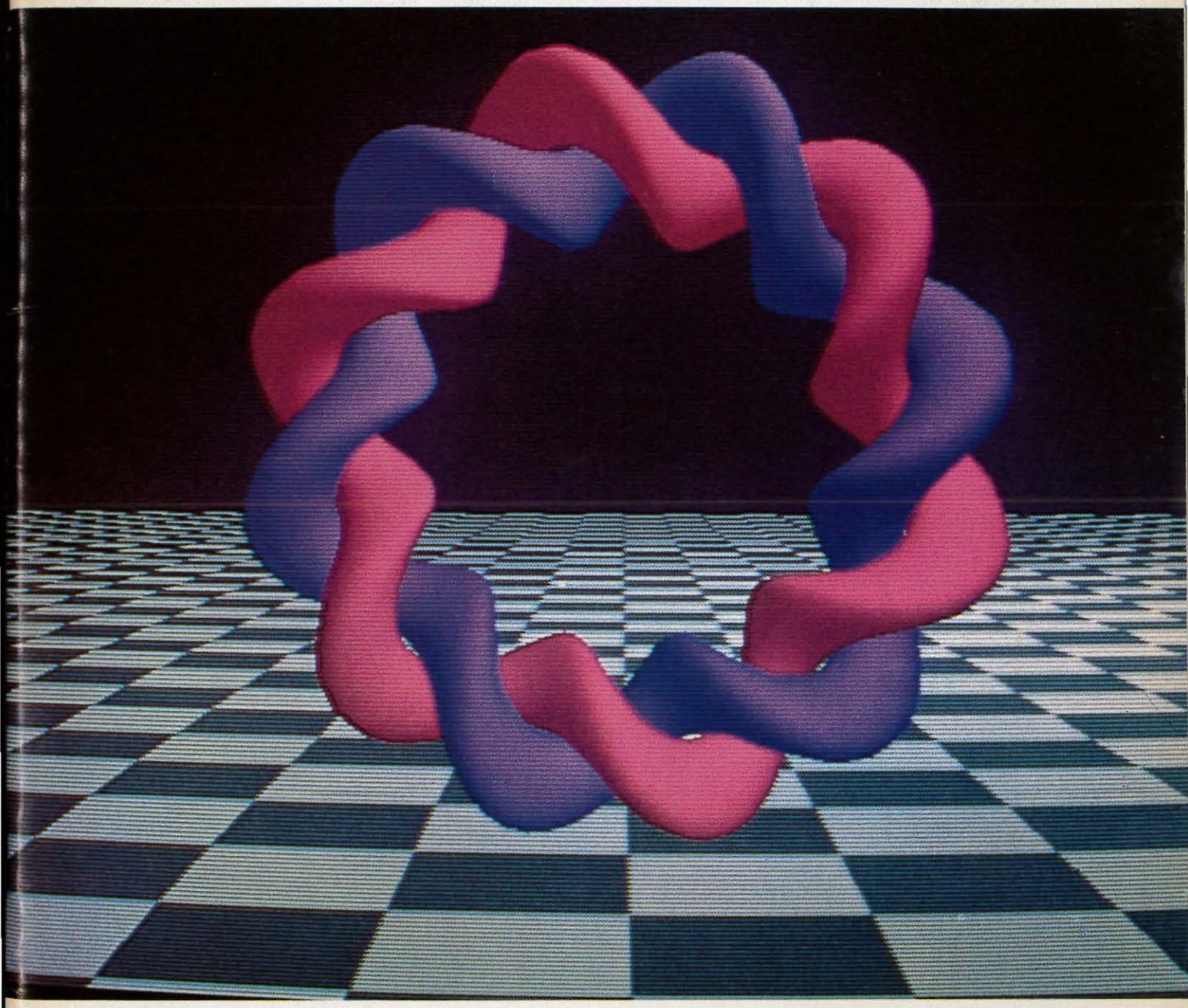
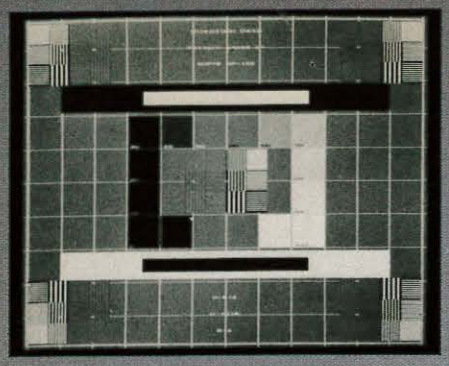
Official Monthly Publication of the Society for Information Display

INFORMATION DISPLAY

September 1987
Vol. 3, No. 8

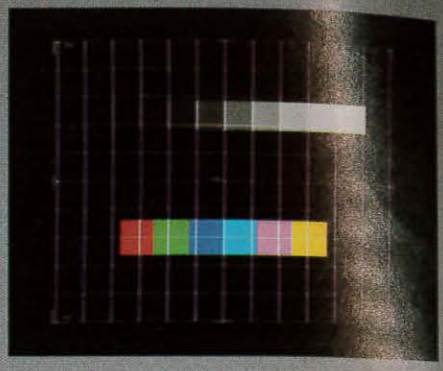


3D hard copy
Miniature CRTs
1987 award winners
Industry directory

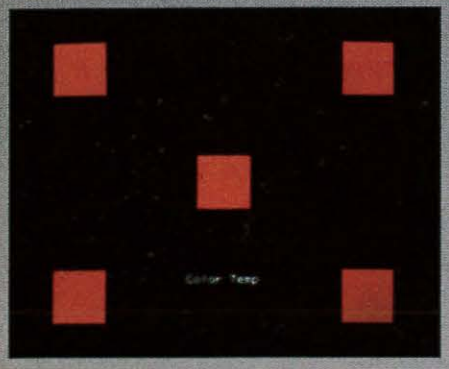


SMPTE RP-133

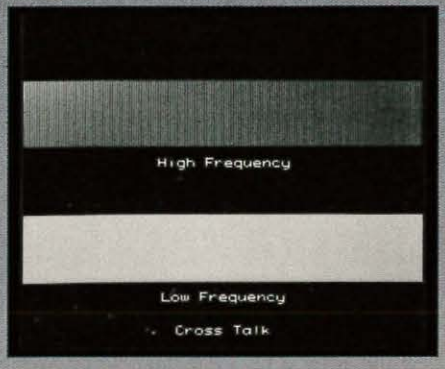
Color Bars



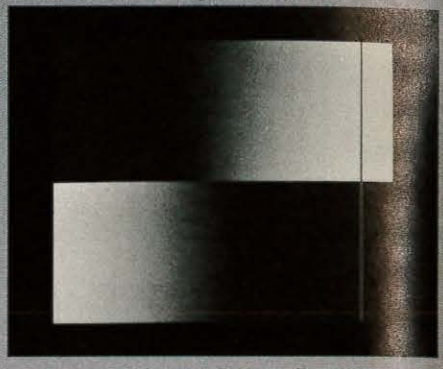
Signal Setup



Color Temperature

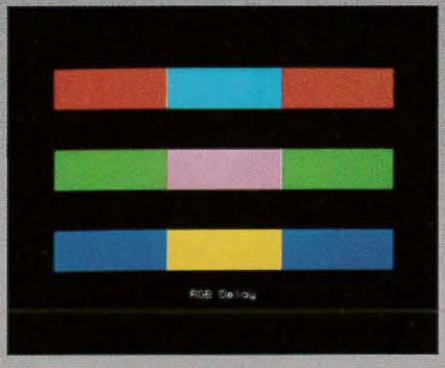


Cross Talk

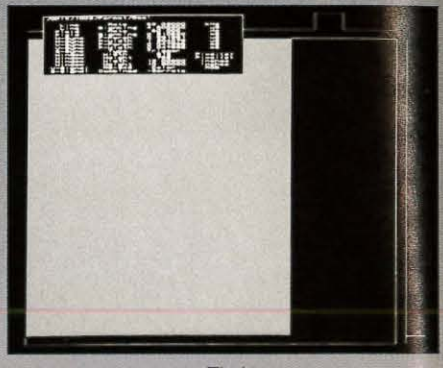


256 Level Gamma Pattern

Text with Circle

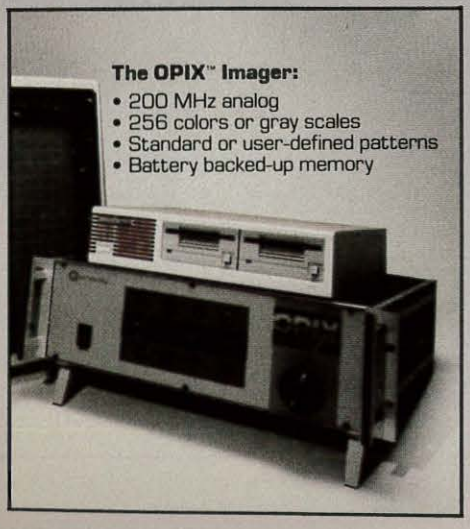


RGB Delay



Timing

THESE PROBLEM SOLVING PATTERNS ARE YOURS AT THE TOUCH OF A BUTTON.



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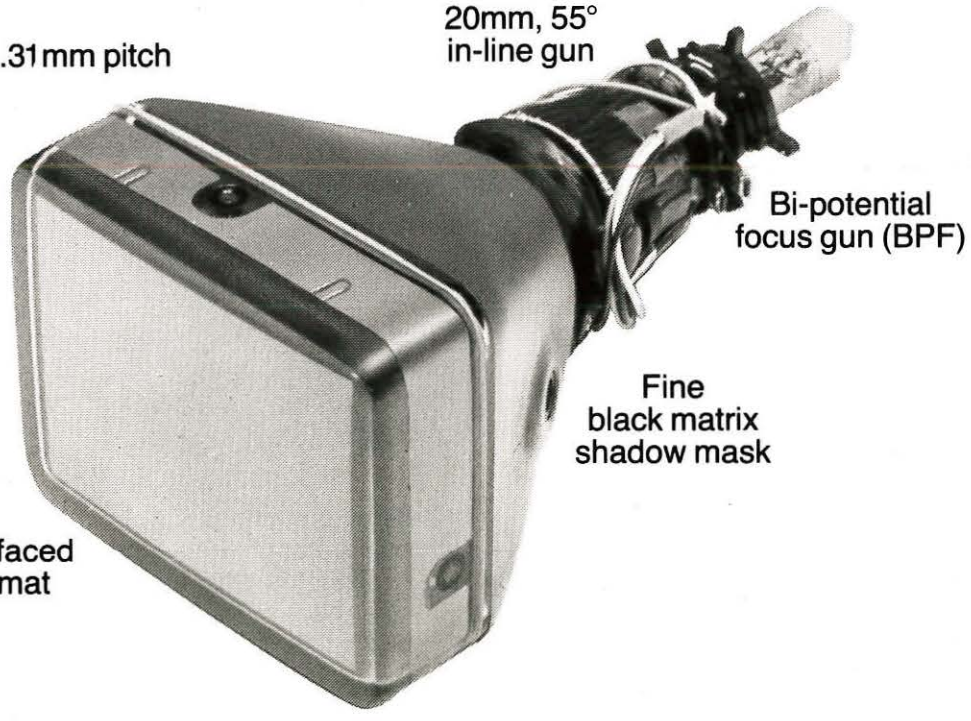

When a portable, high resolution compact color display is required to clearly read information, these small tubes clearly offer brilliant advantages.

From Panasonic...the Image Makers. For more information, contact: Panasonic Industrial Company, Computer Components Division, One Panasonic Way, Secaucus, NJ 07094. Mail Stop 4B5. (201) 348-5278.

Panasonic
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Circle no. 2

Not all CRTs are created equal.

Equality is an appealing concept.
But not in CRTs.

Because in certain demanding applications, most notably in photo-recording, an ordinary CRT often will not be able to meet the required specifications.

That's when you'll want the enhanced performance of a Litton tube. And the freedom it gives you from typical CRT problems.

Freedom from blemishes. In medical imagery, a blemish or false shadow can be a life or death matter. To produce the most blemish-free screens available, we do all fabrication in a total clean room environment using exclusive phosphor deposition techniques.

Freedom from uneven color distribution. In color recording and film scanning, evenness of color is crucial. Litton is the only CRT manufacturer to develop a homogeneous, broad-band phosphor mix. This creates an absolutely even, full-color image without color hot spots.

Freedom from poor resolution. In typesetting, equipment has been built that can project an entire magazine page from a 7-inch tube onto a magazine-sized piece of film with razor sharp resolution. That's because our monochrome screens are finer grained than the typical CRT... and because we offer the smallest spot size available.

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Our full line of recording CRTs ranges from a palm-sized 1-inch tube to a full 14 inches and more. We can also design a CRT to your particular application.

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And it explains why so many builders of high-performance systems carry the torch for Litton CRTs.

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Litton

Electron Devices

Circle no. 3

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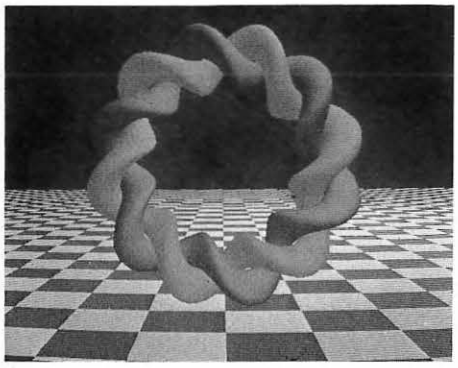
INFORMATION DISPLAY

SEPTEMBER 1987
VOL. 3, NO. 8

Cover: Left-eye perspective view of a twisted torus, half of a stereo pair viewable in 3D by the naked eye. Computer graphics and photography by Louis Harrison. (page 12)



Next Month in Information Display

- Holographic hard copy
- Dedicated graphics processors

Large-screen fiber-optic system installed at Vegas airport

Advance Display Technologies, Inc., Golden, CO, has completed a $960,000 agreement with Videoview Airport Advertising, Inc., to install three of its 6 x 8-ft. FiberVision display screens and three full-color video laser projectors at McCarran International Airport, Las Vegas, NV. The FiberVision system, invented and manufactured by Advance Display, uses a fiber-optic screen and laser projector. Any type of still or moving picture or text can be projected.

Earlier this year, Advance Display reached a $5.1 million licensing agreement, stock purchase, and product sale with Mitsubishi Rayon Co., Tokyo, Japan, to manufacture and market the FiberVision display board in Japan. The sale to Videoview represents the first commercial application of the system.

Riverfront Stadium installs giant screen

Riverfront Stadium, Cincinnatti, OH, unveiled Sony's Jumbotron video screen on May 24, the 52nd anniversary of major league baseball's first night game. The 24 x 32-ft. screen is a version of the world's largest video screen (82 x 131 ft.) exhibited at the 1985 Japan Expo. The Jumbotron is part of a $5 million overhaul of the stadium's scoring and storage facilities, which includes three new matrix-type conventional scoreboards and a remodeled plaza message board outside the stadium. The screen's image sharpness and brightness come from more than 100,000 Sony Trini-Lite high-luminance high-efficiency light-emitting cells.

Laser portraiture

Lumonics, Inc., U.K., has loaned a pulsed laser from its JK Lasers Division to the Museum of Holography, New York, NY. The laser produces the clearest, brightest holographic portraits available. The Museum's "Holo-Fame" exhibits holographic portraits of celebrities ranging from Wall Street's Malcom Forbes to Sesame Street's Big Bird, and includes two new portraits—musician David Byrne of the Talking Heads and artist Keith Haring. Until October 16, anyone can be a holographic celebrity for only $1500, a portion of which is a tax-deductible donation to the museum. The 12 x 16 in. framed portrait is ready within ten days, and the sitting takes only 45 minutes. For further information contact Patrick Sadowski at the Museum of Holography at 212/925-0581.

Multi-national company will make color LCDs

Thomson-CSF, France, General Electric Co., and VDO Luftfahrtgerate Werk Adolf Schindling GmbH, West Germany, have signed an agreement to develop and manufacture LCDs, particularly flat-panel and active-matrix full-color LCDs. Thomson-CSF and VDO Luftfahrt will form a joint subsidiary, Eurodisplay, which will benefit from the technologies developed by General Electric in the U.S. Eurodisplay will enable the three companies to pool their R&D efforts to develop new products for volume production as well as special-purpose devices.

People

Norman Rhodes has been named vice president of engineering and consulting by **Concentration, Heat and Movement (CHAM)**, Huntsville, AL.

John V. Giordano has been appointed corporate controller of **Diagnostic/Retrieval Systems, Inc.**, Oakland, NJ.

DocuPro, Inc., Mountain View, CA, has appointed **Austin F. Ford, Jr.**, director of corporate communications.

Hyundai Electronics America, Santa Clara, CA, has appointed **Carmen T. Reitano** vice president and general manager of its newly formed Information Systems Division.

Alex MacDonald has been promoted to vice president and controller of **Interstate Electronics Corp.**, Anaheim, CA.

Joseph Wielock has been appointed national sales manager for the Still Image Systems Group, New Business Division, **Sony Information Systems Co.**, Park Ridge, NJ.

Dennis K. Medler has been appointed vice president of sales and marketing for **3d Systems, Inc.**, Sylmar, CA.

Isaac R. Barpal has been appointed general manager, research and development, of the **Westinghouse Electric Corp.**, Pittsburgh, PA.

Concept Development. Inc. (CDI) of Costa Mesa, CA, has named **David J. Herby** as general manager.

In memoriam

With deepest sorrow, Lucitron inc, Northbrook, IL, announces the death of its co-founder and vice chairman Joseph Markin on June 9 after a long illness. After working on flat television display devices at Zenith Radio Corp. for 13 years, he co-founded Lucitron to pursue gas-electron-phosphor technology. Mr. Markin specialized in television technology and in military electronics, and also taught at the Illinois Institute of Technology and the University of California at Santa Barbara. He was also an accomplished pianist and teacher of piano for some 50 years, and a judge at Chicago's Science Fairs for 14 years.

Joseph Markin was educated at the Illinois Institute of Technology and the University of Chicago. He published papers on microwaves, cable and subscription TV, and electronic displays, and was awarded six patents. He was a senior member of the IEEE, a member and director of the SID and Sigma Xi, and a registered professional engineer in Illinois. Mr. Markin was a program committee member for the annual SID International Symposium for many years, served as General Chairman in 1975, and was a SID outstanding service award recipient.

Mr. Markin is survived by his wife Jean, three daughters, two granddaughters, and two sisters. He will be greatly missed by his family, friends, and colleagues.

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INFORMATION DISPLAY

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editorial

Our "Directory of the Display Industry" in this month's issue of *Information Display* is, insofar as we know, the first of its kind attempted, and we feel that it will prove to be of real reference value. Creating such a directory "from scratch" has been an interesting experience, as they say. Howard Funk volunteered to get us started by dipping once again into his data bases to give us a printout listing of all U.S. firms engaged in information display. It soon became obvious that limitations would have to be made. Even confining it to firms employing over 100 people with sales over $10 million resulted in a 1.5-in.-thick printout, with hair-splitting categories only a bureaucrat could love. But it was an excellent start. By combining our own lists with selections from Howard's printout, we were able to send out questionnaires to over 1,000 firms.

And now for the directory itself. Part I consists of product categories. Companies are listed alphabetically by name only under as many categories as applicable. Part II is a single alphabetical listing of all companies, giving addresses, telephone numbers, sales contacts, and a brief description of each company's product line. You will notice that certain companies have been listed in boldface type. These are the companies that have placed advertisements in this month's issue, because we wanted to have some distinctive way of recognizing their support for our Society and its journal (that we would be doing so was pointed out in the cover letter sent with each questionnaire, of course.) Because this directory is the first of its kind we can indulge in a bit of hyperbole and state that it is the most comprehensive ever. We feel confident that you, our readers, will refer to the directory on numerous occasions in the coming year. Obviously, though, we welcome your comments, so that next year we can announce how updated and improved our second directory is. We feel confident, too, that our current advertisers, an important component in the kind of *ID* we are trying to provide, will be joined by others who recognize the value of this endeavor.

Our feature article this month is on hard-copy 3D printing technologies. Larry Hodges, Shaun Love, and David McAllister have provided a comprehensive overview, following up on their article in the May issue of *ID*. Because of the size of the Directory, we are running the non-holographic half this month; holography will appear in October's issue.

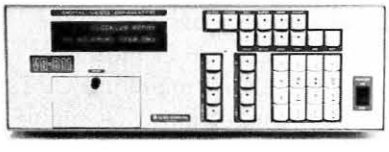
In the April issue of *ID,* Jim Wurtz gave "A Fond Farewell to the Display Industry." Obviously, this farewell did not mean goodbye forever, as his article on applications of miniature CRTs illustrates. Although he outlines the history and current uses of miniature CRTs, he also gives intriguing and far-reaching future applications that should give many of you much to think about.

INTERESTED IN A VIDEO GENERATOR?

Take This "Test" To Make A Better Buying Decision.

	YES	NO
1. *Do you want to display at least 100 levels of gray scales simultaneously at the top speed of your video generator?*	☐	☐
2. *Do you want to display the seven color bars simultaneously at the top speed of your video generator?*	☐	☐
3. *Do you want to set the analog level of your video output to +/— 50% of .7V into 75Ω?*	☐	☐
4. *Do you need horizontal/vertical timing setting accurate enough to give you what you select — not just a "goal"?*	☐	☐
5. *Do you need completely independent dot-clock control?*	☐	☐
6. *Do you want to edit & store up to 100 programs and setups from the front panel of your video generator without an external disk drive?*	☐	☐
7. *Do you want individual pixel-by-pixel control for patterns from the front panel?*	☐	☐
8. *Do you want to use your PC to control the video generator, design your own test routines and store it all on a floppy disk?*	☐	☐

...and if your answers are predominantly "Yes" one of the following Video Generators is the right choice:

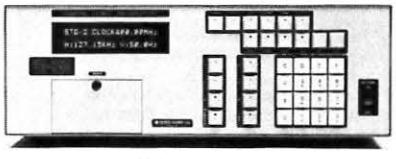


120 MHz

ASTRO VG-811

200 MHz

ASTRO VG-809S



400 MHz

ASTRO VG-850

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TEAM systems

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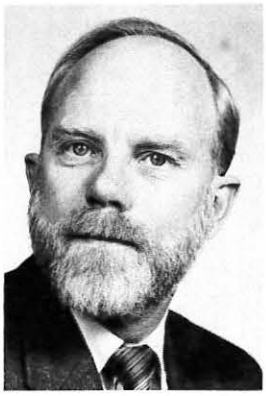
president's message



Most recently, I have used this column for a number of personal observations and comments. It would seem appropriate, therefore, for the sake of balance, to devote this month's column more to Society news and issues.

SID '87 in New Orleans has now become part of history. The attendance of 866 missed the record of SID '86 in San Diego by a fair amount, but Seminar attendance was excellent and the exhibits topped the 100-booth mark for the first time ever. Thus, SID '87 was definitely a success, but it raised again two difficult questions for Tom Credelle's Symposium committee: "How important is site selection to Symposium attendance?" and "How important is the local concentration/presence of display activity and SID members?" We discussed these issues at length, also with a number of our most loyal exhibitors, and Tom Credelle has appointed one of their representatives to his committee to help in the future site selections. As usual, your ideas and opinions, or criticisms, are most welcome.

Yet another important meeting is planned for next spring, the 57th annual meeting of the Inter-Society Color Council (ISCC) to which SID belongs. SID and ISCC are jointly sponsoring this meeting (May 8–10, 1988, in Baltimore, Maryland) just prior to the SID '88 Symposium (May 23–27 in Anaheim, California). The focus of the meeting will be the accurate transfer of colors from computer graphics and video presentations to hard copy, and vice versa. Larry Tannas, SID Vice President, is also Program Chairman of this meeting; a Call for Papers has just been prepared and Larry is eagerly looking forward to receiving a large number of abstracts.

A difficult decision reached by the Board of Directors at its last meeting was prompted by the realization that the mailing costs for our publications to members outside the North American continent are close to our present membership dues. After extensive deliberation and consultation with our overseas colleagues we decided to charge overseas members a mailing surcharge next year as is, in fact, quite common for most other technical societies. I would like to emphasize that we reached this decision reluctantly and that we are working with the overseas chapters to find ways to minimize the effects of this surcharge. Here again we welcome your comments.

Sincerely,

TE

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THE BEAM INDEX CRT IS MORE THAN AN ALTERNATIVE TO THE SHADOW MASK COLOR TUBE. IT HAS...

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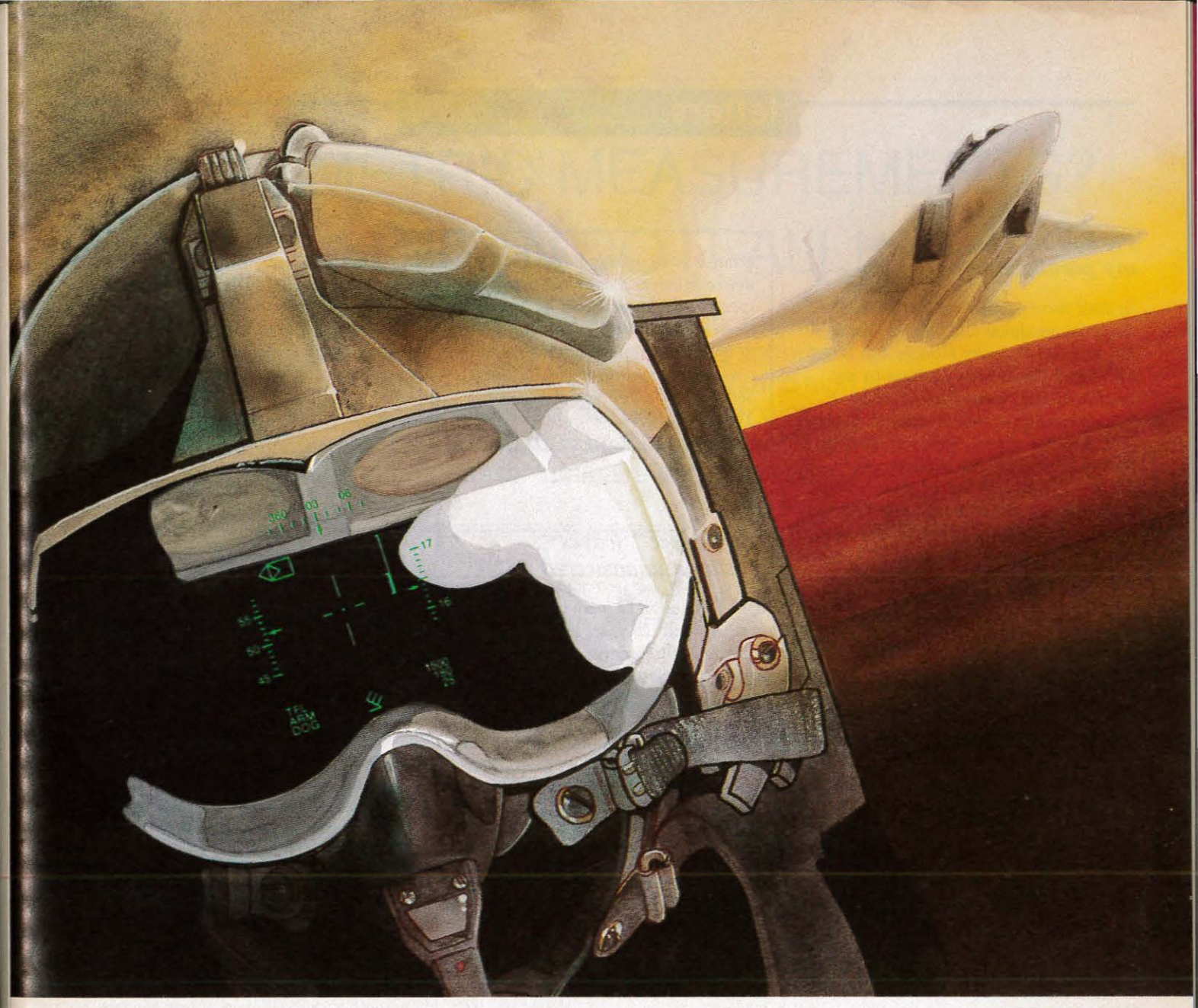

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Hughes special-purpose CRTs range in size from one-half-inch diameter to thirteen inch diagonals. They serve avionics, ground vehicles, manportable displays, helmet-mounted displays and high-performance commercial applications such as phototypesetting and medical research.

Model 1401, actual size.

Hughes has one of the world's finest engineering and technical facilities devoted to CRT production. High manufacturing and testing standards result in the production of tubes of consistent performance, outstanding brightness and resolution factors, low power consumption and high reliability.

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HUGHES
AIRCRAFT COMPANY

Circle no. 6

letters

Pardon me, but isn't that my parallactiscope?

In their survey article on 3-D ("True Three-Dimensional CRT-Based Displays," *ID*, May 1987), Larry Hodges and David McAllister give a brief mention to my parallactiscope, referring to it as an "autostereoscopic time-interlaced display" (Fig. 8 in the article). However, they erroneously attribute its development to SOCS Management Co. (Lowell Noble). Although Lowell has done some fine work—such as projecting the image so that it "appears to float in space"—the use of a moving slit must not be attributed to him.

The fact is, Lowell purchased a parallactiscope from me to use in some of his experiments!

The authors' description of parallactiscope operation is not quite accurate. My new book, *The 3-D Oscilloscope*, just published by Prentice-Hall, has a detailed description of the parallactiscope and a complete history of 3-D.

—Homer B. Tilton
Tucson, Arizona

The authors reply—

We are aware that the parallactiscope was developed by Mr. Tilton and apologize if our article seemed to attribute the origin of this idea to Mr. Noble. SOCS Research has built a display system which uses an electro-optical moving slit. This display has been demonstrated at SIGGRAPH '85 and at SPIE's O/E LASE Symposium in 1986 and 1987.

It was not our intent to present a complete history of 3D display or to describe all viable technology implementations. Our goal was to present an overview of non-holographic true 3D display techniques of current interest and give examples of their implementations. We apologize to Mr. Tilton if our article upset him.

—Larry F. Hodges and
David F. McAllister
North Carolina State University
Raleigh, North Carolina

What is your opinion? ID's editors welcome letters from readers on specific articles or topics of general interest to the display community. Write to the Editor, Information Display, c/o Palisades Institute for Research Services, Inc., 201 Varick St., New York, NY 10014.

"Puff-piece" leaves questions unanswered

Marv Hodges and I were in business together about 20 years ago and, as a small-time entrepreneur myself, I appreciate first-hand the trials and tribulations of bringing a unique product to market.

So it troubles me all the more to complain about Ted Lucas' article on Marv's new video projector ("Improved Single-Lens Projection TV System," *ID*, June 1987). As a *scientific* journal, mention—and comparison—should have been made of the well-known (and of similar design) Electrohome three-gun one-lens projector. Surely such a comparison would have been scientifically useful to help elucidate what advantage the curved faceplate and full liquid immersion of dichroics provides compared to the otherwise similar Electrohome design. As it was, no useful claim was made for choosing this different CRT design.

The full liquid fish tank is said to eliminate an air-to-glass surface. But conventional projection CRTs are decoupled from the glass-to-air interface by multicoating their external surface, or by liquid coupling of the lenses to the CRT. Elimination of shadow masks is an odd "advantage" to tout. Shadow masks are found in no three-gun projector on the market, and never have been. So what advantages does Marv's projector offer? One obvious disadvantage not mentioned in the article is that the electron beam incidence is at an acutely sharper angle in the corners of Marv's CRT than on flat-faced CRTs, so one should expect greater spot aberration. How does Marv handle that very real problem?

Yes, small entrepreneurs have a tough time of it; and yes, American industrial ingenuity is being suffocated by the quarterly bottom-liners. Those real issues do not excuse such a deliberate puff-piece posing as a technical article in our prestigous journal.

—Tom Holzel, President
Arcturus, Inc.
Acton, Massachusetts

Editor's Note: We regret having omitted a comparison of the Triuniplex system to other similar projection devices, which we agree would have enhanced the usefulness of the article. We have asked Marv Hodges to respond to the technical questions raised by Mr. Holzel.

This letter is a response to Tom Holzel's letter to you criticizing the June report on our patented inventions "posing as a technical article." Tom identifies five areas of confusion and/or lack of comprehension: (1) wanted a comparison of our system vs. the Electrohome product because of "similar design"; (2) saw "no useful claim" for our new CRT design; (3) commingled anti-reflection, coupling, immersion, and "fish tank"; (4) stated that a direct-view, full-color image without a shadow mask "is an odd advantage to tout"; and (5) stated that any curved faceplate has a greater beam incidence than any flat faceplate, without any knowledge of deflection angles.

(1) The Electrohome projectors are not single-lens systems, but three-lens designs sharing a common exit element: three separate projection lenses are positioned before the dichroics, and the common exit element comes after (used for corner focus, not magnification); they can be focused down to a 5-ft. image by compressing the sweep and enlarged to a 14-ft. image by expanding them, and nothing beyond these limits. Our design is infinitely variable from 1 ft. to infinity because the magnification optics are outside and are boresighted to the combined color images (like film projectors). TDS generates 1000 lum of peak brightness at

continued on page 56

PHOTOMETRIC MEASUREMENTS? LMT CAN DO IT ALL!

- Battery powered illuminance meters and spot photometers.
- Laboratory grade photometers and integrating spheres.
- Colorimeters with high accuracy (±0.0005 x,y) and high speed.
- Retro-reflectance meters that also measure color.
- Photometer heads with mosaic filters with accuracy of < 1%
- Goniophotometers for luminaire and automotive measurements

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It all started with the fabrication of mosaic filters for correcting detector response to the photopic curve. From the start, this filter type has been reputed to yield the worlds best photopic fit. It just seemed natural to follow on with optics and electronics that match the high quality of the photopic filter. And, as people asked for different things, one thing led to another. Before we knew it, a whole product line dedicated to quality photometric instruments had evolved!

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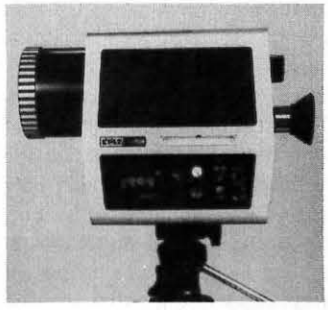

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Hard copy for true three-dimensional images

BY LARRY F. HODGES, SHAUN LOVE, AND DAVID F. MCALLISTER

In an earlier article [*ID*, May 1987], we surveyed current technologies for true three-dimensional (3D) CRT-based display systems. In that article we identified four basic approaches to producing a display system for interactive manipulation of 3D images: multiplanar displays, alternating pair displays, time-parallel stereo pair displays, and time-multiplexed stereo pair displays. *Multiplanar* displays create a 3D image by presenting, in rapid succession, a series of two-dimensional (2D) slices of an object. The slices are optically or physically positioned in space so that a 3D image is perceived by the observer. *Alternating pair* displays create a depth effect by alternating between two perspective views of an object which differ by a vertical rotation of approximately 1 to 2°. *Time-parallel stereo pair* displays present left- and right-eye perspective views simultaneously on a single CRT screen or on separate screens. The correct view is delivered to each eye using special viewing hardware such as polarized glasses, colored glasses, or projecting lenses. *Time-multiplexed stereo pair* systems include both those that switch rapidly between right- and left-eye views of an image, using an electro-optical shutter or moving slit system to deliver the proper view to each eye; and systems that scan horizontal parallax information across a CRT screen while using a moving slit to direct the proper view to each eye. Moving slit systems have recently been described in a new book (Prentice-Hall, 1987) by Homer B. Tilton entitled, *The 3-D Oscilloscope: A Practical Manual and Guide.*

In this article we treat the problem of producing hard-copy representations of computer-generated 3D images for archiving, dissemination, and presentation. We should first note that images that have been generated digitally may require large amounts of memory. For example, to store a single bit-mapped stereo pair that has been produced on a graphics frame buffer with 1024 by 1024 resolution using true color (24 bits/pixel) would require 6 Mbytes of memory, assuming no data compression. A 30-sec animation consisting of 30 stereo pairs/sec would require over 5 Gbytes of storage. There are more efficient techniques for archiving and disseminating computer-generated 3D images. We now examine some alternative techniques for hard-copy representation of such 3D images.

We begin by surveying the possible approaches to producing 3D hard copy. We have divided the general techniques into several categories [Fig. 1]. All the currently useful methods for digital images, including holography, make use of stereo pairs or slices. At the highest level, these techniques may be divided between unaided viewing, or autostereoscopic techniques, and aided viewing, in which some type of viewing apparatus is needed to deliver the correct image to an observer. Autostereoscopic techniques may be further divided into holographic and non-

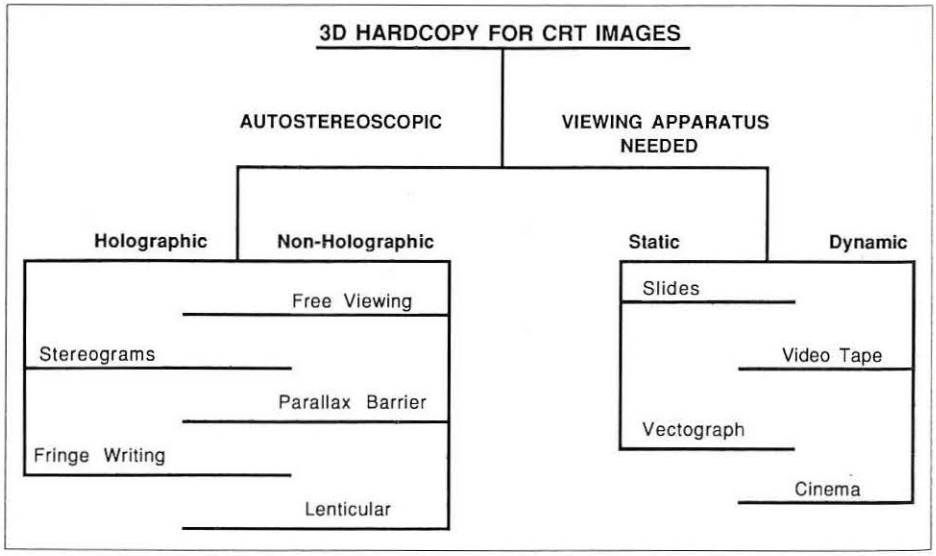

Fig. 1: Techniques for 3D hard copy.

Larry F. Hodges *and* ***Shaun Love*** *are visiting instructors and* ***David F. McAllister*** *is a professor in the Department of Computer Science at North Carolina State University, Raleigh, North Carolina.*

holographic categories. Holography will be covered in a separate article next month. Techniques that require viewing apparatus are divided into static versus dynamic images. Dynamic images allow the introduction of movement into the 3D display.

Free viewing

Perhaps the simplest representation of a 3D image based on stereo pairs is the presentation of the pair side by side. The pair can be created on a graphics printer or plotter, or printed from film. The stereo pair can be viewed without optical aids using a technique called *free viewing*. (This technique is used by stereo photographers when registering transparencies.) There are two different methods of free viewing: parallel viewing and cross-eyed or transverse viewing. With parallel viewing the observer looks at the right perspective view with his right eye and the left perspective view with his left eye [Fig. 2a]. The 3D image appears to be in between the two perspective images. Because it is difficult for most persons to look walleyed (i.e., diverge their lines of view, Fig. 2b), corresponding points in the left- and right-eye perspective views should not be separated by more than the average horizontal distance between the eyes: approximately 2.5 in. This requirement limits the size of the stereo pair.

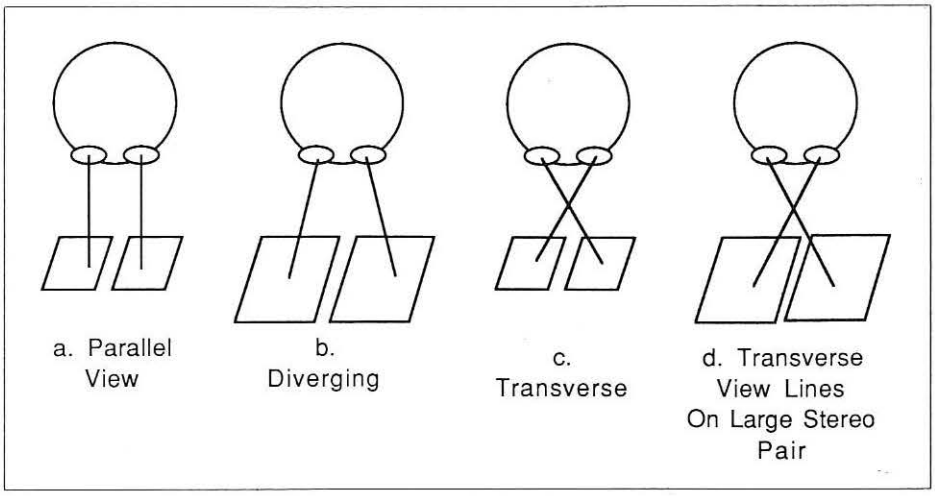

Fig. 2: Methods for free-viewing stereo pairs.

With transverse or cross-eyed viewing, the positions of the left- and right-eye perspective views are reversed, so that the left eye focuses on the perspective on the right and the right eye focuses on the perspective view on the left [Fig. 2c]. This method is usually easier for most people to learn and can be used to view stereo pairs whose perspective views are much larger than 2.5 in. [Fig. 2d].

Figure 3 illustrates both a parallel-view stereo pair and a tranverse-view stereo pair of a twisted torus. The three perspective views are: a left-eye perspective view, a right-view perspective view, and another left-eye perspective view. To see the corresponding 3D images using parallel or transverse viewing, follow the instructions in the figure caption.

Readers can obtain numerous examples of the side-by-side stereo presentation technique from books of stereo pairs such as *Photographing in 3-D* by Burder and Whitehouse or *The World of Stereograms* by Darrah, both of which are available from Reel 3-D Enterprises, Duarte, California.

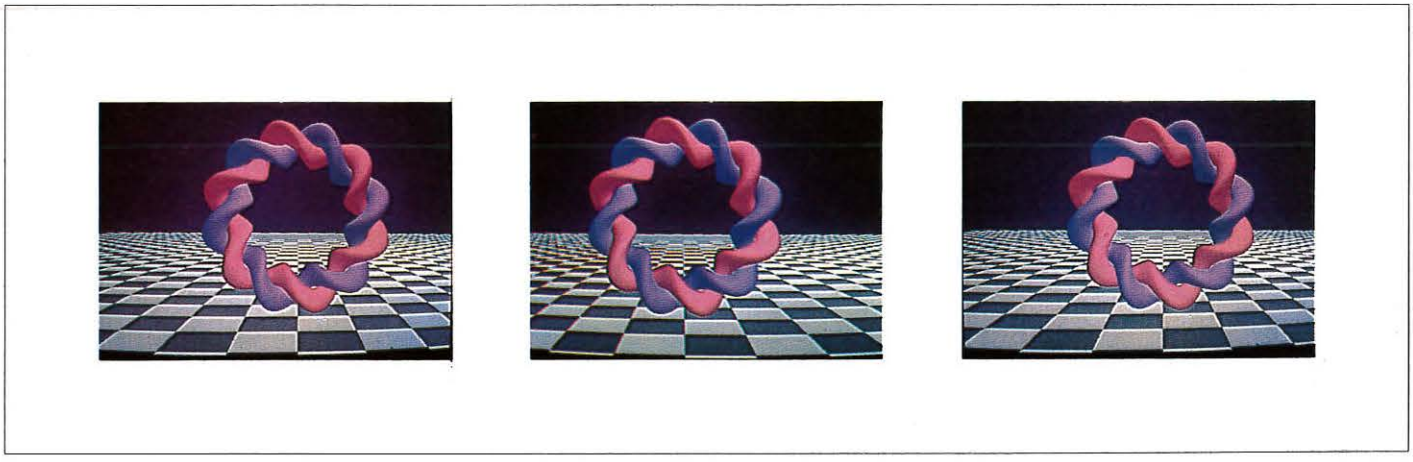

Fig. 3: Exercise in 3D viewing. Both a parallel-view stereo pair and a transverse-view stereo pair of a twisted torus are illustrated. The three perspective views are: a left-eye perspective view, a right-eye perspective view, and another left-eye perspective view. To see the corresponding 3D image using parallel viewing, look at the leftmost perspective with the left eye and the center perspective with the right eye. The viewer's face should be approximately 1 ft. from the page. It is often helpful for beginners to place an index card or sheet of paper between the views so that each eye can see only the proper perspective. The 3D image will appear to be in space between the two perspective views.

To transverse view a stereo pair, look at the perspective view printed in the center of the page with the right eye and the perspective on the right of the page with the left eye. To help in doing this, try holding the sharpened end of a pencil, parallel to this magazine and between the eyes and the perspectives. Position the pencil so that, when only the left eye is open, the pencil point covers a point in the center of the rightmost twisted torus; when only the right eye is open, the pencil point should cover the same point on the leftmost twisted torus. Once the pencil is positioned, look at the pencil point with both eyes, then relax the eyes and pay attention to the image beyond the pencil point—a 3D twisted torus between the two flat perspective views.

Projection of polarized film images

A common method for presenting stereo-pair images to large groups (especially those who may not have mastered the art of free viewing) is to capture left- and right-eye images on film (using two 35mm slides or movie film in which the left- and right-eye images in a stereo pair are stored top and bottom in a frame) and project left- and right-eye perspectives onto a special screen using polarized light. The technique requires two projectors (or a lens mechanism to separate the left- and right-eye images in the case of movie film), polarizers for each lens, a screen with a metallic surface (usually called a silver screen) that retains the polarization of the light after reflection, and polarized glasses for each observer [Fig. 4]. A well-known example of this technique is the *Captain Eo* 3D movie at Disneyworld and Disneyland. Inexpensive stereo slide viewers are available for individual viewing of 35mm stereo pairs.

The optics of polarized light limit the amount of light reaching the observer of a 3D display. A light ray has an electric field that vibrates perpendicular to the direction in which the ray is traveling. This electric field may be thought of as being composed of two orthogonal components. A linear polarizer absorbs the component perpendicular to its transmission axis. If a second polarizing filter is placed in front of the first, with its transmission axis rotated 90° with respect to the first polarizer (crossed orientation), then the light rays that pass through the first filter are blocked by the second. If the transmission axes are oriented in the same direction (parallel orientation), then light passing through the first polarizer is also passed through the second. An ideal set of polarizers would transmit 50% of the visible light rays in a parallel orientation and 0% in a crossed orientation. In practice, using dichroic polarizers, we realize about 0.1% transmission in the crossed orientation and 32% transmission in the parallel orientation.

When used for stereo viewing, the projector polarizers are arranged so that the angle of polarization between perspective views is 90°. The polarized glasses are correspondingly polarized so that each eye's polarizer is in the parallel state with respect to its intended perspective view and in the crossed state with respect to the opposite eye view when the observer's head is in a vertical position. A problem with this technique is that ghosting (one eye seeing part of both perspective views) occurs in the image if the observer tilts his head from the vertical position. Recently, circularly polarized filters and glasses have been developed that eliminate this problem.

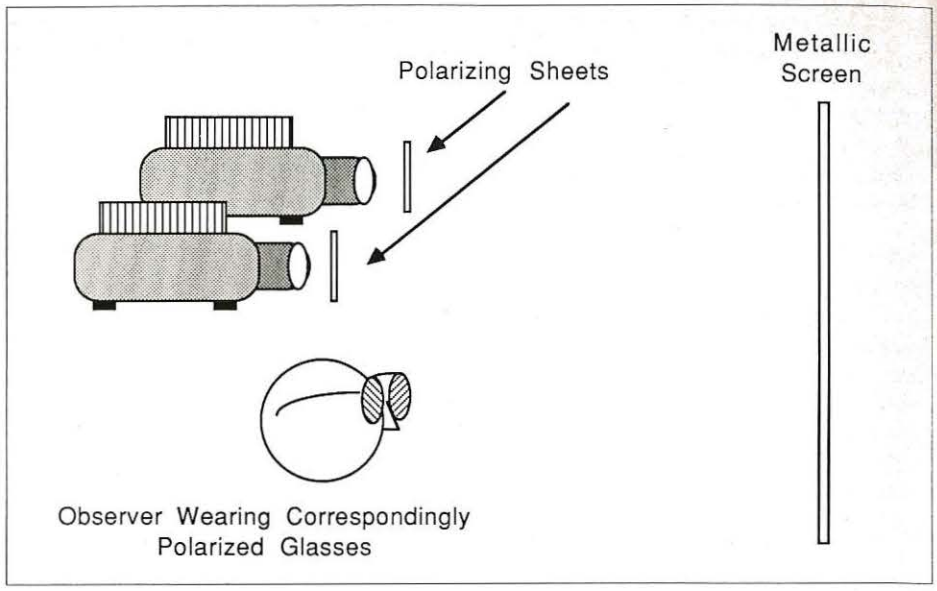

Fig. 4: Projecting polarized perspective views.

Another variation of this approach is Polaroid's Vectograph, a clear plastic laminate of two sheets of polyvinyl alcohol that can be used to record 3D images using pen plotters. The left-eye perspective is plotted on the front side of the material, and the right-eye perspective is plotted on the back side. The 3D image is viewed with polarized glasses.

Video tape

Video tape is an inexpensive technique for storing medium-resolution stereoscopic images. On a 30-Hz interlaced video display the raster screen is scanned at a rate of 30 times/sec. The raster is divided into two fields: one consisting of all the odd scan lines (the odd field) and the other consisting of all the even scan lines (the even field). Each field is updated 30 times/sec producing an interlaced image that is scanned out alternately at a rate of 60 times/sec. To display the dual image of a stereo pair, the perspective image to be seen by one eye is written to the odd field; the perspective image for the other eye is written to the even field. The interlaced update cycle will then actually present not one image, but two different perspectives of a stereo pair that alternate with each other at the rate of 60 times/sec. Fast phosphors are required to reduce ghosting.

To view the image a mechanical or electro-optical shutter system is used to occlude the appropriate eye when the opposite eye image is scanned. Current systems use a liquid-crystal shutter that is placed in front of the monitor screen and is synchronized to the vertical refresh cycle. The shutter uses liquid-crystal π-cells and one circular polarizer to polarize the perspective on the even scan lines and the perspective on the odd scan lines in opposite directions. The observer wears passive glasses with the left and right lenses circularly polarized to allow the proper views to be seen. The primary problem with this method is that some flicker occurs in the image, because the technology dictates the refresh rate.

Parallax barriers

The preceeding methods require special hardware to display and view the 3D image. Autostereoscopic hard copy is clearly more desirable. Parallax barrier methods, whose history dates from the early 1900s, provide an autostereoscopic alternate. These techniques include the parallax stereogram (described in our May article) and parallax panoramagram. A parallax stereogram consists of a fine vertical slit plate which is placed behind a specially prepared image consisting of right- and left-eye perspective views printed in alternate strips. The slits and perspectives are placed so that, from the proper viewing position, each of the observer's eyes can see only the proper perspective view of a stereo pair. For a parallax panoramagram, the width-to-pitch ratio of the slit

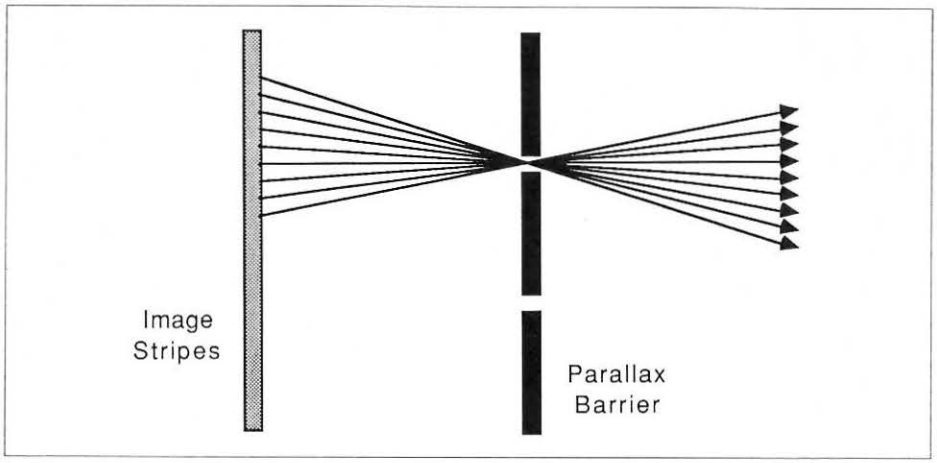

Fig. 5: Parallax panoramagram.

plate is made smaller to provide a wider viewing angle [Fig. 5].

A variety of problems has kept parallax barrier techniques from becoming a popular method for autostereoscopic display. One drawback is that the image is often dark because so much light is blocked by the barrier itself. Another problem has been a lack of clarity caused by improper registration of the parallax barrier with the image strips. Very fine slits are used so that they are not observable. These narrow slits result in diffraction phenomena that also reduce clarity. In addition, the number of perspectives placeable on the image plane without overlap is usually fairly low, resulting in a narrow depth of field.

Lenticular sheets

A lenticular sheet is a linear array of cylindrical lenses. The thickness of the sheet is chosen so that its rear surface coincides with the focal plane of the lenses. Several perspectives of an image are printed in strips on the rear surface of the lenticular sheet so that the right and left eye will each see different perspective views of a stereo pair. (When creating lenticular images of real objects the sheet is placed on the front of the film within the camera and the camera is then slewed along an arc-shaped track.) Because the lenses can be fabricated inexpensively from plastic, 3D lenticular-sheet pictures have been published in magazines and are often used for 3D postcards, greeting cards, or novelty items.

Lenticular sheet displays exhibit a measureable depth of from 2 to 4 in. Image sizes larger than approximately 16 by 20 in. are unusual. Image quality is usually worse than parallax-barrier displays because of imperfections in the plastic lenticals and a lower obtainable strip resolution. Because of small parallax separation between perspectives, lenticular-sheet pictures often also exhibit what is known as the *puppet theater effect,* in which the closest objects in the image look small and extremely near.

Marshall's grating method

Many of the problems with parallax-barrier techniques and lenticular sheets have been solved or minimized by Grayson Marshall using a method originated in concert with Gregory E. Gundlach. Although the method was originally developed for making 3D photographs of real objects, it is readily extendable to 3D images created from a series of computer-generated perspectives.

The method creates the parallax barrier from a piece of film containing a fine-line grating referred to as a *line raster.* The dimensions of the line raster are chosen to maximize diffraction phenomena by concentrating a single Fresnel zone on the film during each exposure of a perspective view onto the master 3D image. From the flexible computer model, different perspective views are photographically transferred to Cibachrome display transparency film CTDF7. The 3D transparency is printed using a line raster that is identical to the one which will be used to view it. A refractive material between the film and the raster during exposure and while viewing the final image allows the compression of more information onto the film, thus increasing the apparent depth of field of the 3D image. Currently, 12 perspectives are put onto the film. The Cibachrome transparency is then laminated onto a sheet of Plexiglas. The line raster is laminated onto the other side of the Plexiglas. Lamination of the line raster requires careful registration of the raster with the image.

The resulting image is viewed by putting a light box consisting of a light source and a diffusion screen on the film-carrying side of the Plexiglas. A bright high-quality 3D image can be seen on the line raster-carrying side of the Plexiglas. Images have been produced up to 52 by 70 in. An observer can view the image from 3 to 25 ft. away. At the optimal viewing distance, approximately 9 ft. for a large picture, the measurable depth of field can range up to 32 in. Movement from side to side produces different perspective views of the image within a range of approximately 45° to either side of a perpendicular to the center of the image. Because the technique is based on raster graphics and photographic technology, full-color images can be created.

It is also possible to produce a master 3D transparency of an image and contact print the image from the master mounted in the vacuum frame and illuminated by a point light source, so that images may be created in mass quantity. Duplicate line rasters can also be made from a master. A combination of automation and bulk purchase of materials could eventually bring the cost of a large 3D image down to a price competitive with a perspective image of the same quality and size.

Examples of this technique have been displayed at Cannes Film Festival, the January 1987 SPIE Conference on True Three-Dimensional Imaging Technologies and Techniques in Los Angeles, and at Disneyland, Tokyo.

Conclusions

We have reviewed several hard-copy techniques for computer-generated true 3D images. Each has its advantages and disadvantages, depending on the ultimate use and requirements of the medium. Except in the recording of multiplanar data in a multiplexed hologram and fringe writing (which will be covered next month), all current techniques depend on the ability to record either single or multiple stereo pairs, and therefore all have the attendant problems with accommodation and convergence [see *ID*, May 1987]. It is therefore crucial that the stereo pairs be computed correctly to avoid image distortion and depth inconsistencies.

For non-autostereoscopic techniques the preferred methods all use polarized light.

continued on page 25

Applications of miniature CRT displays

BY JIM E. WURTZ

WHAT exactly is a miniature cathode ray tube? As a rule of thumb, it is one whose diagonal face diameter is less than 2 in., usually less than 1 in. A typical miniature CRT [Fig. 1] is 25 mm in diameter, including an integral magnetic shield. Its overall length is approximately 115 mm, and its spot size is less than 20 μm at 100-fL output on a TV raster.

In terms of pixels per unit, the CRT can produce a much higher resolution picture than just about any of today's competing flat-panel technologies. Miniature CRTs are available that can produce 1000-line pictures in roughly a ¾-in.-diagonal rectangle. Because the picture is generated sequentially from a single electron beam, there must be some depth to the device to generate and deflect the beam. For high-resolution displays on a CRT with a 25-mm nominal diameter, it is not possible, with today's technology, to make the tube much shorter than about 110 mm. This is sufficiently small so that the tube still does not take up much room. It is small enough and light enough, for instance, to mount on headgear.

The optics can be designed so that the presentation on this miniature face will look much larger to the observer, the effect being that of looking at a 12–14-in. monitor. With proper optics the display will appear to be at a normal viewing distance.

*Until his recent retirement, **Jim E. Wurtz** was senior applications engineer, cathode ray tubes, at Litton Electron Devices, Tempe, Arizona.*

A little bit of history

Miniature CRTs were first used to record dots on aerial film [Fig. 2] to encode information such as date, altitude, and elapsed time.

In the late 1960s, experimenters in the Air Force began to look at helmet-mounted displays as an aid to pilots.[1] Eventually, small tubes were used to provide large apparent displays in a small space in armored vehicles. This application used a CRT approximately 25 mm in diameter that was viewed through an ocular. To the observer, the face of the tube would appear to be over 100 mm in diameter [Fig. 3]. This application is useful only in cases in which the operator's head movement is minimal. Typically, the information displayed is that from a forward-looking infrared (FLIR) camera.

In the early 1970s, researchers at the University of Utah did some noteworthy work with miniature CRTs.[2,3] Two tubes were mounted on a helmet, one for each eye, along with suitable combiners [Fig. 4]. With the computer memories and data-processing power then available, only simple figures such as cubes could be generated. A stereoscopic effect was created by suitably offsetting the tubes for

***Fig. 1:** A typical miniature CRT, 25 mm in diameter and 115 mm in overall length.*

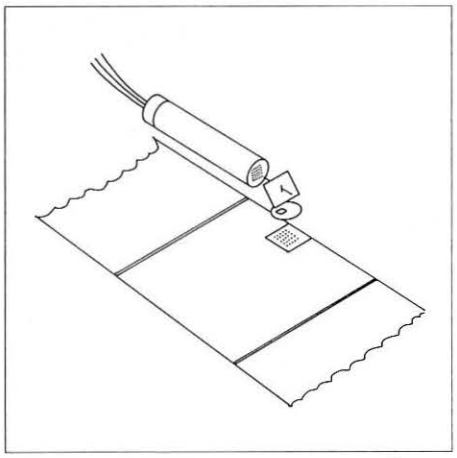

Fig. 2: Early miniature CRTs "read" dots on film from aerial surveillance for date, altitude, elapsed time, etc.

each eye so that figures could be generated in three-dimensional space within a room before the observer. The helmet was attached to a fixed reference, in this case the ceiling of a room. The position and direction of the helmet-wearer's gaze could be fed to the computer through arms and position encoders. Thus, the observer was in the "scene space"; objects generated by the "display" appeared to be floating in space and the observer could walk around them [Fig. 5]. A "wand" was designed to allow interaction with the generated object. For instance, it was possible, with the wand, to "draw" a simple 3D chair.

In the mid 1970s the Mergenthaler CR Tronic was introduced for typesetting in Europe. It employed a miniature CRT to generate characters on its face while it was incremented typewriter-like across the width of a typeset page [Fig. 6].

Helmet-mounted displays

Helmet-mounted displays seem to promise the broadest range of applications. In a helmet-mounted display a combination of mirrors and optics projects the image to the wearer's eye so that the image appears to be at a normal viewing distance and is superimposed on the observer's field of view [Fig. 7]. With this setup, very little refocus of the eye is required to look at displayed data, a picture superimposed on the outside world, or the task at hand.

Once a helmet-mounted display is provided, any kind of information can be shown to the operator, including that from aircraft and navigational systems, radar displays, FLIR, or low-light-level cameras. For example, a cross hair corresponding to the pilot's line of sight can be generated on the display, allowing the pilot to aim his guided missile weaponry simply by looking at the desired target.

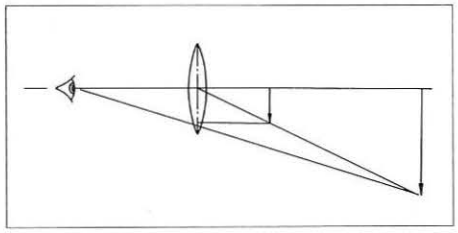

Fig. 3: Miniature CRTs provide large apparent displays in a small space by placing an ocular between the CRT and the viewer.

Under the leadership of Thomas Furnes at Wright-Patterson Air Force Base, Dayton, Ohio, advanced concepts using helmet-mounted displays are being investigated. One version of this display is seen in some technical and semi-technical publications as an outlandish-looking helmet worn by the pilot. A spherical or hemispherical scene is generated which surrounds the pilot.[4] The pilot's head position is used for location of the "window." Various radar and sensor inputs generate graphical representations of enemy radar beams and terrain detail, while the system can show the safest path through this "landscape." The pilot flies a small representation of a plane in the scene. This type of system obviously lends itself to flight simulation applications.

After evolving through a number of different designs, there is only one production helmet-mounted display currently in use by the U.S. military, the integrated helmet and display systems (IHADS) used on the Army's AH64 Apache helicopter.

There has been some hesitancy to use helmet-mounted displays on high-performance fixed-wing aircraft. This hesitancy results from two major problems: display weight and evacuation. Of the two problems, display weight is foremost, particularly if the weight is not balanced. With the gravity forces created by high-speed turns, the weight of a helmet-mounted display can be substantial. The other problem is rapid egress in case of emergency, because cables that lead to the miniature CRT must somehow be reliably severed in a way that will not start a fire. To address the balance problem, one design has the tube at the back of the helmet with the image brought to the front through a coherent fiber-optic bundle [Fig. 8].

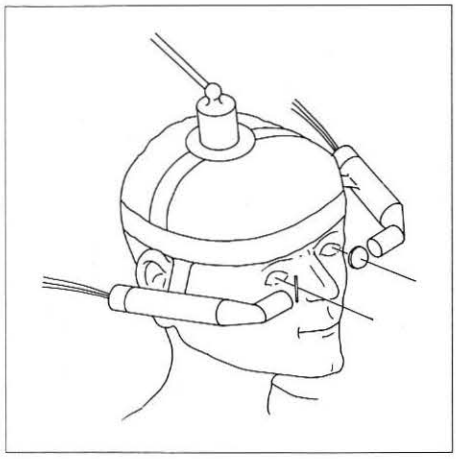

Fig. 4: In the early 1970s, the University of Utah ran an innovative study on stereoscopic imaging using two miniature CRTs.

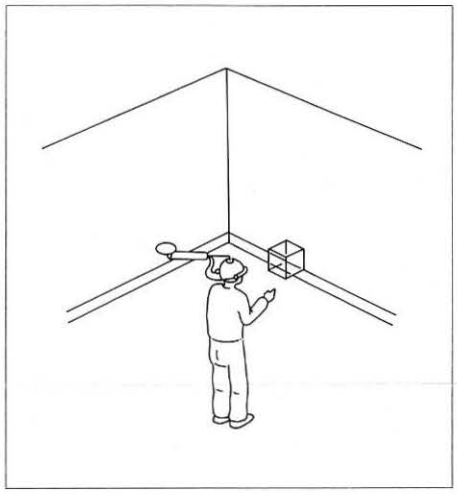

Fig. 5: The University of Utah experiment coupled miniature CRTs with computers to generate 3D objects in space.

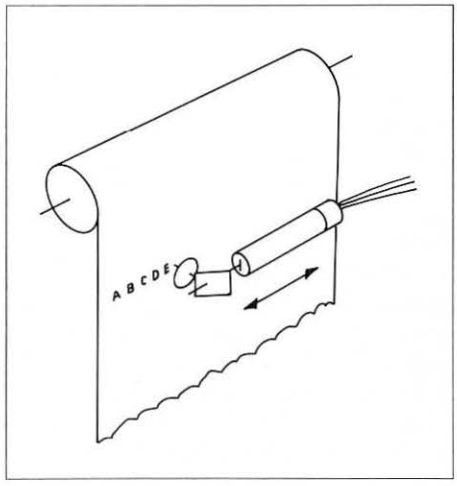

Fig. 6: The Mergenthaler CR Tronic used a miniature CRT to "read" typeset copy.

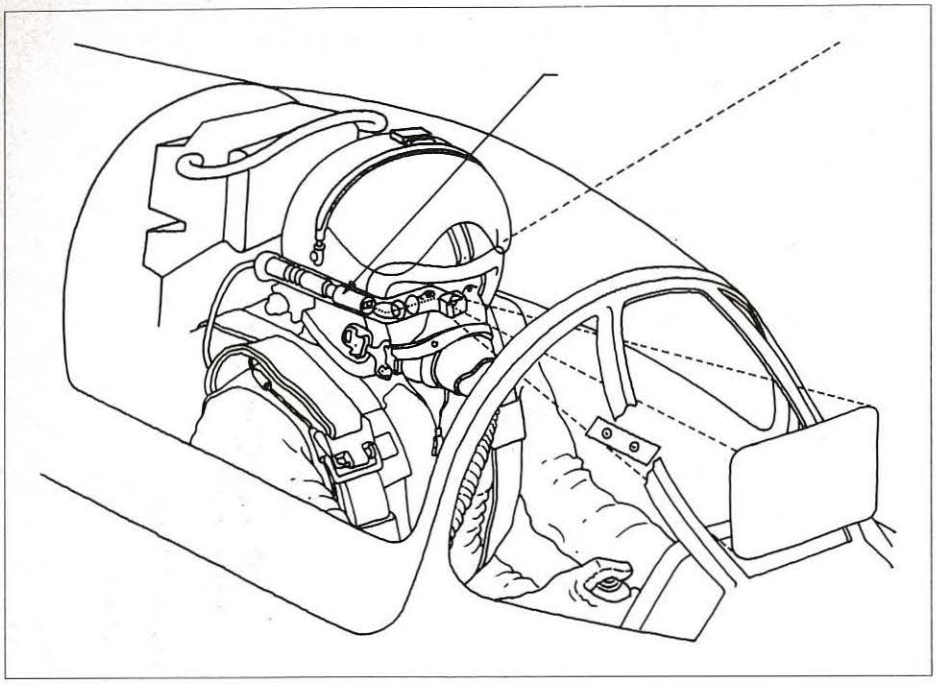

Fig. 7: In helmet-mounted displays the image is made to appear at a normal viewing distance by a combination of mirrors and optics.

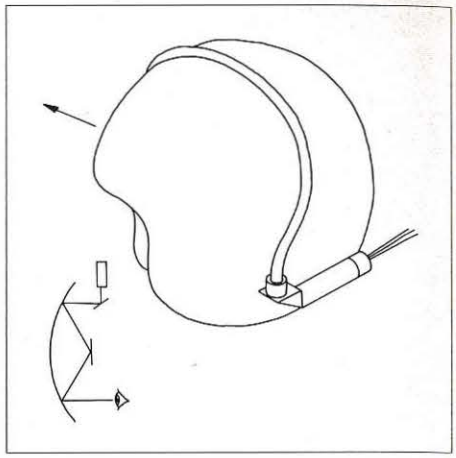

Fig. 8: One attempt to address the problem of helmet balance placed the miniature CRT at the helmet's back.

Future possibilities

A number of years has passed since the pioneering work at the University of Utah. In terms of progress in processing power, 10 years in the semiconductor chip industry is equivalent to a new age. Today's processing power, combined with a dual-tube helmet-mounted display, should provide some very "far out" applications in simulations, medical electronics, and games, although the intriguing games utilizing this technology appear, at present, to be quite expensive.

The Air Force work in simulation is ongoing. For example, the image of an aircraft or a spacecraft could be projected in a helmet-mounted display to appear to be flying over any conceived large-model landscape. Image control would be performed by the user of the helmet. With a master computer, a second helmet with its projected image could be added so that aerial dog fights could be engaged over the model landscape.

In medical electronics, there are systems on the market such as the one from Cemax (formerly Contour Medical Systems), Santa Clara, California, that, given a series of adjacent CT (or magnetic resonance) scan "slices" can produce a 3D image of the space scanned.[5] Examples of suitable scan subjects are the skull, abdominal areas, or joints. Implants can be designed for an injured area, and surgery planned using the data derived from the 3D image.

With the same information applied to a stereo helmet-mounted display, it appears that it would be possible to generate a life-size 3D hip joint, for instance, in space that would allow a doctor to actually rehearse an operation. With the same spatial data, a second helmet could allow another doctor to view the same object from another position. Actually, one doctor could see the volumetric display from any position, even inside out!

Other applications might include the ability to "walk through" a building that has been designed by computer, or the ability to arrange furniture in a simulated space as if one were actually in the room.

For air traffic control, one could function like an overseer standing over the airport with the ability to look around and see airplanes traveling along in various positions within the space covered by the radar. Another often-mentioned application is remotely piloted vehicles, both ground and airborne.

In the future, these miniature displays can be useful whenever it is desired to view the displayed image simultaneously with a real-world task or another image so that the operator does not have to take his eyes off what he is doing in order to see other information. Examples include a head-up display for an aircraft pilot or the driver of any other kind of vehicle, for an operating surgeon who would like to see the patient's electronic function readouts without taking his eyes off his task, or for an office worker at a CRT terminal where it is desired to replace the bulky terminal on the desk with a "visual headphone."

With a stereo arrangement, one could view synthetic scenes on a micro or macro scale, such as the inside of a computer-generated atom or cell or all the space around an airport or a galaxy. It is expected that these tubes may be useful in volumetric displays that were formerly limited in memory and speed of data processing. Continuing advances in computing power should one day even allow the observer to integrate himself into the 3D display.

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1987 SID honors and awards recipients

As pointed out by Bob Knepper in his history of SID in our April issue, it is a privilege of a professional society to honor distinguished accomplishments in its field. SID is proud to honor this year's award recipients.

T. Peter Brody
Karl Ferdinand Braun Prize

The Karl Ferdinand Braun Prize, named after the inventor of the CRT, is a newly created prize, sponsored by RCA, and awarded annually by SID for outstanding achievements in display technologies. The first recipient is T. Peter Brody for his pioneering efforts in the development of thin-film-transistor active-matrix displays. Dr. Brody has devoted his career to the development and commercial realization of flat-panel displays. At Westinghouse, where he worked for 19 years, he established the first programs in active-matrix-addressed EL and LC displays; demonstrated an active-matrix 6 × 6 in. LCD in 1972; EL in 1974; active-matrix EL-TV in 1975; and LCD-TV in 1977. He later founded Panelvision, which introduced the world's first commercial active-matrix LCD in 1984, the Minigraphic. He is now president of Active Matrix Associates, a consulting firm in Pittsburgh, Pennsylvania. Dr. Brody holds approximatley 20 patents and has authored numerous publications, having been the first to introduce the term "active matrix" into the literature in 1975. He is a Fellow of the SID (1983) and recipient of a SID Special Recognition Award (1976).

Gary K. Starkweather
Johann Gutenberg Prize

The Johann Gutenberg Prize, named after the inventor of moveable metal type, is a newly created prize, sponsored by IBM, and awarded annually by SID for achievements in hard-copy technology. This year's recipient is Gary K. Starkweather for outstanding contributions to the development of laser xerography. At Xerox in the 1960s, Mr. Starkweather did pioneering work on the early uses of laser-scanned xerographic systems. His later work on laser scanning led to the development of the Xerox 9700 high-speed laser printer, for which he received the Xerox President's Award in 1977. He is currently senior research fellow at the Xerox Palo Alto Research Center, where he manages a group involved in color imaging systems research, including digital color printing and imaging as well as electronic color reprographics. Mr. Starkweather is the author of many papers on optics and laser scanning and holds 26 patents in optics and electronic printing.

Harold R. Luxenberg
Beatrice Winner Award

The Beatrice Winner Award is named in memory of the late wife of Lewis Winner, who together with her husband devoted many years to the management of the SID Symposia. The award is bestowed periodically for exceptional and sustained service to the Society. It is fitting that in this silver anniversary year, the award should go to the man who more than anyone else was responsible for the founding of the Society, SID's first elected President, Harold R. Luxenberg. It was Dr. Luxenberg's course on "Display Systems Engineering" (a course that is still being offered by UCLA, where it has the distinction of being the University's longest-running summer seminar) that first sparked interest in forming a display society in the early 1960s. A mathematician and meteorologist by training, Dr. Luxenberg has pursued a teaching career, and has taught courses on information display systems, operations research, computer graphics, digital/analog signal processing, robotics, and microprocessor systems design. He is currently Professor Emeritus in Computer Science, California State University, Chico, California. Dr. Luxenberg is a Fellow of the SID (1966).

Shunsuke Kobayashi
Fellow

Shunsuke Kobayashi has been elected to the grade of Fellow for his pioneering and continuing contribution to liquid-crystal displays with high legibility and for his leadership in the display community. Dr. Kobayashi is a Professor on the Faculty of the Department of Electronic Engineeirng, Faculty of Technology, Tokyo University of Agriculture and Technology, which he joined in 1973. From 1964 to 1973 he worked at the Institute of Physical and Chemical Research on infrared lasers, detectors, and liquid crystals. At Tokyo University of Agriculture and Technology, his principal areas of research have been optoelectronics and liquid-crystal displays.

Andras I. Lakatos
Fellow

Andras I. Lakatos has been elected to the grade of Fellow in recognition of his many contributions to the development of electro-optic devices. Dr. Lakatos is manager of the thin-film device area at the Xerox Webster Research Center in Webster, New York. He joined Xerox in 1966 and during the 1970s was responsible for the modelling and characterization of the Ruticon, a deformographic light valve. In 1977 he began work on thin-film transistors for LCDs and the next year was appointed manager of the group responsible for research and development of LCDs and other thin-film devices. In 1985 he was co-recipient of a Xerox Special Recognition Award.

Omesh Sahni
Fellow

Omesh Sahni has been elected to the grade of Fellow for his significant technical contributions in gas discharge displays, electroluminescent devices, and gaseous electronics. Dr. Sahni is department manager of printer technologies at the IBM Thomas J. Watson Research Center, Yorktown Heights, New York. At IBM, he has been involved with all aspects of the physics and technology of information output devices, making major contributions in the areas of plasma panel displays, thin-film electroluminescent displays, and resistive ribbon thermal-transfer printing. Before joining IBM, he did research in flame plasmas and gaseous electronics. Dr. Sahni received a SID Special Recognition Award in 1983.

Dwight W. Berreman
Special Recognition Award

Dwight W. Berreman is a recipient of a Special Recognition Award for significant and continuing contributions to the theory and the reduction to practice of high information content liquid-crystal displays. Dr. Berreman has been on the technical staff of AT&T Bell Laboratories, Murray Hill, New Jersey, since 1961. He is the author of more than 60 papers in the fields of physical optics, x-ray optics, lattice dynamics, and liquid-crystal physics, and holds 14 patents on x-ray and visible-light optical devices including LCDs.

Eiji Kaneko
Special Recognition Award

Eiji Kaneko has been given a Special Recognition Award for significant and continuing contributions to the theory and the reduction to practice of high information content liquid-crystal displays. Since joining the Hitachi Corp. in 1957, Dr. Kaneko has done research on instrumentation for atomic reactors, hybrid and monolithic integrated circuits for computer-aided design, and thin-film magnetic heads for computers. More recently, he has worked on LC, EL, and gas discharge displays and their driving circuits. He is now chief researcher at Hitachi Research Laboratory, Ibaraki, Japan, and responsible for all display work including hard-copy devices such as ink-jet printers, laser-beam printers, and facsimiles.

E. Peter Raynes
Special Recognition Award

E. Peter Raynes has been given a Special Recognition Award for significant and continuing contributions to the theory and the reduction to practice of high information content liquid-crystal displays. Dr. Raynes has studied liquid-crystal materials and their applications since joining the Royal Signals and Radar Establishment in 1971. For his work on cyanobiphenyl liquid crystals he was awarded the Rank Opto-Electronics Prize in 1980 and his division received a Queen's Award for Technological Achievement in 1979. He is currently leader of the liquid-crystal materials section as RSRE, Malvern, U.K.

Martin Schadt
Special Recognition Award

Martin Schadt is a recipient of a Special Recognition Award for significant and continuing contributions to the theory and the reduction to practice of high information content liquid-crystal displays. Dr. Schadt is head of the liquid-crystal R&D section at Hoffman-LaRoche, Basel, Switzerland. Apart from his pioneering work on the twisted nematic and other field effects on which liquid-crystal displays are based, he has investigated electro-optical phenomena and correlations between molecular structures on macroscopic physical properties leading to new liquid-crystal materials and display applications.

Terry J. Scheffer
Special Recognition Award

Terry J. Scheffer has been given a Special Recognition Award for significant and continuing contributions to the theory and the reduction to practice of high information content liquid-crystal displays. Dr. Scheffer is best known for the discovery and development of the supertwisted birefringence effect (SBE) liquid-crystal display in 1983, while he was at Brown Boveri Research Center in Baden, Switzerland. Dr. Scheffer is currently with the display research group in the Imaging Research Laboratory at Tektronix, Inc., Beaverton, Oregon.

Jurgen Nehring
Special Recognition Award

Jurgen Nehring is a recipient of a Special Recognition Award for significant and continuing contributions to the theory and the reduction to practice of high information content liquid-crystal displays. Since 1971, Dr. Nehring has been with the Brown Boveri Research Center in Baden, Switzerland, working on liquid-crystal displays and optoelectronics. He was part of the research team that discovered the supertwisted birefringence effect (SBE) liquid-crystal display.

Larry F. Weber
Best Paper at SID '86

The Award for Best Contributed Paper at SID '86 has been given to Larry F. Weber and Richard C. Younce for their paper "Independent Sustain and Address Technique for the ac Plasma Display Panel" (12.3). Dr. Weber is currently a Research Associate Professor and group director at the University of Illinois at Urbana-Champaign Computer-Based Education Research Laboratory, where, since 1969, he has been actively engaged in the plasma display research group. He lectures frequently, in the U.S. and abroad, on plasma display technology, and holds five patents relating to the ac plasma display panel. Dr. Weber received a SID Special Recognition Award in 1982.

Richard C. Younce
Best Paper at SID '86

Richard C. Younce, co-recipient of the Award for Best Contributed Paper at SID '86, was enrolled at the University of Illinois at Urbana-Champaign as Larry Weber's student while they worked together on the independent sustain and address plasma panel design that became the subject of their award-winning paper. Mr. Younce is currently working toward his Ph.D. at the University of Notre Dame and is employed at the Tellabs Research Center in South Bend, Indiana.

Brian W. Epps
Best Student Paper
at SID '86

The award for the Best Contributed Student Paper at SID '86 has been given to Brian W. Epps for the paper "Comparison of Six Cursor Devices on a Target Acquisition Task" (17.1), which was coauthored by Harry L. Snyder. Mr. Epps was Dr. Snyder's student at Virginia Polytechnic Institute and State University when he presented the paper last year. After receiving his Ph.D. in human factors engineering from VPI, he joined the user systems engineering group at Texas Instruments in Dallas, Texas, where he is now working on projects related to the design of computer-human interfaces for expert systems, manufacturing processes, and large databases.

Dr. Epps is the first recipient of the Best Student Paper Award, which was initiated last year as part of the SID student/professor travel grant program. Under the program, a limited number of travel grants are made available to student authors of accepted papers and their professors to attend the Symposium. To become eligible for the Best Student Paper Award, which carries with it a $500 cash prize, the student must present his or her own paper at the Symposium. ■

patents

Compiled by HOWARD L. FUNK
IBM CORP.

U.S. Pat. No. 4,660,959; Issued 4/28/87

Device for the Electrophotographic Manufacturing of Printing Forms

Inventor: KLAUS-PETER DE SCHOEN
Assigned to: HOECHST A.G.

Disclosed is a device for the electrophotographic manufacture of printing forms, comprising a loading table, an exposure table, and a developing table arranged in the device one after the other in the transport direction of printing plates. The loading table is pivotable and is equipped with spring suction devices, by means of which the uppermost printing plate can be removed from a plate magazine. After the printing plate has been removed, the loading table is swung into its horizontal position, a corona is moved over the loading table and the photoconductive layer of the printing plate is loaded to the required voltage. The printing plate is transported from the loading table to the exposure table and from the latter to the developing table by means of compressed air which forms a cushion underneath the printing plate. The printing plate is guided on the cushion in suspension from processing station to processing station. For this purpose, at least two rows of air nozzles are arranged in the tables of the processing stations. The air nozzles extend at an angle inside the tables and are charged with compressed air. The loading table, at its narrow sides, is equipped with pivotable flaps. The exposure table, at its narrow sides, has fixed guide plates, whereas the developing table is equipped on all four sides with pivotable flaps and, moreover, has two additional rows of air nozzles which are arranged at right angles to the air nozzles which extend along each of the tables in the transport direction.

U.S. Pat. No. 4,654,285; Issued 3/31/87

Electrophotographic Sensitive Member Suitable for Coherent Beams and Method of Producing Same

Inventor: YASUO NISHIGUCHI
Assigned to: KYOCERA CORP.; TAKAO KAWAMURA

The present invention relates to an electrophotographic sensitive member for use in a laser line printer and a method of producing same.

U.S. Pat. No. 4,652,115; Issued 3/24/87

Print Engine for Color Electrophotography

Inventors: KIRK W. CHARLES, GREGORY A. CHATHAM, DAVID R. DAVIS, ANTHONY J. IRELAND, WAYNE C. JONES, KHOSROW LAK, CHARLES S. PALM, PETER F. SAMPSON, DANNY L. SLAYTON, MAURICE S. WHEATLEY, JR.
Assigned to: COLOROCS CORP.

An improved full-color electrophotographic print engine using flexible belts to carry a photosensitive electrostatic image developer and a transfer belt for building up composite developed images is disclosed. Each belt, and an optical scanner, are driven by mechanically independent motors which are synchronized by an electronic digital controller implementing precise servos. The use of the flexible belts allows the machine to be relatively inexpensive, very small compared to previous full-color print engines, and yet maintain precise registration of color composite images. An improved fuser mechanism with increased dwell time at constant machine speed is also shown. The fuser includes a pair of spaced-apart rollers, both of which urge a sheet of image receptor against the heated roller over a predetermined angular portion of the roller. The machine is specifically designed to be used interchangeably with an optical bench source as a copier or with a laser bench as a laser printer. Improved copy quality monitoring by sensing actual amounts of toner deposited on a photoreceptor belt is also shown. Also, improved downwardly facing gravity-fed toner deposition modules are shown including an embodiment which has a purely magnetic gate for opening and closing the toner supply.

U.S. Pat. No. 4,651,278; Issued 3/17/87

Interface Process for an All-Points-Addressable Printer

Inventors: ALEXANDER HERZOG, JAMES W. MARLIN, BRIAN G. PLATTE, FILIP J. YESKEL
Assigned to: IBM CORP.

This invention is a process for interconnecting an all-points-addressable printer with a host application program wherein the application presents output to be printed to the printer; and wherein the host application can be present on a variety of different computer equipment, such as a large host computer, a standalone workstation, or workstation on a local area network; and wherein the all-points-addressable page printer can utilize any type of printing technology such as electrophotographic, magnetic, or other; and wherein the printer and the application host are interconnected by communicating means, such as a channel, local area network, or telecommunication line; and wherein any type of transmission protocol can be used; and wherein the process enables the transmission of commands and data from the host application to the printer in a manner which is independent of the communication means and transmission protocol; and finally, wherein the process enables the transmission of a variety of types of data including text, graphics, image, or bar code which may be merged together on a single printed page.

U.S. Pat. No. 4,653,875; Issued 3/31/87

Infinity Display Apparatus Using Cylindrical Beam-Splitters

Inventor: STEPHEN P. HINES

An apparatus is disclosed for projecting at infinity an image of an object displayed on a convex surface, such as a CRT or rear projection screen. Such apparatus comprises a pair of beam-splitters, preferably cylindrical in shape and arranged such that their respective axes of curvature are perpendicular to one another. Each beam-splitter has an optical power which compliments that of the other, whereby such elements share the image-forming function.

U.S. Pat. No. 4,652,798; Issued 3/24/87

Scanning CRT Display System with Linearity Compensation

Inventors: MICHAEL P. BAFARO, THEODORE V. LESTER

A scanning CRT display system is disclosed in which transitions of a horizontal sync signal are directly utilized to provide control signals for driving a field effect transistor (FET) power drive device which controls horizontal deflection yoke current. Protection circuitry is provided such that the FET power drive device is turned off if excessive FET through current is sensed, and protection circuitry also prevents turning on the FET drive device if an excessively high flyback voltage is present at the drain terminal of the FET device. Linearization of the horizontal deflection yoke current is provided by effectively sensing the temperature variable on resistance of the FET output drive device and providing a compensation control signal in accordance therewith, wherein this compensation control signal controls the magnetization provided by a control winding on a saturable magnetic core on which a

linearity compensation coil is also wound. The linearity compensation coil and the deflection yoke are connected in series and the compensation control signal effectively reduces the series inductance of these elements so as to provide linearity compensation for horizontal deflection yoke current.

U.S. Pat. No. 4,654,650; Issued 3/31/87

Voltage Offset Device and Method for Providing a Smooth Scroll for a Raster Scan Cathode Ray Tube Display

Inventors: RICHARD J. FADEM
Assigned to: NCR CORP.

A device and method is disclosed for providing a smooth scroll of a display on a cathode ray tube display device having a display area, horizontal deflecting means receiving horizontal drive pulses for effecting horizontal scans, vertical deflecting means receiving vertical drive pulses for moving said video display vertically, and a video input for receiving a video input signal. The device includes a microprocessor having an input and an output. The microprocessor counts, and places on its output, digital signals corresponding to its count. A digital-to-analog converter converts the digital signals to an analog signal. A summing device is connected between the digital-to-analog converter output and the vertical deflecting means of the cathode ray tube display device for summing a vertical deflection pulse and the analog signal output of said digital-to-analog converter, thereby vertically displacing the video input signal of the cathode ray tube display device.

U.S. Pat. No. 4,654,616; Issued 3/31/87

Blue Bow Correction for CRT Raster

Inventors: DENNIS L. DODDS, JOSEPH L. WERST
Assigned to: RCA CORP.

In a video display system in which a cathode ray tube exhibits blue bow misconvergence, a correction arrangement includes areas of magnetizable material located within recesses formed in the deflection yoke insulator. The material lies between the end turns of the horizontal coils along the sides of the yoke. The material is magnetized to form a four-pole field to effect correction of the blue bow error.

U.S. Pat. No. 4,653,867; Issued 3/31/87

Liquid Crystal Display Apparatus

Inventors: MIKIO SUGIKI, TETSUO URABE, HIROYA USUI
Assigned to: SONY CORP.

A liquid crystal display apparatus is disclosed wherein laser beams, which are modulated in accordance with modulating signals such as video signals, are irradiated on a liquid crystal cell for writing the display image or picture on the cell. In the present invention, the laser beams emitted from two laser beam sources are combined at a polarization beam splitter with an angular offset between the respective optical axes equal to delta theta, and the picture components corresponding to two scanning lines are simultaneously written into the liquid crystal cell during one scanning period, for increasing the image writing speed. ■

have you read . . . ?

Compiled by HOWARD L. FUNK
IBM CORP.

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3D hard copy

continued from page 15

For showing static images to large groups, 35mm slides are projected through polarizers with crossed orientation onto a metallic screen and viewed through properly polarized glasses. The advantages are that almost no specialized equipment is needed except for polarizers and glasses, that 3D images can be shown to large groups, that the images can be printed in publications for free viewing, and that images can exhibit full color and high resolution in the image. For dynamic images, use of a large liquid-crystal shutter to view interlaced stereo pairs on video tape seems to be the most practical compromise. It requires the least amount of specialized equipment while producing full-color images that can be shown on a standard monitor or projected for large-screen viewing. Some problems exist with flicker, because each eye sees a perspective that is updated only 30 times/sec. These problems can be minimized (but not eliminated) by proper room lighting, brightness of the image, and choice of colors in the image.

For long-term storage of any film-based system, problems such as image fading and distortions can occur because of the recording medium. For example, changes in humidity cause the photographic emulsion to swell and shrink. If these changes are not perfectly reversible, then image distortion will result. Other undesirable features such as printout and microspotting are seen in old photographs and are of concern.

The competing autostereoscopic techniques for static images appear to be multiplexed holograms, which will be discussed next month, and Marshall's grating technique. Both can be made in large sizes and both have good depth. Marshall's technique has the advantage that images can easily be made in full color. It has the disadvantage that images are rigid so that large 3D pictures are not as easily transportable as holograms, which can be rolled up to fit in mailing tubes.

Acknowledgments

We would like to thank Louis Harrison, a graduate student at North Carolina State University, for creating and photographing the stereo pair for Fig. 3, which is also on the cover of this issue of *Information Display*. We would also like to thank Grayson Marshall of Los Angeles, California, who spent many hours of his time answering our questions about his technique. ■

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CRT DISPLAYS

CRTs, beam-index

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CRTs, conventional

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CRTs, flat

AEG Corp.
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Zenith Electronics Corp.

CRTs, miniature

AEG Corp.
CRT Scientific Corp.
EEV Inc.
Ginsbury Electronics Ltd.
Hughes Aircraft Co.
Hughes Aircraft Co., Industrial Products Division
Litton Electron Devices Division
McMahan Electro-Optics, Inc.
The M-O Valve Co. Ltd.
Rank Brimar, Inc.
Rank Brimar Ltd.
Raytheon Co., Industrial Components Operation
Sony Component Products Division
Thomas Electronics, Inc.
Thomson-CSF, Division Tubes Electroniques
Thomson Electron Tubes and Devices Corp.
Toshiba America, Inc.
Video Display Corp.
Westinghouse Electric Corp., Imaging and Sensing Technology Division

CRTs, multibeam

Ginsbury Electronics Ltd.
Raytheon Co., Industrial Components Operation
Sony Component Products Division
Thomas Electronics, Inc.
Thomson-CSF, Division Tubes Electroniques
Thomson Electron Tubes and Devices Corp.

CRT monitors, full color

Barco Electronics, Inc.
Barco-Industries Inc.
Cardinal Technologies, Inc.
Carroll Touch, Inc.
Chromatics, Inc.
Conrac Display Products Group
DataBeam Corp.
Data Ray Corp.
Electrohome Ltd., Video Display Products
Elston Electronics Corp.
Ginsbury Electronics Ltd.
Hartman Systems, a Figgie International Co.
Hitachi, Ltd.
Hitech International
Hughes Aircraft Co.
Ikegami Electronics
Infodex, Inc.
Intelligent Light, Inc.
International Business Machines Corp.
Magnavox/NAP Consumer Electronics
Manitron Displays Ltd.
Mega Vision Inc.
Modgraph Inc.
Monitronix Corp.
NEC Home Electronics (USA), Inc.
Panasonic Industrial Co.
Rockwell International Corp.
Sanders Associates, a Lockheed Co.
Sanyo Business Systems Corp.
Sigmex Ltd.
Sony Component Products Division
Thomson-CSF, Division Tubes Electroniques
Thomson Electron Tubes and Devices Corp.
Toshiba America, Inc.
Toshiba Corp.
Totoku Electric Co., Ltd.
Video Display Corp.
Video Monitors Inc.
Wacom Co., Ltd.
Wells Gardner Electronics

CRT monitors, monochrome

AEG Corp.
Barco-Industries Inc.
Cardinal Technologies, Inc.
Conrac Display Products Group
CRT Scientific Corp.
DAGE MTI Inc.
DataBeam Corp.
Data Ray Corp.
EEV Inc.
Electrohome Ltd., Video Display Products
Elston Electronics Corp.
Ginsbury Electronics Ltd.
Hartman Systems, a Figgie International Co.
Hitachi, Ltd.
Hitech International
Hughes Aircraft Co.
Ikegami Electronics
Infodex, Inc.
International Business Machines Corp.
McMahan Electro-Optics, Inc.
Magnavox/NAP Consumer Electronics
Manitron Displays Ltd.
Modgraph Inc.
The M-O Valve Co. Ltd.
NEC Home Electronics (USA), Inc.
Panasonic Industrial Co.
Rockwell International Corp.
Sanders Associates, a Lockheed Co.
Sanyo Business Systems Corp.
Sigmex Ltd.
Thomson-CSF, Division Tubes Electroniques
Thomson Electron Tubes and Devices Corp.
Toshiba America, Inc.
Toshiba Corp.
Totoku Electric Co., Ltd.
TSD Display Products, Inc.
Video Display Corp.
Video Monitors Inc.
Wacom Co., Ltd.
Wells Gardner Electronics

CRTs, electron guns and deflection yokes for

CELCO
Clinton Electronics Corp.
Display Components, Inc. (DISCOM)
Ginsbury Electronics Ltd.
George D. Harris Assoc., Inc.
Hughes Aircraft Co.
K&R Engineering Sales Corp.
Penn-Tran Corp.
Rank-Brimar, Inc.
Rank-Brimar Ltd.
Syntronic Instruments
Thomson Electron Tubes and Devices Corp.
Toshiba Corp.
Totoku Electric Co., Ltd.
Video Display Corp.

CRTs, other

CELCO
CRT Scientific Corp.
Electro Mechanical Systems, Inc.
George D. Harris Assoc., Inc.
International High Voltage Electronics, Inc.
McMahan Electro-Optics, Inc.
Manitron Displays Ltd.
MicroTouch Systems Inc.
Modgraph Inc.
The M-O Valve Co. Ltd.
Orwin Associates, Inc.
Photo Research Division, Kollmorgen Corp.
Precision Electronic Glass Inc.
Rank Brimar, Inc.
Rank Brimar Ltd.
StereoGraphics Corp.

Tektronix, Inc., Liquid Crystal Shutter SPU
Thomson Electron Tubes and Devices Corp.
XYtron, Inc.
Zenith Electronics Corp.

CRT MATERIALS

Bates Manufacturing Co.
Connector Corp.
Corning Glass Works
CRT Scientific Corp.
Incom Inc.
King Labs. Inc.
Levy Hill Labs. Ltd.
Magnetic Shield Corp., Perfection Mica Co.
Mitsubishi Chemical Industries America Inc.
O&S Research, Inc.
Optical Coating Laboratory, Inc.
Optical Devices Inc.
Owens-Illinois, Inc.
Panelgraphic Corp.
Precision Electronic Glass
SAES Getters/USA Inc.
Syntronic Instruments, Inc.
Toshiba Corp.

FIBER-OPTIC DISPLAY PRODUCTS

BDH Ltd.
Centronic E-O Division, Inc.
Corning Glass Works
CRT Scientific Corp.
Daburn Electronics and Cable Corp.
The Dow Chemical Co.
EM Industries
Galileo Electro-Optics Corp.
Hughes Aircraft Co.
Incom Inc.
Levy Hill Labs. Ltd.
SAIT
Sharp Electronics Corp.
Thin Film Device, Inc.
Thomas Electronics, Inc.
Thomson Electron Tubes and Devices Corp.
3M Industrial Optics
Toshiba America, Inc.
Totoku Electronic Co., Ltd.
Transicoil Inc.
Triplett Corp.
UCE, Inc.

FILTERS AND POLARIZERS

Color filters

Brewer Science, Inc.
Dainippon Ink and Chemicals, Inc.
Futaba Corp. of America
Ginsbury Electronics Ltd.
Greenwich Marketing Corp.
Homalite, Inc.
Hornell Elektrooptik AB
Hoya Optics, Inc.
Infodex, Inc.
Metavac, Inc.
Optical Coating Laboratory, Inc.
Panelgraphic Corp.
Raytheon Co., Industrial Components Operation
Thin Film Device, Inc.
Thomson Electron Tubes and Devices Corp.
3M Industrial Optics
Toshiba Corp.
Xtalite Display Systems Inc. USA
Xtalite Technology Ltd. Canada

Polarizers

Ginsbury Electronics Ltd.
Hoya Optics, Inc.
International Polarizer, Inc.
Optical Coating Laboratory, Inc.
Optical Devices Inc.
Raytheon Co., Industrial Components Operation
Thin Film Device, Inc.
Thomson Electron Tubes and Devices Corp.

FLAT PANEL DISPLAYS

Backlights

IEC Co.
IEE
NEC Home Electronics (USA), Inc.
Futaba Corp. of America
SAIT
Sharp Electronics Corp.
Thin Film Device, Inc.
3M Industrial Optics
Toshiba Corp.
Triplett Corp.
UCE, Inc.
Varitronix Ltd.
Wacom Co., Ltd.

Electrochromic displays

Asahi Glass Co., Ltd.

Electroluminescent displays

Bonar Kard-O-Lite, Inc.
Carroll Touch, Inc.
The Cherry Corp.
Craft Data Ltd.
Digital Electronics Corp.
Emerald Computers, Inc.
Finlux Inc.
Hoffman Engineering Corp.
Hycom, Inc.
IEE
Infodex, Inc.
Interstate Electronics Corp.
Phosphor Products Co. Ltd.
Planar Systems, Inc.
SAIT
Sanders Associates, a Lockheed Co.
Sharp Electronics Corp.
Sigmatron Nova, Inc.
Texas Instruments, Inc.
Thin Film Device, Inc.
UCE, Inc.

Electro-mechanical displays

Densitron Corp.
Ferranti-Packard Electronics
Industrial Service Labs (ISL) Corp.

Gas-discharge displays

Babcock Display Prods.
The Cherry Corp.
Craft Data Inc.
Craft Data Ltd.
Dale Electronics, Inc.
Hughes Aircraft Co.
IEE
Industrial Service Labs (ISL) Corp.
Photonics Technology
SAIT
Texas Instruments, Inc.
Triplett Corp.

Light-emitting diodes

Bowmar/ALI, Inc.
Centronic E-O Division, Inc.
Craft Data Inc.
Craft Data Ltd.
Display * Tech Inc.
Ferranti-Packard Electronics
General Instrument Optoelectronics Division
IEE
Industrial Service Labs (ISL) Corp.
Optotek Ltd.
Sharp Electronics Corp.
Siemens Components, Inc., Optoelectronics Division
Texas Instruments, Inc.
Toshiba Corp.
Triplett Corp.

Liquid-crystal displays

AEG Corp.
Asahi Glass Co., Ltd.
Clover Display Ltd.
Craft Data Inc.
Craft Data Ltd.
Densitron Corp.
EEV Inc.
Electronic Display Systems, Inc.
Emerald Computers, Inc.
Excel Technology Corp. Int'l.
Greyhawk Systems, Inc.
Hitachi, Ltd.
Hornell Elektrooptik AB
Hughes Aircraft Co.
IEE
Industrial Service Labs (ISL) Corp.
Kyocera America Inc.
Litton Panelvision
Norsk LCD
Racal Microelectronic Systems Ltd.
SAIT
Sanders Associates, a Lockheed Co.
Sharp Electronics Corp.
Tektronix, Inc., Liquid Crystal Shutter SPU
Thomson Electron Tubes and Devices Corp.
Toshiba America, Inc.
Toshiba Corp.
Triplett Corp.
UCE, Inc.
Varitronix Ltd.
Wacom Co., Ltd.
Xtalite Display Systems Inc. USA
Xtalite Technology Ltd. Canada

Liquid-crystal displays, active matrix

AEG Corp.
Densitron Corp.
Hitachi, Ltd.
Hughes Aircraft Co.
Litton Panelvision
Ovonic Imaging Systems, Inc.
SAIT
Sharp Electronics Corp.
Thomson Electron Tubes and Devices Corp.
Toshiba Corp.
UCE, Inc.
Xtalite Display Systems Inc. USA
Xtalite Technology Ltd. Canada

Matrix addressing

Display * Tech Inc.
Hughes Aircraft Co.
IEE
SAIT
Tektronix, Inc., Liquid Crystal Shutter SPU
Thin Film Device, Inc.
UCE, Inc.
Varitronix Ltd.

Plasma displays

The Cherry Corp.
Craft Data Inc.
Craft Data Ltd.
Dale Electronics, Inc.
Densitron Corp.
Displays, Inc.
Electro Plasma Inc.
Emerald Computers, Inc.
Hughes Aircraft Co.
IEE
Industrial Service Labs (ISL) Corp.
Interstate Electronics Corp.
Lucitron inc.
Magnavox Electronic Systems Co.
Panasonic Industrial Co.
Photonics Technology
SAIT
Texas Instruments, Inc.
Thomson-CSF, Division Tubes Electroniques
Thomson Electron Tubes and Devices Corp.
World Products, Systems Devices Group

Vacuum fluorescent displays

Babcock Display Prods.
Craft Data Inc.
Craft Data Ltd.
Digital Electronics Corp.
Displays, Inc.
Emerald Computers, Inc.
Futaba Corp. of America
IEC Co.
IEE
Industrial Service Labs (ISL) Corp.
SAIT
Texas Instruments, Inc.
Triplett Corp.

products & services

Flat panel displays, other

EEV Inc.
Hughes Aircraft Co.
IEC Co.
International High Voltage Electronics, Inc.
Lucitron inc.
MicroTouch Systems Inc.
NEC Home Electronics (USA), Inc.
Photo Research Division, Kollmorgen Corp.
UCE, Inc.
Wacom Co., Ltd.

FLAT-PANEL MATERIALS

Andus Corp.
BDH Ltd.
Bonar Kard-O-Lite, Inc.
Brewer Science, Inc.
Corning Glass Works
Dainippon Ink and Chemicals, Inc.
Deposition Technologies Inc.
EM Industries
Futaba Corp. of America
Infodex, Inc.
International Polarizer, Inc.
Ketek Ltd.
Levy Hill Labs. Inc.
Locktite Luminescent Systems Inc.
Mitsubishi Chemical Industries America Inc.
Optical Coating Laboratory Inc.,
Optical Devices Inc.
Phosphor Products Co. Ltd.
SAES Getters/USA Inc.
SAIT
Sharp Electronics Corp.
Supertex Inc.
Thin Film Device Inc.
Thomson Electron Tubes and Devices Corp.
UCE, Inc.

GLASS PRODUCTS

Applied Films Lab. Inc.
Applied Glass Technology, Inc.
Artistic Glass Products Co.
Asahi Glass Co., Ltd.
Brewer Science, Inc.
Corning Glass Works
CRT Scientific Corp.
Deposition Technologies Inc.
Displays, Inc.
Flachglas AG
Hoya Optics, Inc.
Interaction Systems Inc.
Levy Hill Labs. Ltd.
O&S Research Inc.
Optical Coating Laboratory, Inc.
Optical Devices Inc.
Owens-Illinois, Inc.
Precision Electronic Glass
Triunplex Display Systems, Inc.
UCE, Inc.

HIGH-VOLTAGE POWER SUPPLIES

Craft Data Ltd.
Del Electronics Corp.
Display Components Inc. (DISCOM)
Ginsbury Electronics Ltd.
Infodex, Inc.
International High-Voltage Electronics Inc.
Keltron Corp.
K&R Engineering Sales Corp.
P.B.E., The Repair Specialists
Penn-Tran Corp.
PTK/Rantec Division, Emerson Electronics Co.
Toko America, Inc.
Wasatch High Voltage, Inc.
Wells Gardner Electronics

IMAGE PROCESSORS

Datacube, Inc.

IMAGE TUBES, CCD IMAGERS

AEG Corp.
Burle Industries, Inc. (formerly RCA Tube Operations)
Dage MTI Inc.
EEV Inc.
EG & G Reticon
Hughes Aircraft Co.
Incom Inc.
McMahan Electro-Optics Inc.
MII Corp/Teltron Inc.
RCA Tube Operations (see Burle Industries, Inc.)
Sharp Electronics Corp.
Texas Instruments, Inc.
Thin Film Device, Inc.
Thomson-CSF, Division Tubes Electroniques
Thomson Electron Tubes and Devices Corp.
Toshiba America, Inc.
Toshiba Corp.
Westinghouse Electronics Corp., Imaging and Sensing Technology Division

LARGE-SCREEN DISPLAYS

Large-screen matrix displays

Display * Tech Inc.
IEC Co.
Lucitron inc.
Omega Electronics SA
Photonics Technology
UCE, Inc.
Varitronix Ltd.
Xtalite Display Systems Inc. USA
Xtalite Technology Ltd. Canada

Large-screen plasma displays

Craft Data Ltd.
Displays, Inc.
Electro Plasma Inc.
Emerald Computers, Inc.
Magnavox Electronic Systems Co.
Photonics Technology
Quantum Electronics Inc.
SAIT
Thomson Electron Tubes and Devices Corp.
World Products, Systems Devices Group

Large-screen text displays

Display * Tech Inc.
EEV Inc.
Lucitron inc.
Omega Electronics SA
Photonics Technology
Triunplex Display Systems, Inc.
UCE, Inc.
World Products, Systems Devices Group
Xtalite Display Systems Inc. USA
Xtalite Technology Ltd. Canada

Liquid-crystal light-valve projectors

DataBeam Corp.
Excel Technology Corp. Int'l.
Greyhawk Systems, Inc.
Hughes Aircraft Co.
Hughes Aircraft Co./Industrial Products Division
Ovonic Imaging Systems, Inc.
UCE, Inc.
Varitronix Ltd.

Message boards

Craft Data Inc.
Craft Data Ltd.
Display * Tech Inc.
EEV Inc.
Futaba Corp of America
Ginsbury Electronics Ltd.
HECON Corp.
Hornell Elektrooptik AB
Lucitron inc.
Norsk LCD
Omega Electronics SA
Quantum Electronics Inc.
Racal Microelectronic Systems Ltd.
Xtalite Display Systems Inc. USA
Xtalite Technology Ltd. Canada

Projection CRTs

Arcturus, Inc.
Barco Electronics, Inc.
Clinton Electronics Corp.
DataBeam Corp.
EEV Inc.
Electrohome Ltd.
Electrohome Ltd., Projection Products
Electrohome Ltd., Video Display Products
General Electric, Projection Display Products
Ginsbury Electronics LTD.
Hitachi, Ltd.
Ikegami Electronics
Image Amplification Inc.
Infodex, Inc.
Sony Component Products Division
Thomas Electronics, Inc.
Thomson-CSF, Division Tubes Electroniques
Thomson Electron Tubes and Devices Corp.
Toshiba America, Inc.
Triunplex Display Systems, Inc.
XYtron, Inc.
Zenith Electronics Corp.

Simulator displays

Arcturus, Inc.
DataBeam Corp.
Display * Tech Inc.
Ginsbury Electronics Ltd.
Hughes Aircraft Co.
Infodex, Inc.
Lucitron inc.
Rediffusion Simulation Inc.

Large-screen displays, other

Futaba Corp of America
General Electric, Projection Display Products
HECON Corp.
Incom Inc.
Lucitron inc.
MicroTouch Systems Inc.
Norsk LCD
Photo Research Division, Kollmorgen Corp.
Rediffusion Simulation Inc.
StereoGraphics Corp.
Syntronic Instruments, Inc.

MAGNETIC SHIELDING

Ad-Vance Magnetics, Inc.
AEG Corp.
Amuneal Manufacturing Corp.
Eagle Magnetic Co., Inc.
The Inter-Technical Group, Inc.
K&R Engineering Sales Corp.
Magnetic Radiation Labs., Inc.
Magnetic Shield Corp., Perfection Mica Co.
Optical Coating Laboratory, Inc.
Tech Spray, Inc.
Thin Film Device, Inc.
Thomson Electron Tubes and Devices Corp.

MARKET RESEARCHERS

Stanford Resources, Inc

OPTICAL COATINGS

Anti-reflection coatings

Asahi Glass Co., Ltd.
BDH Ltd.
Craft Data Ltd.
Deposition Technology Inc.
Ginsbury Electronics Ltd.
Greenwich Marketing Corp.
Hallcrest Products Inc.
Homalite, Inc.
Hornell Elektrooptik AB
Hoya Optics, Inc.
Infodex, Inc.
Metavac, Inc.
O&S Research, Inc.
Optical Coating Laboratory, Inc.
Optical Devices Inc.
Panelgraphic Corp.
Raytheon Co., Industrial Components Operation
Tech Spray, Inc.
Thin Film Device, Inc.
Thomson Electron Tubes and Devices Corp.
3M Industrial Optics

Custom coatings

Andus Corp.

Resolution-enhancement coatings

BDH Ltd.
Brewer Science, Inc.
Ginsbury Electronics Ltd.
Hallcrest Products Inc.
Optical Coating Laboratory, Inc.
Optical Devices Inc.
Panelgraphic Corp.
Raytheon Co., Industrial Components Operation
Thin Film Device, Inc.
Thomson Electron Tubes and Devices Corp.

Transparent conductive coatings
Applied Films Lab, Inc.

PACKAGING FOR DISPLAYS
Barco-Industries, Inc.
The Cherry Corp.
Chromatics, Inc.
Craft Data Inc.
Craft Data Ltd.
DataBeam Corp.
DataSpan Inc.
Electro Plasma Inc.
Elform, Inc.
Emerald Computers, Inc.
Ginsbury Electronics Ltd.
Hartman Systems, a Figgie International Co.
IEE
Infodex, Inc.
Intelligent Light, Inc.
Korry Electronics Co.
Mega Vision, Inc.
Modgraph Inc.
Panelgraphic Corp.
Raytheon Co., Industrial Components Operation
Sanders Associates, Inc., A Lockheed Co.
Syntronic Instruments, Inc.
Thomson Electron Tubes and Devices Corp.
Toshiba Corp.
Transicoil Inc.
UCE, Inc.
Zenith Electronics Corp.

POWER CONVERSION SYSTEMS
Venus Scientific, Inc.

PRINTERS AND OTHER HARD-COPY DEVICES

Digital film recorders
CELCO
Ektron Applied Imaging, Inc.
Lasergraphics, Inc.
Mega Vision Inc.

Electronic photography
Cilas Alcatel
Dainippon Ink and Chemicals, Inc.
Mega Vision Inc.
Toshiba Corp.

Electrophotographic laser printers
Cilas Alcatel
DataBeam Corp.
DeRex Inc.
International Business Machines Corp.
NBS Southern, Inc.
OKIDATA
QMS, Inc.
Tempest Technologies, Inc.
Texas Instruments, Inc.
Toshiba Corp.

Facsimile devices
Cilas Alcatel
DataBeam Corp.
International Business Machines Corp.
McMahan Electro-Optics, Inc.
Sanyo Business Systems Corp.
Toshiba Corp.

Impact printers
DeRex Inc.
Eaton Printer Products
International Business Machines Corp.
NBS Southern, Inc.
OKIDATA
Sanyo Business Systems Corp.
Tempest Technologies, Inc.
Texas Instruments, Inc.

Ink-jet printers
DeRex Inc.
Diagraph Corp.
International Business Machines Corp.
Mega Vision Inc.
Texas Instruments, Inc.

Optical disks/video disks
Craft Data Ltd.
Dainippon Ink and Chemicals, Inc.
Flachglas AG
International Business Machines Corp.
Mega Vision Inc.
Mitsubishi Chemical Industries America Inc.
Sanyo Business Systems Corp.

Pen plotters
Houston Instruments, Division of Ametek, Inc.
International Business Machines Corp.
Tempest Technologies, Inc.
Wacom Co., Ltd.

Thermal-transfer printers
Craft Data Inc.
Craft Data Ltd.
Eaton Printer Products
Industrial Service Labs (ISL) Corp.
International Business Machines Corp.
Lasergraphics, Inc.
Mega Vision Inc.
OKIDATA
QMS, Inc.
Test and Measurement Systems, Inc.
Texas Instruments, Inc.
Toshiba Corp.

3D hard-copy devices
Cilas Alcatel

Videotape
Dainippon Ink and Chemicals, Inc.
Mega Vision Inc.

Hard-copy devices, other
Enabling Technologies Co.
HECON Corp.
NBS Southern, Inc.
Raytheon Co., Submarine Signal Division

PRINTER PERIPHERALS
Craft Data Inc.
Craft Data Ltd.
Dainippon Ink and Chemicals, Inc.
DeRex Inc.
Diagraph Corp.
Eaton Printer Products
International Business Machines Corp.
James River Corp.
Kyocera America, Inc.
Mitsubishi Chemical Industries America Inc.
Optotek Ltd.
Peripheral Connections, Inc. (PERCON)
Supertex Inc.
Thomson Electron Tubes and Devices Corp.

REPAIR AND MAINTENANCE
P.B.E., The Repair Specialists
TRW Customer Service Division

SOFTWARE FOR DISPLAYS
The Cherry Corp.
Chromatics, Inc.
Computer Peripherals Inc.
Craft Data Inc.
Craft Data Ltd.
DataBeam Corp.
DataSpan Inc.
Digital Electronics Corp.
Display Technology Inc.
Emerald Computers, Inc.
Enabling Technology Co.
Endicott Research Group, Inc.
Futaba Corp. of America
Ginsbury Electronics Ltd.
Global Imaging, Inc.
Hughes Aircraft Co.
International Business Machines Corp.
MicroTouch Systems, Inc.
Modgraph Inc.
Omega Electronics SA
QDP Computer Systems, Inc.
Racal Microelectronic Systems Ltd.
Raytheon Co., Submarine Signal Division
SAIT
Sanders Associates, Inc., A Lockheed Co.
UCE, Inc.
Wacom Co., Ltd.
Xtalite Display Systems Inc. USA
Xtalite Technology Ltd. Canada

TEST AND MEASUREMENT EQUIPMENT
Analogic Corp.
Ball Corp., Electrical Systems Division
Bowmar/ALI, Inc.
CELCO
Control Systems Technology
DataSpan Inc.
Del Electronics Corp.
Display Components Inc. (DISCOM)
Dranetz Technologies Inc.
EG&G Gamma Scientific Inc.
Eltime Vision Systems
Ginsbury Electronics Ltd.
Greenwich Marketing Corp.
Hallcrest Products Inc.
Hoffman Engineering Corp.
IEC Co.
Industrial Service Labs. Corp.
K&R Engineering Sales Corp.
Korry Electronics Co.
LMT
LMT GmBH Berlin
McMahan Electro-Optics, Inc.
Magnetic Shield Corp., Perfection Mica Co.
Meylan Corp.
Microvision
Minolta Corp.
Optical Radiation Corp.
Optotek Ltd.
Particle Data, Inc.
Peer Protocols, Inc.
Photon, Inc.
Photo Research Division/Kollmorgen Corp.
PTK/Rantec Division, Emerson Electronics Co.
Quantum Data Inc.
Test and Measurement Systems, Inc.
Triplett Corp.
United Detector Technologies
Visual Information Institute, Inc. (VII)
Wahl Instruments, Inc.

3D DISPLAYS
Chromatics Inc.
Futaba Corp. of America
Hughes Aircraft Co.
QDP Computer Systems, Inc.
StereoGraphics Corp.
Tektronix, Inc., Liquid Crystal Shutter SPU

TOUCH-INTERACTIVE DISPLAYS
Carroll Touch, Inc.
The Cherry Corp.
Craft Data Inc.
Craft Data Ltd.
Dale Electronics Inc.
DataBeam Corp.
Digital Electronics Corp.
Electro Mechanical Systems Inc.
Electro Plasma Inc.
Emerald Computers, Inc.
Futaba Corp. of America
Houston Instruments, Division of Ametek Inc.
Interaction Systems, Inc.
Interstate Electronics Corp.
Magnavox Electronic Systems Co.
Magnavox/NAP Consumer Electronics
MicroTouch Systems Inc.
Phosphor Products Co. Ltd.
SAIT
Thomson-CSF, Division Tubes Electroniques
TSD Display Products Inc.
UCE, Inc.
Varitronix Ltd.
Wells Gardner Electronics
Zenith Electronics Corp.

VACUUM EQUIPMENT
Hornell Elektrooptik AB
SAES Getters/USA Inc.

VIDEO AMPLIFIERS
Citronix Inc.
Ginsbury Electronics Ltd.
Rank Brimar Ltd.
Video Monitors Inc.

AD-VANCE MAGNETICS, INC.
625 Monroe St.
Rochester, NY 46975
Manufacturers of custom-fabricated magnetic shields, magnetic tape and disk protectors, and magnetic-shielding alloy ray material, foil and sheet.
Kay Nixon, Sales Mgr.
219/223-3158 TWX: 810/290-0294
Fax: 219/223-2524

AEG CORP.
Route 22—Orr Dr.
P.O. Box 3800
Somerville, NJ 08876-1269
Manufacturers of LCDs for special applications, automotive dashboards, sign boards (bus terminals, stock exchange), military/avionics. Features: anti-reflective coatings, chip-on-glass approach, multicolors. Also monochrome CRT assemblies, head-up and head-down displays, high-resolution ruggedized monochrome color CRTs.
G. Barone, LCD Sales Mgr.;
P. Mikel, CRT Sales Mgr.
201/231-8300 Telex: 833409
Fax: 201/722-4905

AMUNEAL MANUFACTURING CORP.
4737 Darrah St.
Philadelphia, PA 19124
Manufacturers of custom and standard magnetic shields for magnetic-sensitive tubes and devices including CRTs, photomultipliers, and transformers. In-plant equipment includes CNC Turret Punch Press (Amada) and hydrogen annealing, automated heliarc welding, hydroforming, and CMM inspection equipment.
Raymond P. Pagliaro, Sales Mgr.
215/535-3000 Fax: 215/743-1715

ANALOGIC CORP.
Data Conversion Products
360 Audubon Road
Wakefield, MA 01880
Manufacturers of display-related products including video D/A converters.
Jim Segre, Mktg. Dir.
617/246-0300 Telex: 466-069
Fax: 617/245-1274

ANALOGIC CORP.
Data Precision Group
16 Electronics Ave.
Danvers, MA 01923
Manufacturers of test and measurement equipment including high-speed video waveform analyzer (Data 6100).
Dave Madsen, Mktg. Mgr.
617/246-1600 800/343-8150
800/892-0528 (MA only)
Telex: 681-7144 DATA PRCN
Fax: 617/777-7625

ANDUS CORP.
21019 Osborne St.
Canoga Park, CA 91304
Manufacturers of custom coatings on flexible substrates.
Linda A. Hoitt, Dir. Mktg./Sales
818/882-5744 Telex: 182374
Fax: 818/882-6519

APPLIED FILMS LAB, INC.
6797 Winchester Circle
Boulder, CO 80301
Manufacturers of sputtered thin-film components including ITO- and metal-coated front and rear display electrodes.
Cecil VanAlsburg, Pres.
303/530-1411 Telex: 450110 APPL FILM Fax: 303/530-3214

APPLIED GLASS TECHNOLOGY, INC.
2575 Sidney Lanier Dr.
Brunswick, GA 31520
Manufacturers of seal rods and spacer rods for flat-panel displays. Also special glasses, redrawn tubing and rod, glass-to-metal and sapphire-to-metal seals. Spacer rods and seal rods available in any cross section, tolerances to suit.
Bob Plumbo
912/265-7386

ARCTURUS, INC.
304 School St.
Acton, MA 01720
Manufacturers and distributors of high-bandwidth video projectors, switchers, RGB distribution amps for terminals operating at 30-70 kHz horizontal scanning frequency.
Tom Holzel, Pres.
617/263-1122 Fax: 617/263-9419

ARTISTIC GLASS PRODUCTS CO.
Kumry Road, Postal Drawer C
Trumbauersville, PA 18970-0051
Manufacturers of specialty-fabricated glass parts. Capabilities include all edge-finishing operations, drilling, chemical strengthening, and laminating.
215/536-0333 Telex: 211089 AGP UR Fax: 215/536-2025

ASAHI GLASS CO., LTD.
1-2, Marunouchi 2-chome, Chiyodaku
Tokyo 100, Japan
Manufacturers of glass products: glass bulbs for CRTs, substrates for LCD and EL devices.
T. Shimamura, Foreign Trade Dept.
03-218-5432 Telex: J24616
Fax: 03-211-5071

BABCOCK DISPLAY PRODUCTS
1051 S. East St.
Anaheim, CA 92805
Manufacturers of gas-discharge displays and VFDs.
John Hackney, Dir. Sales
714/491-5100 Telex: 249646

BALL CORP.
Electronic Systems Div.
P.O. Box 589
9343 W. 108 Circle
Broomfield, CO 80020
Manufacturers of high-speed inspection system and industrial instrumentation (temperature measurement system).
Robert Heiser, Dir. Mktg.
303/460-5272 800/525-1215
Telex: 244826 BALL UR Fax: 303/460-5423

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1500 Wilson Way, Suite 250
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Manufacturers and marketers of CRT-based video projectors, primarily for the computer market. Top-of-the-line unit will scan automatically from 15 to 72 kHz with 100-MHz bandwidth. Also a full line of direct-view monitors.
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BARCO-INDUSTRIES, INC.
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Kortrijk, Belgium 8500
Manufacturers of graphic displays, broadcast monitors, rugged displays, and cockpit displays.
(32) (56) 233211 Telex: 85842
BARIND B Fax: (32) (56) 200418

BARCO-INDUSTRIES, INC.
472 Amherst St., Suite 10
Nashua, NH 03063
Manufacturers of graphic displays, broadcast monitors, rugged displays, and cockpit displays.
Peter Paelinck, Gen'l. Mgr.
603/880-1430 Telex: 0236/6502647465 MCIUW Fax: 603/880-8918

BARCO-INDUSTRIES, INC.
170 Knowless Dr., Suite 212
Los Gatos, CA 95030
Manufacturers of graphic displays, broadcast monitors, rugged displays, and cockpit displays.
Barry Turner, Prod. Mgr.
408/370-3721 Telex: 0236/6502637464 MCIUW Fax: 408/866-9103

THE BATES MANUFACTURING CO.
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Hackettstown, NJ 07840
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201/852-9300 800/222-2837
Telex: 13671 Fax: 201/852-7837

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Manufacturers of LCs for electro-optic displays and thermochromic devices. Also makes single crystals for IR, UV, and scintillator applications; nonlinear optical materials; and inorganic fluorides for fiber-optic use.
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0202 745520 (Nat'l.) 44 202 745520 (Int'l.) Telex: 41186 TETRA G
Fax: 0202 738299 (GP 3)

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Flushing, NY 11354
R&D and consultation in image and data scanning and recording. Specializing in laser-based printing, graphics, industrial, display, and information systems, including CRT and discrete element devices. Patent expertise and in-company guidance and training.
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215/277-2910 Fax: 215/277-2956

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531 Main St.
Acton, MA 01720
Manufacturers of 3-, 5-, and 10-in. analog bargraph/LED panel meters and 5- and 10-in. analog bargraph/digital panel meters.
Allen Warner, Prod. Mgr.
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Fax: 617/263-3358

BREWER SCIENCE, INC.
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P.O. Box GG
Rolla, MO 65401
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314/364-0300 Telex: 351471
Fax: 314/364-7150

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P.O. Box 186
Los Gatos, CA 95031
Consulting and design services in CRT systems including VDTs, HUDs, HDDs, projection, recording, and test equipment; CRT circuits including deflection, video, geometry correction, and color convergence; cameras and solid-state imagers; project management and new product development.
Gus Carroll, Pres.
408/358-0023

CARROLL TOUCH, INC.
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Round Rock, TX 78664
Manufacturers, designers, and developers of both infrared and resistive overlay touch input products. Also market a line of Total-Touch products specifically designed for the systems integrator looking for a packaged solution rather than an add-on product.
Robert Dehm, Nat'l. Sales Mgr.
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CBI CONSULTING
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Belmont, CA 94002
Consulting services in the fields of high-resolution displays, graphics, and analog technologies.
Carlo Infante, Pres.
415/593-5098

CELCO
70 Constantine Dr.
Mahway, NJ 07430
Manufacturers of deflection yokes, deflection amplifiers, CRT test equipment, CRT digital film-recording systems.
Art Weirgen, Sales Engineer
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312/360-3522 Fax: 312/360-3566

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2558 Mountain Industrial Blvd.
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Manufacturers and designers of high-resolution color graphic computers and display systems for military, aerospace, scientific, and commercial applications. CX 2000 series features 1,000,000 vectors/sec; 50,000 flat shaded polygons/sec and 150-μsec full-screen erase.
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Fax: 404/493-1314

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CITRONIX, INC.
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Manufacturers of magnetic deflection amplifiers; magnetic focus amplifiers; and video amplifiers.
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Manufacturers of CRTs for data display, imaging, and consumer electronics. Products include display-grade high-resolution CRTs with special phosphors, "Spectrum" segmented screens, anti-glare options, and ultra-high-resolution CRTs.
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815/633-1444 Telex: 25-7484
Fax: 815/633-8712

CLOVER DISPLAY, LTD.
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Manufacturers of 7 segment LCD and 5 x 7 dot-matrix modules.
Mr. C. L. Chou, Oper. Dir.
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Fax: 3-7541121

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Telex: 759299 CPI Fax:
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Chicago, IL 60646
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607/974-4102 Telex: 932498
Fax: 607/974-8150

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Mission Viejo, CA 92691
Representatives for manufacturers of electronic displays, primarily Dixy Corp. and Mitani plasma displays and NIFCO LCD modules with drivers and standard interfaces and power supplies. Custom LED arrays.
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Michigan City, IN 46360
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219/872-5514 Telex: 532521 DAGEMTI

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Manufacturers of a variety of LC materials for LC displays and related products such as sealants and color filters.
T. Takahashi, Gen'l. Mgr.
(03)272-4511

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Columbus, NE 68601
Manufacturers of dc plasma (gas discharge) displays and display modules. Types include segmented (numeric and alphanumeric), bar graph, dot matrix, and graphic displays.
Darrell Smejkal, Sales Mgr.
402/564-3131 Telex: 6875046
Fax: 402/563-6418

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452 Burbank St.
Broomfield, CO 80020
Manufacturers of monochrome and color CRT displays for the OEM market. Monochrome: screen sizes, 7-23 in. (15.750-100 kHz); color: screen sizes, 13-19 in. (48-64 kHz).
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303/469-5173 Fax: 303/466-9524

DATA SPAN, INC.
3815 California Road
Orchard Park, NY 14127
Manufacturers of converters; video acquisition display stations; image enhancement stations; image communications systems; graphic controllers; and NTSC frame stores.
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Fax: 617/535-5643

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Distributors of plug compatible printer systems from 200 CPS through 8000 LPM. Impact and non-impact for IBM, Unisys, H-P, DEC, Prime, DG and other popular mini and mainframe computers.
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305/753-0840 800/245-7282
Fax: 305/753-0944

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Mt. Vernon, NY 10550
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Fax: 914/699-4005

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2540 W. 237 St.
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914/592-6050 800/431-1230
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Fax: 619/576-9286

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Sunnyvale, CA 94086
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Fax: 408/738-6979

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Fax: 419/242-9713

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Fax: 519/749-3131

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315/781-1350 Telex: 510/582-4699
Fax: 315/789-1489

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Fullbridge, Maldon
Essex, U.K. CM9 7LP
Manufacturers of frame stores, image-processing systems, video noise-reduction systems, automatic visual-inspection systems.
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Fax: 914/592-4660, ext. 308
914/592-4668 (nighttime)

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Fax: 607/754-9255

EXCEL TECHNOLOGY CORP. INT'L.
5-4 Stryker Lane
Belle Mead, NJ 08502
Manufacturers of LCDs.
Michi Chen, Sales Mgr.
201/874-4747 Telex: 910/333-9588
Fax: 201/874-3278

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Fax: 416/625-6197

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Cupertino, CA 95014
Distributors of thin-film ac EL displays: Models 512.256, 15/15 mils, 5.51 × 10.2 × 1.38 in.; 640.200, 12/24 mils, 6.24 × 9.0 × 0.75 in.; and 640.400, 12/12 mils, 6.24 × 9.0 × 0.75 in.
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408/725-1972 Fax: 408/996-7547

FLACHGLAS AG
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P.O. Box 13 09
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Manufacturers of MICROWIT thin and special sheet glasses for LCDs, EC displays, EL displays, optical data-storage discs, photomasks. Also, ITO- and SiO_2-coated glasses (on-line production from raw glass to ready-coated and edge-worked glass).
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Manufacturers of a complete line of scan converters, including radar, video and the new color graphics converter which converts high-resolution color graphics into standard NTSC format for use with video recorders.
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916/985-2481 Telex: 880-440
Fax: 916/985-7236

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34115 W. 12 Mile Road (U.S.)
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Manufacturers of large-screen vacuum fluorescent displays, backlights, controller and driver circuitry, message boards, 3-D displays, color filters, and touch-interactive displays.
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313/553-3038 Fax: 313/553-3176

FUTURE SYSTEMS, INC.
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Publishers of research and information on interactive video, videodisc, compact-disc technology, and related fields. The firm publishes newsletters, reports, books, and market studies.
Rockley Miller, Pres.
703/241-1799 Telex: 4996279

GALILEO ELECTRO-OPTICS CORP.
Galileo Park
Sturbridge, MA 01566
Manufacturers of fiber-optic and electro-optic products.
Lawrence T. Guzowski, Key Acct. Exec.
617/347-9191 800/648-1800 (outside MA)
Telex: 4999014 Fax: 617/347-3849

GENERAL ELECTRIC
Projection Display Products
Electronics Park 6-205
Syracuse, NY 13221
Manufacturers of large-screen video/data projectors including Talaria and MLV light-valve projectors for screen sizes up to 30 ft. wide and imager projectors for screen sizes up to 120 in. diagonal.
315/456-2152 Telex: 192808016 PDPO MKTG
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GENERAL INSTRUMENT OPTOELECTRONICS DIV.
3400 Hillview Ave.
Palo Alto, CA 94304
Manufacturers of a wide range of optoelectronic displays, including photocouplers, LED lamps and displays.
415/493-0400 Telex: 470208
Fax: 415/493-7055

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108 High St., Strood
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Offers full engineering support in the design of industrial, commercial, and military CRT-based display systems.
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(0634) 721484 Telex: 96235
Fax: (0634) 712589

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Solana Beach, CA 92075
Software and systems integration. Turnkey digital image-processing systems.
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800/822-4624 (CA only) Telex: 5106010611

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J. Pat Romeo
203/323-8555 Telex: 5101004279 GMC
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Manufacturers of cholesteric and chiral nematic LC inks, films and temperature-related products.
Rocco A. Sapienza, Pres.
312/998-8580 Telex: 270-575 HPSA

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The Plaza Building
Fair Lawn, NJ 07410
Representatives for manufacturers of magnetic deflection components for CRTs: yolks, focus coils, stigmators, centering coils, precision in-line and delta magnetic components.
George D. Harris, Pres.
201/796-5200 Fax: 201/796-0070

HARTMAN SYSTEMS
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360 Wolf Hill Road
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Manufacturers of monochrome and full-color CRT displays for spaceborne, airborne, shipboard and land-based military application. Available as MIL-qualified or ruggedized configurations.
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Fax: 516/351-1508

HECON CORP.
15 Meridian Road
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Ken Lackey, Prod. Specialist
201/542-9200 800/524-1669
Telex: 132457 Fax: 201/544-1343

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5-1, Marunouchi 1-chome, Chiyoda-ku Tokyo 100, Japan
Manufacturers of color picture tubes, color display tubes, projection tubes, and LCDs.
Electron Tube Div., Sales Engrg. Dept.
03-212-111 Telex: J22395, J22432 HITACHY Fax: 03-215-3689

HITECH INTERNATIONAL
1435 McCandless Dr.
Milpitas, CA 95035
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Paul Flocas, Sales Mgr.
415/263-3300 Telex: 501422 HITECH

HOFFMAN ENGINEERING CORP.
P.O. Box 300
Old Greenwich, CT 06870
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Jeffrey O. Brown, Sales Mgr.
203/325-8933 Telex: 643621
Fax: 203/327-4812

HOMALITE, INC.
11 Brookside Dr.
Wilmington, DE 19804
Manufacturers of color filters and anti-glare contrast-enhancement filters.
Susan Stepchuck, Sales Rep.
302/652-3686 800/346-7802
Telex: 510/600-0874 Fax: 302/652-4578

HORNELL ELEKTROOPTIK AB
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512/835-0900 Telex: 776438
Fax: 512/835-1916

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3400 Edison Way
Fremont, CA 94538
Manufacturers of low-expansion glass substrates for EL panels; color glass substrates for CRT image enhancement; sunlight-readable glass filters for LED displays; anti-reflection coatings; polarizers and laminated image-enhancement filters.
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415/490-1880 Telex: 172-647
Fax: 415/490-1988

HUGHES AIRCRAFT CO.
Industrial Prod. Div.
6155 El Camino Road
Carlsbad, CA 92009
Manufacturers of special-purpose CRTs, direct-view storage tubes, LC light valves, and custom display equipment.
John Roy, Mktg. Mgr.
619/931-3586
Telex: 910/322-1393 HACIWPD CSBD
Fax: 619/931-3334

HUGHES AIRCRAFT CO.
7200 Hughes Terrace
P.O. Box 45066
Los Angeles, CA 90045-0066
Manufacturers of CRTs and monitors; helmet-mounted, large-screen, and 3D displays; flat-panel displays (plasma, gas discharge, LC); LC light-valve projectors; image tubes; display drivers; fiber-optic cables and connectors.
R. D. Grafing, Mgr., RFP Control
213/568-6838 Telex: 910/328-6566
Fax: 213/568-7565

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16841 Armstrong Ave.
Irvine, CA 92714
Distributors of standard Sharp Corp. TFEL products and accessories. Hycom designs and produces custom TFEL display systems, specializing in shaded-video and computer graphics; also integrates TFEL products into network systems for operation with a remote host computer.
William Hedge, Sales Mgr., TFEL Disp.
714/261-6224 Telex: 678408
Fax: 714/261-9321

IEC COMPANY
1450 E. 17 St., Suite 122
Santa Ana, CA 92701
Distributors of high-brightness vacuum fluorescent displays, lighting lab equipment, NVA compatible EL lamps, filters and radiometers, hardware for edgelit display panels.
Gene Hu, Pres.
714/543-6295 Fax: 714/543-7383

IEE
7740 Lemona Ave.
Van Nuys, CA 91405
Manufacturers of LED displays, sealed bezel assemblies and display mounting hardware, VF, dc plasma and LCD modules, military EL display modules and interactive touch panels of various technologies.
Darryl Bloom, Dir. Sales
818/787-0311 Telex: 4720693 IEE IPD Fax: 818/901/9045 G2/G3

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Maywood, NJ 07607
Manufacturers of a complete line of high-resolution color and black-and-white display monitors.
Don Mason, NE Reg'l. Sales Mgr.
201/368-9171

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Manufacturers and distributors of three models of composite video three-tube color projectors with audio. The Ultravision 2000 and 3000 are monitors with monaural audio. The Ultravision 4000 has MTS stereo tuner, IR remote, and built-in stereo audio.
Arnie Ginsburg, Vice Pres./Gen'l. Mgr.
201/882-0584 Telex: 130 236

INCOM, INC.
205 Chapin St., Drawer G
Southbridge, MA 01550
Manufacturers of fiber optic faceplates; flexible light guides; spot-to-line converters; image conduits; rear-projection screens; large fiber-optic CRT screens; image tubes; and CCD imagers.
Jerry Burke, Cust. Serv. Mgr.
617/765-9151 TWK: 710/247-1604
Fax: 617/765-0041

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St. Louis, MO 63108
Distributors of 3-5 digit LED digital panel meters, up to 8-digit counters, timers, rate indicators, LCD and vacuum fluorescent displays.
Peter A. Racon, Vice Pres.
314/535-5760 800/325-8653

INFODEX, INC.
395 W. Main St.
Waterbury, CT 06702
Manufacturers of CRT monochrome and color displays for military, medical, and ruggedized industrial applications, and EL displays.
Roger J. Lemire, Sales Applic. Eng.
203/757-9291 Fax: 203/757-9291, ext. 230

INTELLIGENT LIGHT, INC.
P.O. Box 65
Fairlawn, NJ 07410
Manufacturers of 3-D computer-graphic animation systems. Suppliers of hardware and software for Apollo converters, complete turnkey systems, graphic boards and displays, and video input/output to VTRs or film recorders.
Gary Attanasio, Mgr. No. Amer. Sales
201/794-7550 Telex: 178066

INTERACTION SYSTEMS, INC.
130 Lincoln St.
Brighton, MA 02135
Manufacturers of high-quality solid-glass capacitive touch screens and controllers. Touch screens available in spherical, cylindrical shapes for sizes 9-25 in. and flat-panel shapes up to 22 x 22 in. Touch controllers available in serial interface, parallel interface, IBM PC compatible plug-in board, and stand-alone configurations.
Joanne Dawson, Mktg. Mgr.
617/789-5900 Telex: 753 582

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Old Orchard Road
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National organization. Please refer to your local telephone directory.

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Finance Dr., Commerce Park
Danbury, CT 06810
Manufacturers of OEM high-voltage dc power supplies. Applications include FO, CRTs, video display terminals, projection CRTs, and ELPs.
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High-tech market research and consulting firm which publishes multiclient research reports for vendors involved in several markets.
Carole E. Keogh, Mktg. Comm. Mgr.
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Anaheim, CA 92803
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Russ Summers, Nat'l. Sales Mgr. Display Prod.
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Manufacturers of CAD/CAM laser-cut magnetic shielding.
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914/591-8822 Telex: 7105640802
Fax: 914/591-7336

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10550 Talbert
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Manufacturers of parallel interconnects for flat-panel displays.
Judson Clark, Dir. New Prod. Dev.
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354 Route 206
Flanders, NJ 07836
Product representative for Display Components, Inc. and Advance Magnetics, Inc.
Robert J. Resker, Pres.
201/584-5235 800/631-9362
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Manufacturers of vaporable barium getters for use in any size CRT.
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San Diego, CA 92123
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Fax: 619/569-0396

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Fax: 602/968-4471, ext. 223

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Fax: 619/693-3670

LMT Lichtmesstechnik GmbH
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D1000 Berlin 10, West Germany
Manufacturers of illumination meters, spot photometers, colorimeters (tristimulous filter types), luminance standards, integrating spheres, goniophotometers, retroreflectance meters.
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2160 Park Ave., N
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METAVAC, INC.
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Manufacturers of high-efficiency reflection reducing coating and transparent conductive coatings for contrast-enhancement filters, implosion panels, and glass cocers for displays.
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264 W. 40 St., 20th Fl.
New York, NY 10018-1585
Manufacturers and distributors of time study equipment including stopwatches, counters, event loggers to chart downtime, productive time. Also tachometers, temperature probes, gas detectors, internal timers, hour meters, and vibration meters.
Gary Caporusso, Nat'l. Sales Mgr.
212/391-9150

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Fax: 617/935-0133

MICROVISION
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Campbell, CA 95008
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P.O. Box 395
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Ramsey, NJ 07446
Manufacturers of light and color measurement instrumentation.
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Fax: 201/423-0590

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01 603 3431 Telex: 23435
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Manufacturers of high-performance color monitors. Resolutions of 1600 × 1280, 1280 × 1024, 1024 × 768; bandwidth of 160 MHz, 120 MHz; scan rates of 48-90 kHz, 48-74 kHz modular design.
Kevin Gonor, Vice Pres., Mktg./Sales
614/891-3232 Telex: 51010105 48
Fax: 614/891-2192

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P.O. Box 223699
Carmel, CA 93922
Consulting services and research in vision and visual-display human factors.
Robert T. Hennessy, Pres.
408/625-5285

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100 North Belcher Rd.
Clearwater, FL 34625
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813/441-1981 Telex: 522135
Fax: 813/447-3012

NEC HOME ELCTRONICS (USA), INC.
1255 Michael Dr.
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Fax: (47) 3-880367

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Riverton, NJ 08077
Manufacturers and suppliers of aircraft instrument lighting wedges, cover glasses, and CRT contrast-enhancement filter glass. Line of anti-reflection coatings includes MIL-C-14806A, AMS 2521A, and MIL-C-675C.
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609/829-2800

OCLI—OPTICAL COATING LABORATORY, INC.
2789 Northpoint Parkway
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Manufacturers of high-technology thin-film coatings on glass, plastic, germanium, and other substrates for the control of light. Products include high-efficiency anti-reflection coatings, bandpass filters, beamsplitters, high-performance mirrors, heat/light separators, transparent conductive coatings, optically variable coatings.
Bill Grenawalt, OEM Sales Mgr.
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Telex: 510/744-2083 Fax: 707/525-7410

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609/235-2600 800/OKIDATA
Telex: 710/897-0792 Fax: 609/778-4184

OMEGA ELECTRONICS SA
Rue Stampfli 96
Bienne, Switzerland 2504
Manufacturers of color video replay scoreboards; black-and-white matrix scoreboards; alphanumeric and numeric scoreboards; and timing and judging equipment for all sports.
C. Calderara, Vice Pres., Mktg.
32 429 713 Telex: 931-207 OE CH
Fax: 32 413-321

OPTICAL DEVICES, INC.
805 Via Alondra
Camarillo, CA 93010
Manufacturers of linear polarizers for use in LCDs; contrast-enhancement filters for alphanumeric displays, which incorporate such features as circular polarizers and antireflection glass; and bandpass filters and EMI/RFI layers.
Barbara Winters, Mktg./Sales
805/987-8801 Telex: 18-2233
Fax: 805/388-1123

OPTICAL RADIATION CORP.
1300 Optical Dr.
Azusa, CA 91702
Manufacturers of UV exposure systems, mask aligners, and proximity printers. Photoimaging equipment for flat-panel displays, hybrids, TAB and PBCs.
Chuck Sahli, Mktg. Mgr.
818/969-3344 Telex: 910/584-4851
Fax: 818/969-3681

OPTOTEK, LTD.
62 Steacie Dr.
Kanata, Ont., Canada K2K 2A9
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Fax: 613/591-0584

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Fax: 516/842-7410

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Columbus, OH 43207
Manufacturers of CRT glass parts.
Jim Kyle, Accts. Mgr.
614/443-6551, ext. 306 Telex: 4993701
Fax: 614/443-6551, ext. 346

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201/348-5280; Paul Wasek, Prod. Spec., Plasma Displays
201/392-4710
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Fax: 201/392-4815

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Mobile, AL 36618
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Fax: 205/633-0013

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Mktg./Sales Div., Electron Tubes and Devices
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Chris Rowe, Eastern Reg'l. Accts. Mgr.
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Telex: 66-4406 Fax:
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Fax: 312/252-8072

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Imaging and Sensing Technology Div.
Westinghouse Circle
Horseheads, NY 14845
Manufacturers of military and industrial CRTs for all segments of the display industry. Also manufacture a line of image tubes and storage display tubes.
V. Muccigrosso, Sales Mgr.
607/796-3287 TWX: 510/252-1588
Fax: 607/796-3279

WORLD PRODUCTS
Systems Devices Group
P.O. Box 517
Sonoma, CA 95476
Distributors of NEC ac refresh plasma display products: standard displays 640 × 200, 640 × 400, 512 × 256, 576 × 256, 720 × 350; large signs and monitor screens; custom products.
Sales Dept.
707/996-5201 Fax: 707/996-3380

XTALITE DISPLAY SYSTEMS, INC. (USA)
17632 Metzler Lane, #A
Huntington Beach, CA 92647
Manufacturers of LCD systems for large signs providing computer-controlled animated graphics and text display capabilities for indoor and outdoor applications.
Ed Joseph, Pres.
714/841-5453

XYTRON, INC.
13010 San Fernando Road
Sylmar, CA 91342
Manufacturers of multi-function Raster-Stroke ARINC C- and D-size color monitors and high-resolution color rear projection for simulated cockpits. Also Raster-Stroke multiplexers for MFD operation and stroke-type CRT monitors of all sizes.
Bill Lockshaw, Pres.
818/362-8341 Fax: 818/367-2970

ZENITH ELECTRONICS CORP.
1000 Milwaukee Ave.
Glenview, IL 60025
Manufacturers of a 14-in. "flat tension mask" color display and monochrome displays in various screen sizes for computer, automotive, and other OEMs; and color picture tubes for TV manufacturers.
Matt Mirapaul
312/391-7000 Telex: 25-4396
Fax: 312/391-7253

Flexible EL material comes by the roll

Bonar Kard-O-Lite, Inc., (BKL) has developed a thin flexible EL material that comes in continuous strips 5 and 8 in. wide, with a 12-in. width to be introduced later this year. Called KARD-O-LITE™, the material is particularly suitable for backlighting electronic displays and instrument clusters (such as in automotive applications), membrane switches, graphic panels, point-of-purchase displays, and emergency lighting. The material is less than 0.014-in. thick, can be die cut or hand-trimmed with scissors, is simple to interface with a power supply through BKL terminations, and easy to drive with BKL inverters. Non-glare BKL lamps have low energy consumption, are cool, emit very little infrared energy, and provide a bright light that is visible through smoke and fog.

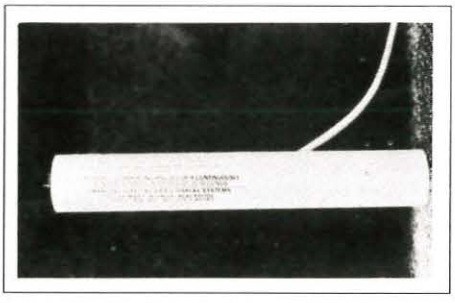
BKL recently created what it believes is the world's largest flexible lamp (see photo) by snipping off 10 ft. from a 100-ft. roll of KARD-O-LITE™ and connecting it to a suitable power source.

The company can provide complete EL systems, including lamps and inverters, and also sells the KARD-O-LITE™ material, which can be converted into a quality EL lamp in five easy steps. Customer support in fabricating EL lamps is provided under a licensing arrangement.

For further information contact Don Kardon, president, Bonar Kard-O-Lite, Inc., 421 Feheley Drive, King of Prussia, PA 19406. 215/277-2910.
Circle no. 13

Streamlined tubular degausser

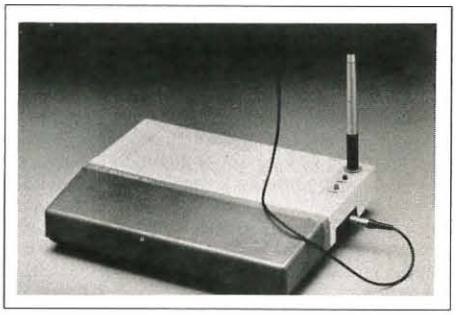
Video Display Systems, U.K., has invented a more-compact easier-to-handle tubular degausser. The degausser is connected to an AC supply, and the coil is held in a vertical position at the top left-hand side of the tube, the face in contact with the glass. The operator slowly sweeps the tube across the top and then the bottom half of the screen; the process is continued away from the tube for 6 ft. before the switch is released. The shadow mask is then demagnetized. The degausser measures 11 x 1.5 in., weighs approximately 19 oz., and is equipped with an 8-ft. electrical cable.



For further information contact J. Wilman, Video Display Systems, c/o British Information Services, 845 Third Ave., New York, NY 10022. 212/752-8400.
Circle no. 14

Signature-verification system

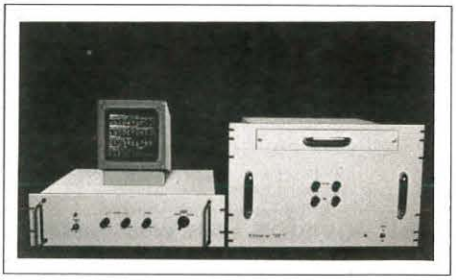
SECURISIGN, from AI Transaction Security, U.K., offers an alternative to existing password systems for computer access and data protection. A user's signature is analyzed and checked against a signature library; if a valid signature is not submitted, the system will reject the transaction and inform the host. Electromagnetic principles track the invisible flourishes of the hand off the surface of the paper—even an expert forgery can be detected. Up to 13 unique signature algorithms can be extracted and stored, and the system has defenses to prevent illegal copying.



For further information contact R. Gittings, AI Transaction Security, c/o British Information Services, 845 Third Ave., New York, NY 10022. 212/752-8400.
Circle no. 15

Multifunctional CRT display

XYtron, Inc., announces its Model MFD multifunctional display system. Utilizing a color CRT monitor and a stroke raster multiplexer, the new system combines the flexibility of raster-generated colors and backgrounds with the accuracy and sharpness of stroke-type graphics. The system's high-resolution CRT and dynamic convergence achieve extreme accuracy. The system achieves a 10-μsec full-screen linear writing rate and a 6-μsec raster flyback time. Internal adjustments provide full control for all geometrical distortion parameters while automatic degaussing and an external magnetic shield isolate

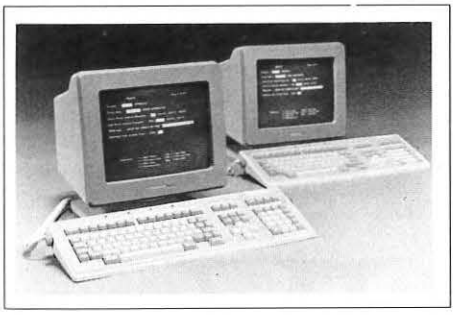


the system from interference caused by external magnetic forces. The MFD accepts both standard RGB video and analog stroke data which are formatted, synchronized, and time-shared for monitor display.

For further information contact Bill Lockshaw, XYtron, Inc., 13010 San Fernando Rd., Sylmar, CA 91342. 818/362-8341.
Circle no. 16

Compact computer terminal

Honeywell Bull, Inc., introduces a new terminal, the Honeywell Bull Display Station Model 5 (HDS 5), for use with its large and small computer product lines. The compact monitor houses both power supply and logic assembly in a tilt-and-swivel base. The non-glare 14-in. screen is available with green or amber phosphor. The 800 x 350 dot-resolution screen displays 80 or 132 standard-sized characters per line, as well as double-height and double-width characters. The new terminal also supports both fast jump and smooth scrolling, and up to five screen partitions. Additionally, an expanded forms mode capability provides new form-validation attributes and immediate transmission of numeric and edited fields. Standard and multilingual keyboards are available for the HDS 5 terminal, and each has 12 programmable function keys, which can be custom configured.



For further information contact Bruce J. MacDonald, Honeywell Bull, Inc., 300 Concord Rd., Billerica, MA 01821. 617/671-2517.
Circle no. 17

Desktop publishing system

The new Epsilon Graphics AT+ Publishing System comes complete with a QMS 300-dots/in. 8-page/min. laser

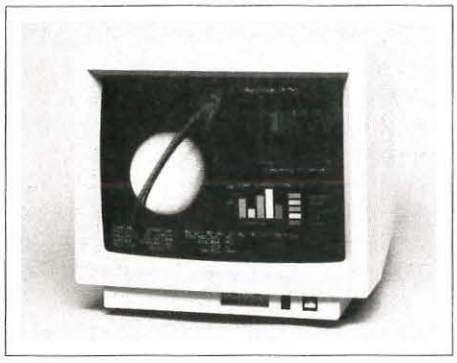
printer, 300-dots/in. Canon IX-12 scanner, Wyse 1280 x 800 resolution 13-in. monochrome display or 13-in. color EGA display system, MS-Mouse and a JLASER Plus scanner/printer controller interface with 2-Mbyte EMS memory board, and is 8-MHz AT-compatible with 30-Mbyte hard disk.

The heart of the Epsilon system, the JLASER PLUS controller, combines scanning and printing in a single board. The 8-MHz AT system combined with the JLASER PLUS board allows the printing of a full page of 300-dots/in. text and graphics in seconds. The Lotus/Intel/Microsoft standard EMS interface of the JLASER PLUS card is compatible with over 20 other publishing-related software products. The system is priced at $7995.

For further information contact Daniel J. Fili, Epsilon Graphics Systems, 1370 E. Edinger Ave., Santa Ana, CA 92705. 714/558-1288.
Circle no. 18

High-line-rate color monitor

The HG-6905BK high-line-rate color monitor with analog input is now available from Mitsubishi Electronics America, Inc., Computer Peripherals Division. The HG-6905BK has a wide scan range from 40 to 67 kHz horizontal, and from 50 to 75 Hz vertical, and features a high-resolution CRT with a self-convergence in-line gun, 0.31-mm dot pitch and 90° deflection angle. Resolution is 1280 x 1024 pixels non-interlaced. The HG-6905BK comes in a compact ergonomically styled chassis with external controls easily accessible on the front panel.



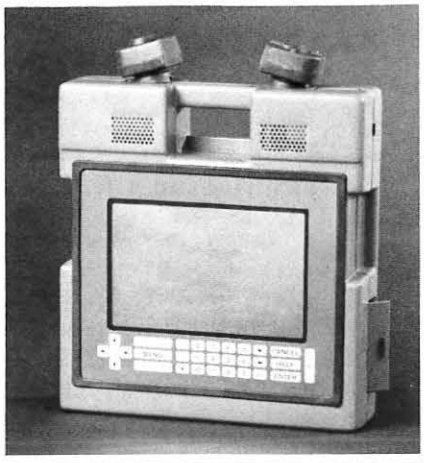
To ensure picture stability, the HG-6905BK incorporates a high-voltage stabilizer circuit. A tap-changing power supply operates on 90-132 VAC or 198-264 VAC for use anywhere in the world. Suggested list price is $3790.

For further information contact Evie Turner, Mitsubishi Electronics America, Inc., Computer Peripherals Division, 991 Knox St., Torrance, CA 90502. 213/515-3993.

Circle no. 20

Portable graphics terminal

Image Storage/Retrieval Systems, Inc., introduces a portable IBM PC-compatible workstation with a touch screen and half-high CD-ROM storage. Two configurations of the workstation will be available. One allows interface to a standalone CD-ROM, and the second has an integrated half-height CD-ROM drive. The system provides two levels of zoom to display graphics, and a touch screen and on-screen keyboard facilitate data entry. The portable unit is powered by either rechargeable batteries or normal wall outlets. Using MS/DOS 3.2, the workstation runs IBM PC software with an optional IBM-compatible keyboard and low-cost printer. It also contains 640 bytes of main memory, up to 4 Mbytes of display memory and an internal 2400-baud



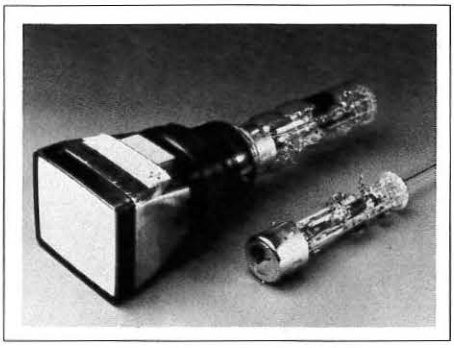
MNP-3 modem.

For further information contact Image Storage/Retrieval Systems, Inc., 850 Bear Tavern Rd., West Trenton, NJ 08628. 609/883-6286.

Circle no. 21

CRT with 500-MHz range

AEG Corp. has announced the availability of a CRT for oscilloscopes and other instrumentation with the broadest range currently available—of the order of 500 MHz. The D14-410 features high deflection sensitivity, high writing speed, and wide bandwidths in excess of 250 MHz. The high deflection sensitivities (vertical, 1.2 V/cm; horizontal, 6 V/cm) are achieved with the aid of scan expansion through quadrapole lenses. High writing speed and good line definition are acheived by means of a recently developed electron gun and by increasing the anode voltage to 24 kV.



For further information contact AEG Corp., Route 22—Orr Dr., P.O. Box 3800, Somerville, NJ 08876-1269. 201/231-8300.

Circle no. 22

High-voltage power-supply test system

The new DISCOM Model DTL30 high-voltage test system comprehensively

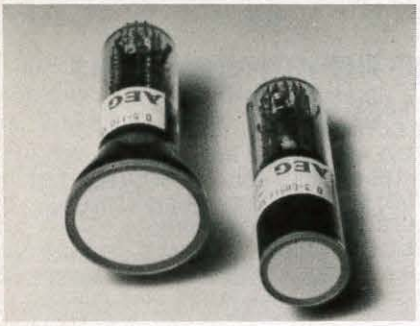
analyzes CRT anode high-voltage sources for engineering performance evaluation, incoming inspection, quality control, and system troubleshooting and diagnostics. The DTL 30 is capable of testing supplies to 30 kV with up to 1.99 mA of output current. Supply loading modes such as constant current, constant resistance, or load switching (dynamic loading) with varying frequency are available, and the DTL 30 is easily adapted to an automated test environment. Using A/D and D/A converters, the DTL can be controlled and monitored by a PC. Automated set-up, data collection, and testing are a sampling of the system's capabilities.

The DTL 30 is single unit priced at $5950 FOB; discounts are available for purchases of three or more units.

For further information contact Peter C. Koronis, Display Components, Inc., 334 Littleton Rd., Westford, MA 01886. 617/692-6000.
Circle no. 24

A 1-in. electrostatic CRT

AEG Corp. announces the availability of their 1-in. electrostatic CRT for use in forward looking infrared (FLIR) systems, compact film recorders, and helmet-mounted displays. The D3-E8515 is a high-resolution CRT, extremely useful for portable applications because of its exclusive 0.55-V heater, rugged construction, and short overall length (less than 5 in.). Also available are larger sizes of electrostatic CRTs with a similar format for



larger viewing needs.

For further information contact AEG Corp., Route 22—Orr Dr., P.O. Box 3800, Somerville, NJ 08876-1269. 201/231-8300.

Circle no. 26

Step-up/step-down dc/dc voltage regulator

ERG's E400 Series provides a small highly efficient low-cost solution for providing regulated "logic-type" voltages from unregulated power sources—without a heat sink or other external components.

Units are just 1.00 x 1.38 x 0.70 in. high, operate typically at 80% at full load, and provide output voltage regulation of 1% line/load (3% line/load/set point). Minimum input or output voltage is 5 V dc; maximum input or output voltage, 35 dc. Price is $7.34 ea. in quantities of 1000.

For further information contact Michael Foldes, Endicott Research

Group, Inc., P.O. Box 269, Endicott, NY 13760. 607/754-9187. ■

Circle no. 27

calendar

September

WELDEX '87: International Welding, Cutting and Metal Fabrication Exposition. British Information Services, 845 Third Ave., New York, NY 10022. 212/752-8400.
Sept. 14–18 Birmingham, England

ADEE East '87. Cahners Exposition Group, 1350 E. Touhy Ave., P.O. Box 5060, Des Plaines, IL 60017-5060. 312/299-9311.
Sept. 15–17 Boston, MA

Symposium on Environmental Issues in Photofinishing. Pam Forness, SPSE, 7003 Kilworth La., Springfield, VA 22151. 703/642-9090.
Sept. 15–17 Los Angeles, CA

Eurodisplay '87: Seventh International Display Research Conference. Clive Jones, The Institute of Physics, 47 Belgrave Sq., London SW1X 8QX, U.K. 01-235-6111. In the U.S.: Palisades Institute for Research Services, Inc., 201 Varick St., New York, NY 10014. 212/620-3388.
Sept. 15–17 London, England

DES '87: Design Engineering Show. British Information Services, 845 Third Ave., New York, NY 10022. 212/752-8400.
Sept. 15–18 Birmingham, England

Fourth Toner and Developer Industry Conference. Diamond Research Corp., P.O. Box 128, Oak View, CA 93022. 805/649-2209.
Sept. 20–22 Santa Barbara, CA

NORTHCON '87 Electronics Show and Convention. Dale Litherland, NORTHCON '87, 8110 Airport Blvd., Los Angeles, CA 90045. 213/772-2965.
Sept. 22–24 Portland, OR

TMI/East: Test, Measurement and Inspection for Quality Control/East. Mary Jo McGuire, Tower Conference Management Co., 331 W. Wesley St., Wheaton, IL 60187. 312/668-8100.
Sept. 22–24 Detroit, MI

October

COMPSAC '87. Dr. Stephen S. Yau, Northwestern Univ., Dept. of EECS, Evanston, IL 60201. 312/491-3641.
Oct. 5–9 Tokyo, Japan

International Astronautical Congress. Gloria W. Heath, Conference Coordinator, SAR-ASSIST, One Island La., Greenwich, CT 06830. 203/869-1322.
Oct. 11–16 Brighton, England

Seventh Gulf Computer Exhibition. Sandra Royan/Abdullah Mohammed, Trade Center Management Co., P.O. Box 9292, Dubai, United Arab Emirates. 372200.
Oct. 12–15 Dubai, UAR

INTERCERAMEX '87: International Ceramic Plant Machinery and Supplies Exhibition. British Information Services, 845 Third Ave., New York, NY 10022. 212/752-8400.
Oct. 12–16 Stoke-On-Trent, England

Newport Conference on Fiberoptic Markets. June Warren, Kessler Marketing Intelligence, Americas Cup Ave. at 31 Bridge St., Newport, RI 02840. 401/849-6771.
Oct. 14–15 Newport, RI

Northeast Computer Faire. The Interface Group, Inc., 300 First Ave., Needham, MA 02194. 617/449-6600.
Oct. 15–17 Boston, MA

Human Factors Society Annual Meeting. Marian Knowles, Human Factors Society, P.O. Box 1369, Santa Monica, CA, 90406. 213/394-1811.
Oct. 19–23 New York, NY

Test and Transducer Exhibition. Show Organizer, Trident International Exhibitions, 21 Plymouth Rd., Tavistock, Devon PL19 8AU, England. 01-822-4671.
Oct. 20–22 London, England

The Animation Festival Bristol 1987. Irene Kotlarz, 41B Hornsey Lane Gardens, London N6 5NY, U.K. 01-341-5015.
Oct. 22–Nov. 1 Bristol, England

Sixth Annual Pacific Northwest Computer Graphics Conference. Paul Katz, Univ. of Oregon Continuation Center, 1553 Moss St. Eugene, OR 97403. 503/686-3537.
Oct. 25–27 Eugene, OR

Cambridge Symposium on Optics in Medicine and Visual Image Processing. SPIE, P.O. Box 10, Bellingham, WA 98227-0010. 206/676-3290.
Oct. 25–30 Cambridge, MA

Digital Image Processing and Visual Communications Technologies in Meteorology. SPIE, P.O. Box 10, Bellingham, WA 98227-0010. 206/676-3290.
Oct. 25–30 Cambridge, MA

New Directions in Photodynamic Therapy. SPIE, P.O. Box 10, Bellingham, WA 98227-0010. 206/676-3290.
Oct. 25–30 Cambridge, MA

Stanford Resources' Fourth International Flat Information Display Conference. International Planning Information, 465 Convention Way #1, Redwood City, CA. 415/364-9040.
Oct. 27–28 San Jose, CA

National Database and Fourth Generation Language Symposium. Mary E. Lownie, Digital Consulting Assoc., Inc., 6 Windsor St., Andover, MA 01810. 617/470-3870.
Oct. 27–30 Dallas, TX

Computer Communication for Developing Countries '87. Dr. P. P. Gupta, CMC Ltd., 1 Ring Rd., Kilokri Opp. Maharani Bagh, New Delhi, India. 631699, 635086, 630827.
Oct. 27–30 New Delhi, India

The Artificial Intelligence and Advanced Computer Technology Conference and Exhibition. Tower Conference Management, 331 W. Wesley St., Wheaton, IL 60187. 312/668-8100.
Oct. 28–30 Atlantic City, NJ

November

Advances in Intelligent Robotics Systems and IECON '87 Joint Conference. SPIE, P.O. Box 10, Bellingham, WA 98227-0010. 206/676-3290.
Nov. 1–7 Cambridge, MA

calendar

Electronic Imaging '87. Richard Murray, Institute for Graphic Communication, 375 Commonwealth Ave., Boston, MA 02115. 617/267-9425.
Nov. 2–5 Boston, MA

COMDEX/Fall '87. The Interface Group, 300 First Ave., Needham, MA 02194. 617/449-6600.
Nov. 2–6 Las Vegas, NV

INFOTEX. The Interface Group, 300 First Ave., Needham, MA 02194. 617/449-6600
Nov. 3–5 Canberra, Australia

International Plastics and Rubber Exhibition. British Information Services, 845 Third Ave., New York, NY 10022. 212/752-8400
Nov. 3–7 Birmingham, England

Workshop on Workstation Operating Systems. Luis-Felipe Cabrera, 6572 Northridge Dr., San Jose, CA 95120. 408/927-1838.
Nov. 5–6 Cambridge, MA

Cambridge Symposium on Fiber Optics/Integrated Optoelectronics. SPIE, P.O. Box 10, Bellingham, WA 98227-0010. 206/676-3290.
Nov. 8–13 Cambridge, MA

Micro Robots and Teleoperators Workshop. MRT Workshop, 4B-623, AT&T Bell Labs, Holmdel, NJ 07733.
Nov. 9–11 Cape Cod, MA

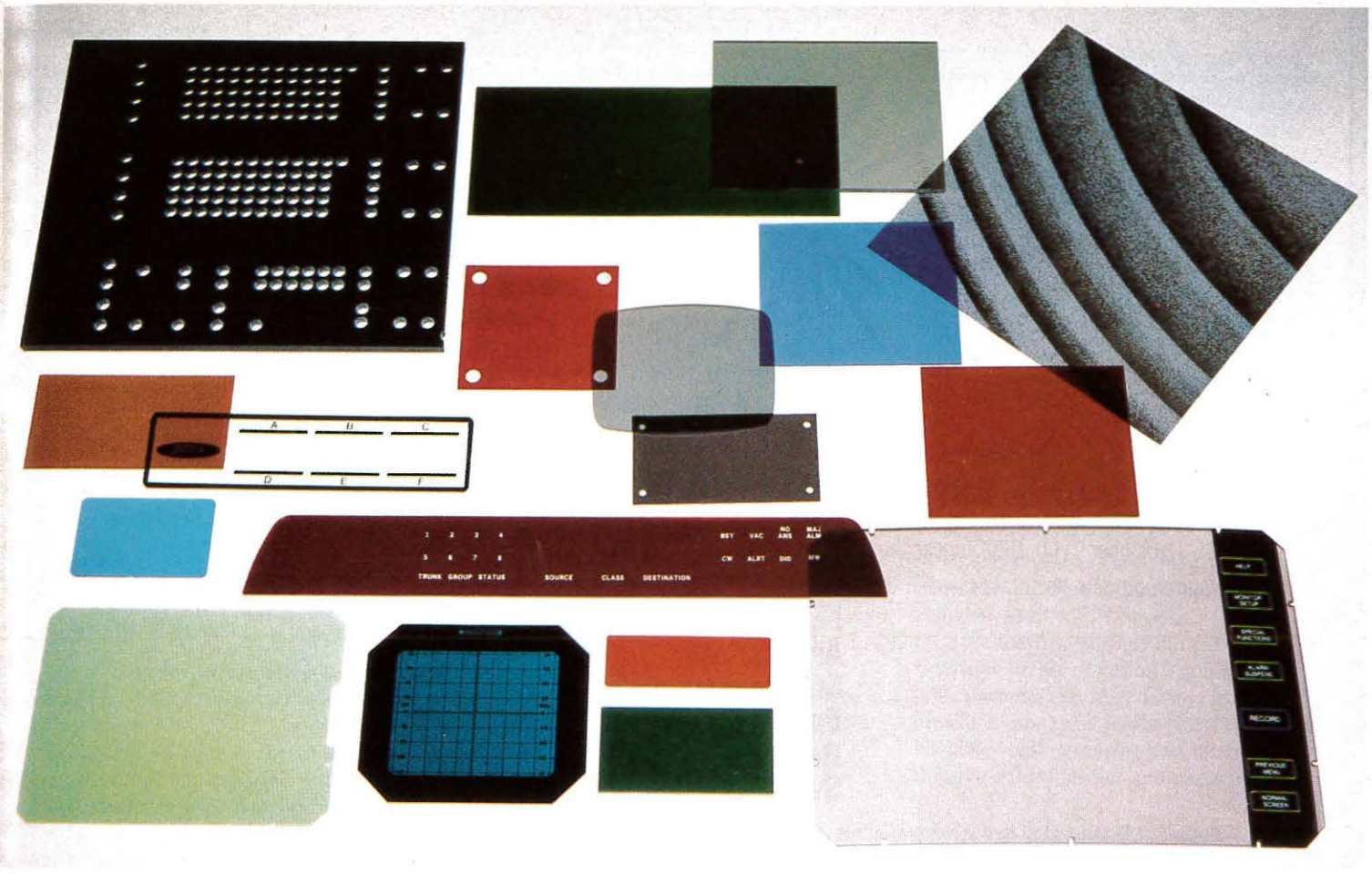
Photometry and Colorimetry for Information Displays—Short Course. UCLA Extension, P.O. Box 24901, Los Angeles, CA 90024. 213/825-1047.
Nov. 9–13 Los Angeles, CA

Drives/Motors/Controls and Programmable Controllers and Systems Exhibitions. British Information Services, 845 Third Ave., New York, NY 10022. 212/752-8400.
Nov. 10–12 Birmingham, England

International Symposium on the Technologies for Optoelectronics. SPIE, P.O. Box 10, Bellingham, WA 98227-0010. 206/676-3290.
Nov. 16–27 Cannes, France

Computer Peripherals and Small Computer Systems Exhibitions. British Information Services, 845 Third Ave., New York, NY 10022. 212/752-8400.
Nov. 17–20 London, England

International Conference on Information Science and Engineering. R. Larry, Institute of Electronic and Radio Engineers,



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Circle no. 33

10th INTERNATIONAL CONFERENCE
on

LASERS '87

DECEMBER 7-11, 1987
HARVEYS RESORT HOTEL
LAKE TAHOE, NEVADA

POST DEADLINE PAPERS

LASERS '87, the Tenth International Conference on Lasers & Applications, will be held at Harveys Resort Hotel, Lake Tahoe, Nevada, December 7-11, 1987, under the sponsorship of the Society for Optical and Quantum Electronics.

Papers are now being accepted in the areas of:

LASER PHYSICS
APPLICATIONS
SCIENCE & MEDICINE
ENGINEERING & TECHNOLOGY
RADIATION & QUANTUM ELECTRONICS
SYSTEMS OPTICAL & LASER

Authors are requested to submit **two copies** *of both* a 35-word *abstract* and a 200-word *summary* of their paper to: LASERS '87, P.O. Box 245, McLean, VA 22101. Since papers will be selected on basis of their summary they should include specific information. The **Deadline** for receipt of *Abstracts and Summaries* is **November 25, 1987**. *Earlier submission is appreciated.*

LASERS '87 AWARD

Sponsored by EG&G Princeton Applied Research Commemorative plaque and $500 to be awarded to the best contributed paper. Selection by the Program Committee is based on originality and timeliness.

KEYNOTE SPEAKER: M.O. SCULLY (U. New Mexico & Max-Planck Inst.)
"Laser Probes of the Micro and Macro Cosmos"

PLENARY SPEAKERS:
R. Alfano (CUNY), Ultrafast Phenomena
A. Aspect (L'ENS), Laser Test of Bell's Inequalities
C. Brau (LANL), Free Electron Lasers
H.J. Caulfield (U. Alabama), Optical Computing
R. Drever (Caltech), Gravitational Waves
R.A. Fisher (R.A. Fisher Cons.), Phase Conjugation
K. Fujii (Ibaraki U.), White Light Lasers
L. Goldman (U. Cincinnati), Laser Cancer Phototherapy
J. Hammond (SDIO), Directed Energy
R.G. Harrison (Heriot-Watt U.), Chaos in Opt. Pumped Molecular Lasers
L.W. Hillman (Cornell U.), Chaos and Instabilities in Dye Lasers
R. Menzies (JPL), IR Doppler Lidar
J. Miller (TRW), High Power Chem. Lasers
W.T. Silfvast (Bell Lab), VUV & X-Ray Lasers
C.R. Vidal (Max-Planck Inst.), VUV Laser Spectroscopy
C.W. Webb (U. Oxford), Copper & Gold Vapor Lasers
L.E. Wilson (AF Weapons Lab), Excimer Lasers

SDI PANEL DISCUSSION

R.G. Briggs (LLNL)
L. Goldman (U. Cincinnati)
J. Hammond (SDIO)
J.A. Ionson (SDIO)
A.R. Kantrowitz (Dartmouth C.)
C. Patel (Bell Labs)
W. Seka (U. Rochester)
R. Sproull (U. Rochester)
E. Teller (Hoover Fund.)

Supported by: U.S. Army Research Office, Eastman Kodak Co. and EG & G PAR

Exhibits of the manufacturers of lasers, accessories and systems will be conveniently located to insure a good flow of traffic. Information on booth space can be obtained as indicated below.

Full proceedings of Lasers '87 will be published in hard-cover copy following the conference.

The announcement of the Call for Papers or other information, including exhibit brochures can be obtained by writing:

LASERS '87, P.O. Box 245, McLean, VA 22101
or calling (703) 642-5835

99 Gower St., London, WC1E 6AZ, U.K.
Nov. 25–27 York, England

Workshop on Computer Vision. Prof. Kang G. Shin, Dept. of EE and Computer Science, Univ. of Michigan, Ann Arbor, MI 48109-1109. 313/763-0391.
Nov. 30–Dec. 2 Miami Beach, FL

Call for Papers

The Society for Information Display 1988 International Symposium, Seminar and Exhibition. May 23–27, Anaheim, CA. Papers are solicited in the following areas: emissive and non-emissive flat panels; CRT displays; hard copy/printers; display systems and applications; automotive displays; display addressing/packaging; interactive I/O technology; human factors; large-area displays; workstations; and avionic displays. For a copy of the call for papers, contact the Society for Information Display, c/o Palisades Institute for Research Services, Inc., 201 Varick St., Rm. 1140, New York, NY 10014. 212/620-3388.
Deadline for abstracts: Dec. 7

ISCC/SID Joint Technical Meeting. May 8–10, Baltimore, MD (jointly sponsored by the Inter-Society Color Council and SID). Papers are solicited in the following areas: accurate color transference between computer/video graphics and electronically generated hard copy; color theory; flat-panel and CRT display color techniques; electronic printer color techniques; standards; human factors of color; color requirements; measurement, characterization, calibration, and viewing of color. Send a 100-word abstract to Lawrence E. Tannas, Jr., 1426 Dana Pl., Orange, CA 92666. 714/633-7874; Fax: 714/633-4174.
Deadline for abstracts: Dec. 10

AI 1988: The Artificial Intelligence and Advanced Computer Technology Conference/Exhibition. May 4–6, Long Beach, CA. Papers are solicited for, but not limited to, the following areas: AI at the turn of the century; user interface at the workstation; AI in healthcare; AI and multiple languages; expert systems; cognitive modeling; knowledge information processing systems (KIPS); AI and aerospace; expert systems development systems; natural language interfaces; AI in training; AI and SDI; imaging; speech recognition; parallel computing; fifth generation computers; machine translation; AI on a CHIP; advisory system and management decision support; AI and CIM; artificial intelligence models; AI in entertainment and sports; AI tools; machine diagnosis and maintenance; AI in non-manufacturing environment; AI workstations; AI languages; AI in space technology; building expert system by the non-programmer; computer vision; AI and business; AI in microcomputers; military application of AI; AI in office automation; AI and machine vision; neural networks; AI and manufacturing; and AI and simulation. Send a 200–300 word abstract to Dr. Murray Teitell, General Program Chairman-AI '88, c/o Intelligent Choice, 1050 Duncan Ave., Suite D, Manhattan Beach, CA 91109. 213/379-9680.
Deadline for abstracts: Nov. 20

SPIE's 1988 Technical Symposium Southeast on Optics, Electro-Optics, and Sensors. April 4–8, Orlando, FL. Papers are solicited for, but not limited to, the following areas: precision engineering of optical elements and systems; electro-optical components and systems; infrared imaging; remote sensing and imaging through varied media; and pattern

SID Honors and Awards

Nominations are now being solicited from SID members for candidates who qualify for SID Honors and Awards.

- FELLOW. Conferred annually upon a SID member of outstanding qualifications and experience as a scientist or engineer in the field of information display, and who has made a widely recognized and significant contribution to the advancement of the display field.
- KARL FERDINAND BRAUN PRIZE. Awarded for an outstanding *technical* achievement in, or contribution to, display technology.
- JOHANN GUTENBERG PRIZE. Awarded for an outstanding *technical* achievement in, or contribution to, printer technology.
- BEATRICE WINNER AWARD. Awarded periodically (but not more than once a year) to a SID member for exceptional and sustained service to SID.
- SPECIAL RECOGNITION AWARDS. Granted to members of the technical and scientific community (not necessarily SID members) for distinguished and valued contributions to the information display field. These awards may be made for contributions in one or more of the following categories: (a) outstanding technical accomplishments; (b) outstanding contributions to the literature; and (c) outstanding service to the Society.

Nominations should comply with the Guidelines for SID Honors and Awards Nominations (see *ID,* July-August 1987, p. 34) and should be submitted to the Honors and Awards Committee Chairman before **October 1, 1987.**

calendar

recognition and signal processing. Send SPIE four copies each of the following: author application, a brief professional biography, and a 200-300 word abstract typed double-spaced on 8½ x 11″ white paper. For a detailed copy of the call for papers and an author application, write SPIE Technical Program Committee/1988 Symposium Southeast, P.O. Box 10, Bellingham, WA 98227-0010. 206/676-3290. Late submissions may be considered. Deadline for abstracts: Sept. 28 ■

letters

continued from page 10

NTSC scan rates and 800 lum with 1000 lines of resolution—greatly exceeding the brightness of conventional projectors, including the Arcturus modifications.

(2) The "useful claim" for the new CRT design seemed abundantly clear in the article, but is now repeated: any lens prefers a curved image surface, *not a flat one.* Further, by curving the phosphor surface towards the lens, a greater quantity of light can be concentrated into the lens aperture—light that is now wasted in *all* conventional CRTs (beam spot luminance is gaussian, not lambertian). Technically, one of the TDS inventions is a quad-element lens system, with three of the lens elements being phosphor coated (the CRT is now an integral lens element as well as an image source).

(3) Anti-reflection, coupling, and immersion are as different as is their spelling: *coupling* and *anti-reflection* are aspirins and only provide relief. We have totally changed the art and have perfected a liquid lens system in which the phosphor lens elements are *immersed* into a master lens system. By creating a heat-sinking optical fluid, rather than a solid lens, we can tolerate more beam current than conventional CRTs.

(4) With all three color images optically converged within the master lens, a direct-view image is now available *free of shadow-mask defects* and immune to ambient light. How the above can be confused with his own products that can only be mechanically converged at a fixed distance and only viewed off a separate display surface is perplexing.

(5) Lastly, I don't know how to discuss electron beam incidence without first knowing the deflection angles being used: we selected a 6.5-in. radiused faceplate for optimum luminous efficiency, then designed a 30° deflection envelope for aberration free corners.

—Marv Hodges, President
Triuniplex Display Systems, Inc.
Simi Valley, California

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Classified ad rates: $55/column-inch (min.); $10/line (for fractions of an inch); $10/insertion for blind box no. at *ID* (replies forwarded). **Size:** 1 column-inch = 10 lines (ave. 6 words/line). Large-type all-caps heading (max. 17 characters) takes up 2 lines. Allow 1 line for blind box no. **Deadline:** One month before issue date. **Payment:** Send minimum $55 payment with order to: Information Display, c/o Palisades Institute, 201 Varick St., Suite 1140, New York, NY 10014. **Questions?** Call 212/620-3371.

job opportunities

Monitronix Corporation is a high growth company that designs, manufactures, and markets ultra high performance color monitors used in CAE workstations where unusual levels of brightness and clarity are required to ensure superior user productivity. We are seeking to fill two of the following positions.

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miscellaneous

SID '87 PUBLICATIONS

The SID '87 *Digest of Technical Papers* and *Seminar Lecture Notes* are available from SID. The SID '87 *Digest* (480 pp., illus.) contains the texts of 106 papers presented during the three-day Symposium May 12-14, 1987. Topics include VDT standards, automotive displays, active-matrix LCDs, large-screen projection displays, plasma and VFDs, human factors, CRT technology, printer technologies and materials, EL technology, color display applications, display systems, and workstations. Price is $55 ($45 for SID members).

The SID '87 *Seminar Lecture Notes* comes in two volumes. Vol. 1, May 11 (269 pp., illus.), contains seven seminar lectures: "State of the Display Industry" (Tannas); "Visual Perception Basics" (Murch); "EL Displays" (Mueller); "Direct-Multiplexed LCDs" (Scheffer); "Active Matrices for LCDs" (Firester); "Display Measurement Technology" (Miller); and "The Evolutionary CRT" (Seats). Vol. 2, May 15 (237 pp., illus.), contains eight lectures: "Colorimetry of Displays" (Benzschawel); "Tactical Aircraft Displays" (Adam); "Plasma Displays" (Mikoshiba); "Color Hard Copy" (Mills); "Advances in Image Processing for Art, Medicine, and Mapping" (Bernstein); "Image Synthesis and Computer-Generated Animation" (Bacon); "Electronic Projection Displays" (Feigenblatt); and "Touch Input Technology" (Carroll and Carstedt). Price is $30 for either volume ($20 for SID members) or $50 for the two-volume set ($35 for SID members).

Prices include book rate or surface postage. Add $10 per order for air mail shipment overseas. Order from: Society for Information Display, 8055 W. Manchester Ave., Suite 615, Playa del Rey, CA 90293. 213-305-1502. Back issues of SID publications are also available. Ask for a publications brochure.

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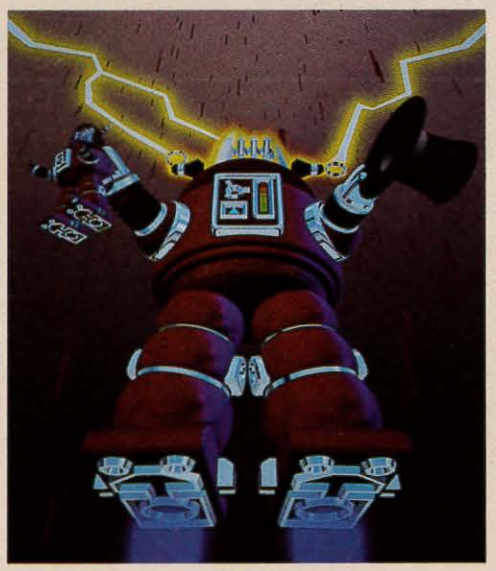

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