The lamp was introduced in a Sony rear-projection TV receiver. A Japanese metal-halide lamp with a 3-mm arc length was used in business projectors. This arc gap is suitable for 3-in. LCDs but is too large for 0.75-in. LCDs. However, the long arc gap contributed a rated life of 4000 hours.

1996. Welch Allyn reported the development of an 18/24-W metal-halide lamp with an arc gap of 1.2 mm which is suitable for use with 0.75-in. LCDs. Its initial light output is 1150 lm for the 18-W version and 1850 lm for the 24-W version. It is 49 mm from base to tip.

1998. Advanced Radiation Corp. developed a 120-W direct-current Hg short-arc lamp with a 1.27-mm arc gap for projection systems. The lamp's luminous flux is 7000 lm, and the luminous efficiency is 58 lm/W with 30 W of visible radiation. It is 71.1 mm from base to tip.

1998. Ushio introduced new metal-halide lamps, one with an electrode gap of 1.5 mm and a power consumption of 270 W, and another with a gap of 2.0 mm and a power consumption of 350 W. These lamps have a correlated color temperature of 5400 K and an average life of 2000 hours.

1998. Philips announced its 100-W ultra-high-pressure (UHP) alternating-current Hg lamps with 1.3- and 1.0-mm arc lengths.

1999. Welch Allyn received \$2 million from the U.S. Display Consortium (USDC) to develop a smaller, brighter lamp for projection displays.

Projection Systems

There are five basic types of projection systems in common use excluding the 35-mm incandescent tungsten-lamp system:

1. Theatrical lamp/film system.
2. CRT.
3. LCD transmission.
4. Micromirror reflection.
5. LCD reflection.

The first is the standard movie-theater xenon-lamp projection system using photographic film media. This category can be expanded to include the newer IMAX type of projection systems with their large 15-kW water-cooled xenon lamps. CRT projectors, being self-luminous systems, do not use lamps and therefore do not interest us for the purposes of this article.

Transmissive liquid-crystal-display (LCD) systems use color filters that can require a light source with more blue light than is necessary for other systems; therefore, a metal-halide lamp is appropriate, but with reflective systems a xenon arc or other source with less blue content might be preferred. This is a generalization that might have to be modified for particular lamps. For instance, the new Philips lamp is an Hg arc lamp with a correlated color temperature of 8500 K, so it can be used with reflection systems. It is interesting to note that direct-view color-television sets are set up with points from 5900 to 13,700 K, depending on manufacturer and user preferences.

Conclusions

Different projection methods generally require a specific projection lamp to function properly. Micromechanical and liquid-crystal-on-silicon (LCoS) microdisplay systems, because of their small sizes, require a source with a short arc length. Philips, Welch Allyn, and ARC, among other companies, are working vigorously on short-arc-length technology. Larger LCDs can use a larger lamp, but the optical characteristics of the color filters used in these systems may require the bluer light of a metal-halide lamp.

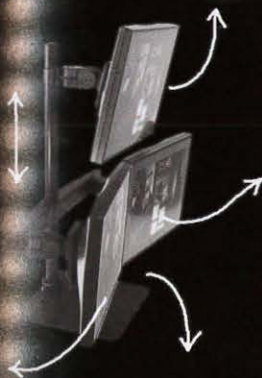
We believe that manufacturers of projection displays have not always been aware of the importance of matching lamp technology to the projection method being used, and that there is a wide range of lamps available for solving the manufacturers' problems.

Lamps for projection displays is, of course, a large topic, and we have not even gone into the effect of reflectors and dichroics, which also affect the choice of lamps for projection displays. Even so, we hope we have given our readers a better understanding of the lamps now widely used in projection displays.

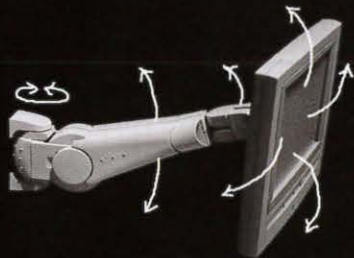
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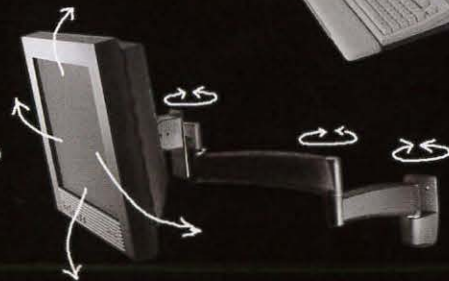
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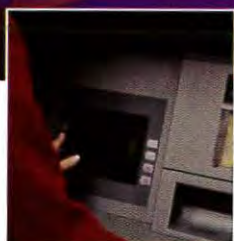
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Millennium Monitors at CeBIT 2000

CeBIT's millennium event couldn't fail to impress with its record-breaking turnout of exhibitors and visitors – and an abundance of innovative displays.

by Michelle Barnes and Bryan Norris

AT the Hannover Messe, from February 24 to March 1, CeBIT 2000 reached such huge proportions that the show's organizers are again talking about reducing both the number of fair days and the number of non-business attendees. Of the 750,000 visitors (compared to 698,000 last year), 650,000 were classed as "trade professionals." They were there to see the 7802 exhibitors (vs. 7412 for 1999), 2945 of which were from countries outside Germany.

As usual, the show was preceded by a Press Day (February 23) for IT journalists. The hot topics were E-commerce and wireless application protocol (WAP), and M-commerce and the mobile Internet. *Nokia* predicted that Internet access by mobile phones would exceed PC access by 2003! Monitors may not evoke the same buzz as these trendy topics, but in their respective press conferences companies such as *Panasonic* and *Philips* were keen to present their new and forthcoming monitors to the assembled journalists.

Revolutionary Digital CRTs

Even with helpful pointers from press-conference presenters, hunting down the monitor innovations at CeBIT is a daunting task when

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over 80 companies are exhibiting displays. We were particularly keen to search out the new digital CRTs. These "revolutionary" dual-input CRT monitors are to be marketed as an "investment protection for customers" because the Digital Visual Interface (DVI) they employ will work with current systems as well as with the digital-output-only PCs of the future. Mind you, such "protection"

comes at a price. These monitors will probably cost around 30% more than traditional analog units – at least initially.

iiyama showed its new digital 19-in. monitor, the Vision Master A902MT. This 30–115-kHz Diamondtron™ Natural Flat model features USB and speakers, and has a release date of Q2 '00. *ViewSonic* exhibited two digital "displays for tomorrow," the 17-in.

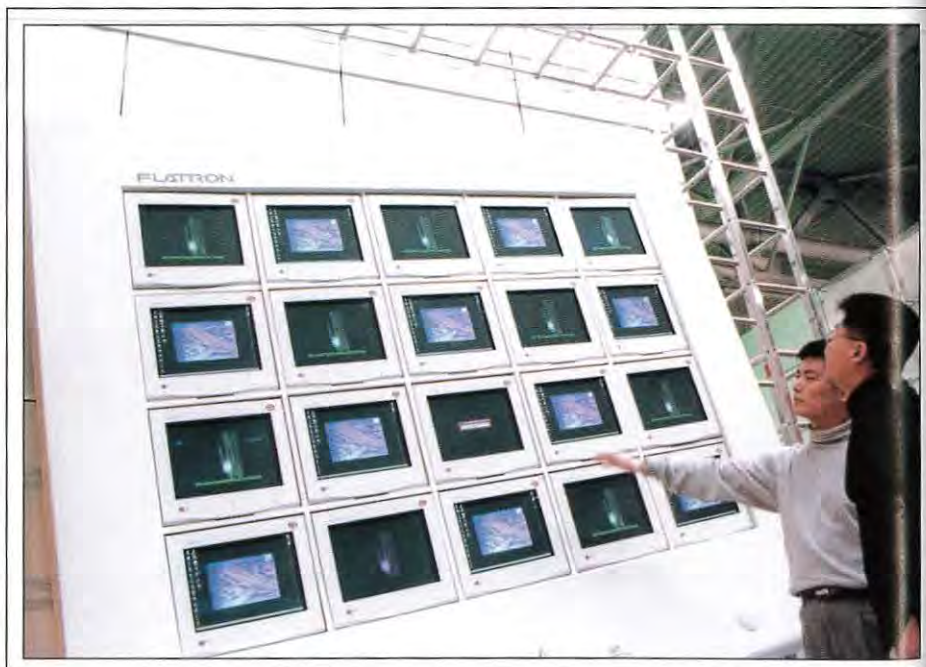
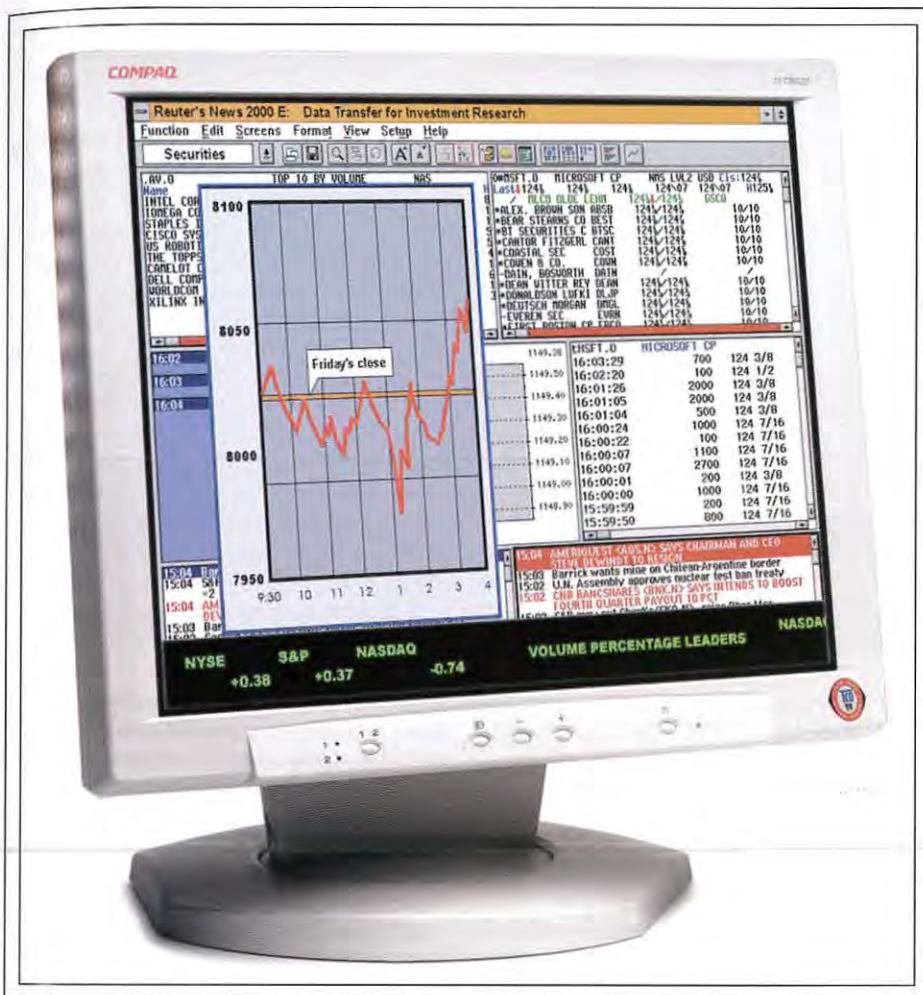


Fig. 1: "Perfectly," "naturally," and "purely" flat CRT monitors were an important – even dominant – part of many CRT lines at CeBIT 2000. LG Electronics was uninhibited in showing off its Flatron™ line, which is unusual in that the inner surface of the tube's faceplate, as well as the outer surface, is flat.

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Fig. 2: With prices still well over \$2000, 18-in. LCD monitors such as the Compaq TFT8020 are certainly not "entry level" for most customers, but they no longer overwhelm because of their size alone now that prototype panels of 20 in. and greater could be seen all over CeBIT.

PF77 and 19-in. PF97 – also expected to be shipping in Q2 '00 – with estimated street prices of £249/US\$400 and £349/US\$560. The PF77 and PF97 have the same specifications as the PF775 and PF790, but feature ViewSonic's new multiple-input OptiSync™ technology. Both models have a maximum resolution of SXGA at 85 Hz in digital mode and UXGA (1600 × 1200) at 77 Hz in analog mode.

At its press conference, **Philips** introduced the all-new "future-proof" Model 109P2 19-in. DVI digital CRT monitor, which is part of a new Philips range due to be released in the second half of the year. And **ADI** announced it will be launching a 17- and a 19-in. digital CRT with DVI input at the Intel

Developer Forum in Palm Springs, California, August 31 to September 2, 2000.

Other suppliers showing digital CRTs were **Samsung**, with its 19-in. 110-kHz SyncMaster 950NF, and **Eizo**. And **NEC** was also promising to introduce digital CRT monitors this year using its new ambix™ technology, which is already employed in two new LCD monitors.

Brands for the Masses

Despite the exciting new digital developments, some CRT-monitor suppliers had more prosaic business matters on their minds. Last year, we saw dramatic CRT price drops in Europe, especially in the bread-and-butter 17-in.-CRT market. And there were wide-

spread predictions that 15-in. LCD panels would experience significant price falls from mid-2000 onwards, as Asian investments in production come to fruition.

The German-branded CRT market has been particularly price-sensitive over the last year, and a number of suppliers are fighting for pole position in the entry-level market. **Scott**, the monitor brand of **Zulauf International**, moved into the Number 2 position for German-branded CRT sales in Q4 '99 after only 2 years on the market. Its monitors, with tubes and panels from LG and Samsung, are marketed with 4-year on-site warranties, and are selling in large volumes through retail and PC-assembler channels. And Scott is pushing ahead in other countries too.

Maxdata, big boy on the block, was fighting back with a new two-brand strategy. The **Monxx** 17- and 19-in. CRT monitors have been introduced as competition for **Scott** and other "economy" suppliers in Germany, such as **Video7** (from **Macrotron**). Monxx's 72-kHz 17-in. model with TCO '99 was selling at the show for DM344/US\$175.

Meanwhile, important U.K. player **Taxan** has also been "responding to demand from users who want excellent quality at an affordable price." The company was shouting about the success of its new award-winning economy 17-in. CRT model, the ValueVision 1710 TCO '99, which was introduced in February at a street price of only £139/US\$220.

Industry Blues

Falling prices wasn't the only gloomy subject at this year's CeBIT, which was also awash with talk of further consolidation in the industry. The recent spate of mergers led to a subdued atmosphere on many stands.

A few weeks before the show, **ViewSonic** had signed an agreement to acquire the **Nokia**-branded display business in Europe and North America, along with its European sales organization. So some of ViewSonic's monitors were displayed on the nearby Nokia stand. And Nokia's CeBIT press releases presented a cheerful face to the world, announcing "ViewSonic positioned to become a major player in Europe" and stressing, "as far as shipments and quality are concerned, it will be business as usual for the established Nokia channels and customers."

The merger between **NEC** and **Mitsubishi** was not due for completion until April 1, 2000, in Japan, so there was no hint on the



Fig. 3: Sharp attracted attention at CeBIT with a prototype 28-in. TFT-LCD video monitor, the LC-28HM2, featuring a resolution of 1280 × 768.

CeBIT stands of this planned coalition. In Europe, moves on the ground to combine forces in the various countries are likely to begin around mid-year, but the brands will probably continue to run in parallel until 2001. NEC is no longer producing its large-screen CRT monitors, and the Mitsubishi Diamondtron™ technology is now being employed in some of NEC's product range instead of ChromaClear®.

Although *Fujitsu* and *Siemens* differed somewhat in ethos, they appear to be making a fairly smooth transition into one organization, and more emphasis is being given to monitors. The new *Fujitsu Siemens Computers* promoted its combined display line-up at Hannover, although neither company had devoted stand space to the promotion of monitors at a major show before.

Flat Tubes Take Over

CRT monitors took center stage this year on many stands, with a plethora of flat-screen CRT models on show. In fact, flat-screen offerings now dominate the monitor ranges of some suppliers.

All the *Sony* and *Mitsubishi* models promoted at CeBIT employed their respective maker's flat tubes, the FD Trinitron® and Nat-

ural Flat Diamondtron™. And, not surprisingly, Mitsubishi's new partner NEC was promoting its new range of all NF products.

Elsa, with a new family of eight CRTs, demonstrated that it too has wholeheartedly embraced flat-tube technology, with both FD and NF models making up its 17–21-in. range.

Mitsubishi exhibited four new models in its NF eight-product range: a 17- and 19-in. and two 22-in. units. The 22-in. 121-kHz Diamond Pro 2040U is fitted with Dynamic Beam Landing Optimizer (DBLO) technology, which evens out the changes in temperature after switching on. This produces color images with stable gamma values after a much-shortened warming-up period.

NEC's range of eight Natural Flat products also included four new models: a 17-in., 19-in., and two 22-in. monitors. And other new NF models were exhibited by *Acer*, *Eye-Q*, *Iiyama*, *Lite-On*, *Philips*, *Samsung*, *Taxan*, *Video7 (Macrotron)*, *ViewSonic*, and *Vidi (CA&G)*.

Not to be left behind, *Philips* has upgraded its Brilliance line to flat-screen products: the 17-in. 96-kHz 107P10, the 19-in. 110-kHz 109MP, and the 21-in. 121-kHz 201P, which is being categorized as a 21-in. model. *Samsung* showed off its new range of four NF

models, including the digital SM950NF, alongside its DynaFlat products. Meanwhile, *ViewSonic* launched its first 22-in. PerfectFlat™ display, the 117-kHz PF815.

Sony was promoting its all-FD CRT line-up at CeBIT (15–21 in.). Even the economical E-series displays were featuring the FD SAGIC™ technology. Other branded suppliers promoting FD models in their new line-ups were *ADI*, *CTX*, *Elsa*, *MAGiC (Wortmann)*, and *Nokia*.

Meanwhile, the international PC houses are also offering FD Trinitron® products in their monitor line-ups, notably *Fujitsu Siemens*, *Compaq*, *IBM*, and *H-P*. *Fujitsu Siemens* is releasing two FD models in May 2000, the 19-in. 19T2 and 21-in. 21T2, and these were previewed at the show. *Compaq* and *H-P* already have “performance lines” consisting of FD models.

In addition to its now-familiar DynaFlat 17-in. 700IFT and 19-in. 900IFT products, *Samsung* exhibited a prototype 23-in. DynaFlat CDT. The 23-in. tube has a 16:10 aspect ratio, allowing two A4-sized pages to be visible. Other suppliers that have chosen the DynaFlat technology for new flat-screen offerings include *Scott*, with its 17-in. 96-kHz 795F, *Daewoo*, with its new 19-in. 95-kHz 904DF, and *Hyundai*, with a new “Perfectly flat” 19-in. 95-kHz DeluxScan F990.

LG Electronics's Flatron™ tube technology, providing “completely flat outer and inner surfaces,” is still all but exclusive to LG's monitor line-up (Fig. 1). The exception is *Hyundai*, which has employed the Flatron tube in its new “Perfectly flat” 17-in. model, the 95-kHz DeluxScan F790. Meanwhile, *Hitachi* introduced its first flat-screen product, the CM771ET, using the Hitachi “Flat” tube. This 19-in. 31–96-kHz model with a dot pitch of 0.21/0.23 (center/corner) and a maximum resolution of 1800 × 1350 was scheduled for release in Q2 '00.

TFT Displays – Big Is Beautiful

The number of new LCD monitors continued to astonish. This year's CeBIT revealed over 55 new 15-in. models alone (nine of which were digital), although many were second-generation “improved” versions (Fig. 2).

Perhaps the most interesting 15-in. on show was *Mitsubishi*'s LXA580W, the “world's first sRGB LCD monitor,” which uses the new Mitsubishi Advanced Color System – an algorithm for color conversion in digital dis-



ADI

Fig. 4: ADI showed a monitor cabinet that is really green – although it may appear more like brown in this photo. Half flax and half cellulose diacetate, the composite material of which the cabinet is made can be put in a compost pile and returned to the soil – presumably after the monitor stops functioning.

plays using the best parts of two conventional methods, matrix calculation and 3-D look-up tables. It produces faithful color for moving and stationary images without the huge amounts of memory usually required for such operations. The 15-in. unit was available in Germany for DM2413/US\$1230, with an 18-in. version (the LSA831W) scheduled for May 2000 at around DM5862/US\$2990.

Despite this impressive technology, it is always the large TFT displays and prototypes that grab the most attention. **Sharp** exhibited the next LCD novelty, a prototype 28-in. TFT-LCD video monitor, the LC-28HM2, featuring a resolution of 1280 × 768 × RGB (2.9 million sub-pixels), a depth of only 60 mm (without the tabletop stand), and a weight of 10.3 kg (Fig. 3). There was also a new 20-in. LCD video monitor, the LC-20VM2E, with a sleek 49.5-mm-deep metallic case and an Industrie Design Forum of Hannover (iF) award.

Samsung, meanwhile, featured an example of its 24-in. LCD screen and a 21.3-in. monitor, the 2100TFT, both planned for Q3 '00. And **LG** presented its forthcoming 22-in. multimedia TFT monitor, the Digital-Wide 220LC, which accepts analog and digital input

as well as DTV, RGB, and NTSC AV signals. The 22-in. panel has been developed by the joint-venture company **LG.Philips LCD Co. Ltd.** for uses such as desktop publishing and digital TVs, and the mass production of this model, billed as the “largest TFT-LCD commercially available on the market today,” started back in October 1999.

ViewSonic's 20.8-in. LCD monitor, the VP211hd, planned for September, used the high-density panel which IBM impressed us with at last year's CeBIT. This QXGA (2048 × 1536) panel approaches the level at which electronic displays can begin to be compared to a printed page. Other products in ViewSonic's pipeline are models with a 23.1-in. 1600 × 1200 Fujitsu panel and the 17.3-in. Mitsubishi panel first used in the Silicon Graphics monitor.

Other large-screen models of note were **NEC's** new 2110P, which uses the company's 21.3-in. panel. The panel is selling successfully in air-traffic-control (ATC) applications. Other large entries were **Eizo's** forthcoming 19.6-in. TFT display, the L771, with a Sharp 1600 × 1200 panel and DVI interface (due for release in June 2000), and **Panasonic's** 19-in. LC90S, scheduled for March 2000 at a price

of DM8190/US\$4200. The LC90S boasts the proprietary “pixel conversion function” to guarantee a clear display even with a poor graphics card.

Plasma Record Breakers

But, of course, the large-screen TFTs are tiddlers in comparison with the big plasma monitors, which are designed for the growing HDTV market. Sixty-inch plasma units were shown by **LG Electronics** and **Panasonic**. LG claimed that its PD-60X1 is “the world's biggest plasma screen in HDTV quality,” while Panasonic boasted its unit was the “highest-quality 60-in. plasma display in the world.” These 60-in. models have a brightness of 450 cd/m² and a horizontal viewing angle of 160°.

Just in case the sheer size wasn't impressive enough, Panasonic pointed out that the array of 1366 × 768 full-color pixels matches the eye's ability to resolve details of about 1 mm at a distance of 10 ft. (Dark-room contrast ratios were quoted as 550:1 for the PD-60X1 and greater than 500:1 for the Panasonic unit.)

Meanwhile, most of the plasma units available for sale are a mere 42 in. Here, Panasonic believes that its TC-42P1F has “the best image quality of any panel in its class.” The **Philips** Brilliance 420P boasts high-contrast reproduction through the use of a “unique” glass-filter plate and an anti-reflection-coated glass screen.

Acer was also showing off a 42-in. plasma panel, the 7843, which uses Acer's own technology. Despite the recent increase in 42-in. units, some are claiming that 37 in. will become the favored size. (The current suppliers in this class are Hitachi and Panasonic.)

Desktops Grow Green – Literally

But if one's monitor isn't the largest, or the cheapest, or even the flattest on display, don't despair, because it may be the greenest. In this category, the real accolade is **TÜV Rheinland's** ECO Circle 2000 mark. TÜV's Berlin/Brandenburg IT product laboratories thoroughly test all the CRT- or FPD-monitor parameters that may impact on user health or the environment. Four monitors shown at CeBIT could boast of earning this mark. Three were from **Eizo**: the 21-in.-CRT FlexScan F980, the new 15-in.-LCD FlexScan L350, and the 18-in.-LCD FlexScan L661. The only non-Eizo monitor in the quartet was **Samsung's** new 15-in.-LCD SyncMaster

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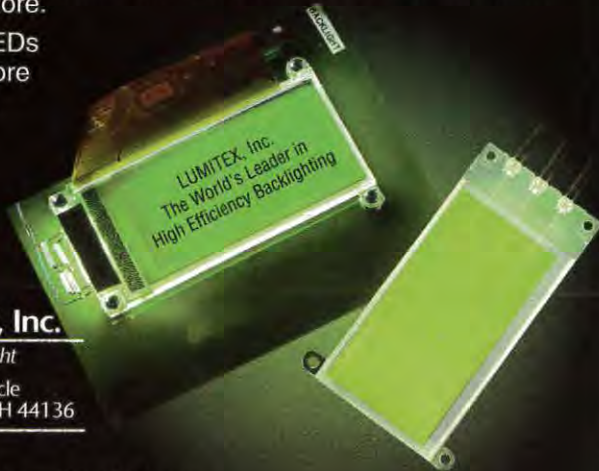
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Circle no. 25

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show report

570PTFT. The three LCD monitors had to meet the latest ergonomic standard, ISO 13406-2 (equivalent to ISO 9241-3/7/8 for CRTs) for efficient image quality, as well as the most stringent values for lack of radiation in accordance with the new "MPR III," EN 50279. [For further details, contact Stephan Scheuer (scheuer@de.tuv.com) or Hans-Jürgen Herrman (herrman@de.tuv.com) at TÜV Rheinland Product Safety in Cologne; telephone +49-(0)-221-806-1654/1547.]

But when we say "green," the prize at this year's show would have to go to **ADI's** new monitor cabinet (Fig. 4). The company has been developing a monitor case that is both resource-saving and "compostable." The current prototype, which is also green in the chromatic sense, uses a grassy-looking material consisting of 50% flax and 50% cellulose diacetate that is apparently not significantly more expensive than conventional plastics. We think the back-to-nature look could catch on, although ADI is hedging its bets by planning to produce a 17-in. model using this material that looks the same as conventional displays, as well as a special green edition in which the fibers remain visible.

What will we compost next? Could this be the approach the Hannover Messe is looking for to reduce the biomass of next year's CeBIT? To find out, watch for our report on CeBIT 2001, to be held March 22-28, 2001.

Note

Display prices quoted in this article are recommended retail prices (RRP) excluding local tax, unless otherwise stated. ■

SID '01

Symposium, Seminar,
and Exhibition

San Jose, California

San Jose Convention Center

June 3-8, 2001

Industry Directory

ID's fourteenth annual directory of the display industry.

COMPILED AND EDITED BY THE EDITORIAL STAFF

Part I, beginning on this page, is a listing of products and services relevant to the display industry. Part II, the company directory, begins on page 45.

Part I: Products and Services

ADHESIVES

□ Adhesives Research □ Applied Vacuum Coating □ Avnet □ ITO America □ Sheldahl

ANTIREFLECTION COATINGS

See optical coatings

ANTIREFLECTION SCREENS

See filters

ANTISTATIC CHEMICALS AND DEVICES

□ ACL/Staticide □ Ernst W. Dorn Co. □ Exxene □ Eyesaver □ Homalite □ Ion Systems □ Lamination Technology □ OCLI □ SIMCO □ Tech Spray □ Teknek Electronics □ 3M Electronic Products □ 3M Product Information

ASSOCIATIONS AND PROFESSIONAL SOCIETIES

□ ALCOM □ American Institute of Small Business □ Global Display Network □ Human Factors Society □ Instrument Society of America □ Machover Associates □ National Computer Graphics Associates □ SEMI □ Society for Information Display □ SPIE □ SPSE □ University of Michigan □ USDC □ VESA

BACKLIGHTS (for liquid-crystal displays)

□ AlliedSignal □ All American □ Avalex □ Avnet □ Axonix □ Bi-Search □ BKL □ Breault □ Brimar □ Briteview Technologies □ Clare Micronix □ Craft Data Ltd. □ Crystal Visions Solutions □ CTP Coil □ D&T □ Data Modul □ Dolch Computer □ Dimension Technologies □ Display Engr. □ Earth Computer □ EG&G Optoelectronics □ ELtech □ Electro-Optics □ EMCO □ Eurecran □ Flat Panel Display □ General Electric □ Ginsbury □ GUNZE □ High Lumen Displays □ H-P □ IEE □ Imaging & Sensing □ Innova Electronics □ Insync Peripherals □ ITO America □ Jaco Electronics □ JKL Components □ Kristel

□ Korry Electronics □ Lamination Technology □ Landmark Technology □ LCD Lighting □ Microsemi LinFinity □ Litton Systems □ L-3 Display Systems □ Luminescent Systems □ Lumitex □ Man & Machine □ Manhattan Skyline □ Milgray Electronics □ Modutec □ Multichip Assembly □ National Semiconductor □ Ophys □ PanelX.com □ Performance Display Systems □ Physical Optics □ Pixelink □ Planar Advance □ Planar Flat Candle □ Poly-Optical Products □ Precision Lamp □ Purdy Electronics □ Racal-Mesl □ Raytheon □ Review Display Systems □ Reynolds Industries □ Rikei Corp. □ Rockwell Collins □ SAIC □ SAI Technology □ SI Diamond □ I. I. Stanley □ Stanley Electric □ Swiss Controls □ Taiyo Yuden USA □ TDK □ Teledyne Lighting & Display □ Thomas Electronics □ 3M Product Information □ Vertex LCD □ Visus □ VL Electronics □ Voltarc Technologies □ Wedgelight □ White Electronics □ Winsor □ WPI Electronics □ Wyle Electronics

CABLES

□ Axon'

CATHODES AND COMPONENTS

□ Brimar Ltd. □ Ceronix □ FEPET □ General Vacuum □ Incom □ Intevac □ JACO Electronics □ Kimball Physics □ Mshield □ OCLI □ Pixelink □ Princeton Display □ Printable Field Emitters □ SI Diamond □ Thomson Components & Tubes □ UTI Corp. □ VDC (Apex) □ VDC (Southwest Vacuum)

CCD IMAGERS AND CAMERAS

□ American ELTEC □ Ball Aerospace □ Burle Industries □ CID Technologies □ Coreco □ Craft Data Ltd. □ Data Plus □ DRS Technologies □ DynaColor □ Eastman Kodak □ EEV □ EEV Ltd. □ EG&G Optoelectronics □ EG&G Reticon □ ELDIM □ Electro-Optics □ Incom □ IPS Automation □ JENOPTIK □ Kollmorgen □ Kontron □ Lighting Sciences □ Loral Fairchild □ MegaVision □ Mekel Engr. □ Milgray Electronics □ Optical Radiation □ Philips Components □ Pulnix America □ Raytheon □ Sarnoff Corp. □ Schott Fiber Optics □ Scientific Systems □ Security Defense Systems □ Seiwa Optical □ Sony

Display Device Group □ Symco □ Telesensory □ Thomson Components & Tubes □ Thomson Tubes Electronique □ Wyle Electronics □ Xyblon

CHARACTER RECOGNITION DEVICES

□ Coreco □ Eastman Kodak □ Poly-Optical Products □ Sharp Digital Information Products □ Telesensory □ Voice Connexion

CID IMAGERS AND CAMERAS

□ CID Technologies □ Digital Vision □ Raytheon

CLEANING AGENTS

□ Applied Technology □ American Polarizers □ Arizona LCD □ Borer Chemie AG □ Ernst W. Dorn Co. □ Kisco □ OCLI □ Silicon Valley Chemlabs □ Tech Spray □ 3M Product Information □ Valtech

COLOR MATCHING SYSTEMS

□ AVT □ Barco Display □ Color Technology Solutions □ Electronic Image Systems □ Electro-Optics □ Minolta □ T&M Instruments □ 3M Product Information □ Topcon □ Torrey Pines Research □ TRICOR Systems

COMPUTER VIDEO INTERFACES

□ AAeon Electronics □ All American □ Allinex □ AVED □ Communications Specialties □ Covid □ Data Plus □ DDWG □ Densitron □ Eaton PSD □ Epson America □ Epson Electronics America □ Extron □ Fakespace □ Genesis Microchip □ Imagine Graphics □ Laversab □ Luminary Technologies □ Milgray Electronics □ Mintronix □ Molex □ Panoram Technologies □ Pixelink □ Pixelworks □ Pivotal Technologies □ PsiTech □ Racal-Mesl □ RGB Spectrum □ SAIC □ SI Diamond □ Simtech □ Teleline Canada □ 3M Product Information □ Univision □ WACOM □ Wyle Electronics

CONNECTORS AND SOCKETS

□ All American □ Applied Technology □ Thomas Betts □ Caton Connector □ Display Components □ Elform □ Eurecran □ Flex Interconnect □ Fujipoly America □ General Atronics □ Hosiden America □ HP Reid □ JAE Electronics □ ITO America □ ITT Cannon □ Jaco Electronics □ JAE Electronics □ Kisco □ Meritec □ Molex □ Multichip Assembly □ Pixelink □ Pulse □ Raytheon

□ Reynolds Industries □ Stan-Allen □ Stanley Palmer □ Teledyne Kinetics □ 3M Electronic Products □ 3M Product Information □ Young Technology

CONSULTANTS

□ AGI □ ALCOM □ Applied Technology □ ARD □ Arizona LCD □ ASM America □ AZ LCD □ Leo Beiser □ Bozel Kamstra □ Breault □ Carroll Consulting □ Color Technology Solutions □ Consillum □ CSERIAC □ Display Components □ Display Device Components □ Display Engineering □ Display Labs □ Displays Consultant Group □ Display Products Technology □ DisplaySearch □ Display technology Consulting □ Eagle Magnetics □ Electronic Image Systems □ Epson Electronics America □ Ergonomics □ Ergosyst Associates □ Flatscreen Technologies □ H. L. Funk □ Future Focus □ Jerold Gard □ Ginsbury □ GreenLight □ H. W. Grossbohlir □ Joe Hallett & Associates □ Walter Hett & Associates □ High Lumen Displays □ Home Theater □ IDT □ Imaging Display □ Infinite Graphics □ InterLingua □ Intertech □ Ion Systems □ Kahn Intl. □ Kenix Industries □ LC-Tec □ Bernard J. Lechner □ Logystyx □ Machover Associates □ Man & Machine □ LM Bejtlich & Associates □ Manx Research □ Matrix Components □ Meko □ McLaughlin Consulting Group □ Meissner & Wurst □ MIRC □ Monterey Technologies □ Multichip Assembly □ Nutmeg Consultants □ Optis □ Optics 1 □ Pacific Media Associates □ Pearson & Associates □ Phosphor Technology □ Pixelink □ Pixel Interconnect □ Rainbow Optics □ Scott Redmond □ Louis Rudzinsky Associates □ SCT Group □ Peter Seats □ Alan Sobel □ Solomon Technology □ Sonera Technologies □ SOPRA □ Stanford Resources □ Stanley Palmer □ Stereomedia □ Tannas Electronics □ Tech-Cor □ Telic Optics □ 3D Imagetek □ 3DTV □ Torrey Pines Research □ Tyson Consulting Group □ UCE □ U.S. Electronics □ Aron Vecht & Associates □ VDC (HQ) □ Venture Development □ Visus □ Westland Electronics

CONVERTERS, DIGITAL/ANALOG

□ Absopulse Electronics □ All American □ Allinex □ AVED □ Best Power Technology □ Bi-Search □ Calspan SRL □ Cardion Electronics □ Clare Micronix □ Colorado Video □ Data Modul □ Data Translaton □ Digital Vision □ Extron □ Ginsbury □ Grass Valley Group □ Infax □ Info-Lite □ Interaction Systems □ Itron

Jaco Electronics Kollmorgen Kristel
 Luminary Technologies Mekel Engrg.
 Molex Multichip Assembly Omega
 Electronics PanelX Pivotal
 Technologies Pixelink Rantec
 Raytheon Sumitomo Metals Team
 Systems Touch Controls Vertex LCD
 Wyle Electronics Yamaha Systems
 Technology

CONVERTERS, DIGITAL/VIDEO

All American AVED Best Power
 Technology Bi-Search Calspan SRL
 Clare Micronix Colorado Video
 Communications Specialties Coreco
 Data Modul Data Translation Digital
 View Digital Vision DRS Military
 Systems Extron General Electric
 Genesis Microchip Ginsbury Grass
 Valley Group Hitachi Denshi America
 Imagine Graphics Jaco Electronics
 Molex Multichip Assembly PanelX
 Pixelink Pivotal Technologies
 Raytheon RGB Spectrum Touch
 Controls Wyle Electronics

CONVERTERS, POWER

Advanced Conversion Tech AHV All
 American Applied Concepts Best
 Power Technology Crane Aerospace
 Display Components Del Global
 Technologies Eldec Ginsbury
 Hyacinth Technology Jaco Electronics
 Landmark Technology Lorad Power
 Systems Stanley Palmer Pixelink
 Swiss Controls Taiyo Yuden USA
 TDK WPI Electronics

CRT DESIGN SERVICES

AVT Brimar Brimar Ltd. Clinton
 Electronics Display Components
 Display Labs EMCO Frontline
 Systems Ginsbury IDT Imaging
 Display Interstate Electronics (GPS)
 IST Jaco Electronics Kent Modular
 Electronics Lexel Imaging Systems
 Milgray Electronics Panoram
 Technologies Pixelink Princeton
 Display Raytheon Sascal Displays
 SGB Enterprises Stanley Palmer
 Teleline Canada Thomas Electronics
 U.S. Electronics VDC (HQ) VDC
 (Teltron) VDC (Z-Axis) XKD Corp.
 Zenith Electronics

CRT DISPLAYS

**See also large-screen displays,
 projection displays, simulator displays,
 3D display systems, touch interactive
 displays, deflection yokes, electron
 guns, focus coils, glass for CRTs**

CRT monitors, color

ADT Advanced Innovative Marketing
 Astronautics Aydin Displays Barco
 Barco Chromatics Barco Display
 Barco Video & Commun. Bi-Search
 Brimar Brimar Ltd. Canadian Marconi
 Candescent Technologies Capetronic
 Cardion Electronics Ceronix Clinton
 Electronics Craft Data, Inc. Data Ray
 Digitran Display Labs Dotronix
 Dynamic Displays Eaton IDT EDL
 Displays Elform Electronic Image
 Systems Electro-Optics Elographics
 EMCO EMCO-Fraker Philips FIMI
 General Electric Ginsbury Gritz's
 Emporium Honeywell IBM IDT
 Infodex Intecolor Interstate
 Electronics Jaco Electronics Kent
 Modular Electronics Kristel Lockheed
 Sanders L-3 Display Systems Marshall

Industries Matsushita MII Milgray
 Electronics Monitem MTL Systems
 Nortech Engineering Nortech Imaging
 Orwin Associates Panasonic
 Communications & Systems Panasonic
 Computer Peripherals Panasonic
 Industrial Panoram Technologies
 Pegasys Displays Philips Consumer
 Electronics Philips Display Components
 Philips FIMI Pixelink Planar Systems
 Precision Imaging Rasterops
 Raytheon Richardson Electronics
 Sampo America Sarnoff Corp.
 Sascal Displays SGB Enterprises
 Siemens AG Sony Sony Display
 Device Group Sony Graphic Display
 Symco Tatung Tektronix Teleline
 Canada VDC (Teltron) Thomson-CSF
 Thomson Tubes Electronique Totoku
 Electric Touch Controls Unigraf
 U.S. Electronics Teleline Canada
 VDC (Teltron) VDC (Z-Axis) View
 Magic Vidwall Vivitek Wells Gardner
 Wyle Electronics XKD

CRT monitors, very high resolution (1600 x 1200 and higher)

AVT Barco Display Brimar
 Brimar Ltd. Clinton Electronics Display
 Labs Dynamic Displays Image Systems
 Imagine Graphics Imaging Display
 IST Kristel MII Nortech Imaging
 Panoram Technologies Philips Display
 Components Thomson Tubes & Displays
 Thomson Tubes Electronique Touch
 Controls Unigraf U.S. Electronics
 VDC (Teltron)

CRT monitors, high resolution (1024 x 768)

Advanced Innovative Marketing Apricot
 Sigmex Aydin Displays Barco Barco
 Chromatics Barco Display Barco Video
 & Commun. Bi-Search Brimar
 Brimar Ltd. Candescent Technologies
 Capetronic Cardion Electronics
 Clinton Electronics Cornerstone
 Technology Dage-MTI Data Plus
 Data Ray Digitran Display
 Components Display Labs Display
 Tek Dotronix DRS Technologies
 Dynamic Displays EDL Displays
 Electronic Image Systems Elographics
 EMCO Evans & Sutherland Computer
 Philips FIMI Ginsbury Honeywell
 IBM IDT Image Systems Imagine
 Graphics Imaging & Sensing Imaging
 Display Infodex Intecolor Interstate
 Electronics IST Jaco Electronics
 Kent Modular Electronics Kristel
 Litton Electron Devices Lockheed
 Sanders L-3 Display Systems Mega
 Scan MII Milgray Electronics
 Monitem MTL Systems National
 Semiconductor Nortech Engineering
 Nortech Imaging Orwin Associates
 Panasonic Computer Peripherals
 Panasonic Industrial Pegasys Displays
 Philips Consumer Electronics Philips
 Display Components Philips FIMI
 Precision Imaging Princeton Display
 Rasterops Raytheon Richardson
 Electronics Sampo America Sarnoff
 Corp. Sascal Displays SGB
 Enterprises Siemens AG Sony Sony
 Display Device Group Sony Graphic
 Display Stanley Palmer Tatung
 Tektronix Teleline Canada Texas
 Industrial Peripherals Thomson-CSF
 Totoku Electric Touch Controls
 Unigraf U.S. Electronics VDC
 (Teltron) VDC (Z-Axis) Whittaker
 XKD

CRT monitors, monochrome

ADT Advanced Innovative Marketing
 Astronautics Ball Aerospace Barco
 Barco Display Brimar Brimar Ltd.
 Burle Industries Calspan SRL
 Capetronic Cardion Electronics
 Clinton Electronics Cornerstone
 Technology CRT Scientific Dage-MTI
 Data Plus Data Ray Digitran
 Display Components Display Labs
 Dotronix Dynamic Displays EDL
 Displays Electronic Image Systems
 El-Op Electrooptics Industries EMCO
 General Electric Ginsbury Gritz's
 Emporium Honeywell IBM IDT
 Image Systems Imaging & Sensing
 Imaging Display Infax Infodex
 Interstate Electronics IST Kent
 Modular Electronics Kristel Lockheed
 Sanders L-3 Display Systems Mega
 Scan MII Monitem National
 Semiconductor Nortech Imaging
 Opto-Cal Orwin Associates Palomar
 Products Pegasys Displays Philips
 Consumer Electronics Philips FIMI
 Precision Imaging Princeton Display
 Rasterops Raytheon Richardson
 Electronics Sampo America SAMTEL
 USA Sarnoff Corp. Sascal Displays
 Siemens AG Sony Display Device
 Group Stanley Palmer Symco
 Tatung Tektronix Teleline Canada
 Thomson Tubes Electronique Totoku
 Electric TSD Display Products Unigraf
 U.S. Electronics VDC (Teltron) VDC
 (Z-Axis) View Magic Wells Gardner
 XKD

CRTs, beam-index

Digitran Display Components
 Display Labs Electronic Image
 Systems Ginsbury Honeywell IDT
 L-3 Display Systems Lexel Imaging
 Systems Raytheon Sarnoff Corp.
 Sony Display Device Group Stanley
 Palmer Thomas Electronics Thomson
 Components & Tubes Thomson Tubes
 Electronique U.S. Electronics

CRTs, shadow mask/aperture grill

ADT AVT Burle Industries
 Canadian Marconi Cardion Electronics
 CRT Scientific Digitran Display Labs
 Dotronix EDL Displays EEV Ltd.
 Electronic Image Systems General
 Atronics General Electric Ginsbury
 Gritz's Emporium Honeywell IDT
 Imaging & Sensing Imaging Display
 ISE Electronics Matsushita
 Micronic Laser Systems Milgray
 Electronics Mitsubishi Electronics Sales
 America Monitem MTL Systems
 Pegasys Displays Philips Display
 Components Planar Systems
 Princeton Display Raytheon
 Richardson Electronics SAMTEL USA
 Sarnoff Corp. SGB Enterprises Sony
 Display Device Group Tektronix
 Thomas Electronics Thomson
 Components & Tubes Thomson Tubes
 Electronique Toshiba America U.S.
 Electronics VDC (Chroma) VDC (Data
 Display) VDC (Video Electronics)
 Vidwall XKD Zenith Electronics

CRTs, flat

AVT Aydin Displays Brimar
 Clinton Electronics CRT Scientific
 Digitran Display Labs Display
 Research Labs Dotronix DRS
 Technologies EEV Ltd. Electronic
 Image Systems FEPEP Futaba
 Futaba America Ginsbury

Honeywell Defense Avionics IDT
 Imagine Graphics Imaging Display
 Infodex Jaco Electronics Lexel
 Imaging Systems Mega Scan MII
 Motorola FPD MTL Systems Milgray
 Electronics Mitsubishi Electronics Sales
 America Panoram Technologies
 Panasonic Communications & Systems
 Panasonic Computer Peripherals
 Philips Display Components Raytheon
 Richardson Electronics Samsung
 Semiconductor Sarnoff Corp. SGB
 Enterprises Si Diamond Sony Sony
 Display Device Group Thomas
 Electronics Toshiba America Touch
 Controls U.S. Electronics Wyle
 Electronics XKD Zenith Electronics

CRTs, miniature

ADT Brimar Brimar Ltd. Burle
 Industries CRT Scientific Digitran
 Display Labs Dotronix EEV Ltd.
 Electronic Image Systems General
 Atronics Ginsbury Gritz's Emporium
 Honeywell IDT Imaging & Sensing
 Imaging Display IST Lexel Imaging
 Systems Litton Electron Devices
 Raytheon Richardson Electronics
 Sarnoff Corp. SGB Enterprises Sony
 Display Device Group Thomas
 Electronics Thomson Components &
 Tubes Thomson Tubes Electronique
 VDC (HQ) VDC (Teltron) Vivitek

CRTs, multibeam

Brimar Digitran Display Labs
 General Atronics Ginsbury
 Honeywell Infodex Lexel Imaging
 Systems Litton Electron Devices L-3
 Display Systems Raytheon Richardson
 Electronics Sarnoff Corp. Sony Display
 Device Group Thomas Electronics
 Thomson Components & Tubes
 Thomson-CSF Tubes Thomson Tubes
 Electronics VDC (Teltron)

CRT MATERIALS

**See individual listings for filters,
 getters, glass, magnetic shielding,
 materials, optical coatings, phosphors,
 polarizers**

CRT TESTING LABORATORIES

Brimar Display Labs DynaColor
 ELDIM Erogonics Hoffman
 Engrg. Lexel Imaging Systems MECC
 National Technical Systems Sonera
 Technologies TÜV Rheinland

DEFLECTION AMPLIFIERS

Brimar Brimar Ltd. Celco Celco
 Pacific Citronix Display Labs
 Ginsbury Imaging Display Infodex
 MECC M. S. Kennedy National
 Semiconductor Orwin Associates SGB
 Enterprises Wasatch High Voltage

DEFLECTION YOKES

Brimar Brimar Ltd. Display
 Components Display Labs DynaColor
 EEV Ltd. Ginsbury Infodex K & R
 Engrg. Panasonic Industrial Sampo
 Sarnoff Corp. Sony Display Device
 Group Stanley Palmer Syntronic
 Instruments Thomson Tubes & Displays
 Totoku Electric WinTron

DEPOSITION EQUIPMENT

Balzers AEG Balzers Thin Films
 Balzers Thin Films GmbH BOC
 Coating Technology BOC Edwards

□ Edwards □ FAS Technologies □ General Vacuum □ Innotec □ Intevac □ Kisco □ Kurdex □ Kurt J. Lesker Co. □ Leybold □ Materials Research Corp. □ SI Diamond □ Spectrum Sciences □ Techni-Met □ Temascal □ Torrey Pines Research □ TSC □ ULVAC Technologies □ **ZC&R Coatings**

DEPOSITION SERVICES

□ Balzers AEG □ Balzers Thin Films □ Balzers Thin Films GmbH □ **Brimar Ltd.** □ CPFilms □ Edwards □ General Vacuum □ Information Products □ Innovative Specialty Films □ Intevac □ IST □ Kurdex □ Leybold □ Metavac □ NeoVac □ Sheldahl □ Spectrum Sciences □ Superior MicroPowders □ Thin Film Technology □ Torrey Pines Research

DIGITAL FILM RECORDERS

□ **Brimar Ltd.** □ **Celco Pacific** □ **Eastman Kodak** □ ECRM Trust □ Ektron Applied Imaging □ Hybrid Micrographics □ **Imapro** □ Lasergraphics □ Management Graphics □ Mekel Engrg. □ Polaroid □ SGB Enterprises □ Tartan Technical □ 3M Product Information

DIGITAL VIDEO SYSTEMS

□ Applan Graphics □ Astronautics □ Boland Communications □ Barco □ Burle Industries □ Colorado Video □ Digital Vision □ DRS Technologies □ **Eastman Kodak** □ Eltime Vision Systems □ Grass Valley Group □ Honeywell □ Incom □ Infodex □ Innovated Image □ Imagine Graphics □ Mekel Engrg. □ Pivotal Technologies □ Primagraphics □ PsiTech □ Sarnoff Corp. □ SI Diamond □ Simtech □ SmartASIC □ Texas Instruments □ 3M Product Information □ Touch Controls □ Univision □ VDC (Z-Axis) □ Virtual Vision

DIGITIZING TABLETS/DIGITIZERS

□ IBM □ Information Products □ Numonics □ Pivotal Technologies □ WACOM

DISABLED DISPLAY USER AIDS

□ Enabling Technologies □ Telesensory

DISPENSER CATHODES

□ **Brimar Ltd.** □ Electronics Sources □ Formosa Advanced Tech. □ Raytheon □ Sony Display Device Group

DISPLAY DRIVERS AND CONTROLLERS

□ Advanced Conversion Tech □ All American □ Anorad □ Arithmos □ Avalex □ Avnet □ Aurora Systems □ AVED □ Babcock □ Barco □ Barco Chromatics □ Barco Display □ Chips & Technologies □ Chip Supply □ Cirrus Logic □ Clare Micronix □ Communications Specialties □ Computer Dynamics □ Craft Data, Inc. □ Craft Data Ltd. □ Crane Aerospace □ Densitron □ Digital View □ Digitran □ Display Labs □ Dolch Computer □ DRS Military Systems □ DRS Technologies □ Eaton FPD □ Eaton/Cutler Hammer □ EG&G Power Systems □ Eldec □ **ELDIM** □ Epron America □ F-P Electronics □ Genesis Microchip □ Gennum □ Honeywell □ Imagine Graphics □ Infodex □ International Micro □ Itron □ Jaco Electronics □ Kent Modular Electronics □ Korry Electronics □ Lockheed Sanders □ Liquid Crystal Institute □ Litton Systems □ LM Bejtlich & Associates □ L-3

Display Systems □ Luminary Technologies □ **Luxell** □ Manhattan Skyline □ Marshall Industries □ MECC □ Metheus □ Milgray Electronics □ Moniterm □ M. S. Kennedy □ Multichip Assembly □ National Semiconductor □ Night Vision Corp. □ Omega Electronics □ Optotek □ Panoram Technologies □ Photonics Systems □ Pixelworks □ Primagraphics □ PsiTech □ Racal-Mesl □ Review Display Systems □ RGB Spectrum □ Sage □ SGB Enterprises □ SI Diamond □ Smart Alec □ S-MOS □ **Solomon Systech** □ Supertex □ Synaptics □ Tektronix □ Texas Instruments Japan □ Thomson-CSF Services □ Trident Microsystems □ **Unigraf** □ Univision □ Versatrac □ Vidwall □ ViewTEK □ **Westar** □ Wyle Electronics □ Yamaha Systems Technology

DISPLAY HOUSING, RUGGEDIZED

□ ADT □ Avnet □ AVT □ All American □ AVED □ Barco □ Barco Chromatics □ **Brimar** □ Burle Industries □ Calspan SRL □ Chief Manufacturing □ Computer Dynamics □ Craft Data, Inc. □ Crystal Visions Solutions □ D&T □ Digital View □ Digitran □ Dolch Computer □ DRS Military Systems □ Eaton FPD □ Eaton/Cutler Hammer □ Eaton PSD □ EDL Displays □ El-Op Electrooptics □ EMCO □ EMCO-Fraker □ Eurecran □ Ginsbury □ Honeywell □ IEE □ Infodex □ Jaco Electronics □ LCSP-Deeco □ **Luxell** □ L-3 Display Systems □ Marshall Industries □ Milgray Electronics □ Multichip Assembly □ Nortech Engineering □ Panoram Technologies □ Pegasus Displays □ Phoenix Group □ Photonics Systems □ Plessy Naval Systems □ **Polar Vision** □ Precision Imaging □ Raytheon □ Retroscan □ Review Display Systems □ SAIC □ SAI Technology □ Sascal Displays □ **Silver Cloud Mfg.** □ Tektronix □ Teletline Canada □ Thomson-CSF Services □ **Three-Five Systems** □ Touch Controls □ Ultra Electronics □ VDC (Data Display) □ ViewTEK □ Virtual Vision

DISPLAY SIMULATION AND MODELING SYSTEMS

□ ADT □ ALCOM □ autronic □ Brealut □ Coryphaeus □ **CRL** □ DRS Military Systems □ Eaton FPD □ EDL Displays □ Evans & Sutherland Computer □ Hitachi Denshi America □ Hughes LV Products □ Infodex □ Interface Displays & Controls □ Itron □ Kisco □ Liberty Mirror □ Liquid Crystal Institute □ MicroPix □ Milgray Electronics □ MTL Systems □ Panoram Technologies □ Sarnoff Corp. □ Shintech □ Sonera Technologies □ Tektronix □ Visus

DISPLAY SUBSYSTEMS

□ AED □ All American □ Arithmos □ Astronautics □ AVED □ Avnet □ Babcock □ Balzers AEG □ Balzers Thin Films □ Balzers Thin Films GmbH □ Barco □ Barco Chromatics □ Barco Display □ **Brimar** □ Calspan SRL □ Clare Micronix □ Clinton Electronics □ ColorLink □ Computer Dynamics □ Craft Data, Inc. □ Craft Data Ltd. □ Crystaloid □ Crystal Visions Solutions □ D&T □ Densitron □ Digilens □ Digital View □ Dimension Technologies □ Dolch Computer □ DRS Technologies □ Eaton FPD □ Eaton/Cutler Hammer □ Eaton PSD □ EG&G

Optoelectronics □ EEV □ Element Displays □ EMCO □ EMCO-Fraker □ Fakespace □ Genesis Microchip □ Ginsbury □ High Lumen Displays □ Honeywell □ Infinity Multimedia □ Interface Displays & Controls □ Jaco Electronics □ Kent Modular Electronics □ Korry Electronics □ Lexel Imaging Systems □ Leybold □ Liquid Crystal Institute □ Litton Systems Canada □ L-3 Display Systems □ **Luxell** □ Man & Machine □ Mark IV Industries □ Marshall Industries □ MicroOptical □ Milgray Electronics □ Multichip Assembly □ National Display Systems □ Night Vision Corp. □ Norsk Display □ Nortech Engineering □ **OCLI** □ Optical Devices □ Optical Radiation □ Optotek □ Palomar Products □ Panoram Technologies □ Panelview □ Peerless Industries □ Performance Display Systems □ Phoenix Group □ Photonics Systems □ Pivotal Technologies □ PixelVision □ Pixelworks □ Planar Flat Candle □ **Polar Vision** □ Poly-Optical Products □ PRP Optoelectronics □ Quantum Electronics □ Racal-Mesl □ Raytheon □ Retinal Displays □ Review Display Systems □ RGB Spectrum □ Rockwell Collins □ Sage □ SAI Technology □ Silicon Light Machines □ Teledyne Lighting & Display □ Texas Instruments □ Thomson-CSF Services □ **Three-Five Systems** □ UCE □ Univision □ VDC (Teltron) □ Virtual Vision □ Vista Controls □ WACOM □ XKD

DISPLAY SYSTEM INTEGRATORS

□ All American □ Astronautics □ AVED □ Avnet □ Barco Chromatics □ BBV Digital □ Calspan SRL □ Canadian Marconi □ Carroll Touch □ Chief Manufacturing □ Clare Micronix □ Computer Dynamics □ Computer Devices Canada □ Craft Data, Inc. □ Crystaloid □ DBI □ Densitron □ Digital View □ Digitran □ DRS Military Systems □ DRS Technologies □ **Eastman Kodak** □ Eaton FPD □ Eaton/Cutler Hammer □ Eaton PSD □ Elographics □ El-Op Electrooptics Industries □ EMCO □ EMCO-Fraker □ Eurecran □ Fakespace □ F-P Electronics □ Honeywell □ Hoya Electronics □ IEE □ Innova Electronics □ Insync Peripherals □ Interface Displays & Controls □ Jaco Electronics □ Kent Modular Electronics □ Kollmorgen □ LCSP-Deeco □ Litton Systems Canada □ Lockheed Sanders □ L-3 Display Systems □ Man & Machine □ Mark IV Industries □ Marshall Industries □ MicroOptical □ MicroPix □ Milgray Electronics □ National Semiconductor □ Panoram Technologies □ Pegasus Displays □ Performance Display Systems □ Photonics Systems □ Plessy Naval Systems □ Quantum Electronics □ Retroscan □ Review Display Systems □ SAI Technology □ Sanders Associates □ SI Diamond □ Smart Alec □ Tech-Com □ Thomson-CSF Services □ Ultra Electronics □ **Unigraf** □ U.S. Electronics □ Vidwall □ ViewTEK □ Virtual Vision □ Vista Controls □ Whittaker

DISPLAYS

See listings under specific technology, i.e., CRT, plasma, electroluminescent

DISTORTION CORRECTION DEVICES

□ **Celco** □ **Celco Pacific** □ Citronix □ Display Labs □ DynaColor □ Ginsbury □ Intronic □ K & R Engrg. □ Sonera Technologies □ Thomson-CSF

ELECTROCHROMIC DISPLAYS

□ Mito Fine Glass □ **OCLI** □ **PanelX** □ Polyvision □ Techni-Met □ 3M Product Information

ELECTROLUMINESCENT DISPLAYS

□ Alien Technology □ Barco □ Barco Chromatics □ Canadian Marconi □ Capetronic □ Clare Micronix □ CPFilms □ Craft Data Ltd. □ Densitron □ Digitran □ Durel □ Earth Computer □ Eaton FPD □ Eaton IDT □ ELtech □ Electro-Optics □ GUNZE □ Honeywell Defense Avionics □ Hoya Electronics □ IEE □ Infodex □ Innovative Specialty Films □ Interface Displays & Controls □ Interstate Electronics □ Jaco Electronics □ Kaiser Electronics □ Liquid Crystal Institute □ Lite Array □ Litton Systems □ **Luxell** □ Manhattan Skyline □ Marshall Industries □ MicroOptical □ Milgray Electronics □ Night Vision Corp. □ Opsys □ **PanelX** □ Planar America □ Planar Intl. □ Planar Systems □ Poly-Optical Products □ PPM Photomask □ Quantex □ Racal-Mesl □ Review Display Systems □ Rogers Corp. □ Sarnoff Corp. □ Sharp Digital Information Products □ Sharp Microelectronics □ I. I. Stanley □ Stanley Electric □ Swiss Controls □ Techni-Met □ Thomson-CSF □ 3M Product Information □ UNIAX □ VDC (Teltron) □ WAMCO □ Westaim □ Wyle Electronics

ELECTROMECHANICAL DISPLAYS

□ Ametek Aerospace Products □ Applied Technology □ Densitron □ Digitran □ Displays Inc. □ Earth Computer □ F-P Electronics □ Honeywell Defense Avionics □ Infax □ Interface Displays & Controls □ Mark IV Industries □ Omega Electronics □ **PanelX** □ Sharp Digital Information Products □ Stan-Allen □ Thin Film Technology □ 3M Product Information

ELECTRON GUNS

□ **Brimar Ltd.** □ Clinton Electronics □ General Atronics □ Innotec □ Kimball Physics □ Philips Components □ Lexel Imaging Systems □ Princeton Display □ Raytheon □ Sarnoff Corp. □ SI Diamond □ Sony Display Device Group □ Thomas Electronics □ Thomson-CSF □ Thomson Tubes & Displays □ 3M Product Information □ VDC (Apex) □ VDC (Southwest Vacuum) □ VDC (Video Electronics) □ Zenith Components Group □ Zenith Electronics

ENCLOSURE DESIGN SYSTEMS

□ All American □ **Chomerics** □ Eaton PSD □ EMCO-Fraker □ Info-Lite □ Retroscan □ Review Display Systems □ Tech-Corn □ 3M Product Information □ Touch Controls

EYE AND HEAD MOVEMENT TRACKERS

□ Applied Science Labs □ El-Op Electrooptics Industries □ Fakespace □ Honeywell □ ISCAN □ Night Vision Corp. □ Polhemus □ Redifusion Simulation □ Retinal Displays □ Reynolds Industries □ Sarnoff Corp. □ Virtual Vision

FIBER-OPTIC FACEPLATES

□ Digitran □ Future Focus □ General Atronics □ Incom □ Poly-Optical Products □ Raytheon □ S & S Optical □ Schott Fiber Optics □ 3M Electronic Products □ 3M Product Information □ Touch Controls

FIELD-EMITTER DISPLAYS

□ Candescent Technologies □ eMagin
□ FEPET □ Futaba America □ Manhattan
Skyline □ Micron Display □ MRS
Technology □ Night Vision Corp. □ PixTech
□ Printable Field Emitters □ Review
Display Systems □ Si Diamond

FILTERS

□ ADT □ American Polarizers □ Applied
Vacuum Coating □ Astra Products □ Avnet
□ Balzers AEG □ Balzers Thin Films
□ Balzers Thin Films GmbH □ Brewer
Science □ Brimar □ Cando □ CLCEO
□ ColorLink □ Corning Optical Corp.
□ CPFilms □ D&T □ Denglas □ Denton
Vacuum □ DigiLens □ Dontech □ EMCO
□ Eyesaver □ Flex Products □ Fosta-Tek
□ Genesis Microchip □ Ginsbury
□ Hoffman Engrg. □ Homalite □ Hoya
Electronics □ Hoya Optics □ I.G.S. □
Information Products □ Innovative Specialty
Films □ International Polarizers □ ITG
□ Kaiser Optical □ Korry Electronics
□ Lamination Technology □ Leybold
□ Liberty Mirror □ Man & Machine
□ Melles Griot □ Metavac □ Milgray
Electronics □ Mito Fine Glass □ NoRad
□ O&S Research □ OCLI □ Optical
Devices □ Panelgraphic □ Panelview
□ Polaroid □ Precision Optical Filters
□ Raytheon □ Review Display Systems
□ RMF Products □ Romag Glass □ Schott
Glass □ Silver Cloud Mfg. □ Southwall
Technologies □ Thin Film Devices □ Thin
Film Technology □ 3M Product Information
□ U.S. Precision Glass □ Viratec □
WAMCO □ ZC&R Coatings

FLAT-PANEL DISPLAYS

See individual listings for backlights,
electroluminescent displays, electro-
mechanical displays, electrochromic
displays, field-emitter displays large-
screen displays, light-emitting diode
displays, liquid-crystal displays, plasma
displays, filters, projection displays,
simulator displays, 3D displays, touch
interactive displays, vacuum fluorescent
displays

FLAT-PANEL MATERIALS

See individual listings for masks, filters,
glass, magnetic shielding, materials,
optical coatings, photolithography
equipment, polarizers

FLEXIBLE CIRCUITS

□ Elform □ Innovative Specialty Films
□ ITO America □ L. E. Flex Circuits
□ Meritec □ Sheldahl

FOCUS COILS

□ Brimar □ Celco □ Del Global
Technologies □ Display Components
□ Ginsbury □ K & R Engrg. □ Raytheon
□ Sarnoff Corp. □ Stanley Palmer
□ Syntronic Instruments □ Thomson
Tubes & Displays □ WinTron

GETTERS

□ Andrews Glass □ Raytheon □ SAES
Getters

GLASS FOR COMPONENTS

□ Andrews Glass □ Denton Vacuum
□ Donnelly Applied Films □ Feldman
Technology □ Hoya Optics □ Information
Products □ I.G.S. □ Kisco □ Lamination
Technology □ Liquid Crystal Institute
□ Metavac □ Nippon Electric Glass

□ Optical Devices □ PanelX □ Philips
Components □ Pilkington LOF □ Precision
Glass Technologies □ Polar Vision
□ Princeton Display □ Raytheon □ Romag
Glass □ S & S Optical □ Schott Corp.
□ Schott Fiber Optics □ Schott Glass
□ SEM-COM □ U.S. Precision Glass
□ VDC (Data Display) □ ZC&R Coatings

GLASS FOR CRTS

□ Corning Asahi □ Donnelly Applied Films
□ Eyesaver □ Hoya Electronics □ Hoya
Corp. □ I.G.S. □ Information Products
□ Lamination Technology □ Mito Fine
Glass □ Nippon Electric Glass □ O&S
Research □ Precision Electronic Glass
□ Raytheon □ S & S Optical □ Schott
Corp. □ Schott Glass □ SEM-COM
□ Technoglas □ U.S. Precision Glass
□ VDC (Video Electronics)

GLASS FOR FLAT-PANEL DISPLAYS

□ Applied Films □ Applied Technology
□ Applied Vacuum Coating □ Billico Mfg.
□ Corning ADP □ Denglas □ Denton
Vacuum □ Donnelly Applied Films □ EEV
Ltd. □ Emerging Display Technologies
□ Eyesaver □ Flachglas AG □ Fujitsu
Microelectronics □ Glaverbel □ Hoya
Electronics □ Hoya Optics □ I.G.S.
□ Information Products □ Lamination
Technology □ Man & Machine □ Pilkington
LOF □ Pilkington Micronics □ Polar Vision
□ Metavac □ Mito Fine Glass □ Nippon
Electric Glass □ O&S Research □ Optical
Devices □ Pixelink □ Rytak □ S & S
Optical □ Saint-Gobain □ Schott Corp.
□ SEM-COM □ U.S. Precision Glass
□ VIOX □ ZC&R Coatings

GRAPHICS BOARDS AND PROCESSORS

□ AAEON Electronics □ All American
□ American ELTEC □ Appian Graphics
□ Avalex □ AVED □ Barco □ Barco
Chromatics □ Barco Display □ Calspan
SRL □ Chips & Technologies □ Coreco
□ Data Translation □ Densitron □ Ernst W.
Dorn Co. □ Evans & Sutherland Computer
□ General Electric □ Genesis Microchip
□ Honeywell □ Hybrid Micrographics
□ IBM □ Imagine Graphics □ Imagraph
□ Imapro □ Kollmorgen □ Lasergraphics
□ L-3 Display Systems □ Luminary
Technologies □ Matrox Electronic Systems
□ Mathews □ Omnicomp Graphics
□ Parallax □ Pixelworks □ Polaroid
□ Primagraphics □ PsiTECH □ Racal-Mesl
□ Rasterops □ Review Display Systems
□ Richardson Electronics □ Simtech
□ Sony □ Sony Graphic Display
□ Sumitomo Metals □ Tatung □ Thomson-
CSF Services □ 3M Product Information
□ Trident Microsystems □ Unigraf
□ Univision □ ViewTEK □ Vivitek
□ Yamaha Systems Technology

GRAPHICS SUBSYSTEMS

□ All American □ American ELTEC □
Appian Graphics □ Astronautics □ AVED
□ Babcock □ Barco □ Barco Chromatics
□ Barco Display □ Calspan SRL
□ Densitron □ Ernst W. Dorn Co.
□ Genesis Microchip □ Imagine Graphics
□ Review Display Systems □ RGB
Spectrum □ Thomson-CSF Services
□ Unigraf □ Univision

GRAPHICS WORKSTATIONS

□ Barco □ Barco Chromatics □ Barco
Display □ Ernst W. Dorn □ Eaton IDT
□ Evans & Sutherland Computer □ Grass
Valley Group □ Hughes LV Products □ IBM
□ Laversab □ Lockheed Sanders

□ Management Graphics □ NuVision
Technologies □ Primagraphics □ SAIC
□ Sanders Associates □ Thomson-CSF
□ 3M Product Information □ Touch
Controls

HARD-COPY DEVICES

See individual listings for digital film
recorders, facsimile machines, plotters,
printers (impact, ink-jet, thermal-transfer,
electrophotographic, color graphic),
printer supplies, printheads

HOLOGRAPHIC DIFFUSERS

□ DigiLens □ DuPont □ Innovative
Specialty Films □ Physical Optics
□ Polaroid Optical Films

IMAGE COMPRESSION

□ Imagraph □ Pixelworks □ PsiTech
□ Schott Fiber Optic □ Sumitomo Metals
□ Symco □ 3M Product Information

IMAGE STORAGE

□ Colorado Video □ Stereomedia
□ Sumitomo Metals □ Symco □ 3M
Product Information □ VDC (Teltron)

IMAGE TUBES

□ Burle Industries □ EEV □ EEV Ltd.
□ Incom □ Kollmorgen □ Lexel Imaging
Systems □ Liton Electron Devices
□ Philips Components □ Sony Display
Device Group □ Thomson Components &
Tubes □ VDC (Teltron)

IMAGING BOARDS

□ American ELTEC □ Barco □ Barco
Display □ Coreco □ Data Plus □ Data
Translation □ DOME □ DynaColor
□ Eastman Kodak □ EPIX □ Genesis
Microchip □ IBM □ Imagraph □ Kollmorgen
□ Matrox Electronic Systems □ Mathews
□ Philips Components □ Primagraphics
□ PsiTECH □ Sharp Digital Information
Products □ Symco □ Univision

IMAGING WORKSTATIONS

□ Amerinex □ Decision Images □ DRS
Technologies □ IBM □ Image Analytics
□ Imagraph □ Kollmorgen □ Laversab
□ Management Graphics □ Mega Scan
□ MegaVision □ Panoram Technologies
□ SAIC □ Sarnoff Corp. □ Sharp Digital
Information Products □ 3M Product
Information

JOYSTICKS

□ ADT □ Digitran □ White Electronics
□ WICO

KEYBOARDS

□ ADT □ Computer Keyboard Systems
□ Craft Data, Inc. □ Digitran □ Futaba
□ IBM □ Innovated Image □ Itron □ Jaco
Electronics □ Korry Electronics □ Laversab
□ Marshall Industries □ Poly-Optical
Products □ Phoenix Group □ PROMED
Keyboard Group □ Racal-Mesl □ SDMS
□ Silver Cloud Mfg. □ Texas Industrial
Peripherals □ Two Technologies □ White
Electronics

LAMPS AND LIGHT SOURCES

□ autronic □ BKL □ Data Display Products
□ Dialight □ EG&G Optoelectronics □
EFOS □ EG&G Power Systems □ EMCO
□ Ginsbury □ Gordon Instruments

□ Hoffman Engrg. □ ILC Technology
□ Info-Lite □ ITO America □ JKL
Components □ LCD Lighting
□ Luminescent Systems □ Lumitex □ Man
& Machine □ OAI □ Opto-Cal □ ORC
Electronic Products □ OSRAM Sylvania
□ Panelview □ Poly-Optical Products
□ Purdy Electronics □ Review Display
Systems □ SAIC □ Schiederwerk GmbH
□ Seiwa Optical □ Si Diamond □ Silver
Cloud Mfg. □ Teledyne Lighting & Display
□ UCE □ Unigraf □ Ushio America
□ Visus □ WAMCO □ Welch Allyn

LARGE-SCREEN DISPLAYS, ALL TECHNOLOGIES

See also projection displays

□ Adaptive Micro Systems □ Advanced
Display Systems □ All American □ Applied
Vacuum Coating □ Avnet □ AVT □ Balzers
AEG □ Balzers Thin Films □ Balzers Thin
Films GmbH □ Barco Display □ Barco
Projection □ Barco Video & Commun.
□ BBV Digital □ Breault □ Capetronic
□ Chief Manufacturing □ Clarity Visual
Systems □ Comfuteur □ Computer Devices
Canada □ Cornerstone Technology □ Craft
Data Ltd. □ Crystal Visions Solutions
□ Crystop Display □ Daktronics □ Davies
□ Draper □ Densitron □ Digital View
□ Digitran □ Display Labs □ Display
Research Labs □ Display Tech □ dnp
Denmark □ Dolch Computer □ Dontech
□ Doltronix □ DRS Technologies □ Eaton
FPD □ EDL Displays □ EEV Ltd.
□ Electronic Image Systems □ Element
Displays □ Epson America □ Euroscan
□ Evans & Sutherland Computer
□ Eyesaver □ FEPET □ Flat Panel Display
□ F-P Electronics □ Fresnel Optics □
Fujitsu □ General Electric □ Ginsbury
□ Hitachi America □ Hitachi Denshi
Display □ Hudson Photographic
□ Hughes-JVC □ Hughes LV Products
□ Imagine Graphics □ Incline □ Incom
□ Infinity Multimedia □ Innovated Image
□ Jaco Electronics □ L-3 Display Systems
□ Lamination Technology □ LC-Tec
□ Leybold □ Liquid Crystal Institute
□ Litton Systems □ Man & Machine
□ Micron □ MITAC □ Mito Fine Glass
□ Mitsubishi Electric Sales America
□ Monitern □ MRS Technology □ Noritake
□ Norsk Displays □ Nortech Imaging
□ nView □ Omega Electronics □ Optical
Radiation □ ORC Lighting □ Palomar
Products □ Panoram Technologies
□ Panelight □ Physical Optics □ Plasmaco
□ Poly-Optical Products □ PPM Photomask
□ Prolux □ Proxima □ Quantum
Electronics □ Rasterops □ Raytheon
□ Rediffusion Simulation □ Retroscan
□ Review Display Systems □ SAI
Technology □ Samsung Semiconductor
□ Sarnoff Corp. □ Screen Technology
□ Si Diamond □ Silicon Light Machines
□ Smart Alec □ SmartASIC □ Sony
□ Sony Display Device Group
□ Stereomedia □ Tatung □ Tech-Com
□ Techni-Met □ Tektronix □ Telesensory
□ Telex Communications □ Texas
Instruments □ Thomson-CSF Services
□ Touch Controls □ UCE □ Varitronix
□ VDC (Teltron) □ Ultra Electronics
□ Video Display Corp. □ Vidival □ XKD
□ Zenith Components Group

LASER-ADDRESSED DISPLAYS

□ NEMATEL

LIGHT-EMITTING DIODES AND LED DISPLAYS

□ Acculux □ Adaptive Micro Systems
□ Alien Technology □ Avnet □ BBV Digital

□ Breault □ Bivar □ Comfuture □ Craft Data Ltd. □ Daktronics □ Data Display Products □ Dialight □ Digitran □ Display Systems □ Earth Computer □ **EFOS** □ EG&G Optoelectronics □ Electro-Optics □ eMagin □ F-P Electronics □ Future Focus □ General Electric □ Hoffman Engrg. □ H-P □ IBM □ IEE □ Incom □ Info-Lite □ Interstate Electronics (GPS) □ ITO America □ Jaco Electronics □ JKL Components □ Kisco □ Korry Electronics □ **Kurt J. Lesker Co.** □ Litton Systems Canada □ Mark IV Industries □ Marubeni □ Milgray Electronics □ MITAC □ Modutec □ Morrison Electronics □ Nichia America □ Night Vision Corp. □ Opto-Cal □ Optotek □ **PanelX** □ PPM Photomask □ Poly-Optical Products □ PRP Optoelectronics □ **Purdy Electronics** □ Quantum Electronics □ Reflection Technology □ Smart Alec □ I. I. Stanley □ Stanley Electric □ Teledyne Lighting & Display □ **Three-Five Systems** □ Univ. of Michigan □ Varitronix □ WAMCO

LIGHT PENS/POINTING SYSTEMS

□ Digitran □ IBM □ Interactive Computer Products □ Crystal Visions Solutions □ Rikei Corp. □ SDMS □ 3M Product Information □ WACOM

LIQUID-CRYSTAL DISPLAYS, ACTIVE-MATRIX

□ Accolux □ Acme Portable Machines □ ADT □ **AEI Components** □ Alien Technology □ All American □ **Allus Technology** □ American Panel □ Applied Technology □ Arithmos □ ASM America □ Astronautics □ Avnet □ AVT □ Barco □ Barco Display □ Bi-Search □ Boland Communications □ Canadian Marconi □ Casio LCD □ Clinton Electronics □ Colorado Microdisplay □ Computer Dynamics □ Computer Devices Canada □ Craft Data, Inc. □ Craft Data Ltd. □ **CRL** □ Crystal Visions Solutions □ CTX Opto □ Data Modul □ Data Plus □ Davies □ DBI □ Densitron □ Digitran □ Dolch Computer □ dpiX □ DRS Technologies □ Earth Computer □ Eaton PSD □ EEV □ EEV Ltd. □ Electronic Designs □ Electronic Image Systems □ EMCO □ EMCO-Fraker □ Epson America □ Epson Electronics America □ Flat Panel Display □ Fujitsu □ General Electric □ Ginsbury □ High Lumen Displays □ Hitachi America □ Honeywell Defense Avionics □ Honeywell □ Hosiden America □ Hyundai Electronics □ IEE □ Image Systems □ Imaging Display □ Incline □ Incom □ Innova Electronics □ Innovated Image □ Interface Displays & Controls □ Interstate Electronics □ Interstate Electronics (GPS) □ Inviso □ Jaco Electronics □ Kent Modular Electronics □ Kisco □ Kopin □ Korry Electronics □ **Kristel** □ Laversab □ L-3 Display Systems □ National Display Systems □ Night Vision Corp. □ **LG.Philips LCD** □ Litton Systems □ Lockheed Sanders □ L-3 Display Systems □ Manhattan Skyline □ Matrix Components □ Merck □ Micron □ **Micronic Laser Systems** □ Micro-Optics □ MII □ Milgray Electronics □ Mintronix □ MITAC □ Mitsubishi Electric Sales America □ Mitsubishi Electronics America □ Mitsui Comtek □ Miwa □ Modutec □ MRS Technology □ National Semiconductor □ NEC □ NEC Electronics □ Nippon Electric Glass □ nView □ n-Vision □ Omega Electronics □ Palomar Products □ Panelview □ **PanelX** □ Panoram Technologies □ Panasonic

Computer Peripherals □ Panasonic Industrial Co. □ Philips Flat Display Systems □ Phoenix Group □ Pixelink □ PixelVision □ Planar Advance □ Poly-Optical Products □ Polytronix □ PPM Photomask □ Proxima □ **Purdy Electronics** □ Racal-Mesi □ RDI Computer □ Review Display Systems □ Richardson Electronics □ Rikei Corp. □ Rockwell Collins □ ROLIC Technologies □ SAIC □ Samsung Semiconductor □ Sarif □ Sarnoff Corp. □ Sharp Microelectronics □ Shintech □ Silscape □ Stereomedia □ Technical Visions □ Tektronix □ Teletel Canada □ Texas Industrial Peripherals □ 3-D ImageTek □ **Three-Five Systems** □ 3M Product Information □ Timeline □ Toshiba America □ Touch Controls □ UCE □ Unipac □ Univ. of Michigan □ U.S. Electronics □ Varitronix □ **Vertex LCD** □ Vivid Semiconductor □ ViewTEK □ VL Electronics □ WAMCO □ Wyle Electronics □ XMR

LIQUID-CRYSTAL DISPLAYS, COLOR

□ Acme Portable Machines □ Advanced Display Systems □ AEG □ **AEI Components** □ ALCOM □ Alien Technology □ All American □ **Allus Technology** □ American Panel □ Applied Technology □ Arizona LCD □ Asia Wintek □ Avnet □ AVT □ Aydin Displays □ Barco □ Barco Display □ BBV Digital □ Boland Communications □ **Brimar** □ Casio LCD □ Clinton Electronics □ Clover Display □ Colorado Microdisplay □ ColorLink □ Computer Dynamics □ Craft Data, Inc. □ Craft Data Ltd. □ Crystal Visions Solutions □ CTX Opto □ Data Modul □ **Data International** □ Data Plus □ DBI □ Delta Service & Products GmbH □ Densitron □ Dolch Computer □ dpiX □ DRS Technologies □ Earth Computer □ Eaton PSD □ Electronic Image Systems □ Electro-Optics □ EMCO □ EMCO-Fraker □ Epson America □ Epson Electronics America □ Flat Panel Display □ FPD Technologies □ Fujitsu □ Ginsbury □ Hantronix □ High Lumen Displays □ Hitachi America □ Hosiden America □ Hunet □ IEE □ Image Systems □ Incline □ Innovated Image □ Insync Peripherals □ Interface Displays & Controls □ Interstate Electronics (GPS) □ Inviso □ Jaco Electronics □ Kisco □ **Kristel** □ Kyocera □ **LG.Philips LCD** □ Liquid Crystal Institute □ Litton Systems □ L-3 Display Systems □ Manhattan Skyline □ Matrix Components □ Merck □ Micron □ **Micronic Laser Systems** □ MicroOptical □ MicroPix □ Milgray Electronics □ MITAC □ Mitsubishi Electronics America □ Mitsui Comtek □ National Display Systems □ National Semiconductor □ NEC Electronics □ Nippon Electric Glass □ Night Vision Corp. □ NuVision Technologies □ nView □ **Optrax America** □ Optrax/Satori □ Palomar Products □ **PanelX** □ Panoram Technologies □ Panasonic Computer Peripherals □ Panasonic Industrial Co. □ Philips Flat Display Systems □ Phoenix Group □ Pixelink □ PixelVision □ Poly-Optical Products □ Polytronix □ Proxima □ **Purdy Electronics** □ Racal-Mesi □ RDI Computer □ Review Display Systems □ Richardson Electronics □ Rikei Corp. □ ROLIC Technologies □ SAIC □ Samsung Semiconductor □ Seiko Instruments □ Sharp Microelectronics □ Shoreline Electronics □ Shintech □ Silscape □ Stanley Electric □ Stalaw □ I. I. Stanley □ 3-D ImageTek □ Teletel Canada □ Texas Industrial Peripherals □ **Three-**

Five Systems □ Touch Controls □ UCE □ Varitronix □ **Vertex LCD** □ ViewTEK □ Vivid Semiconductor □ Vivitek □ White Electronics □ Wyle Electronics □ VL Electronics

LIQUID-CRYSTAL DISPLAYS, FERROELECTRIC

□ ALCOM □ Arizona LCD □ AZ LCD □ **Brimar** □ Canon, Inc. □ ColorLink □ **CRL** □ Crystop Display □ Digitran □ Display Products Technology □ EEV Ltd. □ Electronic Image Systems □ Frontline Systems □ Eurecran □ Hornell Elektrooptik □ Interstate Electronics (GPS) □ Liquid Crystal Institute □ Micro-Optics □ MicroPix □ MITAC □ Night Vision Corp. □ **PanelX** □ Pixelink □ Poly-Optical Products □ PPM Photomask □ ROLIC Technologies □ Shintech □ Varitronix

LIQUID-CRYSTAL DISPLAYS, PASSIVE

□ Acme Portable Machines □ ADT □ Advanced Display Systems □ Aerospace Display Systems □ ALCOM □ All American □ **Allus Technology** □ Ametek Aerospace Products □ Applied Technology □ Arithmos □ Arizona LCD □ Asia Wintek □ Avnet □ AZ LCD □ Batron □ Casio LCD □ Clover Display □ Computer Dynamics □ Craft Data, Inc. □ Craft Data Ltd. □ Crystaloid □ Crystal Visions Solutions □ Crystop Display □ **Data International** □ Data Modul □ Data Plus □ DBI □ DCI □ Densitron □ Digitran □ Earth Computer □ EEV □ EEV Ltd. □ Element Displays □ EM Microelectronic □ Emerging Display Technologies □ Epson America □ Epson Electronics America □ Eurecran □ Excel Technology □ FPD Technologies □ General Electric □ Ginsbury □ Hantronix □ Hitachi America □ Hornell Elektrooptik □ Hosiden America □ IEE □ Incline □ In Focus Systems □ Interface Displays & Controls □ Interstate Electronics (GPS) □ LC-Tec □ Kent Displays □ Kisco □ **Kristel** □ Kyocera □ Liquid Crystal Institute □ Litton Systems □ LXD □ Manhattan Skyline □ Mark IV Industries □ Matrix Components □ Merck □ **Micronic Laser Systems** □ Mito Fine Glass □ Mintronix □ MITAC □ Mitsubishi Electric Sales America □ Mitsui Comtek □ National Semiconductor □ NEMATEL □ Night Vision Corp. □ nView □ Ocular □ Omega Electronics □ **Optrax America** □ Optrax/Satori □ **PanelX** □ Panoram Technologies □ Planar Standish □ Planar Systems □ Philips Flat Display Systems □ Pixelink □ Poly-Optical Products □ Polytronix □ Proxima □ **Purdy Electronics** □ Review Display Systems □ Rikei Corp. □ SAIC □ Satori Electric □ Seiko Instruments □ Sharp Microelectronics □ Shintech □ Shoreline Electronics □ S-MOS □ **Solomon Technology** □ Sony Display Device Group □ I. I. Stanley □ Stanley Electric □ Stereomedia □ Telex Communications □ **Three-Five Systems** □ Timeline □ UCE □ Varitronix □ VGI □ VL Electronics □ Wyle Electronics

LIQUID-CRYSTAL DISPLAYS PASSIVE, ACTIVE ADDRESSING

□ Advanced Display Systems □ Aerospace Display Systems □ Arizona LCD □ Avnet □ Craft Data Ltd. □ **CRL** □ Crystaloid □ Crystal Visions Solutions □ **Data International** □ Data Modul □ Densitron □ EMCO □ EMCO-Fraker □ Epson Electronics America □ Excel Technology □ Ginsbury □ Hantronix □ Hitachi America

□ Hosiden America □ Incline □ Interface Displays & Controls □ Interstate Electronics (GPS) □ Liquid Crystal Institute □ Luminary Technologies □ LXD □ Manhattan Skyline □ Merck □ **Micronic Laser Systems** □ Milgray Electronics □ Mintronix □ MITAC □ Mitsui Comtek □ Night Vision Corp. □ **Optrax America** □ Optrax/Satori □ **PanelX** □ Pixelink □ Poly Optical Products □ Polytronix □ Review Display Systems □ SAIC □ Sharp Microelectronics □ Shintech □ Stanley Electric □ Stalaw □ Stereomedia □ **Three-Five Systems** □ UCE □ Varitronix □ Vivid Semiconductor □ VL Electronics □ Wyle Electronics

MAGNETIC SHIELDING

□ **Ad-Vance Magnetics** □ All American □ Amuneal □ Barco □ Barco Display □ **Chomerics** □ Eagle Magnetics □ EDL Displays □ Eyesaver □ Fosta-Tek □ General Atomics □ General Vacuum □ Gerome □ Ginsbury □ Homalite □ Hoya Electronics □ Information Products □ Innovative Specialty Films □ K & R Engrg. □ Lindgren RF Enclosures □ Liberty Mirror □ **Magnetic Radiation Labs** □ Magnetic Shield □ Mshield □ NoRad □ Pixelink □ Raytheon □ **Silver Cloud Mfg.** □ 3M Product Information □ Vakuumschmelze □ **ZC&R Coatings**

MANUFACTURING EQUIPMENT

□ Acme Portable Machines □ Accudyne □ Advanced Display Systems □ AeroTech □ Anotech □ Applied Photonics □ Applied Technology □ ASM America □ autronic □ AZ LCD □ Best Power Technology □ Bilco Mfg. □ BOC Coating Technology □ Brooks Automation □ CFM Technologies □ Dark Field Technologies □ Donnelly Applied Films □ Ernst W. Dorn Co. □ DynaColor □ Eaton Corp. □ Eaton FP Equipment □ Eaton IDT □ **EFOS** □ Fairchild Convac □ FAS Technologies □ FEPET □ Genmark □ Gerber Systems □ Glen Technologies □ Holographic Lithography □ Hornell Automation □ Hornell Engrg. □ H-Square □ Hybrid Micrographics □ Image Processing Systems □ Innotec □ International Micro □ Interserv □ Intevac □ IPS Automation □ ITO America □ Kenix Industries □ Kisco □ Kurdex □ Lambda Physik □ Laversab □ LC-Tec □ Lighting Sciences □ LM Bejtlich & Associates □ **LMDC** □ Materials Research Corp. □ Micron □ MicroJoin □ **Micronic Laser Systems** □ Miwa □ MRS Technology □ Napak Sales □ Nanometrics □ Nikon Precision □ Nippon Seiko K.K. □ OAI □ Optical Radiation □ ORC Electronic Products □ Palomar Products □ Plasma-Therm □ PRI Automation □ PTG □ Radiant technology □ Schott Corp. □ Semiconductor Systems □ Semitool □ Sonera Technologies □ Sony □ Tamarack Scientific □ Teknek Electronics □ Teletrac □ Temescal □ 3M Electronic Products □ 3M Product Information □ TLC International □ Toray Engineering □ Torrey Pines Research □ TRICOR Systems □ Ultra t □ ULVAC Technologies □ VDC (Apex) □ VDC (HQ) □ Villa Precision □ Watkins-Johnson □ Wande □ XMR □ Young Technology

MARKET RESEARCHERS/PUBLISHERS

□ AGI □ American Institute of Small Business □ Dempa □ Display Research Labs □ DisplaySearch □ Display Technology Library □ Electronic Information Displays □ Electronic Trend □ Ergosyst

Associates □ Global Display Network □ Joe Hallett & Associates □ Waller Hett & Associates □ L. A. Holt & Assoc. □ Home Theater □ InterLingua □ Kahn Intl. □ Machover Associates □ Meko □ MIRC □ Multimedia and Videodisc Monitor □ Nutmeg Publishing Consultants □ Pacific Media Associates □ PanelX □ Photonics Spectra □ Pixel Interconnect □ The Rankin Group □ SEMI-FPD □ Stanford Resources □ Tyson Consulting Group □ Venture Development

MASKS

□ Advance Reproductions □ Applied Image □ Brewer Science □ Electrographics □ Eureka □ Hoya Electronics □ IMT □ Infinite Graphics □ Liquid Crystal Institute □ **Micronic Laser Systems** □ Microphase Labs □ MRS Technology □ Photonics □ Pholronics-Colorado □ PPM Photomask □ Process Technologies □ Terapixel □ 3M Product Information

MATERIALS

electrochromic displays

□ AGFA-Gevaert □ Applied Films □ Applied Technology □ Arconium □ Cyro Industries □ Donnelly Applied Films □ General Vacuum □ Glaverbel SA □ IDM □ I.G.S. □ Indium America □ Lamination Technology □ Merck □ Photonics □ Pilkington LOF □ Polaroid Optical Films □ Target Materials □ Techni-Met □ Terapixel □ **Thin Film Devices** □ 3M Electronic Products □ 3M Product Information □ U.S. Precision Glass □ Vacuum Engineering

electroluminescent displays

□ AGFA-Gevaert □ Applied Films □ Applied Technology □ Arconium □ Astra Products □ Atomergic Chemicals □ BKL □ Brewer Science □ CPFilms □ Cyro Industries □ D&T □ Donnelly Applied Films □ Dotech □ DuPont □ Durel □ ELtech □ General Vacuum □ Glaverbel SA □ Hoffman Engr. □ Idemitsu □ IDM □ I.G.S. □ Indium America □ Innovative Specialty Films □ Kisco □ Lamination Technology □ Liquid Crystal Institute □ **Luxell** □ Marubeni □ NeoVac □ Nichia America □ Opsys □ Photonics □ Pilkington LOF □ Pilkington Micronics □ Polaroid Optical Films □ Sheldahl □ Stan-Allen □ Superior MicroPowders □ Target Materials □ Techni-Met □ Terapixel □ **Thin Film Devices** □ 3M Electronic Products □ UCE □ U.S. Precision Glass □ Vacuum Engineering □ VisPro □ WAMCO

electromechanical displays

□ Arconium □ Cyro Industries □ F-P Electronics □ IDM □ I.G.S. Industries □ Mushield □ Photonics □ Polaroid Optical Films □ Terapixel □ 3M Electronic Products □ U.S. Precision Glass □ Vacuum Engineering

large-screen displays

□ Adaptive Micro Systems □ Applied Technology □ Arconium □ Barco Video & Commun. □ Cyro Industries □ Crystal Visions Solutions □ Dana Enterprises □ Draper □ Donnelly Applied Films □ Dotech □ Feldman Technology □ FEPET □ Fresnel Optics □ General Vacuum □ Glaverbel SA □ Physical Optics □ Hyacinth Technology □ I.G.S. □ Incom □ Indium America □ Infinite Graphics □ IDM □ Kaiser Optical □ Kisco

□ Lamination Technology □ L-3 Display Systems □ Optical Radiation □ Photonics □ Pilkington LOF □ Pilkington Micronics □ Plasmaterials □ Polaroid Optical Films □ Rantec □ Retrosan □ SI Diamond □ Superior MicroPowders □ Target Materials □ Tech-Com □ Techni-Met □ Teledyne Lighting & Display □ Terapixel □ **3M Optical Systems** □ Tosoh SMD □ **Unigraf** □ U.S. Precision Glass □ Vacuum Engineering □ **VIQX** □ Visus

light-emitting diode displays

□ Adaptive Micro Systems □ Arconium □ Astra Products □ Cyro Industries □ Data Display Products □ DuPont □ Feldman Technology □ F-P Electronics □ H-P □ IDM □ I.G.S. □ Indium America □ Innovative Specialty Films □ Kisco □ Marubeni □ Nichia America □ Optotek □ Phosphor Technology □ Pilkington Micronics □ Photonics □ Plasmaterials □ **Purdy Electronics** □ Quantum Electronics □ Stanley Electric □ Techni-Met □ Teledyne Lighting & Display □ Terapixel □ Tosoh SMD □ U.S. Precision Glass □ Vacuum Engineering □ VisPro □ WAMCO

light pens/pointing systems

□ CPFilms □ Cyro Industries □ I.G.S. □ Photonics □ Plasmaterials □ **Purdy Electronics** □ U.S. Precision Glass □ Vacuum Engineering

liquid-crystal displays

□ AGFA-Gevaert □ ALCOM □ AlliedSignal □ Applied Films □ Applied Technology □ Arconium □ Arithmos □ Arizona LCD □ Astra Products □ AZ LCD □ Bi-Search □ Brewer Science □ **Brimar** □ CLCEO □ CPFilms □ **CRL** □ Cyro Industries □ Crystal Visions Solutions □ Dainippon Ink & Chemicals □ D&T □ Dana Enterprises □ Donnelly Applied Films □ Dotech □ DuPont □ Earth Computer □ **Elmwood Sensors** □ Emerging Display Technologies □ EM Industries □ Exxene □ Feldman Technology □ F-P Electronics □ General Vacuum □ Glaverbel SA □ I.G.S. □ Incom □ Indium America □ Innovative Specialty Films □ Kaiser Optical □ Kenix Industries □ Kisco □ Lamination Technology □ L-3 Display Systems □ Liquid Crystal Institute □ Mark IV Industries □ Marubeni □ Merck □ MicroPix □ Multichip Assembly □ Nagase California □ NEMATEL □ Optrex/Sator □ Photon Dynamics □ Photonics □ Pilkington Micronics □ Plasmaterials □ Polaroid Holographic □ Polaroid Optical Films □ Poly-Optical Products □ **Purdy Electronics** □ Rexam Image Products □ ROLIC Technologies □ Sanritz □ Sekisui Chemical Co. □ Silicon Valley Chemlabs □ **Solomon Technology** □ Target Materials □ Techni-Met □ Teledyne Lighting & Display □ Terapixel □ **Thin Film Devices** □ 3-D ImageTek □ **3M Optical Systems** □ 3M Product Information □ Toshiba America □ Tosoh SMD □ UCE □ Univ. of Michigan □ U.S. Precision Glass □ Vacuum Engineering □ **VIQX** □ Visus □ WAMCO

plasma displays, ac

□ Applied Films □ Applied Technology □ Arconium □ Astra Products □ Babcock □ Cyro Industries □ Data Modul □ Donnelly Applied Films □ DuPont □ Eyesaver □ Feldman Technology □ Glaverbel SA □ IBM Canada □ IDM □ I.G.S. □ Innovative Specialty Films □ Kisco □ Marubeni □ Nichia America

□ Panasonic Industrial Co. □ Photonics □ Pilkington LOF □ Pilkington Micronics □ Polaroid Optical Films □ **Polar Vision** □ Rexam Image Products □ Saint-Gobain □ SEM-COM □ Superior MicroPowders □ Target Materials □ Terapixel □ Touch Controls □ U.S. Precision Glass □ Vacuum Engineering □ **VIQX** □ WAMCO

plasma displays, dc

□ Applied Technology □ Arconium □ Astra Products □ Data Modul □ Displays □ Donnelly Applied Films □ DuPont □ Feldman Technology □ Glaverbel SA □ IDM □ Kisco □ Marubeni □ Micron □ Nichia America □ Noritake □ Photonics □ **Polar Vision** □ Quantum Electronics □ Target Materials □ Terapixel □ U.S. Precision Glass □ Vacuum Engineering □ **VIQX** □ WAMCO

spacers

□ AGFA-Gevaert □ Applied Technology □ Bivar □ Dana Enterprises □ ITO America □ Kenix Industries □ Kisco □ Liquid Crystal Institute □ Marubeni □ Photonics □ Saint-Gobain □ Schott Fiber Optics □ Sekisui Chemical Co. □ SEM-COM □ Superior MicroPowders □ U.S. Precision Glass □ Vacuum Engineering

thin films

□ Adhesives Research □ AGFA-Gevaert □ Applied Technology □ Applied Vacuum Coating □ Arconium □ Atomergic Chemicals □ Balzars AEG □ Balzars Thin Films □ CPFilms □ Dotech □ **DSM Desotech** □ Edwards □ Feldman Technology □ General Vacuum □ I.G.S. □ Indium America □ Information Products □ Innovative Specialty Films □ Kaiser Optical □ Kisco □ Lamination Technology □ **Kurt J. Lesker Co.** □ Leybold □ Liquid Crystal Institute □ Marubeni □ Multichip Assembly □ NeoVac □ Phosphor Technology □ Photon Dynamics □ Photonics □ Polaroid Optical Films □ **Polar Vision** □ Silicon Valley Chemlabs □ Specialty Coating Systems □ Stan-Allen □ Superior MicroPowders □ Target Materials □ Techni-Met □ Tekra □ 3M Product Information □ Tosoh SMD □ U.S. Precision Glass □ Viratec

touch screens

□ AGFA-Gevaert □ Applied Vacuum Coating □ Arconium □ Astra Products □ AVED □ AVNET □ Carroll Touch □ CPFilms □ Cyro Industries □ Crystal Visions Solutions □ D&T □ **DSM Desotech** □ **Elmwood Sensors** □ Feldman Technology □ General Vacuum □ Glaverbel SA □ I.G.S. □ Information Products □ Innovative Specialty Films □ ITO America □ Kisco □ Lamination Technology □ Multichip Assembly □ NeoVac □ Photonics □ Pilkington LOF □ Polaroid Optical Films □ **Polar Vision** □ **Purdy Electronics** □ Racal-Mesi □ Rexam Image Products □ Romag Glass □ Saint-Gobain □ Sheldahl □ Target Materials □ Techni-Met □ Tekra □ **Thin Film Devices** □ U.S. Precision Glass

MATERIALS HANDLING

□ Accudyne □ Applied Technology □ Dover □ Gerber Systems □ Kisco □ Kurdex □ Progressive System Technologies □ PTG □ Rorze Automation □ Tamarack Scientific

MEDICAL DISPLAYS

□ All American □ AVNET □ Dynamic Displays □ Excel Technology □ Image Systems □ Imaging Display □ Interstate Electronics (GPS) □ Innova Electronics □ Kent Modular Electronics □ **Kristel** □ L-3 Display Systems □ MicroOptical □ Mill □ National Display Systems □ Noritake □ Pixelink □ Planar Systems □ Review Display Systems □ SGB Enterprises □ Sharp Microelectronics □ **Spire** □ Teleline Canada □ Thomson Components & Tubes □ U.S. Electronics

MICE AND OTHER POINTING DEVICES

□ Digitran □ Hosiden America □ IBM □ Innovated Image □ Proxima □ Texas Industrial Peripherals □ Synaptics □ WACOM

MICROCHANNEL PLATES

□ Galileo □ Intervac □ Philips Components □ Schott Corp. □ Schott Fiber Optics

MICRODISPLAYS

□ Colorado Microdisplay □ Inviso □ Liquid Crystal Institute □ The MicroDisplay Corp. □ Philips Flat Display Systems □ Photon Dynamics □ **Three-Five Systems**

MEMS

□ **CRL** □ **Spire** □ Silicon Light Machines

Single Crystal

□ Liquid Crystal Institute

MONITOR MOUNTING DEVICES

□ AVNET □ Ergotron

OPTICAL COATINGS

See also filters, polarizers

□ ADT □ All American □ AlliedSignal □ American Polarizers □ Applied Films □ Applied Science Labs □ Applied Vacuum Coating □ ASM America □ Astra Products □ AVNET □ Balzars AEG □ Balzars Thin Films □ Balzars Thin Films GmbH □ Bi-Search □ Brewer Science □ Cando □ CLCEO □ Corning Optical Corp. □ CPFilms □ CTP Coil □ D&T □ Denglas □ Denton Vacuum □ Donnelly Applied Films □ Dotech □ Draper □ DRS Technologies □ **DSM Desotech** □ Exxene □ Eyesaver □ Flex Products □ Fosta-Tek □ Galileo □ General Vacuum □ Ginsbury □ Hoechst Celanese □ Homalite □ Hoya Electronics □ Hoya Optics □ IBM Canada □ I.G.S. □ Incline □ Information Products □ Innovative Specialty Films □ Kollmorgen □ Kurdex □ Leybold □ Liberty Mirror □ Liquid Crystal Institute □ **LMDC** □ Man & Machine □ Marubeni □ Melles Griot □ Metavac □ Mito Fine Glass □ O&S Research □ **OCLI** □ Optical Devices □ Opto Sigma □ Panelgraphic □ Panelview □ Pilkington LOF □ Plasmaterials □ Plasma-Therm □ Polaroid □ Polaroid Optical Films □ **Polar Vision** □ PPM Photomask □ Precision Glass Technologies □ Racal-Mesi □ Rexam Image Products □ ROLIC Technologies □ Romag Glass □ **Silver Cloud Mfg.** □ Southwall Technologies □ Tech-Com □ **Thin Film Devices** □ Thin Film Technology □ 3M Product Information □ TSP □ U.S. Precision Glass □ Viratec □ WAMCO □ **ZC&R Coatings**

OPTICAL COMPONENTS

□ Adhesives Research □ AlliedSignal □ Astra Products □ Atomergic Chemicals

AVNET □ Balzars AEG □ Balzars Thin Films □ Balzars Thin Films GmbH □ CLCEO □ ColorLink □ Corning Optical Corp. □ CFFilms □ CRL □ CTP Coil □ DigiLens □ DRS Technologies □ DuPont □ ELDIM □ Elmwood Sensors □ EMCO-Fraker □ Fresnel Optics □ Hoffman Engrg. □ Hoya Corp. □ Hudson Photographic □ I.G.S. □ Incom □ Korry Electronics □ Leybold □ Liquid Crystal Institute □ LMDC □ Melles Griot □ Metavac □ OCLI □ Opto Sigma □ Optro-Mechanics □ Panelview □ Polar Vision □ Poly-Optical Products □ Precision Glass Technologies □ Purdy Electronics □ Rainbow Optics □ Retinal Displays □ Romag Glass □ Rorze Automation □ S & S Optical □ Schott Fiber Optics □ Seiwa Optical □ Tekra □ Teledyne Lighting & Display □ 3M Product Information □ U.S. Precision Glass □ U.S. Precision Lens □ Visus □ WAMCO □ Carl Zeiss □ ZC&R Coatings

OPTICAL DESIGN SERVICES

AVNET □ Breault □ CTP Coil □ DRS Technologies □ EMCO-Fraker □ Future Focus □ Innovative Specialty Films □ Kaiser Optical □ Man & Machine □ Night Vision Corp. □ OCLI □ Opto Sigma □ ORC Lighting □ Panelview □ Physical Optics □ Pixel Interconnect □ Poly-Optical Products □ Rainbow Optics □ Retinal Displays □ Schott Fiber Optics □ Seiwa Optical □ Shintech □ Tech-Corn □ Teledyne Lighting & Display □ U.S. Precision Lens □ Visus

OPTICAL DISCS AND SYSTEMS

Canon, Inc. □ Eastman Kodak □ Honeywell □ IBM □ Kisco □ Mito Fine Glass □ Pentax Technologies □ S & S Optical □ Sony Display Device Group □ 3M Product Information

OPTICAL SEMICONDUCTOR DEVICES

Clare Micronix □ Electron Tubes □ Melles Griot □ 3M Product Information □ Seiwa Optical

PC-BASED TEST EQUIPMENT

Anorad □ autronic □ AVNET □ Data Plus □ Display Labs □ ELDIM □ Image Processing Systems □ Incline □ IPS Automation □ Klein Instruments □ Laversab □ Pixel Interconnect □ SAIC □ Sonera Technologies □ Team Systems □ 3M Product Information □ Torrey Pines Research □ TRICOR Systems □ Unigraf □ Xtronic

PHOSPHORS

Atomergic Chemetals □ Brimar □ EEV Ltd. □ General Atronics □ Hoya Electronics □ Intevac □ ITO America □ Marubeni □ Nichia America □ Opsys □ ORSAM □ Sylvania □ Philips Display Components □ Phosphor Products □ Quantex □ Raytheon □ Sarnoff Corp. □ Sony Display Device Group □ Superior MicroPowders □ Zenith Electronics

PHOTOLITHOGRAPHY CHEMICALS

Brewer Science □ Clariant □ Hoechst Celanese □ Hoechst Celanese AZ □ 3M Product Information □ Silicon Valley Chemlabs

PHOTOLITHOGRAPHY EQUIPMENT

AeroTech □ Applied Technology □ Canon USA □ Dover Instrument □ Fairchild Convac □ Gerber Systems

Holographic Lithography □ Holtronic □ Interserv □ Kisco □ Lambda Physik □ Micronic Laser Systems □ MRS Technology □ Nikon Precision □ OAI □ ORC Electronic Products □ Steag MicroTech □ Karl Suss □ Tamarack Scientific □ 3M Product Information □ Ultra

PHOTOLITHOGRAPHY SERVICES

Advance Reproductions □ Brewer Science □ CRL □ Holographic Lithography □ Holtronic □ IMT □ Infinite Graphics □ Process Technologies □ Technical Visions □ Thin Film Technology □ 3M Product Information

PHOTOMASKS

See masks

Advance Reproductions □ Brewer Science □ IMT □ Infinite Graphics □ Liquid Crystal Institute □ Micronic Laser Systems □ Photonics □ Photronics-Colorado □ Process Technologies □ Terapixel □ 3M Product Information

PLASMA DISPLAYS, AC

All American □ AVNET □ Clarity Visual Systems □ Craft Data Ltd. □ Densitron □ Donnelly Applied Films □ Eaton FPD □ Eaton PSD □ Electro-Optics □ Electro Plasma □ EMCO □ Fujitsu Microelectronics □ General Electric □ Ginsbury □ IEE □ Imagine Graphics □ Incline □ Interstate Electronics □ Litton Systems □ Micron □ Milgray Electronics □ Mito Fine Glass □ NEC Electronics □ PanelX □ Pearlless Industries □ Philips FIMI □ Phosphor Technology □ Photonics Systems □ Pioneer New Media □ Plasmaco □ Review Display Systems □ Rexam Image Products □ Romag Glass □ SAIC □ Thomson-CSF □ Whittaker

PLASMA DISPLAYS, DC

Babcock □ Cherry Electrical □ Dale Electronics □ Densitron □ Displays □ Donnelly Applied Films □ Eaton FPD □ General Electric □ Micron □ Milgray Electronics □ Mito Fine Glass □ Phosphor Technology □ Quantum Electronics □ SAIC

PLASTIC MOLDINGS

Astra Products □ CTP Coil □ RMF Products

PLOTTERS

John Fluke Mfg. □ Gerber Systems □ IBM □ Infinite Graphics □ Versatec □ Xerox Engrg. Systems

POLARIZERS

ADT □ Advanced Display Systems □ American Polarizers □ Applied Technology □ Applied Vacuum Coating □ AVNET □ Balzars AEG □ Balzars Thin Films □ Balzars Thin Films GmbH □ Brimar □ CLCEO □ ColorLink □ D&T □ Dana Enterprises □ Dotech □ EMCO □ Eyesaver □ Fosta-Tek □ Hoya Electronics □ Hoya Corp. □ Image Analytics □ Incline □ International Polarizer □ Kisco □ Leybold □ Liquid Crystal Institute □ Man & Machine □ Marubeni □ Melles Griot □ Metavac □ Nitto Denko □ Optical Devices □ Opto Sigma □ Panelview □ Polaroid □ Polaroid Optical Films □ Polar Vision □ Precision Optical Filters □ Reel 3-D □ Rexam Image Products □ Romag Glass □ Sanritz □ Silver Cloud Mfg. □ 3M Optical Systems □ 3M Product Information □ UCE

POLYMER FILMS

AGFA-Gevaert □ AlliedSignal □ Applied Vacuum Coating □ AVNET □ Brewer Science □ CLCEO □ CFFilms □ DuPont □ Innovative Specialty Films □ Kisco □ Lamination Technology □ Liquid Crystal Institute □ ROLIC Technologies □ Sheldahl □ SI Diamond □ Specialty Coating Systems □ Stanley Palmer □ Tekra □ Thermedics □ 3M Product Information

POWER SUPPLIES, HIGH VOLTAGE

Absopulse Electronics □ Advanced Conversion □ AHV □ All American □ American High Voltage □ Applied Concepts □ B&K Precision □ Best Power Technology □ Brimar □ Burle Industries □ Cherry Electrical □ Clare Micronix □ Crane Aerospace □ Data Plus □ Data Translation □ Del Global Technologies □ Digitran □ Display Components □ Display Labs □ E and M Electronics □ EEV Ltd. □ EG&G Optoelectronics □ Eldec □ Electron Tubes □ Endicott □ John Fluke Mfg. □ Ginsbury □ Honeywell □ Hyacinth Technology □ Innotec □ Innova Electronics □ K and M Electronics □ K & R Engrg. □ Kisco □ Lorad Power Systems □ National Semiconductor □ OAI □ ORC Lighting □ Rascal-Mesl □ Rantec □ Review Display Systems □ Reynolds Industries □ Sampo America □ Sanders Associates □ Schiederwerk GmbH □ Schott High Voltage □ SDMS □ Stanley Palmer □ T&M Instruments □ TDK □ Thomson Tubes & Displays □ Voltage Multipliers □ Wasatch High Voltage □ WinTron □ WPI Electronics

PRINTERS, COLOR GRAPHIC

Data Plus □ IRIS Graphics □ Lasergraphics □ Lasertechnics □ Polaroid □ QMS □ Tartan Technical □ Texas Instruments □ 3M Product Information □ Torrey Pines Research

PRINTERS, ELECTROPHOTOGRAPHIC (LASER AND LED)

Canon, Inc. □ Harris Corp. □ IBM □ Lasertechnics □ NBS Southern □ Pentax Technologies □ QMS □ Raytheon □ Tartan Technical □ Torrey Pines Research

PRINTERS, IMPACT

Advanced Innovative Marketing □ Axiohm □ IBM □ NBS Southern □ SAIC □ SDMS □ Torrey Pines Research

PRINTERS, INK-JET

Canon, Inc. □ Howtek □ IRIS Graphics □ Phoenix Group □ SDMS □ Tartan Technical □ Torrey Pines Research

PRINTERS, THERMAL-TRANSFER AND DYE-SUBLIMATION

Acculex □ Axiohm □ AVNET □ Craft Data Ltd. □ Data Modul □ Data Plus □ Eastman Kodak □ IBM □ Lasergraphics □ Lasertechnics □ Phoenix Group □ QMS □ Raytheon □ SDMS □ Seiko Micro Printer □ Tartan Technical □ Team Systems □ Torrey Pines Research □ Toyo Spectrum □ Versatec □ Xerox Engrg. Systems

PRINTHEADS

Axiohm □ AVNET □ Craft Data Ltd. □ Ernst W. Dorn Co. □ Kyocera □ Optotek □ Stanley Electric □ Torrey Pines Research

PROJECTION DISPLAYS

Liquid-crystal projectors

Clarity Visual Systems □ ColorLink □ CRL □ CTX Opto □ Electronic Image Systems □ Epson America □ Fujitsu □ Hitachi America □ Innovated Image □ Interface Displays and Controls □ Iristal □ Liquid Crystal Institute □ Man & Machine □ MicroOptical □ Palomar Products □ Panoram Technologies □ Panasonic Industrial Co. □ Physical Optics □ Prolux □ ROLIC Technologies □ SmartASIC □ Stalaw □ Symco □ Tartan Technical □ Vivitek

Liquid-crystal light-valve projectors

Barco Projection □ ColorLink □ Davis A/S □ Dontech □ Electrohome □ Electronic Image Systems □ Excel Technology □ Eurocan □ Evans & Sutherland Computer □ Flat Panel Display □ General Electric □ Hitachi America □ Hosiden America □ Hughes LV Products □ Incom □ Lamination Technology □ Liquid Crystal Institute □ Micron □ Micro-Optics □ nView □ Panasonic Communications & Systems □ Panelight □ Philips Flat Display Systems □ Polytrox □ PPM Photomask □ Proxima □ Retroscon □ Sarnoff Corp. □ Sony Display Device Group □ Tech-Com □ Telex Communications □ 3M Product Information □ UCE

DLP/DMD

Clarity Visual Systems □ ColorLink □ Digital Projection □ Panoram Technologies

Projection CRTs

Barco Projection □ Brimar □ Calspan SRL □ Clinton Electronics □ Digitran □ Display Labs □ Dontech □ EEV Ltd. □ El-Op Electrooptics □ Electrohome □ Electronic Image Systems □ Evans & Sutherland Computer □ General Atronics □ Ginsbury □ Gritz's Emporium □ Hitachi Denshi America □ Incom □ IST □ MII □ Mitsubishi Electric Sales America □ Panoram Technologies □ Panasonic Industrial Co. □ Pioneer New Media □ Princeton Display □ Raytheon □ Rediffusion Simulation □ Retroscon □ Sarnoff Corp. □ SGB Enterprises □ Sony Display Device Group □ Stereomedia □ Symco □ Tech-Com □ Thomas Electronics □ Thomson Components & Tubes □ Thomson-CSF □ 3M Product Information □ VDC (Novatron) □ VDC (Teltron) □ Vidwall □ Zenith Electronics

PROJECTION SCREENS

Front □ CRL □ Da-Lite Screen □ Draper □ ITG □ MicroPix □ Physical Optics □ SEOS Displays □ SMART Technologies

Rear

CRL □ Da-Lite Screen □ Display Components □ Draper □ Fresnel Optics □ I.G.S. □ Iristal □ Liquid Crystal Institute □ MicroPix □ Rexam Image Products □ SEOS Displays □ SMART Technologies □ Stanley Palmer □ Physical Optics

REPAIR AND MAINTENANCE

of computer systems

Display Products Technology □ Hitech Intl. □ IBM □ Man & Machine □ Matrix Components □ Pix Electronics □ VDC (Data Display) □ Xyratex

of display systems

□ Babcock □ Brimar □ D&T □ Display Labs □ Display Products Technology □ DRS Technologies □ EMCO □ General Electric □ IBM □ Interface Displays and Controls □ Klein Instruments □ Kristel □ LM Bejlich & Associates □ Man & Machine □ Matrix Components □ Micron □ MicroJoin □ Midwest Computer □ Miwa □ Multichip Assembly □ Nortech Imaging □ Incline □ Photon Dynamics □ Photonics Systems □ Pix Electronics □ Quantum Electronics □ Raytheon □ Review Display Systems □ SGB Enterprises □ Sharp Microelectronics □ Signatone □ Sonera Technologies □ T&M Instruments □ Tech-Com □ Teletel Canada □ Teletrac □ TNP □ VDC (Data Display) □ VDC (Teltron) □ XKD □ Xyratex

of high-voltage power supplies

□ Advanced Conversion □ American High Voltage □ B&K Precision □ Best Power Technology □ Brimar □ Display Labs □ F-P Electronics □ Hyacinth Technology □ Pix Electronics □ Reynolds Industries □ T&M Instruments

SCAN CONVERTER TUBES

□ Raytheon

SCANNERS, DOCUMENT AND FILM (GRAPHICS)

□ Data Plus □ Digital Vision □ Eastman Kodak □ ECRM □ Howtek □ IBM □ Imipro □ Mega Scan □ Mokol Engr. □ Mitsubishi Electric Sales America □ Pentax Technologies □ SGB Enterprises □ Tartan Technical □ Telesensory □ Torrey Pines Research □ Versatec □ Wasatch High Voltage

SCOREBOARDS/STADIUM DISPLAYS

□ Adaptive Micro Systems □ BBV Digital □ Daktronics □ EEV Ltd. □ Element Displays □ F-P Electronics □ Hughes LV Products □ Mark IV Industries □ Norsk Display □ Quantum Electronics □ Review Display Systems □ Screen Technology □ SI Diamond

SCRIBERS

□ Applied Technology □ Kenix Industries □ Kisco □ TNP □ Villa Precision

SEALANTS

□ Applied Technology □ Dainippon Ink & Chemicals □ ITO America □ Kisco □ Marubeni □ Tech Spray □ 3M Product Information

SEMICONDUCTORS

□ Applied Technology □ Arithmos □ Atomergic Chemetals □ Chips & Technologies □ Clare Micronix □ Display Labs □ Display Research Labs □ Eaton Corp. □ EM Microelectronic □ Genesis Microchip □ H-P □ HP Reid □ Intevac □ International Micro □ Jaco Electronics □ Kenix Industries □ Microsemi LinFinity □ NEC Electronics □ NIMTEC □ PixelFusion □ Pixelworks □ Samsung Semiconductor □ SmartASIC □ Sumitomo Metals □ 3M Electronic Products □ 3M Product Information □ Vivid Semiconductor □ Voltage Multipliers

SIMULATOR DISPLAYS

□ American Panel □ Applied Science Labs □ Barco □ Barco Chromatics □ Barco Video & Commun. □ Brimar □ Coryphaeus

□ CRL □ CTP Coil □ Dontech □ DRS Military Systems □ Dynamic Displays □ EDL Displays □ Electronic Image Systems □ El-Op Electrooptics Industries □ Evans & Sutherland Computer □ Fakespace □ High Lumen Displays □ Hughes LV Products □ Interface Displays and Controls □ Kristel □ Night Vision Corp. □ n-Vision □ Optical Radiation □ Palomar Products □ Panoram Technologies □ Pegasys Displays □ Photonics Systems □ Precision Imaging □ Primagraphics □ Rediffusion Simulation □ Sanders Associates □ SGB Enterprises □ Shintech □ Ship Analytics □ Silicon Light Machines □ Simtech □ Tech-Com □ Teletel Canada □ XKD

SOFTWARE FOR DISPLAYS

design & optimization software

□ ADT □ American Institute Small Business □ Arithmos □ autronic □ Breault □ Cardion Electronics □ Contec CAE □ Coryphaeus □ CTP Coil □ CSER/AC □ Display Labs □ DRS Military Systems □ El-Op Electrooptics Industries □ Honeywell Defense Avionics □ IBM □ Infinite Graphics □ Kisco □ Kollmorgen □ Ligature Software □ Lighting Sciences □ L-3 Display Systems □ n&k Technology □ Optis □ Photon Dynamics □ Pixelworks □ Portrait Displays □ Sarnoff Corp. □ Shintech □ Sonera Technologies □ Stereomedia

graphics systems software

□ ADT □ Appian Graphics □ Barco Chromatics □ Breault □ Calspan SHL □ Cardion Electronics □ Coryphaeus □ Dalim Computer □ Data Translation □ Honeywell Defense Avionics □ IBM □ Infax □ Infinity Multimedia □ Kollmorgen □ L-3 Display Systems □ Pixelworks □ Polaroid □ Portrait Displays □ Primagraphics □ Racal-Mesl □ Rediffusion Simulation □ Sarnoff Corp. □ Ship Analytics □ Sonera Technologies □ Thomson-CSF Services □ 3M Product Information □ Trident Microsystems □ Univision

image processing software

□ ADT □ Amerinex □ Applied Science Labs □ Cardion Electronics □ Coreco □ Dalim Computer Graphic Systeme □ Data Translation □ Decision Images □ DOME □ DRS Military Systems □ DynaColor □ Eastman Kodak □ El-Op Electrooptics Industries □ Eltime Vision Systems □ EPIX □ Global Imaging □ Honeywell Defense Avionics □ Howtek □ IBM □ Integral Vision □ Kaiser Optical □ Kollmorgen □ L-3 Display Systems □ MegaVision □ Photon Dynamics □ Pixelworks □ Portrait Displays □ Rediffusion Simulation □ Sarnoff Corp. □ Security Defense Systems □ Sharp Digital Information Products □ 3M Product Information □ Torrey Pines Research □ TRICOR Systems □ Univision □ Versatec □ Videotek Systems □ Vidival □ Carl Zeiss

optical analysis software

□ ADT □ Applied Science Labs □ Breault □ CTP Coil □ Eldim □ El-Op Electrooptics Industries □ Eltime Vision Systems □ Global Imaging □ IBM □ Honeywell □ Kisco □ Klein Instruments □ Kollmorgen □ Kontron □ Lighting Sciences □ Contec CAE □ n&k Technology □ Optis □ Portrait Displays □ Sarnoff Corp. □ Sensor Products □ Shintech □ Telic Optics □ TRICOR Systems □ Carl Zeiss

signal processing software

□ Arithmos □ Calspan SRL □ Cardion Electronics □ Data Translation □ DRS Military Systems □ DRS Technologies □ DynaColor □ Honeywell Defense Avionics □ IBM □ Kaiser Optical □ Kollmorgen □ L-3 Display Systems □ Pixelworks □ Portrait Displays □ Racal-Mesl □ Sarnoff Corp.

SPEECH INPUT/OUTPUT DEVICES

□ ADT □ Crystal Visions Solutions □ IBM □ Stalaw □ Touch Controls

TEST AND MEASUREMENT EQUIPMENT

automatic convergence systems

□ Barco Projection □ Sonera Technologies □ Display Labs □ DynaColor □ EeRise □ Electro-Optics □ General Electric □ Image Processing Systems □ Maylan □ Minolta □ Scientific Systems □ T&M Instruments □ Telesensory □ 3M Product Information □ Torrey Pines Research

automated test equipment

□ Anorad □ Applied Technology □ AST Products □ autronic □ B&K Precision □ Calspan SRL □ Chroma ATE □ Coreco □ Cybeq □ Crystop Display □ Dark Field Technologies □ Data Plus □ Data Translation □ DIS □ Display Labs □ Dover Instrument □ DynaColor □ EeRise □ ELDIM □ Eltime Vision Systems □ Ergonomics □ John Fluke Mfg. □ GenRad □ Hoffman Engr. □ Instrument Systems □ Integral Vision □ Kenix Industries □ Klein Instruments □ Image Processing Systems □ Integral Vision □ Inter-Logic □ KLA Acrotec □ KLA Instruments □ Kontoy Products □ Lasertec □ Laversab □ Lighting Sciences □ MECC □ Micromanipulator Co. □ Microvision □ Miwa □ MTL Systems □ Nanometrics □ Nippon Seiko K.K. □ Olympus □ Optro-Mechanics □ Orbotech □ Photon Dynamics □ Photo Research □ Pixel Interconnect □ SAIC □ Scientific Systems □ Sencore □ Signatone □ SOPRA □ Spectron Engineering □ Steag MicroTech □ T&M Instruments □ Teletrac □ Tencor Instruments □ 3M Electronic Products □ 3M Product Information □ TNP Instruments □ TRICOR Systems □ Unigraf □ Veeco Process Metrology □ VisiTec Microtechnik □ Wande □ Westar □ Carl Zeiss

colorimeters

□ Chroma ATE □ Data Plus □ DynaColor □ ELDIM □ Electro-Optics □ Gamma Scientific □ Hoffman Engr. □ Image Processing Systems □ Institute for Photometry & Radiometry □ Klein Instruments □ Lighting Sciences □ LMT □ Microvision □ Minolta □ n&k Technology □ Opto-Cal □ Photo Research □ Protelevision □ Sencore □ T&M Instruments □ Topcon America □ TRICOR Systems □ UDT Instruments □ XtroniX

convergence gauges

□ Chroma ATE □ Display Labs □ DynaColor □ Ginsbury □ Klein Instruments □ Microvision □ T&M Instruments

gonioreflectometers

□ autronic □ ELDIM □ Hoffman Engr. □ Instrument Systems □ Lighting Sciences □ Microvision □ n&k Technology □ Westar □ J. A. Woollam

hot stages

□ ELDIM □ Micromanipulator Co. □ Palomar Products □ TNP □ Carl Zeiss

microscopes

□ autronic □ Celco □ Inter-Logic □ Klein Instruments □ Lasertec □ Leica □ Micromanipulator Co. □ Nikon Precision □ Olympus America □ Optro-Mechanics □ Seiwa Optical □ T&M Instruments □ TNP □ VisiTec Microtechnik □ Carl Zeiss

photometers

□ autronic □ Gamma Scientific □ ELDIM □ Electro-Optics □ Hoffman Engr. □ Institute for Photometry & Radiometry □ Instrument Systems □ Labsphere □ Lighting Sciences □ LMT □ Microvision □ OAI □ Opto-Cal □ Optronics Labs □ Photo Research □ Spectron Engineering □ Tektronix □ T&M Instruments □ Topcon America □ TRICOR Systems □ UDT Instruments □ Unigraf □ Carl Zeiss

radiometers

□ Electro-Optics □ Ergonomics □ EFOS □ Gamma Scientific □ Hoffman Engr. □ Institute for Photometry & Radiometry □ Labsphere □ Minolta □ OAI □ Opto-Cal □ Optronics Labs □ Photo Research □ Spectron Engineering □ T&M Instruments □ Tektronix □ Topcon America □ UDT Instruments

spectrometers

□ autronic □ Gamma Scientific □ Hoffman Engr. □ Instrument Systems □ Laversab □ Microvision □ MKS Instruments □ n&k Technology □ Nanometrics □ Opto-Cal □ Optronics Labs □ Photo Research □ Spectron Engineering □ T&M Instruments □ TNP Instruments □ Topcon America □ TRICOR Systems □ VisiTec Microtechnik □ J. A. Woollam □ Carl Zeiss

video generators

□ autronic □ B&K Precision □ Barco Chromatics □ Chroma ATE □ Colorado Video □ Data Plus □ DRS Military Systems □ DRS Technologies □ DynaColor □ ELDIM □ John Fluke Mfg. □ Ginsbury □ Klein Instruments □ Image Processing Systems □ Leader Instruments □ MECC □ MTL Systems □ Optro-Mechanics □ Photon Display □ Quantum Data □ Sencore □ Sonera Technologies □ T&M Instruments □ Team Systems □ Unigraf □ Video Instruments □ XtroniX

video oscilloscopes

□ B&K Precision □ Colorado Video □ General Electric □ Laversab □ Leader Instruments □ Photon □ Sencore □ T&M Instruments

THIN FILMS

□ AGFA-Gevaert □ Applied Films □ Applied Technology □ Applied Vacuum Coating □ Atomergic Chemetals □ Balzars AEG □ Balzars Process Systems □ Balzars Thin Films □ Balzars Thin Films GmbH □ Corning Optical Corp. □ CPFilms □ CRL □ Dontech □ DRS Technologies □ Dynapro □ Eaton FP Equipment □ Edwards □ Feldman Technology □ FEPET □ General Vacuum □ Ginsbury □ Hoya Corp. □ I.G.S. □ Information Products □ Innotec □ Innovative Specialty Films □ Intevac □ ITG □ Kaiser Optical □ Kisco □ Kurdex □ Lambda Physik

Lamination Technology Kurt J. Lesker Co. Leybold Liquid Crystal Institute LMDC Materials Research Corp. Mellis Griot Nanometrics NeoVac NIMTEC OCLI Opto Sigma Polaroid Optical Films Polar Vision Sheldahl Silver Cloud Mfg. SOPRA Specialty Coating Systems Spire Stan-Allen Technical Visions Techni-Met Thin Film Devices Thin Film Technology 3M Product Information TNP Torrey Pines Research Viratec ZC&R Coatings

3-D DISPLAY SYSTEMS

Breaull CLCEO Coryphaeus Dimension Technologies Dontech EDL Displays Electronic Image Systems Evans & Sutherland Computer Fakespace Flat Panel Display General Electric Ginsbury I.G.S. Infinity Multimedia Liquid Crystal Institute Matrox Electronic Systems Minolta MicroOptical Night Vision Corp. NuVision Technologies n-Vision Panoram Technologies Polhemus Reel 3-D Sarnoff Corp. Security Defense Systems StereoGraphics Stereomedia Tektronix 3-D ImageTek 3DTV UCE Visonics Labs Zebra Imaging

TOUCH-INTERACTIVE DISPLAYS

Alien Technology All American AVT Applied Technology AVED AVNET Barco Chromatics Craft Data Ltd. Crystal Visions Solutions Cybertouch D&T Data Modul Densitron Digitran Dolch Computer Dynamic Displays Dontech Eaton FPD Eaton PSD Eaton IDT Electro Mechanical Systems Electro Plasma Elographics Elo TouchSystems EMCO-Fraker Flat Panel Display IBM Image Systems Information Products Innova Electronics Intecolor Interaction Systems Interstate Electronics (GPS) Jaco Electronics Kristel Laversab Litton Systems Lockheed Sanders Manhattan Skyline MITAC NeoVac Nortech Engineering OI Direct Palomar Products Phoenix Group Photonics Systems Poly-Optical Products Polar Vision Racal-Mesl Review Display Systems RGB Dynamics SMART Technologies I. I. Stanley Synaptics Techni-Met Three-Five Systems Touch Controls Ultra Electronics U.S. Electronics Varitronix View Magic XKD WACOM

TOUCH SCREENS

Acme Portable Machines ADT AEI Components All American Applied Films Applied Technology Applied Vacuum Coating Asia Wintek AVNET AVT Bergquist CAM Graphics Carroll Touch Computer Dynamics CPFilms Craft Data Ltd. Crystaloid Crystal Visions Solutions CTX Opto Cybertouch D&T Dale Electronics Data Modul DBI Densitron Dolch Computer Dontech Dynapro Earth Computer Eaton FPD EDL Displays Electro Mechanical Systems Elform Elographics Elo TouchSystems EMCO EMCO-Fraker Epson America Feldman Technology John Fluke Mfg. Ginsbury GUNZE IBM IEE I.G.S. Image Systems Imagine Graphics Information Products Innovative Specialty Films Intecolor

Interaction Systems Interface Displays and Controls Interstate Electronics (GPS) ITO America Jaco Electronics Kent Modular Electronics Kisco Lamination Technology Laversab Litton Systems Man & Machine Manhattan Skyline Microtouch Systems Mintronix MITAC NeoVac O&S Research Optical Devices Philips Flat Display Systems Phoenix Group Photonics Systems Poly Optical Products Purdy Electronics Racal-Mesl Review Display Systems RGB Dynamics Richardson Electronics Romag Glass SDMS Synaptics Techni-Met Teleline Canada Telesensory Texas Industrial Peripherals Thin Film Devices Thin Film Technology Touch Controls U.S. Electronics Varitronix View Magic ViewTEK WACOM White Electronics

TOUCH TABLETS

ADT Carroll Touch Crystal Visions Solutions Information Products Phoenix Group Review Display Systems SDMS Synaptics WACOM

TRACKBALLS

Computer Keyboard Systems Digitran Intecolor Polhemus

VACUUM EQUIPMENT

Anorad Applied Films ASM America Balzers AEG Balzers Process Systems Balzers Thin Films Balzars Thin Films GmbH BOC Coating Technology BOC Edwards Brooks Automation Edwards FEPEP General Vacuum Innovative Specialty Films Innotec Intevac Kimball Physics Kisco Kontony Products Kurdex Kurt J. Lesker Co. Leybold LMDC Manhattan Skyline Materials Research Corp. MDC Vacuum Products MKS Instruments SAES Getters Temascal TSC ULVAC Technologies VAT Viratec

VACUUM FLUORESCENT DISPLAYS

Babcock Display Research Labs Futaba America IEE ISE Electronics Itron Kent Modular Electronics LCSP-Deeco Noritake Morrison Electronics Review Display Systems

VIDEO AMPLIFIERS

Celco Pacific Clare Micronix Communications Specialties Extron Imaging Display Kollmorgen MECC National Semiconductor T&M Instruments U.S. Electronics

VIDEO AND DISPLAY STANDARDS

Color Technology Solutions DynaColor M. S. Kennedy SAIC Sonera Technologies T&M Instruments 3M Product Information VESA

VIDEO CUBES

Clarity Visual Systems Unigraf ViewTEK

VIDEO WALLS

BBV Digital Clarity Visual Systems Daktronics Display Components Display Labs Draper FEPEP L-3 Display Systems Panoram Technologies Review Display Systems Stanley Palmer Pioneer New Media Unigraf

VIEWING SCREENS

Barco Display BBV Digital CRL Draper Liquid Crystal Institute Physical Optics Poly-Optical Products Tech-Corn

VIRTUAL IMAGING

Future Focus MicroOptical Multichip Assembly Panoram Technologies Reflection Technology Reel 3-D Retinal Displays SEOS Displays Silscape Stereomedia Virtual Vision

VIRTUAL-REALITY DISPLAYS

Breaull Display Research Labs eMagin Fakespace Future Focus Gritz's Emporium Incom Liquid Crystal Institute MicroOptical Multichip Assembly Night Vision Corp. n-Vision Reflection Technology Reel 3-D Silscape Stereomedia Tech-Corn 3-D ImageTek 3DTV 01 Products

X-RAY IMAGE STORAGE SCREENS

Incom Levy Hill Quantex Security Defense Systems Spire T&M Instruments

X-RAY IMAGING

Clinton Electronics CR Technology EEV Kevex X-Ray Nicolet Imaging Systems Nortech Imaging T&M Instruments Thomson Components & Tubes Thomson Tubes Electronique U.S. Electronics VDC (Teltron)

WIRE

Caton Connector Daburn Display Components ORSAM Sylvania Stanley Palmer

Part II: Companies

Listings are in strict alphabetical order. Punctuation, spaces, and the initial definite article "The" are ignored. Numbers (3D, 3M, 01), symbols (&), and abbreviations (Co., Corp., Inc., Ltd.) are listed as though fully spelled out.

AAEON ELECTRONICS, INC., 3 Crown Plaza, Hazlet, NJ 07734-1135

Designers and manufacturers of PC-compatible single-board computers utilizing on-board LCD flat-panel graphics controllers, as well as PC/104 add-on modules for LCD graphics.
 Timothy Kenny, Slis, Mgr.
 732/203-9300, fax 732/203-9311
 e-mail: sales@aaeon.com
 www.aaeon.com

ABSOPULSE ELECTRONICS, LTD., 232 Castor St., Carp, Ontario K0A 1L0, Canada

Designers and manufacturers of custom and standard dc-input dimmable backlight inverters. Offering any dc input, pre-heating, dimming, and flashing. Output power up to 250 W.
 Nanno Habets, Mktg. Mgr.
 613/836-3511, fax: 613/836-7488
 e-mail: absinfo@absopulse.com
 www.absopulse.com

ACCUDYNE CORP., 1415 Foundation Park Blvd. S.E., Palm Bay, FL 32909

Manufacturers of flat-panel-display mid-line processing equipment: rubbing, cleaning, spacer applicators, spacer counters, assembly, filling, laser-based glass separation, and in-line material handling. All equipment is clean-room compatible and operator friendly.
 Jim Lawson, Pres.
 407/724-6500, fax: 407/727-1632

ACCULEX CORP., 440 Myles Standish Blvd., Taunton, MA 02780

Manufacturers/distributors of industrial process monitoring and display products. Surface-mount technology designs; rugged digital panel meters (LCD and LED) for measuring temperature, pressure, voltage current, etc.
 Richard Mullen, Prod. Mktg. Mgr.
 508/880-3660, fax: 508/880-0179

ACL, INC./STATICIDE, 1960 E. Devon Ave., Elk Grove Village, IL 60007

Manufacturers of STATICIDE topical anti-static solution, a highly effective method for long-term static control, which is non-toxic, non-flammable, non-staining, and completely biodegradable. Available in general-purpose and heavy-duty sprays or wipes for use on CRT screens.
 Tony Banks, V.P. Slis/Mktg.
 708/981-9212, 1-800-782-8420,
 fax: 708/981-9278

ACME PORTABLE MACHINES, INC., 14140 Live Oak Ave., Unit D, Baldwin Park, CA 91706

Manufacturers of ruggedized portable flat-panel and VGA technologies for field environments. The Acme Lunchbox computers are adaptable platforms for industrialized multitask operations: medical, networking, teleconferencing, diagnostic testing, and more.
 Jimmy Chang, Slis. Mgr.
 626/814-0516 fax: 626/814-0323
 www.acmeportable.com

ADAPTIVE MICRO SYSTEMS, INC., 7840 N. 86th St., Milwaukee, WI 53224

Manufacturers of high-quality indoor and outdoor color LED message displays, including PowerView, Beta-Brite, and indoor and outdoor Alpha lines and custom modules for OEM products. Single- and multi-line signs with characters from 1.5 to 7.2 in. high for displaying text, graphics, and logos.
 Curt Lillie, V.P. Alpha Slis.
 414/357-2020 x223, 1-800-558-7022
 fax: 414/357-2029

ADAPTIVE MICRO SYSTEMS, INC., SMART ALEC, 7840 N. 86th St., Milwaukee, WI 53224

Developers of intelligent messaging software that automatically messages real-time and scheduled information to PowerView LED message displays, e-mail, intranets, pagers, voice mail, PA systems, and more. Acquires information from virtually any source using DDE, serial, ASCII de-limited files, MAPI compliant e-mail, or custom interface.
 Mike Rimrod, Smart Alec Slis. Mgr.
 414/357-2020, 1-800-558-7022
 fax: 414/357-2029

ADHESIVES RESEARCH, INC., P.O. Box 100, Glen Rock, PA 17327

Manufacturers of ARClear™ optically clear pressure-sensitive adhesive-coated products used for bonding backlights,

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www.ddwg.org

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Manufacturers of color resource image-processing software for image editing and enhancement, transforms, 3D perspective, and multispectral classification. Supports

selective video cameras, scanners, printers, film recorders, and image boards.
Robert Mills, Pres.
609/683-0234, fax: 609/683-4068

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1 Commerce Park, Valhalla, NY 10595
Manufacturers of custom and standard high-voltage power supplies and transformers for the display industry.
Jeremy Simon, Mgr. Mktg./Sls.
914/686-3600, fax: 914/686-5424

DELTA SERVICE & PRODUCTS GmbH, Toellen Linde 5, Delbrueck 33129, Germany

Providers of repair service for LCD screens.
Hubert Hankemeier, Gen. Mgr.
+49-5250-98540, fax +49-5250-52659
e-mail: info@deltaservice.de
www.deltaservice.de

DEMPA PUBLICATIONS, INC.,

275 Madison Ave., New York, NY 10016
Publishers of trade magazines (Display Devices, JEE, JEI, OEP, AEU, EBG, Almanac).
Soo Sonntag, Subscription Mgr.
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Manufacturers of antiglare filters for VDTs, broadband AR coatings on clear and absorbing glasses, dichroic filters, and beamsplitters.
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Jenny Rodriguez, Inside Sls.

408/737-1100 x228, fax 408/737-1190

e-mail: jenny.rodriguez@digilens.com
www.digilens.com

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770/420-1350, fax: 770/420-1360
e-mail: powerinfo@digitalprojection.com
www.digitalprojection.com

DIGITAL VIEW, 20/F Kam Chung Communication Bldg., 19-21 Hennessy Rd., Wanchai, Hong Kong

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James Henry
+852-2861-3615, fax: +852-2520-2987

DIGITAL VIEW, INC., 18440 Technology Dr., Ste. 130, Morgan Hill, CA 95037

Manufacturers of flat-panel-display subsystems, complete monitor solutions, as well as enterprise wide digital visual communications systems.
Dusty Perryman, Sls. Mgr.
408/782-7773, fax: 408/782-7883
e-mail: sales@digitalview.com
www.digitalview.com

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fax: 408/922-9862
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Manufacturers of high-luminance multi-color vacuum fluorescent display (VFD) products ranging from simple numeric and dot-matrix displays to large multifunction graphic panels. High-luminance monochrome color FED standard products.
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Manufacturers of high-brightness multicolor vacuum fluorescent display products ranging from simple numeric and dot-matrix displays to large multifunction graphic panels. Also, high-brightness monochrome color field-emission display (FED) standard products.
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FUTABA CORP. OF AMERICA, 1605 Penny Lane, Schaumburg, IL 60173

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Pat Dolezal, Advertising Asst. 847/884-1444, fax: 847/884-1635
e-mail: pdolezal@futaba.com
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FUTURE SYSTEMS, INC., P.O. Box 26, Falls Church, VA 22040

Publishers of the Multimedia & Videodisc Monitor (formerly the Videodisc Monitor) which provides news and analysis of multimedia, interactive video, compact disc, and related technologies. Covers product applications in areas including training, retailing, education, the military, and home entertainment.

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fax: 508/347-3849
www.galileocorp.com

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Manufacturers of electro-optical instruments, including spectroradiometers, colorimeters, photometers, radiometers, NIST-traceable light sources, laser eye-safety power meters, and various other light-measurement devices.
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fax: 619/576-9286
e-mail: info@gamma-sci.com
www.gamma-sci.com

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JEROLD H. GARD, Displays Consultant, 5469 Beechwood Ln., Los Altos, CA 94024

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Jerold H. Gard, Displays Consultant 415/968-2731, fax: 415/968-4795

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e-mail: rob@genesis-microchip.com
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fax: 978/589-2050

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GLOBAL DISPLAY NETWORK, 60 S. Market, Ste. 490, San Jose, CA 95119

The only Web-based comprehensive searchable compendium of information on the flat-panel-display industry designed to

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Consultant to manufacturers and users of display products. Investigation and analysis of user needs, product definition, proposals, and market information for end users and OEMs. Background in consumer, industrial, aerospace, TV, and computer applications. Development, application, and marketing of CRT, flat-panel, and related technologies. Also available. Joe Hallett, Consultant 503/692-5054

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HORNELL AUTOMATION, Tunavägen 281, Borlänge S-781 73, Sweden
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Manufacturers of digital film recorders, computer-output microfilm recorders, digital-output microfilm recorders. Thomas A. Hoopes, Pres. 801/264-1818, fax: 801/264-10855

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Manufacturers of mounting equipment and accessories for video displays, including plasma monitors, TV monitors, LCD projectors, as well as computer monitors. 708/865-8870, 1-800-865-2112
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TSD DISPLAY PRODUCTS, INC., 35 Orville Dr., Bohemia, NY 11716-2598
Manufacturers of high-resolution monochrome CRT display monitors.
Steven R. Sloan, Dir. Sls.
516/589-6800, fax: 516/589-6858

TSP, INC., 2009 Glenn Pkwy., Batavia, OH 45103-1676
Manufacturers of electronic display anti-glare and contrasting windows for LCDs and all energy-emitting displays. Coated windows provide scratch and chemical

resistance and reduce glare. Fabrication and printing of finished parts.
Stewart Nellis, Sls. Mgr.
513/732-8900, 1-800-277-9778
fax: 513/732-6988
e-mail: stewn@tsp.com

TÜV RHEINLAND OF NORTH AMERICA, INC., 5860 W. Las Positas Blvd., #19, Pleasanton, CA 94588
Testing house providing ergonomics testing and certification services for hardware and firmware for the European market. Other services include certification to the ANSI/UL 1950 standard for the U.S. market, EMC testing, and ISO 9000 registrations
Klaus Ehrlich
510/734-8100, 510/734-8455

TWO TECHNOLOGIES INC., 419 Sargon Way, Horsham, PA 19044
Designers and manufacturers of hand-held terminals.
Joan Rickards, V.P. Sls.
215/441-5305

TYSON CONSULTING GROUP, 612 White Pine Rd., Buffalo Grove, IL 60089-3330
Consultancy in medical-device development covering: market evaluation, demographics, and needs analysis; concept testing and refinement; and marketing-program planning, including direct sales, distribution, and promotion. Seminars available on the health-care industry, with emphasis on product-related activities and trends.
Ted R. Tyson, Pres.
847/459-9189, fax: 847/215-6141

UCE, INC., 1580 Route 52, Hopewell Junction, NY 12533
Manufacturers of LCDs, application-specific displays, and custom and standard displays. Liquid crystals include nematic, scattering, dichroic, phase-change, and stored scatter. Also, optical light valves, shutters, attenuators for projection and direct-view, and optical switches.
Greg Borstelmann, Sls. Mgr.
914/456-7119, fax: 914/892-1710

UDT INSTRUMENTS, Marketing Dept., 727 S. Wolfe St., Baltimore, MD 21231
Manufacturers of electro-optical instruments, including colorimeters, photometers, radiometers, fiber-optic power meters, and position-sensing equipment.
Vince Shapanus, Sls. Engr.
410/342-2626, 1-800-891-2709
fax: 407/673-7005
e-mail: info@udtinstruments.com
www.udtinstruments.com

ULTRA ELECTRONICS COMMAND & CONTROL SYSTEMS, Knaves Beech Business Centre, Loudwater, High Wycombe, Buckinghamshire HP10 9UT, U.K.
Manufacturers of a range of display and console solutions for the military market. These slim-profile consoles products are based on large-area high-resolution COTS display equipment, re-housed and ruggedized.
Mike Williams, Technology Products Mgr.
+44(0)-1628-530-000
fax: +44(0)-1628-524-557
e-mail: mike-williams@ueccs.co.uk
www.flatcreens.co.uk

ULTRA I EQUIPMENT CO., 2391 Zanker Rd., #370, San Jose, CA 95131
Manufacturers of configurable photo-lithography cluster tools for coating, devel-

oping, and cleaning of substrates up to 34 in. on the diagonal. Also spin coaters for uniform coating of square and rectangular substrates, high-pressure and megasonic spray cleaners, spray developers, and high-accuracy flip-chip bonders.
Fred Namek, V.P. Mktg./Sls.
408/955-7850, fax: 408/955-7878

ULVAC TECHNOLOGIES, INC., 401 Griffin Brook Dr., Methuen, MA 01844
Supplier of PVD, PE-CVD, RIE, and evaporation systems for TFT, LCD, FED, OLED, and other FPD manufacturing. New products include research and pilot-sized production systems for the manufacture of OLEDs.
Robert L. Gardner, Corp. Dir. Sls./Mktg.
978/686-7550, fax: 978/689-6300

UNIAX CORP., 6780 Cortona Dr., Santa Barbara, CA 93117-3022
Developing polymer emissive displays for portable hand-held devices. Target markets are cellular phones and pagers.
James H. Long, Jr., Pres. & CEO
805/562-9293, fax: 805/562-9144
www.uniax.com

UNIGRAF, Ruukintie 18, Espoo 02320 Finland
Manufacturers of industrial computers, videowall controllers, and displays for control-room applications. Also, PC-based programmable video test generators for video-monitor service and manufacturing.
Jouko Ala-Tuori, Dir.
+358-9-802-76423, fax: +358-9-802-6699
e-mail: jouko.ala-tuori@unigraf.fi
www.unigraf.fi

UNIPAC OPTOELECTRONICS CORP., No. 3 Industry E, 3rd Rd., Science-Based Industrial Park, Hsinchu, Taiwan
Manufacturers of slim-module color TFT-LCDs in sizes ranging from 1.8 to 14.1 in.
Tyler Shan, Dir. Mktg. & Sls.
+886-3-577-2700 x1502,
fax: +886-3-577-2730
e-mail: tyler@unipac.com.tw

UNIVERSITY OF MICHIGAN, Display Technology & Manufacturing Center, 2360 Bonisteel Blvd., Ann Arbor, MI 48109-2108
University research facility offering R&D in FPD manufacturing and materials technologies. Capabilities in FPD devices, materials, and circuits; process control; microelectronics on low-temperature substrates; and factory optimization and control.
Linda K. Owens, Admin. Mgr.
313/764-4336, fax: 313/936-0347

U.S. DISPLAY CONSORTIUM (USDC), 50 W. San Fernando St., #920, San Jose, CA 94403
An industry-led public/private partnership providing a common platform for FPD manufacturers, developers, users, and the equipment and supplier base. Mission is to establish and enlarge the U.S. supplier infrastructure required to support a world-class U.S.-based manufacturing capability for FPDs.
Michael Ciesinski, CEO
408/277-2400, fax 408/277-2491
e-mail: usdc@usdc.org
www.usdc.org

U.S. ELECTRONICS, INC., 5730 Duluth St., Minneapolis, MN 55422
Design and consulting services for high-resolution monochrome and color CRT displays. Distributor of Totoku Electric Co., Ltd., CRT and flat-panel LC (active matrix)

displays for kiosk, medical, industrial, and desktop-publishing applications. CRT monitors range from 15 to 22 in., while LCD monitors range from 12 to 18 in. Offering touch panels and touch-panel controllers such as SAW, resistive, and capacitive. Madhu Reddy, Pres. 612/591-2605, 1-888-926-2605, fax 612/591-0726 e-mail: useisales@aol.com www.uselectronix.com

USHIO AMERICA, INC., 10550 Camden Dr., Cypress, CA 90630

An ISO-9001 manufacturer of metal halide, xenon, and halogen lamps for LCD and DMD™ projection applications. Both ac and dc metal-halide lamps are available, ranging from 125 to 575 W with or without reflectors. These lamps feature long-life and consistent color performance. Rachael Perkins, OEM Prod. Spec. 714/229-3178, 1-800-838-7446 fax 1-800-776-3641 www.ushio.com

U.S. PRECISION GLASS, 1900 Holmes Rd., Elgin, IL 60123

Manufacturers of flat-glass components for a variety of touch screens and flat-panel display manufacturers. Services include cutting, grinding, polishing, chemical tempering, optical coating, silk screening, and light assembly. Greg Olson, Natl. Sls. Mgr. 847/931-6403, fax: 847/931-4144

U.S. PRECISION LENS, 3997 McMann Rd., Cincinnati, OH 45245

Specializing in optical design, tooling design, and fabrication. Glass and polymer lens manufacturing, metrology, mounting and assembly, and coating. Mike O'Keefe, Sls. Engr. 513/752-7000, 1-800-877-0787 fax: 513/752-2841 e-mail: info-uspl@corning.com www.uspl.com

UTI CORP., Collegeville, PA 19426

Manufacturers of precision miniature metal components in 100 different alloys; specifically, oxide and dispenser cathode components. Paul Ashby 610/539-0700, 1-800-523-0441 fax: 610/489-1150

VACUUM ENGINEERING & MATERIALS CO., INC., P.O. Box 4480, Santa Clara, CA 95056-4480

Manufacturers of sputtering targets, evaporation materials, and backing plates. A large selection of high-purity metals, intermetallics, dielectrics, and cermet for PVD coatings. Sputtering targets and evaporation materials manufactured to customer's exact specifications of size and purity. Also, a complete line of cathodes and crucible liners. Jack Kavanaugh, Sls. Mgr. 408/986-8900, fax: 408/986-8980

VACUUMSCHMELZE GmbH, Gruener Weg 37, Hanau D-6450, Germany

Manufacturers of magnetic shieldings from low-frequency ac fields through to earth's fields; customer-specified monitor shielding, standard monitor shielding, shielding sheets for monitors; foils, parts, and magnetically shielded rooms. Hans-Dieter Naunheim, Dipl.-Ing. +49-6181-38-2768, fax: +49-6181-38-2645

VALTECH CORP., 1011 Daisy Point Rd., Pughtown, PA 19465

Manufacturers of VALTRON® detergents formulated for precision cleaning of FPDs, available in acidic, neutral, and alkaline formulations. Effective in contact and non-contact cleaning systems; micron-filtered prior to packaging with excellent detergency. Richard T. Girard, Pres. 610/469-9634, fax: 610/469-9635

VARITRONIX, LTD., 22 Chun Cheong St., TKO Industrial Est., Tseung Kwan O, Hong Kong

Manufacturers of custom and standard LCDs, custom and standard dot-matrix and graphic LCD modules, touch-sensing customer input terminals, and touch screens. Caleb Dong, Mktg. Mgr. +852-2343-6000, fax: +852-2343-9555

VARITRONIX S.A.R.L., 74 Avenue Charles de Gaulle, 91420 Morangis, France

Distributors of custom and standard LCDs, custom and standard dot-matrix and graphic LCD modules, touch-sensing customer input terminals, and touch screens. Guy Cresson +33-1-6909-7070, fax: +33-1-6909-0535

VARITRONIX (UK) LTD., 3 Milbanke Ct., Milbanke Way, Bracknell, Berks RG12 1RP, U.K.

Manufacturers of both custom and standard liquid-crystal displays and modules. New products include graphics panels and direct-contact touch overlays. Robert Hill, Appl. Engr. +44(0)-1344-303-077, fax: +44(0)-1344-300-099

VAT, INC., 500 W. Cummings Park, Woburn, MA 01801

Manufacturers of high-quality vacuum valves. Products include gate, angle, fast-closing, throttle, pressure control, retrofit, and customized valves for a variety of applications. Joyce Mackiewicz, Sls. & Mktg. Coord. 781/935-1446, 1-800-935-3940 fax: 781/935-3940

e-mail: usa@vatvalve.com www.vatvalve.com

VDC, One Apple Hill, Natick, MA 01760

Business planning, product planning, and market research for the electronics industry: materials, components, subsystems, and systems level. Marc Regberg, V.P. 508/653-9000, fax: 508/653-9836

ARON VECHT & ASSOCIATES, 95 Corringham Rd., London NW11 7DL, U.K.

Consultants specializing in displays: phosphors, EL, LCDs, etc. Also, super-pure chemicals, thin-film technology, CVD, financial and marketing, assessment of new technologies, technology transfer, and liaison between Europe and U.S. Aron Vecht +44-1-81-455-4361, fax: +44-1-81-316-8405

VEECO PROCESS METROLOGY, 602 E. Montecito St., Santa Barbara, CA 93103

Manufacturers of the Dektak OSP-1100, the first stylus-based surface profiler with the capacity to measure film thickness on large FPD substrates up to 1100 mm square. Tim Ballinger, Mktg. Commun. Mgr. 805/963-4431, 1-888-24-VEECO fax: 805/965-0522 www.veeco.com

VENTURE DEVELOPMENT CORP., 1 Apple Hill, Natick, MA 01760

Consultancy specializing in technology market research and strategy. Publishers of The North American Market and User Needs for Operator Interfaces and Monitors in Discrete & Process Manufacturing Applications, 3rd edition. Robert Wollkief, Gen. Mgr. 770/934-2245, fax: 770/934-2286

VERTEX LCD CO., 600 S. Jefferson St., Unit K, Placentia, CA 92870

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VESA Video Electronics Standards Assn., 920 Hillview Ct., Ste. 140, Milpitas, CA 95035

International not-for-profit organization that sets and supports industry-wide electronic standards for the video, audio, and graphics interface of computer designs. Develops open, interoperable international standards. Joan Holewinski, Member Svcs. Mgr. 408/957-9270, fax: 408/957-9277 e-mail: sales@vesa.org www.vesa.org

VIDEO DISPLAY CORPORATION, 1868 Tucker Industrial Rd., Tucker, GA 30084

International headquarters of parent company, guiding a group of eight divisions, manufacturing CRTs, camera tubes, electron optics, and custom monitors. 770/938-2080, 1-800-241-5005 fax: 770/493-3903

VIDEO DISPLAY CORPORATION (APEX ELECTRONICS DIVISION), 100 8th St., Passaic, NJ 07055

Manufacturers of electron-optics equipment and manufacturing equipment. M. Dorota, Gen. Mgr. 201/773-1220, fax: 201/838-1298

VIDEO DISPLAY CORPORATION (CHROMA VIDEO DIVISION), P.O. Box 119, White Mills, PA 18473

Manufacturers of entertainment and high-resolution data display color tubes from 10 to 35 in. Automated 150,000-ft.² in-line production facility. Ervin Kuczog, Gen. Mgr. 717/253-3910, fax: 717/253-3912

VIDEO DISPLAY CORPORATION (DATA DISPLAY DIVISION), 1868 Tucker Industrial Rd., Tucker, GA 30084

Manufacturers of monochrome CRTs, avionics and military CRTs, and research and development. Robert S. Liss, Prod. Serv. Mgr. 770/938-2080, 1-800-241-5005 fax: 717/493-3903

VIDEO DISPLAY CORPORATION (NOVATRON DIVISION), 1416 Alpine Blvd., Bossier City, LA 71111

Manufacturers of projection tubes and assemblies from 5 to 9 in. Automated 35,000-ft.² in-line production facility. Charles Acurio, Gen. Mgr. 318/747-0140, fax: 318/747-6690

VIDEO DISPLAY CORPORATION (SOUTHWEST VACUUM DIVISION), 4601 Lewis Rd., Stone Mountain, GA 30083

Manufacturers of electron-optics, components, custom cathodes, and custom gun mounts. Robert Wollkief, Gen. Mgr. 770/934-2245, fax: 770/934-2286

VIDEO DISPLAY CORPORATION (TELTRON TECHNOLOGIES DIVISION), Baltic Mews Corporate Center, 2 Rigla Lane, Birdsboro, PA 19508

Manufacturers of general, military, and special-purpose image and cathode-ray tubes to the most stringent specifications. MIL-145208A qualified supplier to DoD, FAA, NASA, DESC, and government prime contractors. Arthur Mengel, Gen. Mgr. 610/582-9450, fax: 610/582-0851

VIDEO DISPLAY CORPORATION (VIDEO ELECTRONICS DIVISION), Calle Zinc #99, Garza Garcia, Nuevo Leon 66210 Mexico

Manufacturers of monochrome CRTs from 7 to 24 in. Automated 150,000-ft.² in-line production facility. Rafael Garcia, Gen. Mgr. +52-8-336-1897, fax: +52-8-336-0578

VIDEO DISPLAY CORPORATION (Z-AXIS DIVISION), 15 Eagle St., Phelps, NY 14532

Manufacturers of specialty monochrome and color monitors. Carl Beechler, Gen. Mgr. 315/548-5000, fax: 315/548-5100

VIDEO INSTRUMENTS, 2155 Bellbrook Ave., Xenia, OH 45385-4043

Manufacturers of reference image generators for performance evaluation of medical-imaging video systems and displays of all types, including recorders and image processors. Precise yet affordable miniature units with a wide range of traditional a special patterns. Rita Bohon, Sales 937/376-4361, 1-800-962-8905 fax: 937/376-2802 e-mail: sales@videoinstruments.com www.videoinstruments.com

VIDEOTEX SYSTEMS INC., 8499 Greenville Ave., Ste. 205, Dallas, TX 75231

Manufacturers of display terminals with digitized video pictures, featuring TV quality pictures. Sold as a complete terminal or software only (T-VIEW). Bob Gillman 214/343-4500

VIDIWALK CORP., 30 Chapin Rd., Pinebrook, NJ 07058

Manufacturers of videowall processor, stackable projection cubes, and monitors, and a complete line of peripheral control products and software. Michael Serwe, Mktg. Dir. 201/882-0584, fax: 201/882-0656

VIEWMAGIC, INC., (Formerly ETC Computer, Inc.) 2917 Bayview Dr., Fremont, CA 94538

Manufacturers of small-footprint specialty display monitors: 10-in. color (super VGA) and 9- and 10-in. monochrome monitors, designed for space-limited applications. Also, providers of turnkey integrated touch screens for 10-, 14-, 15-, and 17-in. monitors. Kent Huang, Pres. 510/226-6250, fax: 510/226-6252

VIEWTEK, INC., 150 Executive Dr., Ste. Z, Edgewood, NY 11717
Designers/manufacturers of LCD controllers and industrial monitors. Controller boards support both graphics and video. Offering the highest quality video from VGA to XGA, supporting NTSC/PAL and SECAM formats.
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516/243-5600, 1-888-FLAT-PANEL
fax: 516/243-3308
e-mail: sales@view-tek.com
www.view-tek.com

VIKAY AMERICA, INC., 195 W. Main St., Avon, CT 06001
Manufacturers of custom and standard TN- and STN-LCDs; graphic, dot matrix, and general-purpose LCD modules; LCD keypad assemblies; turnkey LCD product assembly. Singapore and Malaysia manufacturing locations.
Tom Markiewicz
860/678-7600, fax: 860/678-7625

VIKING IMAGING, INC., 8060-A Byan Dairy Rd., Largo, FL 33777
Manufacturers of impact printers, electro-photographic laser printers, and non-impact ion-deposition printers.
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Thomas L. Muir, Managing Dir.
602/266-2366, fax: 602/266-2926
www.villa.com

VIQX CORP., 6701 Sixth Ave. So., Seattle, WA 98108
Manufacturers of custom glass frits and powders for the electronic and display industries. Providers of glass development, laboratory samples, and volume manufacturing for high-purity technical glasses.
Harlan Brown, Dir. Sls. & Mktg.
206/766-6534, fax: 206/763-2577
e-mail: glass@viqx.com
www.viqx.com

VIRATEC THIN FILMS, INC., 2150 Airport Dr., Faribault, MN 55021
Manufacturers of sputter-deposited optical thin-film coatings on glass and plastic for displays and imaging applications. Patented multilayer AR coatings are designed to reduce glare and reflection, improve light transmission and contrast, and provide static dissipation and electromagnetic shielding. Applications include directly coated CRTs, bonded panels for flat CRTs, PDP filters, anti-glare filters for computer monitors, TVs, TFT-LCDs, and laptops for industrial instrumentation, navigational, and automotive dashboard displays.
Kurt Ruelenacht, Dir. Sls. & Mktg.
507/334-0051, fax: 507/334-0059
e-mail: kruelena@viratec.com
www.viratec.com

VIRTUAL VISION, INC., 7659 178th Pl. N.E., Redmond, WA 98052
Developers and marketers of head-wearable display systems for computing in maintenance and repair, on-line inventory management, inspection, military, medical, and entertainment applications. Providers of

products which equip mobile workers with real-time data for hands-on work activities.
Mansour Amjadi, Bus. Devel. Mgr.
408/567-9700, fax: 408/727-3719
e-mail: info@virtualvision.com
www.virtualvision.com

VISICOM IMAGING PRODUCTS, 1 Burlington Woods Dr., Burlington, MA 01803
Manufacturers of graphics display controllers and frame grabbers for VME, PC-ISA, VL, PCT, and IBMRISE 6000 computers. Supports CRTs and EL displays with resolutions from 640 x 480 up to 1600 x 1280 with 8, 12, 24, and 32 bits per pixel. Digital and analog video inputs are also supported.
Larry H. Taitelbaum, Dir. Sls. East
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VISITEC MICROTECHNIK GmbH, Karl Marx Str. 14, Grevesmuehlen D-23936, Germany
Manufacturers of large-chamber scanning electron microscopes for non-destructive analyzing of displays and substrates up to 800 x 800 mm. Energy dispersive spectrometer EDS and focused ion-beam-gun FIB can be integrated and operated simultaneously.
Martin Klein, Dipl.-Ing.
+49-3881-79049, fax +49-3881-79048
e-mail: mklein@visitec-em.de
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VISONICS LABS, 8401 E. Desert Steppes Dr., Tucson, AZ 85710
Manufacturers of 3-D oscillographic displays in real time; multiple viewers each see a unique view without glasses; autostereoscopic, autoperallactic displays.
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520/885-5840, fax: 520/885-2922

VISPRO CORP., P.O. Box 6239, Beaverton, OR 97007-0239
Manufacturers of structural ceramic products typically used as envelopes for CRTs. Multilayer ceramic packages include LTCC, HTCC, and MCMS.
Steven E. Annas, Pres.
503/526-5268, fax: 503/644-9652

VISTA CONTROLS CORP., 27825 Fremont Ct., Santa Clarita, CA 91355
Manufacturers of helmet-mounted displays providing unrestrained inertial-sensed head-position and high-resolution stereoscopic video using active-matrix VGA FPDs. The family of products include the Vista Vision, See-Thru-Armour™, and the Wireless Stereo Vision System.
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+972-3-535-0968, fax: +972-3-534-1650

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602/961-3200, fax: 602/961-1135
www.vividsemi.com

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Manufacturers of field-sequential full-color LCDs. Sizes range from 1-, 5-, 7-, and 9-in. monitors for industrial and commercial applications. ASIC IC and video boards for conversion from computer (VGA) or video (NTSC/PAL) signals to field-sequential format. Also, an LCD projector with SVGA resolution.
Henry Chern, Gen. Mgr.
+886-3-5779-436, fax: +886-3-5779-449

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503/641-6246, 1-800-959-3660
fax: 503/641-7269

VL ELECTRONICS, INC., 3250 Wilshire Blvd., Ste. 1901, Los Angeles, CA 90010-1502
Manufacturers of custom and standard LCDs; custom and standard graphic, dot-matrix LCD modules; TN, STN, film-compensated b/w STN, b/w double STN, color-coded STN, guest-host, Heilmair, extended-temperature STN displays; touch-sensitive screens; turnkey complete product development and manufacturing.
Christopher Kreslake, Oper. Mgr.
213/738-8700, fax: 213/738-5340

VOICE CONNEXION, 17971 Skypark Cir., Ste. F, Irvine, CA 92614
Manufacturers of voice recognition and synthesis products for PCs. Also, handheld computers with voice I/O, keypad, and barcode.
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714/261-2366, fax: 714/261-8563

VOLTAGE MULTIPLIERS, INC., 8711 W. Roosevelt Ave., Visalia, CA 93291
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Karen Spano, Sls. Admin. Mgr.
559/651-1402, fax: 559/651-0740
e-mail: kspano@voltagemultipliers.com
www.voltagemultipliers.com

VOLTARC TECHNOLOGIES, INC., 400 Captin Neville Dr., Waterbury, CT 06705
Manufacturers of custom-designed hot- and cold-cathode fluorescent lamps for use in backlighting of liquid-crystal displays, and aperture lamps for use in scanning and inspection.
Ellen Debs, Sls. Engr.
203/578-4600, 1-800-962-6366
fax: 203/578-4605

WACOM CO., LTD., 4-1-12 Ikebukuro, Toshima, Tokyo 171 Japan
Manufacturers of LCD integrated digitizers with a cordless stylus; LCD integrated data terminal with handwriting recognition.
Masahiko Yamada, Dir. Intl. Div.
+81-33-985-0097, fax: +81-33-985-8636

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Manufacturers of digitizer pen tablets and pen input subsystems. The patented, battery-free, eraser-pen technology works with a variety of display devices, including TFT color LCDs. The low-frequency rf signal is fully compliant with host radio-communication systems, and is integrated into many ruggedized and commercial pen computers.
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360/750-8882, 1-800-922-6613
fax: 360/750-8924

WAMCO, INC., 11555 A Coley River Circle, Ft. Valley, CA 92708
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714/545-5560, 1-800-225-4810
fax: 714/545-6093

WANDE, INC., 4088 Lindberg Dr., Dallas, TX 75244
Manufacturers of a complete line of automated equipment for LCD production. The integrated system includes glass scribing/breaking/polishing, glass cleaning, imaging, developing/etching/stripping, printing/coating, buffing, spacer application, liquid-crystal filling, ITO sputtering subsystems, etc.
David Chen, V.P. Mktg./Bus. Dev.
972/701-8886, fax: 972/701-8885

WASATCH HIGH VOLTAGE, 2424 So. 900 West, Salt Lake City, UT 84119
Manufacturers of flying-spot scanners, high-voltage power supplies, and sweep deflection systems.
Ginnie Johnson, Mgr.
801/973-4090, fax: 801/973-0176
www.nylone.com

WATKINS-JOHNSON COMPANY, Semiconductor Equipment Group, 440 Kings Village Rd., Scotts Valley, CA 95066
Manufacturers of high-throughput continuous process APCVD reactors for thin-film deposition in flat-panel-display array fabrication. The WJ 16CVD system provides high-quality deposition of SiO₂ dielectric films for large-size AMLCD substrates and most advanced TFT devices. High utilization capability and high throughput provide for extremely low total cost of ownership.
Linda Johnson, Sls./Mktg.
408/438-2100, fax: 408/438-6827

WELCH ALLYN, Lighting Products Div., 4619 Jordan Rd., Skaneateles Falls, NY 13153-0187
Manufacturers of miniature metal-halide arc lamps with arc gaps of 1-2 mm. Lamps are ideal for compact LCD projectors.
Jim Kiesa, Sls. Mgr.
315/685-4347, fax: 315/685-2854

WELLS-GARDNER ELECTRONICS CORP., 2701 N. Kildare Ave., Chicago, IL 60639
Manufacturers of monochrome and color CRT displays. Products range from CGA through SVGA. Custom and standard products are available. Video-related contract assembly also available.
Lawrence J. Brady, V.P., Sls. Mgr.
312/292-5640, fax: 312/252-8072

WESTAIM ADVANCED DISPLAY TECHNOLOGIES, INC., 15 City View Dr., Toronto, Ontario M9W 5A5, Canada

Manufacturers of solid-state displays, which are a combination of thin-film phosphors with thick-film screen printing. Advantages include low-cost high-yield manufacturing processes, fewer process steps, greater viewing angles, rugged structure, and crisper brighter colors with full-motion video response speeds. Stefani Chan, Mktg. Coord. 416/246-1030 x223, fax: 416/246-0458 e-mail: schan@westaim.com www.westaimad.com

WESTAR CORP., 11520 St. Charles Rock Rd., St. Louis, MO 63044

International supplier of display-performance measurement systems, display tuning systems, and drive electronics. Featuring the Microdisplay Inspection System that performs rapid manufacturing test and inspection, as well as engineering performance measurements on microdisplay devices. Susan Carrillo, Mktg. & Sls. Mgr. 314/298-8748 x234, fax: 314/298-8067 e-mail: dtes@westar.com www.westar.com

WESTLAND ELECTRONICS, P.O. Box 215, 30 Depot La., Old Chatham, NY 12136

Consulting services for electronic-display equipment and systems. Technological studies and reports on all subjects related to these specialties. Sol Sherr, Pres. 518/794-8151, fax: 518/794-9426 e-mail: ssherr@taconic.net

WHITE ELECTRONIC DESIGNS, 1 Research Dr., Westborough, MA 01581

Manufacturers of AMLCDs, display interface products, and mechanical products. Standard product offerings include display head modules and 4-18 in. custom products. The interface products include switch panels and keyboards, front-panel assemblies, and custom LCD modules. Dennis Oberlin, Dir. Sls. 508/366-5151, 1-800-800-7726 fax: 508/836-4850 e-mail: doberlin@bowmarttechnologies.com www.whiteedc.com

WHITTAKER ELECTRONIC SYSTEMS, 1785 Voyager Ave., Simi Valley, CA 93063

Manufacturers of MIL-SPEC high-resolution color and monochrome monitors for domestic and international naval applications that pass MIL-S-901C Grade B shock. Also provide plasma programmable entry panels for airborne applications. Stephen C. Jones, Mgr. Product Dev. 605/584-8200, fax: 605/527-8332

WICO, 7847 N. Caldwell, IL 60714

Manufacturers of analog and digital joystick controls for video arcade games and home computer entertainment systems. Bill Potzke 1-800-323-4258, fax: 847/647-8526

WINSOR CORP., Ceramic Lighting Div., 410 S. 96th St., #7, Seattle, WA 98108

Manufacturers of high-performance backlights for LCDs. These are typically flat monolithic fluorescent lamps using hot-cathode technology to achieve high output and high luminous efficacy. John Ford 206/767-4070, fax: 206/767-3747

WINTRON TECHNOLOGIES, 614 Spearing St., Howard, PA 16841

Designers/manufacturers of CRT components including deflection yokes, high-voltage power supplies, transformer multipliers, flyback transformers, width and linearity coils, degaussing coils, and sweep boards.

Rose Hutchings, Dir. Sls./Mktg. 814/625-2720, fax: 814/625-2725 e-mail: winsales@wintrontech.com www.wintrontech.com

WPI ELECTRONICS, INC., 40 Depot St., Warner, NH 03278

Designers and manufacturers of standard and custom electronic ballasts, power supplies, and ignitors for xenon, mercury, and metal-halide arc lamps ranging from 35 to 1200 W. Paul Iverson, Product Mktg. Mgr. 603/456-3111, fax: 603/456-2498

WYLE ELECTRONICS, 15370 Barranca Parkway, Irvine, CA 92618

Distributors of flat-panel displays by Sharp Electronics. Products include AMLCDs, passive color and monochrome displays, character displays, and EL displays. Integrates displays in ISO 9002 facility. 714/788-3720, 1-800-283-9953 fax: 714/789-1461

XEROX COLOR GRAPHICS, 5853 Rue Ferrari, Bldg. A, MS 3-12, San Jose, CA 95138

Manufacturers of engineering copiers, printers, Versatec plotters, and supplies for document management. 1-800-538-6477

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Manufacturers of CRT monitors for use in aircraft simulators, radar installations, ruggedized models for use in ground mobile, airborne, and shipborne applications. Monitors range in size from 4 x 3 in. devices to 25-in. CRT systems. L. C. Heinzmann, Pres. 408/224-8460, fax: 408/224-8190 e-mail: sales-service@xkd.com www.xkdcorp.com

XMR, INC., 47281 Bayside Pkwy., Fremont, CA 94538

Manufacturers of high-power industrial excimer lasers and laser-based systems for use in manufacturing high-definition display devices. Developed and proven processes for recrystallizing a-Si to poly-Si for improved AMLCD manufacturing. Len Goldfine, Dir. Sls./Mktg. 510/668-1517, fax: 510/668-0169

XTRONIX CORP., 3150 Clinton Ct., Norcross, GA 30071

Manufacturers of computer-monitor test equipment with expensive pattern generator performance at a surprisingly low price, horizontal frequency to 200 kHz; Auto-Learn EDID data and Auto-Setup; high-voltage regulation test; burn-in sequence and timing; optional colorimeter; RS-232C port. Bill Rogers, V.P. Sls. 770/495-4881, fax 770/495-4885 e-mail: brogers@XtroniX.com www.XtroniX.com

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YAMAHA SYSTEMS TECHNOLOGY, 100 Century Center Court, Suite 800, San Jose, CA 95112

Manufacturers of single-chip or board-level IBM VGA, EGA, CGA, MDA, and Hercules compatible graphics controllers for driving EL, plasma, LCD (color or monochrome), or CRT displays all from a single device. Robert Starr, Natl. Sls./Mktg. Mgr. 408/437-3133, 1-800-543-7457 fax: 408/437-8791

YOUNG TECHNOLOGY, 277 Rickenbacker Circle, Livermore, CA 94550

Manufacturers of a line of thermal press equipment used for bonding of heat-seal connectors for connecting flat-panel displays to PCBs. Alex Rossi 510/490-6373, 1-800-394-6373 fax: 510/456-9810

Z-AXIS, INC., 15 Eagle St., Phelps, NY 14532

Designers and manufacturers of high-reliability color and monochrome CRT displays ranging in size from 5 to 27 in. Z-axis provides monitors for industrial control, medical instruments, commercial test equipment, and point-of-sale applications. John Dillman, Sls. Mgr. 315/548-5000, fax: 315/548-5100 www.z-axis-monitors.com

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1000 Milwaukee Ave., Glenview, IL 60025 Manufacturers of 5-19 in. (monochrome) and 9-25 in. (color) displays with a wide range of phosphors, face treatments, operating frequencies, and auxiliary power. Robert Uhr 708/391-7733, 1-800-827-8720 fax: 708/391-7078

ZENITH ELECTRONICS CORP., Rauland Div., 2407 W. North Ave., Melrose Park, IL 60160

Manufacturers of 19V, 20V, 25V, and 27V consumer-grade CRTs, with expansion to 17-in. conventional monitor tubes in 1997. Also, manufacturers of electron guns for both consumer and display-grade applications. Richard Steinmetz, V.P. Tech. Sls./Mktg. 708/450-8306, fax: 708/450-8393

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Directory notes

• Listings are free and without obligation. Companies advertising in this issue are listed in boldface type in both Parts I and II.

Suggestions for new categories of products and services relevant to the display industry, or further subdivisions or clarification of existing categories, are welcomed.

• If your organization is not included in this year's directory and would like to be listed in next year's directory, the Fifteenth Annual Directory, please write to Jay Morreale, c/o Palisades Institute for Research Services, Inc., 411 Lafayette Street, 2nd Floor, New York, NY 10003; 212/460-8090 x212, fax -5460.

Company divisions can be listed separately if they are at different locations with different product lines - please submit a separate application form for each division.

Application forms for the Fifteenth Annual Directory of the Display Industry will be mailed with the February 2001 issue. ■



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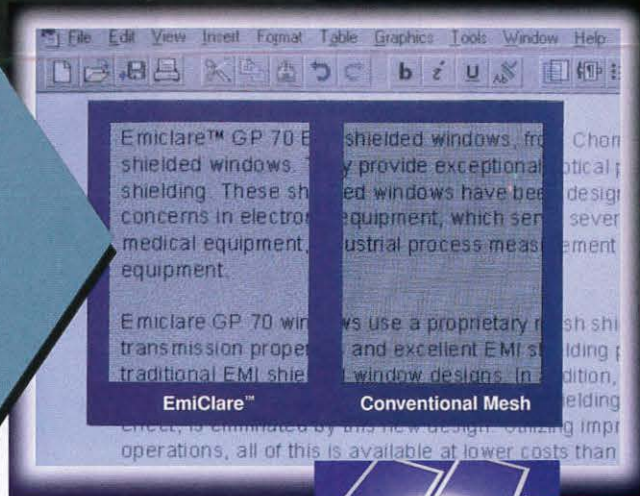
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Circle no. 29



Society for Info CONFERENCE

25 SEPTEMBER 00

IDRC
International Display
Research Conference
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Palm Beach, Florida

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

SID

7 NOVEMBER 00

Color Imaging Conference
November 7-10, 2000
Scottsdale, Arizona

- An international multi-disciplinary forum for dialogue on:
 - Creation and capture of color images
 - Color image reproduction and interchange
 - Color image display
- Co-sponsored with IS&T

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6 NOVEMBER 00

Display Phosphors Conference
November 6-8, 2000
San Diego, California

- 6th annual international conference on display phosphors

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For Information on SID Conferences, Contact:

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Society for Information Display
31 East Julian Street, San Jose, CA, USA 95112-4006*

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EMAIL: office@sid.org

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Information Display CALENDAR

21 NOVEMBER 00

EID 2000
NOVEMBER 21-23, 2000
ExCel Convention Center
London, UK

• EID is a single-track technical conference and exhibition featuring UK and European display products.

SID

29 NOVEMBER 00

IDW 2000
November 29-December 1, 2000
Kobe, Japan

- Information Display Workshops
- Invited experts will present talks at workshops on:
 - Emissive Displays
 - Non-Emissive Displays
 - Plasma and EL Displays
- Sponsored by SID/Asia Region, Japan Chapter, IEICE, ITEJ

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ITE

3 JUNE 01

SID 2001
International Symposium,
Seminar and Exhibition
June 3-8, 2001
San Jose, California
San Jose Convention Center

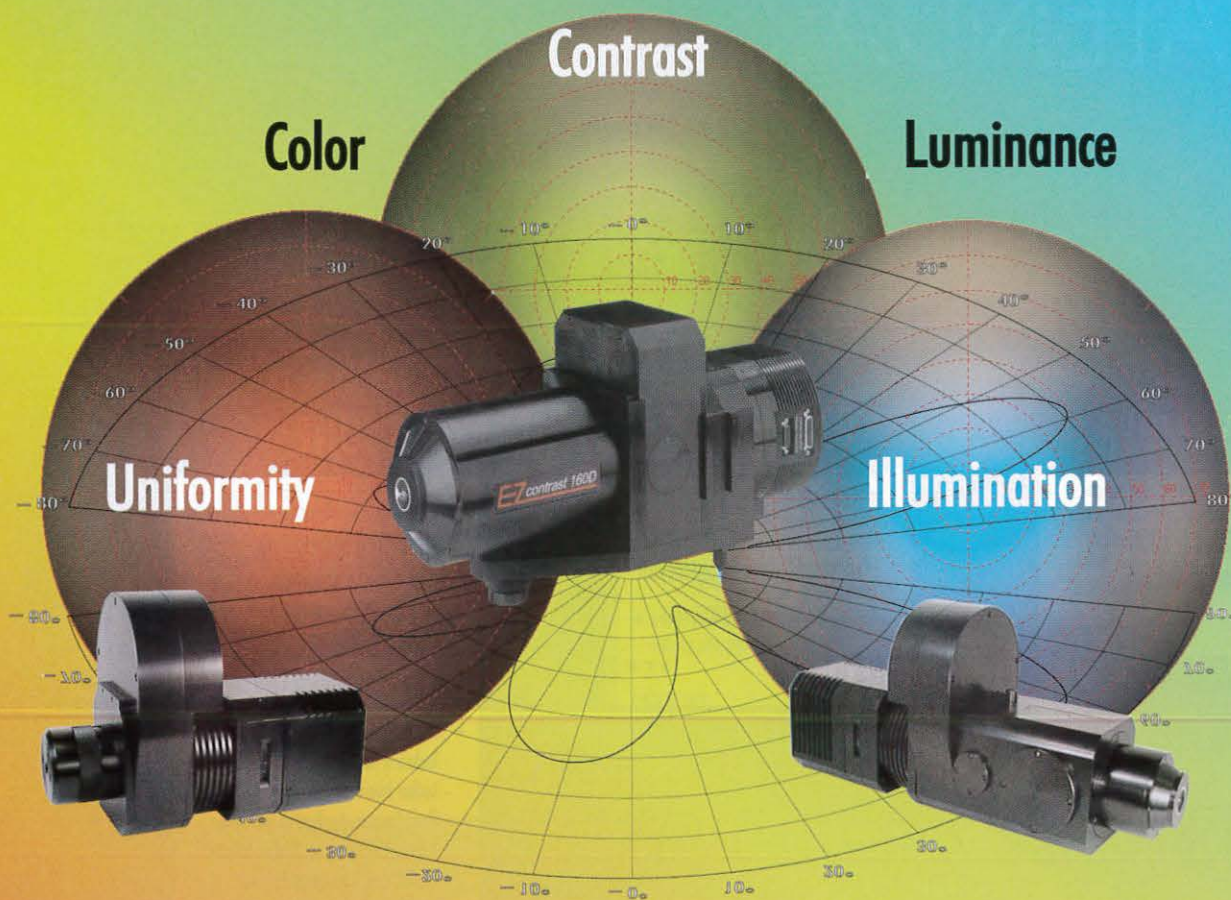
- SID's MAJOR ANNUAL EVENT, featuring:
 - Technical Sessions, Poster Session
 - Author Interviews, Evening Panels
 - Short Courses, Application Seminars
 - Technical Seminars, Application Sessions
 - Product and Technology Exhibits
 - Display Technology Showcase

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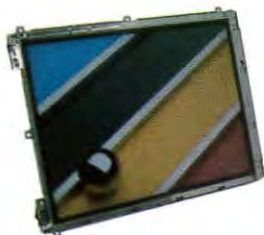
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SID '01

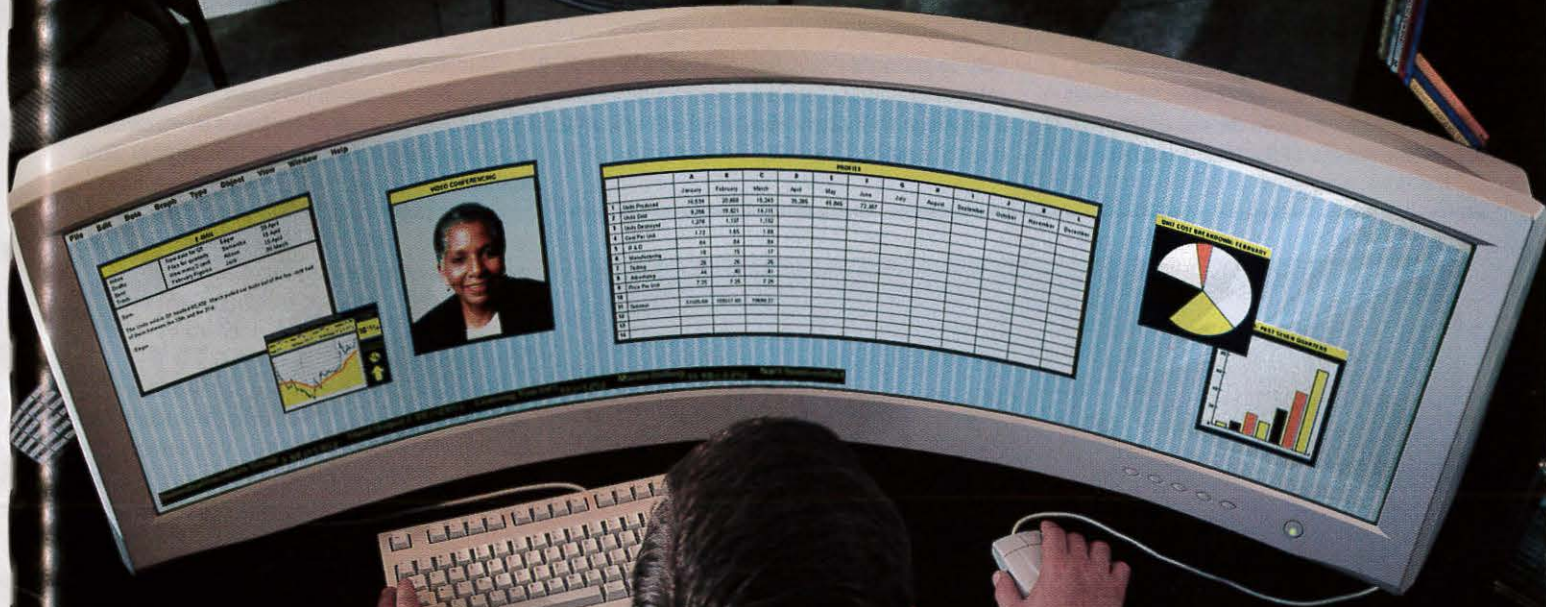
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Convention Center

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Circle no. 34

a view from the hilltop

continued from page 4

office tools areas), and a great detriment to potential competitors. Of course, Microsoft makes a nice profit from the use of its products, while the use of the English language

only requires that we learn the vocabulary and rules of grammar – not the easiest of tasks for a language with many peculiar and illogical rules of usage.

This trend will not go away. It will instead accelerate. We are in the midst of a major changeover from location-based to wireless (location-independent) communications. This transition is already well advanced in voice communications and is now happening in e-mail, data, and financial transactions. Once we can reach each other anytime and anywhere in the world, we will be pushed even harder to adopt a common standard by which we communicate.

For the foreseeable future, the use of a common language will be more prevalent than the use of electronic language translators. While such translators will eventually become quite capable and will be able to accurately simulate real speech, I believe that they will be more popular for checking grammar and for aiding communications than for real-time translation – with the possible exception of those people who have infrequent interactions with international colleagues. We can expect that person-to-person meetings will continue to increase in frequency, especially among those of us in the technical and business communities, as more world-wide cooperative business relationships are established and as the value of frequent technical interactions and information exchanges is reinforced by the participants.

There are, however, a few unfortunate aspects of these societal behaviors that encourage one language, one operating system, and a common communications protocol that drive all others into oblivion. It can result in the blending and eventual extinction of the cultural diversity that makes this world a more interesting place in which to live. It also appears to create an arrogance, a false pride, among those who happen to live where English – or the Windows™ operating system – are the native languages. It creates an impatience and a lack of consideration for those who have had to struggle later in life to acquire these skills. Perhaps it is the demonstration of some of these behaviors that has created the less-than-desirable reputation of some Americans as tourists.

Within the display community, we will certainly continue to encourage and appreciate the worldwide diversity of our membership while promoting open, frequent, and rapid communication among all. We must of necessity go along with the trend to one dominant language and hold our international meetings in English. However, we should all work hard

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Circle no. 35

to accommodate our colleagues who are still developing their English language skills. Having grown up in a bilingual home and, even today, continuing with the joys and

struggles of trying to achieve a modest level of fluency in several other languages, I appreciate the challenges of communicating in a language not learned during childhood.

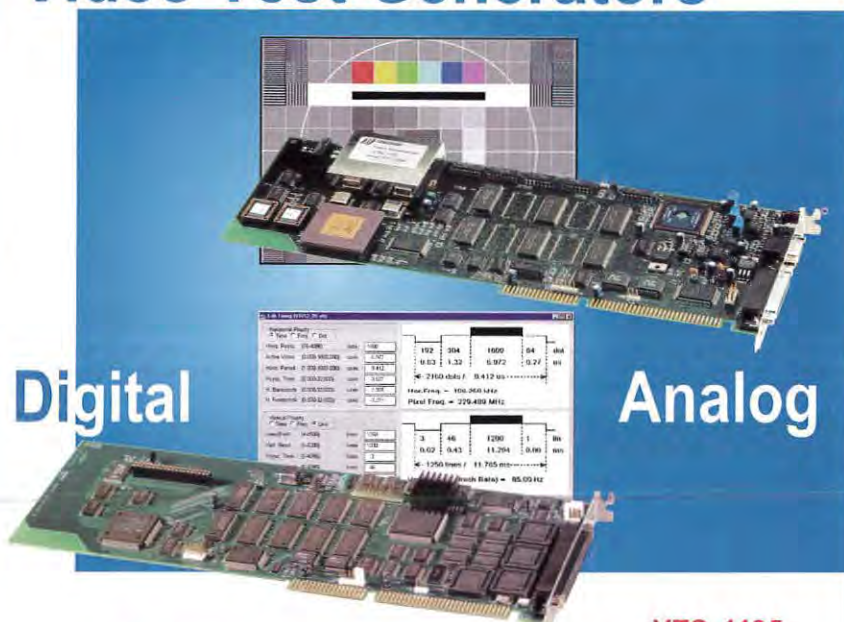
There is so much we can learn from each other. The worldwide personal interactions are especially important. Through such technical interactions, the entire display community benefits. New technologies can reach product status and commercial success faster. To that end, SID will continue to build its chapter activities in all regions of the world and to develop even more international meetings in order to facilitate opportunities for the creation of personal relationships which can then be further enhanced using electronic media.

Please use both personal and electronic communications methods to express your thoughts to me on what else you would like to see SID do to develop opportunities for enhancing your worldwide network of colleagues. You may reach me by e-mail at silzars@attglobal.net or at president@sid.org, by telephone at 425/557-8850, by fax at 425/557-8983, or by regular mail at 22513 S.E. 47th Place, Issaquah, WA 98029. ■

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GRAPHIC DISPLAYS

# of dots	Model No.	Model Size	View Area	Dot Size	Built-in
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122x32	DG-12232	84.0x44.0x10.0	60.5x18.5	0.40x0.45	SED1520
	DG-12232-01	65.1x27.1x5.3	60.5x18.5	0.40x0.45	SED1520
128x64	DG-12864	93.0x70.0x9.5	71.7x39.0	0.48x0.48	HD61202
	DG-12864-01	82.0x65.0x10.8	53.0x33.5	0.35x0.42	HD61202
	DG-12864-02	110.0x70.0x14.5	73.4x38.8	0.48x0.48	HD61202
	DG-12864-03	113.0x65.0x14.5	73.4x38.8	0.48x0.48	HD61202
128x128	DG-12128	72.4x69.9x10.0	49.0x49.0	0.32x0.32	HD61830
160x32	DG-16032	116.0x44.0x14.0	94.36x18.84	0.55x0.55	SED1521
160x80	DG-16080	100.0x54.0x11.0	72.3x37.8	0.39x0.39	HD61830
160x160	DG-16160	87.0x87.0x10.9	62.0x62.0	0.34x0.34	HD66204F
240x64	DG-24064	180.0x65.0x11.0	132.0x39.0	0.49x0.49	HD61830
	DG-24064-01	180.0x65.0x10.8	132.0x39.0	0.49x0.49	T6963C
	DG-24064-02	180.0x65.0x10.0	132.0x39.0	0.49x0.49	T6963C
240x128	DG-24128	144.0x104.0x12.5	114.0x64.0	0.40x0.40	HD66204
	DG-24128-01	170.0x104.0x14.0	132.0x76.0	0.47x0.47	T6963C
320x240	DG-32240	167.1x109.0x10.0	122.0x92.0	0.33x0.33	HD66204

CHARACTER DISPLAYS

Char. x line	Model No.	Character Fonts	Module Size	View Area	Character Size	Dot Size
8x2	DV-0802	5 x 8	58.0x32.0x13.8	35.0x15.24	2.95x5.46	0.55x0.65
16x1	DV-16100	5 x 8	80.0x36.0x10.0	64.5x13.8	3.07x6.56	0.55x0.75
16x1	DV-16110	5 x 7 + cursor	122.0x33.0x10.0	99.0x13.0	4.84x8.06	0.92x1.10
16x2	DV-16210	5 x 7 + cursor	122.0x44.0x10.0	99.0x24.0	4.84x8.06	0.92x1.10
	DV-16230	5 x 8	85.0x29.5x10.0	62.5x16.1	2.78x4.89	0.55x0.50
	DV-16236	5 x 8	85.5x36.0x10.0	62.2x17.9	2.95x5.55	0.55x0.65
	DV-16244	5 x 8	84.0x44.0x10.0	62.2x17.9	2.95x5.55	0.55x0.65
	DV-16252	5 x 8	80.0x36.0x10.0	62.5x16.1	2.78x4.89	0.55x0.50
	DV-16257	5 x 8	85.0x32.6x10.0	62.2x17.9	2.95x5.55	0.55x0.65
16x4	DV-16400	5 x 8	87.0x60.0x10.0	61.4x25.0	2.95x4.75	0.55x0.55
20x2	DV-20200	5 x 8	116.0x36.0x10.0	83.0x18.8	3.20x5.55	0.60x0.65
	DV-20210	5 x 7 + cursor	180.0x40.0x10.0	149.0x23.0	6.00x9.66	1.12x1.12
	DV-20211	5 x 8	182.0x60.0x20.0	137.0x29.2	5.90x12.7	1.10x1.50
	DV-20220	5 x 8	108.0x39.0x10.0	83.0x18.8	3.20x5.55	0.60x0.65
20x4	DV-20400	5 x 8	98.0x60.0x10.0	76.0x25.2	2.95x4.75	0.55x0.55
	DV-20410	5 x 8	146.0x62.5x10.0	118.8x38.5	4.84x9.22	0.92x1.1
24x2	DV-24200	5 x 8	118.0x36.0x10.0	94.5x18.0	3.20x5.55	0.60x0.65
	DV-24210	5 x 8	208.0x40.0x10.0	178.0x23.0	6.00x9.66	1.12x1.12
40x2	DV-40200	5 x 8	182.0x33.5x10.0	154.0x16.5	3.20x5.55	0.60x0.65
40x4	DV-40400	5 x 8	190.0x54.0x10.5	147.0x29.5	3.54x4.89	0.50x0.55

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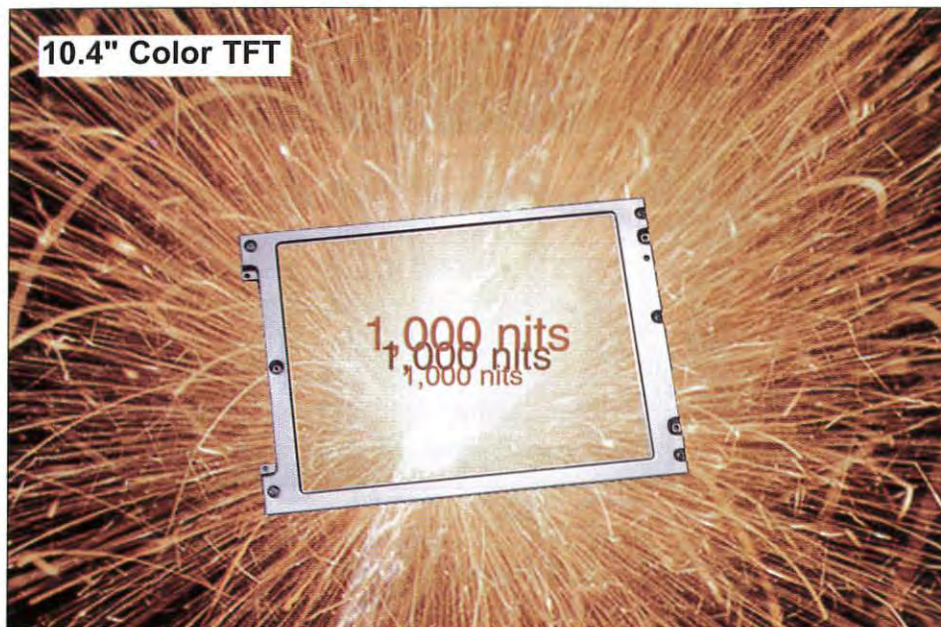
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Active-Matrix Circuit

In their article on PLED matrix displays [*ID*, February 2000, p. 15 – *Ed.*], Johnson and Sempel in their discussion of active-matrix drive for PLEDs say: “The basic circuit that performs the function just described [drive the poly-LED and also provide storage] is the two-transistor circuit introduced by Kodak.” Permit me to point out that this circuit (which Kodak actually has attempted to patent) is identical to the one we used for our original AM-EL work, both in design and function, and was published as Fig. 2 in our 1975 paper, “A 6 × 6-in. 20-lpi Electroluminescent Display Panel,” *IEEE Trans. Electron Dev.* **22**, 739 (Sept. 1975). People with short memories are encouraged to refer to this paper, which, incidentally, introduced the term “active matrix” into the literature.

– *T. P. Brody*
President
Active Matrix Assoc.

LCD Flicker

The BARCO article on the Navy waterfall problem appearing in the March 2000 issue of *Information Display* stated that a low-frequency flicker problem is noticeable on LCD monitors. It also stated that although some flicker is detectable on a CRT it is of a low level and not objectionable. Also noted was that the LCD outperformed the CRT in identifying targets. Fixes as identified in the article are said to accomplish the goal of eliminating flicker. However, the difficulties presented in incorporating these fixes have prompted me to look into alternate solutions.

Techniques I am developing consider the following facts to eliminate flicker:

- The low data update rate of sonar data results in a disturbing image flicker on an LCD screen.
- When a high-resolution CRT is used, this data causes a much lower perceptible flicker.
- With the refresh rate set to 75 Hz or higher, the data update rate is the sole cause of the flicker.

Adding my assumption that the proximity of data on subsequent lines makes movement appear to merge on a CRT, reducing the perception of flicker, I reached the conclusions that

1. The CRT beam writes to pixels adjacent to those addressed.

2. At least one of these adjacent pixels is an addressed pixel when the data is updated.
3. This overlapping action merges the signals and provides a smooth spatial transition,
 - Lowering the flicker perception (good),
 - Lowering the target-detection capability (bad).
4. The LCD writes to only the addressed pixels.
5. This lack of overlapping causes a discontinuity when the adjacent pixels are addressed.
 - Flicker (waterfall) becomes apparent (bad).
 - Target-identification is enhanced (good).

I have been testing techniques, combinations of software and hardware, to make the LCD emulate the performance of a CRT. One of these techniques smoothes the motion within the image and eliminates the low-frequency flicker caused by the slow movement of high-contrast images across the screen. This solution will minimize the waterfall problem and eliminate the effect when the data change is within one pixel in any direction (as is the usual case with waterfall).

My techniques, when adapted to a high-resolution LCD, provide more flicker reduction than the CRT and maintain the LCD's high accuracy for target identification. These circuits can be external to the monitor and will drive any LCD to emulate a CRT. The results are reduced fatigue due to flicker and improved target identification due to the LCD.

– *Don Hill*
Consultant
Fullerton, CA
don-hill@pacbell.net

Don Hill has over 30 years of experience in designing circuits and managing systems for high-resolution calligraphic and raster CRT- and LCD-monitor systems. – Ed.

DVI Standards

The article [*ID*, January 2000, pp. 18–21 – *Ed.*] on the progress of digital video interface standards bothered me because I think the time for dedicated interfaces for displays is coming to an end. If the display community does not start working with the groups that

are working on standards such as FireWire and USB, these interfaces will not be designed with displays in mind, and display manufacturers will have to live with the standard.

There are a number of reasons I think that video will need to make use of standard interfaces.

- Laptop computers are being made smaller, lighter, and cheaper. There is also a concern about power, and another interface will require more power. The design requires a trade-off of features. Analog video ports are not on quite a few of them.
- There are already a few stripped-down desktop PCs that only have a minimum of interfaces – usually a video port and several USB ports. Keeping the number and types of ports down decreases cost.
- Having keyboard and mouse ports on the display is becoming more common. This will require at least two cables if a dedicated video port is used.
- If one of the standardized interfaces is used, there will be less of a problem supporting multiple displays off a single computer. This could be particularly beneficial when one wants both a projection display and a CRT for monitoring.

We are already seeing displays with USB support. If video standards for these digital interfaces can be created, then there will be fewer configuration problems, and performance can be optimized through various software tricks to reduce bandwidth.

Obviously, there are costs in supporting these standard interfaces. One of them is the cost of the monitor, since it will now have to have more memory. In time, this concern should be less, with the cost of memory coming down so quickly. Second is performance. This is why the display manufacturers need to get involved with the standards groups for these interfaces.

– *Clifford Nelson*

Components Time Bomb

I am an electronics engineer designing digital avionics circuits. The “Display Continuum” [p. 4, January 2000] relates to me differently in a scary way. Modern digital circuitry uses programmable devices to define and control the functionality and personality of the entire system. The most basic of these is read-only

memory (ROM). The original and best of these was mask programmed at the foundry and had a retention so long that it was not mentioned. Over the years, we have seen PROM, UVEPROM, EEPROM, fusible-link PROMs, and FLASH. The data capacity has risen from 256 bytes to 4 Mbytes. Each of these has been easier to use than the last. You could program one in your own company! You could erase them and re-use them! The first ones needed several power supplies. Now, they need only 3.3 V. But, what has happened to the data retention? Good news for our frequent fliers: They forget in ten years. ... What?

I am putting a time bomb into an aircraft. Technology seems to leave no choice. The old parts are obsolete. The new parts are like the color photo film in your column: they are given 125 msec to record a huge amount of data and are expected to remember it for 2,522,880,000 times that length of time!? Next time you are on a plane, think about the high-tech electronics that are taking care of you up in front. They have an expected expiration date coming up. Soon.

— Gareth D.

P.S. I don't want to frighten people too badly. Early expiration dates certainly don't apply to all, or even most, components. The fact is that we kick vendors out the door who push short-lived components. We will not use 10-year parts. In one of my recent designs, the devices had a 100-year guaranteed data retention and an actual expected retention of 400 years. I was happy with that design.

Archiving: Media vs. Format

I was munching on lunch and reading Aris Silzar's column on archival storage in the January issue of *Information Display*. I have been giving a lot of thought to the issues raised in your piece and I'd like to make some comments.

When we talk about "media" and imaging in the same sentence, I believe that we tend to focus (pardon the pun) on the wrong issues. When I think back to all the Viking images that were lost because the tape drives no longer exist to recover the data, I get sick. The key to archiving images lies not in the media, but in the format and discipline to back up data and formatting information. Even if we could read the Viking tapes today, we still

couldn't get to the image data because the formatting for the data is lost as well. That is why JPEG and MPEG are so important. The delivery media can change but the digital formatting must be public and secure.

It is my belief that as bandwidth grows and our reliance on the Internet becomes more apparent, the need for consistent data storage formats will eclipse the limitations of media life. In the photo world, we have always

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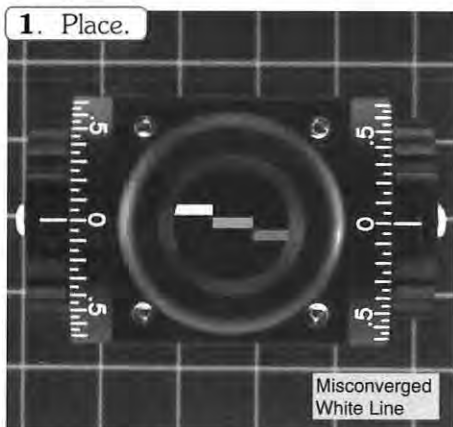
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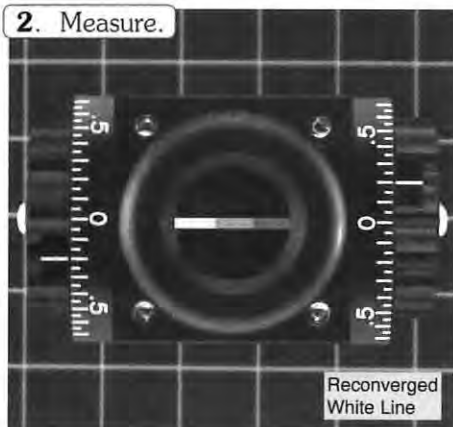
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letters

hunted for the holy grail of achivalness and we have yet to find it. The key to the solution of the problem is to carry the database across formats. This will happen as the Net becomes an extension of our day-to-day lives. As more aspects of our lives revolve around Net-based activities, the implicit archiving of our data at the Internet provider becomes a bigger issue. If lots of storage is available, why not store all my pictures, all my records, all my life details at some virtual site that routinely backs it up using the latest techniques and media. Isn't that where we are heading?

I would feel comfortable with the storage of all my data by my provider so long as I had exclusive control of its dissemination. I believe that the media issue surrounding imaging goes away when we solve the ethical issues of how to store and retrieve any information.

Great column.

— Tom Lianza
Technical Director
Sequel Imaging, Inc.
25 Nashua Rd.
Londonderry, NH 03053

Developing Archival Standards

Aris Silzar's recent column discussion [*ID*, January 2000, p. 4—*Ed.*] on the subject of audio-visual content preservation reached me as I am involved in serious efforts to get standards that assure content longevity for digital television assets. Some years ago, during my work in a Canadian Taskforce on the Preservation and Enhanced Access to Our Heritage of Audio-Visual Works, we realized that very little attention had been paid by busy engineers to the problems of rapid recording-technology "refreshment" that causes archival collections to become almost instantly obsolescent. So I was elected as chair of the Society of Motion Picture and Television Engineers WG on Television Archiving. This work was discovered by the European Broadcasting Commission and we now cooperate in developing professional user requirements with the television archivists of some 50 member countries. We realized that we needed to give a voice to archivists, who are transitioning from being "chief keepers of the cemeteries" of audio-visual works to "digital-asset managers" of audio-visual works. So I was elected to chair the Association of Moving Image Archivists (AMIA) Preservation Committee. We are now busy defining Guiding Principles.

The evolution of technology options in the marketplace has become extremely complex to manage from an asset-management perspective. In a way, display manufacturers and archivists are both kind of at the end of the line, on the receiving end of the user significant content, but the manner in which it reaches us is often no credit to the money invested in producing the content in the first place. This makes us allies.

I have enjoyed for many years reading *Information Display* and the *Journal of the Society for Information Display* as a subscriber. I enjoy keeping apprised of the progress in this important industry.

— Ed H. Zwaneveld
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Eurodisplay in Berlin

I really enjoyed your article about the Berlin trade show, especially the photos of the various sights. Such an article reminds me of the German math textbooks: each new chapter has a little historical summary of who invented that type of calculus, algebra, etc., to let the student know that what he was going to learn did not spring fully formed out of the earth, but has a past and was the result of having problems to solve.

The shot of the restored Reichstag reminded me of how it looked when I first remember seeing it, in 1956, when it was black with soot, and there was not a square meter on the facade that was not pocked with bullet holes, artillery craters, or shrapnel scars. The inside was a total wreck, and the grounds were littered with rubble. Walking around, as an impressionable kid, I felt as if WWII had just ended a few minutes earlier.

— Tom Holzel
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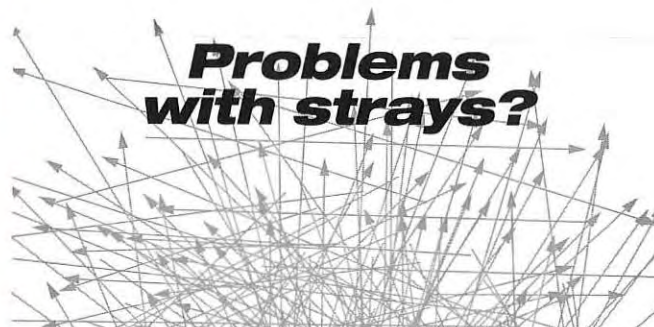
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editorial

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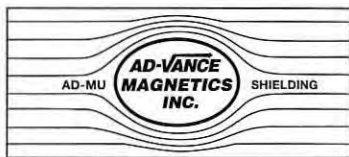
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