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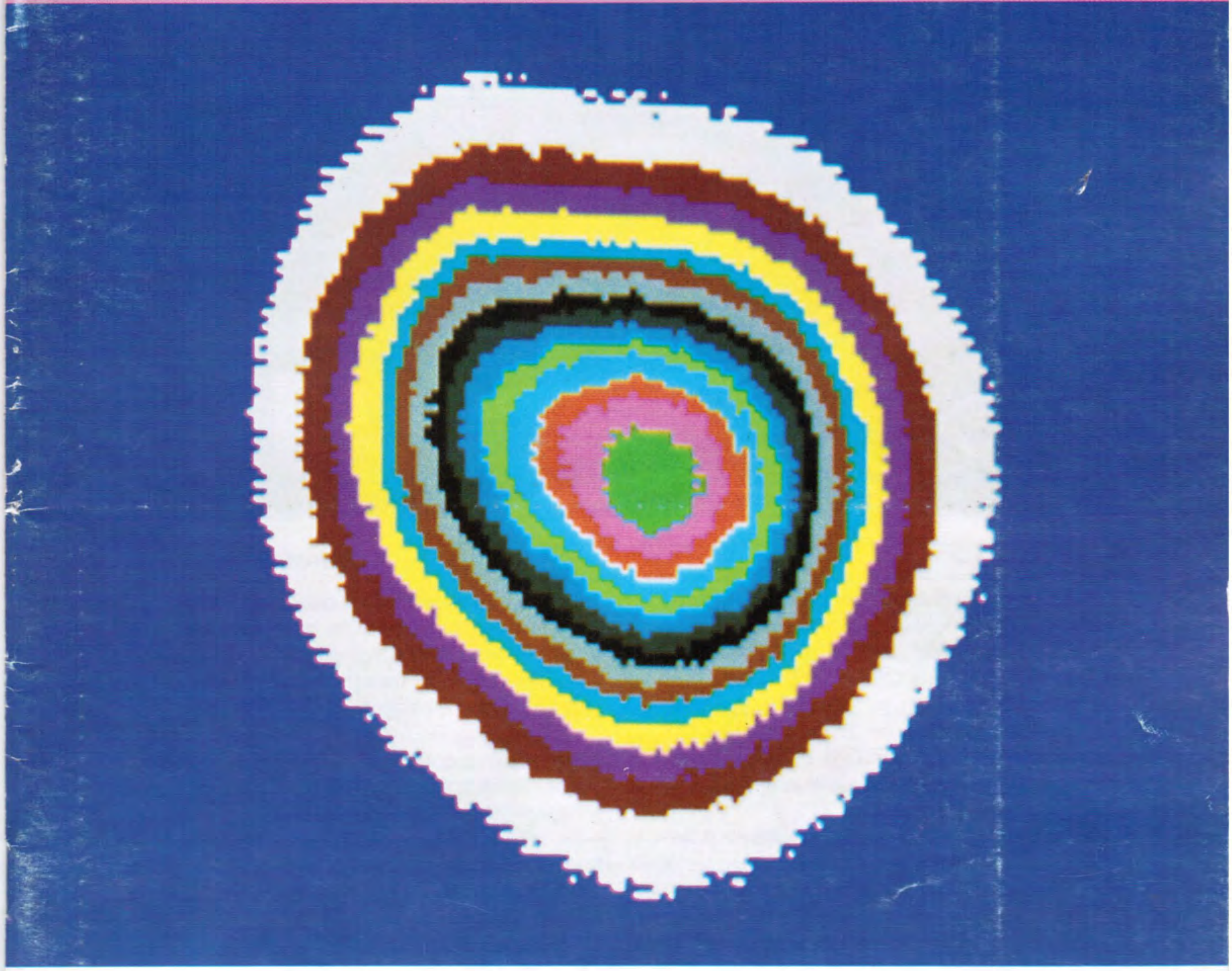
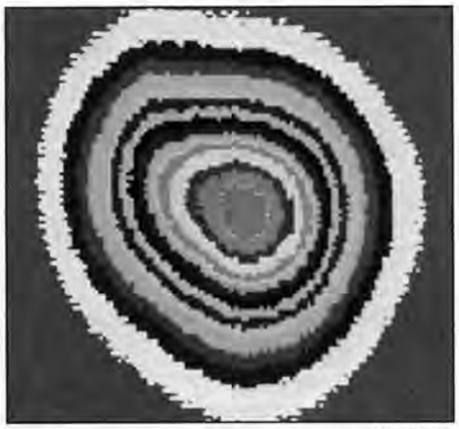
CRT TECHNOLOGY ISSUE



Color-beam profiling
Air-traffic-control displays
Display controllers
SMAU '93 report

Cover: The beam-energy distribution profiles that provide important information about monochrome CRT display design and performance have not been readily available for color CRTs because the shadow mask interacts with the beam and prevents most of the beam energy from reaching the screen. However, a beam-energy distribution map can be compiled by moving the beam in fine increments behind the mask in x and y, and taking as many samples as needed for beam reconstruction. There is now a commercial system that automates this procedure. See page 8.



Microvision

Next Month in Information Display

Flat Panel Issue
- JTEC update
- Ferroelectric marketing strategies
- Eurodisplay '93 show report

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guest editorial

New Lives for Nuclear Labs

by Hans A. Bethe

For half a century, the U.S. has led the world in creating new scientific knowledge, inventing new technology and educating scientists and engineers. But now America's basic research is in crisis.

The crisis has its roots in the end of the cold war and the resulting reduction in the demand for military technology, and in the shortsighted misconception that Government and corporations should support only research that promises a quick payoff for taxpayers and stockholders.

Today the nation has an opportunity to redirect its huge investment in nuclear weapons laboratories toward research aimed at problems that we are sure to face but that universities and private industry do not have the resources to address.

The labs – Los Alamos, Livermore, Sandia – are organizations of unrivaled technical power. They employ a large number of highly skilled scientists and engineers and have unique, sophisticated facilities. Most of their employees are eager to turn their talents to nonmilitary problems. They are thus ideal for applied research, which must be strengthened if the U.S. is to be competitive.

The labs have already begun moving in this direction by tackling problems of interest to industry. But a huge lab like Los Alamos cannot live long on outside jobs that arise haphazardly; it must have steady support from the Government for a long-term civilian objective to replace the role played by nuclear weapons.

How to determine suitable goals for the labs? A Presidential task force, appointed in consultation with Congress, should be created to answer this question. Its members ought to be drawn from industry, academia and, most important, the labs themselves, because it is essential that their workers' enthusiasm be tapped.

The labs could develop new technologies to free us from our dependence on fossil fuel, especially for road transport. They could work on designing cells in which liquid fuel is directly converted into electricity to drive engines, greatly increasing efficiency and decreasing pollution. Another project would be high-temperature superconductors for industry. Microrobotics could be very useful in medicine. A project under way uses supercomputers to ease traffic congestion.

Once a general plan has been approved, the lab should be left largely to itself, without the micromanagement from Washington that has become endemic and stifles creativity.

The plan should lay to rest the misguided if well-intentioned effort to divert funds from basic long-term research toward short-term applied research.

The National Science Foundation has been under increasing Congressional pressure to channel a large part of its relatively modest resources into applied research, even though the corporate leaders on last year's Commission on the Future of the National Science Foundation opposed such a move.

When the foundation was created in the 1950's, it was understood that pure research is the basis from which the most important and unexpected inventions flow. It is the only Federal agency whose primary purpose is to support basic research and the advanced training of research scientists and engineers. Basic research is unpredictable: nobody in the 1950's could have anticipated lasers and magnetic resonance imaging, which have found multiple applications.

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the display continuum

The Overhead Projector – The Slide Rule of the 1990s?

by Aris Silzars

I have a son, a senior in college, who is studying to be a manufacturing engineer. I told him I was working on a column about how new technologies can wipe out entire industries. I described how I was going to draw a comparison between overhead projectors and what happened to the slide rule when electronic calculators came along. His response: "Dad . . . What's a slide rule?" Now, that for sure made me feel the generation gap, and my age.

After a day or two dedicated to regaining my composure, I decided to go with my original premise anyway. However, to accommodate the more recent college grads among *Information Display's* readers, I am going to devote the next few paragraphs to a brief, but I think historically significant, summary of "The Last Days of the Slide Rule Era."

During this era, the slide rule was one of the proudest possessions an engineer could have. Made from white plastic-coated bamboo, with precisely etched logarithmic and trigonometric scales, it was the epitome of mechanical beauty and precision.

A computing device that looks like a ruler, with a center section that slides back and forth, and a precision cursor that pinpoints where the scales have been juxtaposed, thereby allowing one to perform mathematical operations, such as multiplication, division, and the finding of powers, logarithms, and trigonometric functions, doesn't come along every day. Learning how to use one was tantamount to achieving membership in a secret fraternity.

Well, yes, it did have a few limitations: you couldn't add or subtract on it, you had to keep track of the powers of ten in your head, and your answers were only accurate to three significant figures. But for certain other operations, such as taking ratios and doing quick estimates, it could (and still can) do better than the electronic calculator.

So why did the slide rule make such a rapid disappearance in the mid-70s? Simply put, the electronic calculator provided so much additional capability, with so few disadvantages, that within just 2 or 3 years the slide rule was history and every engineering student had switched to wearing a belt-attached calculator pouch. This, of course, turned out to be an even more fashionable accessory to complement the ever-present plastic shirt-pocket pen-protector that has since the Renaissance been a required article of apparel for every self-respecting engineer.

If new technology in the form of the electronic calculator could so quickly obsolete a product as widely used as the slide rule, is it also possible that the ubiquitous overhead projector will similarly be replaced with new electronic imaging technology, and also in just a few short years?

For close to 10 years now, liquid-crystal panels have been available that can be placed where the view-foil normally goes on an overhead projector. Although these panels provide display capability, their biggest drawback is that most of the light does not make it to the screen and they get in the way if normal transparencies need to be viewed. The room lights must be dimmed and all the stray light spilling from around the projector is a distraction.

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Getting Behind the Shadow Mask

Beam-energy distribution profiles have long been used for analyzing monochrome CRTs, but how do you profile a color-CRT beam that has interacted with a shadow mask before reaching the screen?

by Kraig Chellew and Ian Mallender

BEAM-ENERGY distribution profiles are often used to provide important information about monochrome-CRT display design and performance. Because shadow-mask color CRTs have three beams acting in cooperation, it is even more desirable to obtain accurate information about the energy distribution in each of these beams. Unfortunately, only a small percentage of each beam arrives at the phosphor screen. The rest is conducted away via the mask, which makes it difficult to gather the required information. Fortunately, there is a way to (metaphorically) strip away the mask and provide a true model of beam-energy distribution.

There are three types of shadow mask in use today: dot-matrix aperture, slot aperture, and the Sony Trinitron aperture grill (Fig. 1).[1] The relationship between beam size, aperture size, and aperture pitch determines the proportion of beam energy that passes through the mask and arrives at the phosphor screen. The shape of the aperture and the phosphor pattern on the screen jointly determine the spatial distribution of that portion of the energy that is converted into screen-phosphor emission. In short, the relationship between actual beam-energy distribution and screen luminance is complex.

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Producing a well-formed beam and maintaining optimum focus, shape, and size over the entire display field is central to the CRT industry. CRT designers are able to examine beam profiles under experimental conditions by eliminating the shadow mask. The design

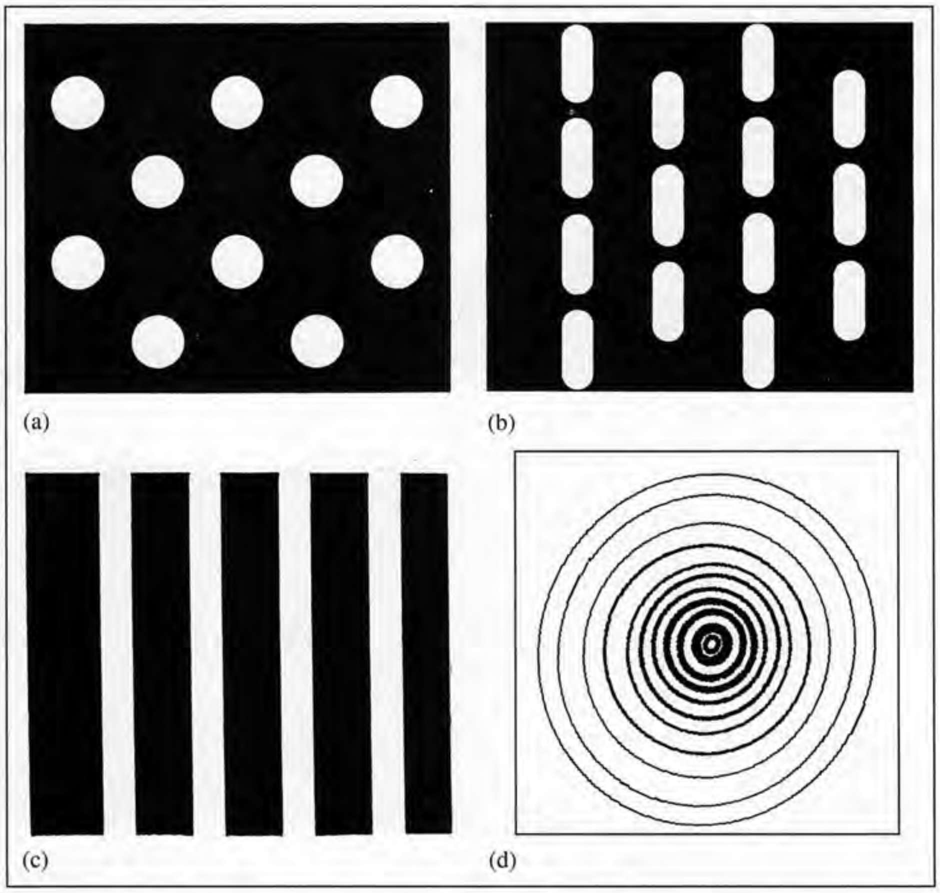
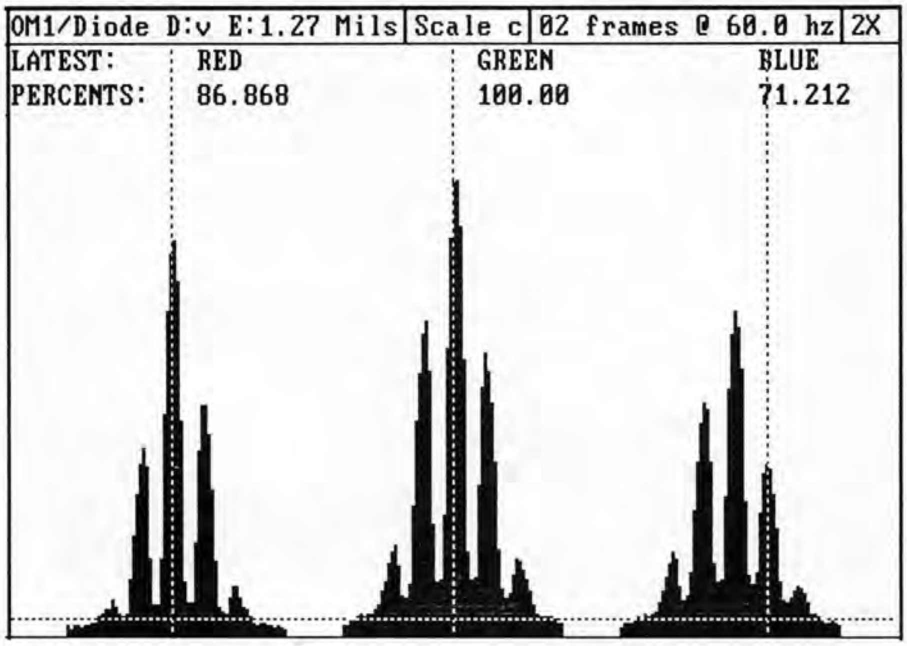
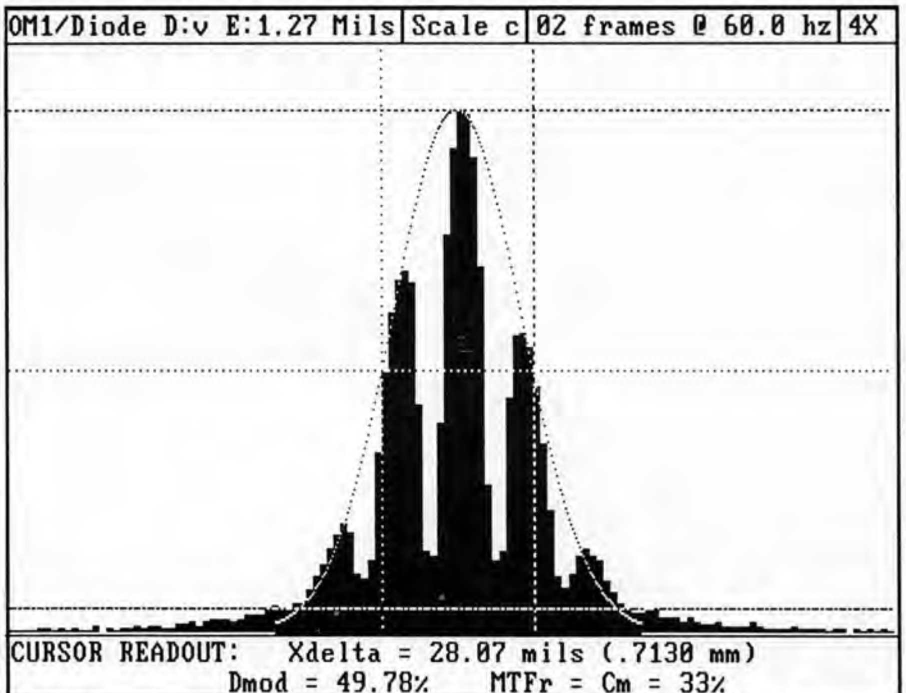


***Fig. 1:** There are three types of shadow mask in use today: (a) dot-matrix aperture, (b) slot aperture, and (c) the Sony Trinitron aperture grill. The size of a typical beam (d) is shown to the same scale as the mask aperture patterns.*



(a)



(b)

Fig. 2: *Intensity profiles from shadow-mask color displays can be confusing. The profiles contain a number of peaks (a) that depend upon the ratio of beam size to dot pitch, among other factors. The linewidth (b) can be estimated by curve fitting, but care must be take when selecting the curve-fit approximation.*

goals of these designers vary widely by application. HDTV and high-resolution computer graphic displays, for example, must meet very different requirements.[2]

Although experimental conditions and computer modeling are convenient for predicting final performance, the only true evaluation of the result is in the finished product, when all subsystem components are integrated into a display module. It is at this time that the CRT designer, the subsystem integrator, the display manufacturer, and the customer all require a method for evaluating total performance. But the most meaningful indicator, beam profile, is not readily available.

Current Practice

Existing instruments provide intensity profiles of light emission from display screens.[3] For monochrome CRTs this provides a clear indication of beam-energy profile, but for shadow-mask color displays the intensity profile is of limited value [Fig. 2(a)]. What the instrument sees is the emission from those phosphor dots that fall within the active beam width in the sample direction. The number of peaks is dependent upon the ratio of beam size to dot pitch, and also to the phase relationships between beam, mask, and profile-sampling scan. When making linewidth measurements, the sampling scan is taken while the beam is unblanked and in motion. Obviously, linewidth can only be estimated from such a simple scan sample, and curve-fitting approximation techniques are employed. A Gaussian fit is most often used [Fig. 2(b)] but there are many examples of distinctly non-Gaussian beam profiles, and errors can occur if the wrong technique is used.[4]

It is sometimes assumed that the linewidth profile, with curve-fit approximation, is the same as the beam-energy profile. This assumption is invalid for several reasons, as we will soon explain. An even worse assumption is that vertical and horizontal linewidth measurements represent the major and minor axes of an elliptical beam. This assumption can be particularly misleading at the corner of the display, where it can lead an observer to construe highly elliptical beams as circular.

Phosphor-Emission Samples and Beam-Energy Distribution

To obtain a true picture of beam energy from screen phosphor emission, we must establish a valid set of measurement conditions. First, measurements should ideally be made with a stationary beam, but doing so would require that the unit under test be operated in an atypical manner. The alternative is to turn the beam on for a short duration, keeping all other operating conditions normal. Any distortion introduced by spot motion is entirely predictable and can be corrected if required.

Understanding the samples one obtains with traditional instruments is not always straightforward, as can be seen from the brightness contours obtained from an x-y scan of a single color spot [Fig. 3(a)]. The phase relationship between beam position and shadow mask has been carefully adjusted to make the beam center coincide with a hole in the shadow mask. Several details are evident from this figure. First, we see a clear representation of the (green) phosphor dots within the beam area. The pitch of the phosphor dots tells us the pitch of the shadow-mask apertures, providing a highly accurate way of calibrating the size of the image in Fig. 3(a). Clearly, the beam is subject to diffraction by the apertures as it passes through the shadow mask. Although we can safely assume that the beam-energy distribution is increasing toward the central dot, Fig. 3(a) shows that this information is only carried in the central region of the phosphor-dot emission contour. (In a badly aligned system phosphor-dot edge effects will also be evident.)

Figure 3(a) leads to the conclusion that, although perhaps 20% of the beam energy may arrive at the screen,[1] a significantly smaller proportion of the beam-energy distribution data is carried by screen-emission contours, and a large number of samples must be taken to arrive at a reliable beam-energy contour map.

Getting Behind the Shadow Mask

If it were possible, we could compile a beam-energy distribution map by moving a single aperture in fine increments in x and y, taking as many samples as required for beam reconstruction. In practice we must move the beam in small increments behind the stationary aperture mask and fit the samples together accurately in our reconstruction [Fig. 3(b)].

Beam increments can be introduced by small delays in x- and y-axis sync pulses or by offset deflection–current increments. By selecting the number of x-axis samples per scan and the y-axis increment between successive

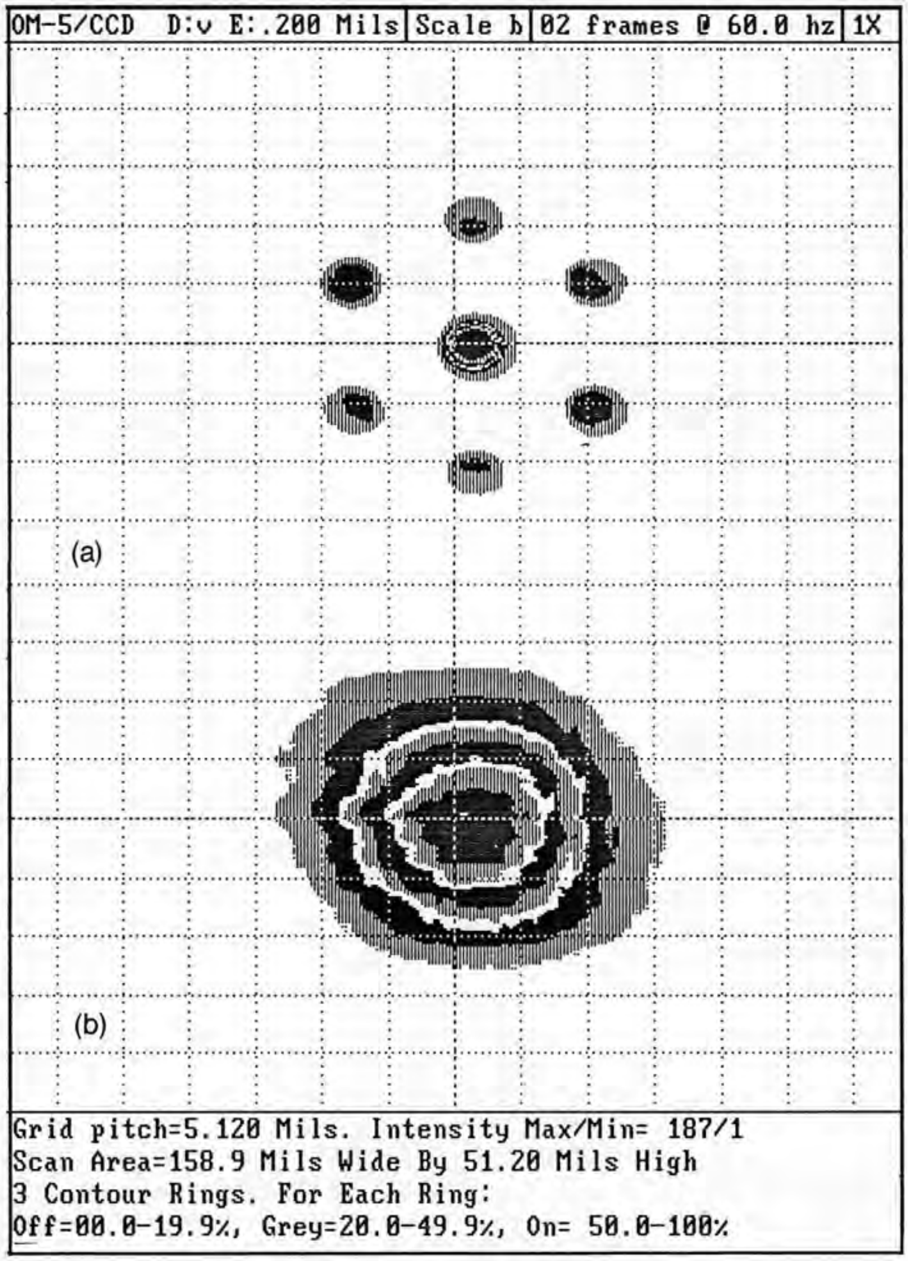
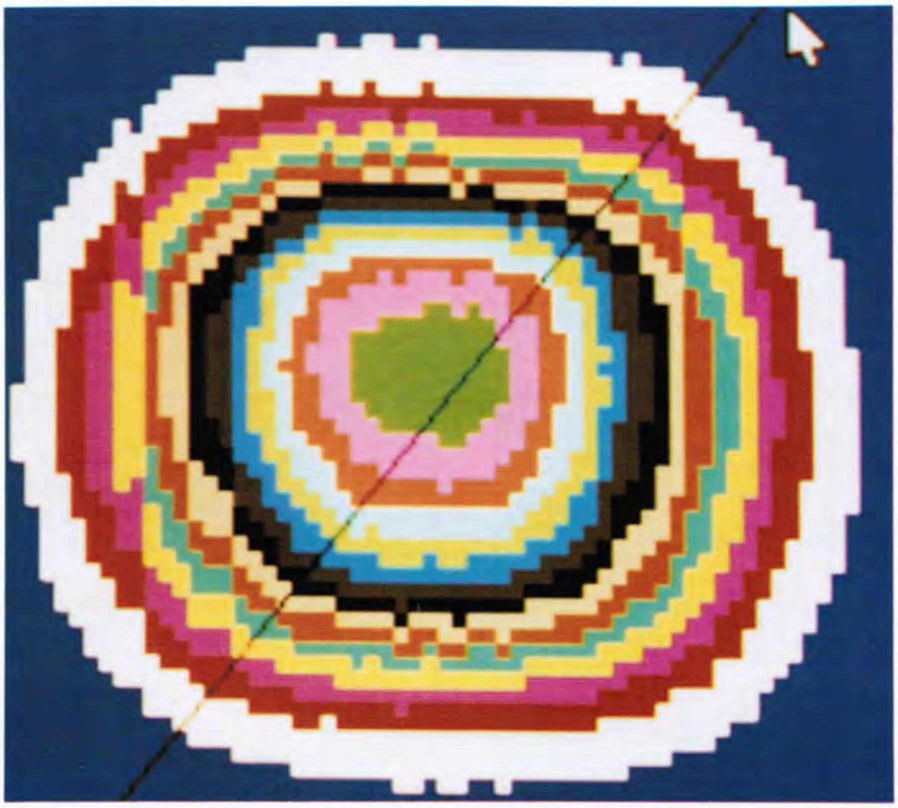
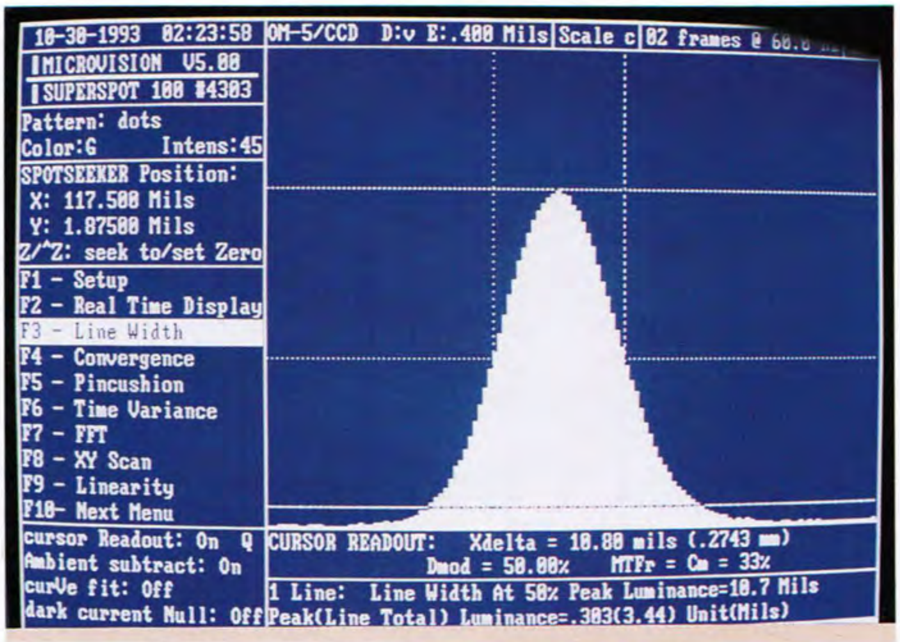


Fig. 3: (a) Understanding the samples one obtains from shadow-mask color screens with traditional instruments is not always easy, as can be seen from the brightness contours obtained from an x-y scan of a single color spot. (b) However, a beam-energy distribution map can be compiled by moving the beam in fine increments behind the mask in x and y, taking as many samples as needed for beam reconstruction.



(a)



(b)

Fig. 4: *(a) Raw Beamview data for a single spot and (b) the profile of the beam taken at the section marker – the diagonal line running from lower left to upper right – through the raw data.*

scans, it is possible to gather data from a single aperture or a number of adjacent apertures. Some overlap is necessary to overcome the edge effects noted above. The position of the sampling device must remain constant during the entire data-gathering process. A critical part of the process lies in calibrating the beam increments in both the x and y axes. This calibration is a function of the detector geometry, the required fidelity of the reconstructed image, and the type of CRT under evaluation.

Calibration

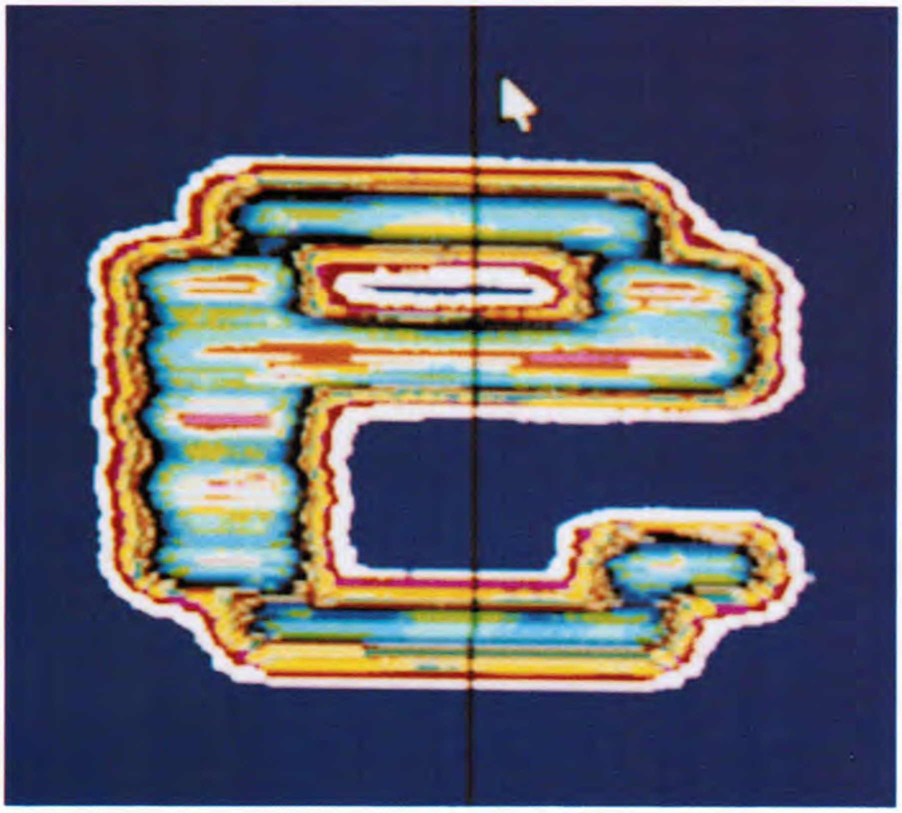
For an aperture-grill (Sony Trinitron) CRT, it should only be necessary to increment the beam along the x axis [Fig. 1(c)]. By using a high-resolution linear CCD detector, y-axis data can be obtained directly and the complete beam-contour map can be generated in a single horizontal pass of the beam. Sample pitch in the y axis is directly related to the detector resolution and optical magnification. Sample pitch in the x axis is equal to the beam increment.

A more difficult case is the circular dot-aperture mask, which requires a sufficient number of passes to fill in the gaps between vertically adjacent apertures. Assuming a linear detector array correctly aligned to pass through the centers of a column of apertures, the number of scans required must be at least the ratio of dot pitch to dot diameter. In the case illustrated in Fig. 1(a) six scans would be appropriate.

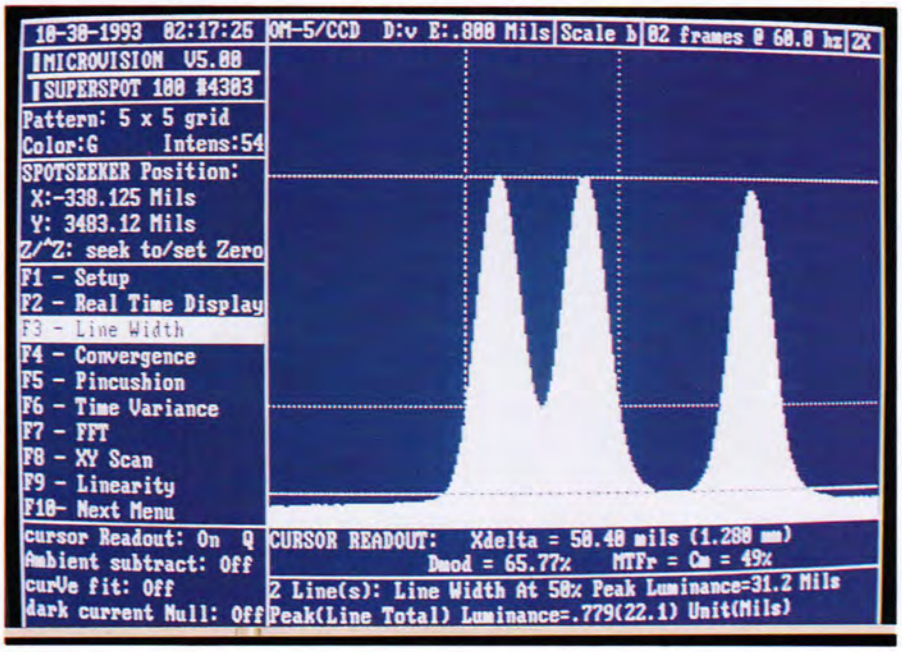
The slot-type mask lies somewhere between these two extremes. In the case illustrated in Fig. 1(b), the slot height is much greater than the obscured space between the slots. While one scan is inadequate, two scans clearly provide a great deal of redundancy.

It is distinctly advantageous to employ a detector with enough elements to cover a much larger field than the immediate beam diameter, thereby avoiding the need for precise mechanical location.

Given these detector parameters – a high-resolution sampled field many times larger than the beam diameter – we have the means to accurately calibrate beam increments by



(a)



(b)

Fig. 5: Characters, in this case an "e," can be reconstructed as well as spots. (a) The reconstructed image is the image that would have been produced if there were no shadow mask – that is, the image expected from a monochrome display with the same beam characteristics. (b) "Unmasking" the image allows the true depth of modulation to be measured, as shown in the vertical-section profile.

introducing a total beam shift equal to one or more phosphor-dot pitches in the x and y axes. Since we know this dimension, we can establish the sampling resolution in both axes to high accuracy. Assuming roughly 100 steps across the beam axis in a 256-element CCD-array field, we would have 8–10 phosphor-dot pitches to work with for calibration purposes. Either linear or two-dimensional CCD arrays can be used.

Beamview: A Practical Implementation

The principles presented thus far in this article are well known to CRT designers. At Microvision, we have developed a system, called "Beamview," that implements these principles in a practical and convenient way.[5] The beam of Fig. 3(a) was scanned with Beamview, which produced a beam-contour map by x-y sampling the beam through a dot-matrix aperture mask [Fig. 3(b)]. The full field displayed is 256 × 256 samples. In this instance, a 2048-element linear CCD array was used, and data was collected from the 256 CCD elements centered upon the beam-measurement position. These elements are represented on the vertical axis. The CCD sampling resolution in the vertical axis is 5000/in. (200/mm).

The beam is incremented 256 steps in the horizontal direction beneath the stationary linear array, which is aligned with a column of phosphor dots. The horizontal axis represents these increments. Beam incremental resolution in the horizontal axis is 4000/in. (160/mm). The data was collected in six passes. Each pass collected horizontal stripes from three vertically adjacent apertures. Each stripe of data was approximately 20 CCD samples high, corresponding to the diameter of the shadow-mask aperture. The beam was then shifted in the vertical direction by one-sixth of the vertical pitch between apertures. This is a large shift compared to the x-axis increment, but smaller than the stripe height of 20 CCD samples, allowing a substantial stripe overlap to accommodate edge effects. During each successive pass, new stripes of data were collected. It is important that the detector array and shadow mask remain stationary, and all stripes are gathered by the same groups of 20 CCD elements as the first stripe.

The reassembly process is carried out by memory shifts corresponding to vertical beam shifts. Each data sample is stored as an 8-bit value. Intensity information is collected during calibration and used to establish limits for 256-gray-level scaling. After all stripes have been collected, the entire beam-contour model is reconstructed, matching contour levels in overlapping regions. This model can then be scaled, sliced, and presented in the same manner as the beam-contour model of a monochrome CRT.

Once calibration has been carried out, the entire data gathering and beam-contour model construction is automatic. In the case illustrated, the entire process was carried out in under 1 min. Using an area array reduces this time to a few seconds.

Beamview Applications

Single spots. Once the computer model is generated, it can be displayed in 3D form and sliced to present any desired section. Figure 4 shows the raw data without filtering. Repeating the process for the red, blue, and green beams at the same physical location provides important information about the beams' geometric relationships.

Characters or display elements. By increasing the sampled field, the principles we've been discussing can be applied to elements larger than a single spot. Figure 5 shows the process applied to the character "e." The field of interest and the sample increment are increased by a factor of 4, and samples are taken from more mask apertures along the vertical axis. Of course, selection of the sampling resolution along both axes is determined by the required fidelity of the reconstructed image.

The character "e" was displayed in a single color (green) and moved in small increments across the detector array along the x axis. The reconstructed image [Fig. 5(a)] is the image that would have been produced if there were no shadow mask – that is, the image that could be expected from a monochrome display with the same beam characteristics. "Unmasking" the image allows the true depth of modulation to be measured, as shown in the vertical section profile of the character [Fig. 5(b)].

Conclusion

The basic principles of beam sampling and reconstruction are well established,[6,7] but modern component technology has made it possible to carry out the entire process in seconds using cost-effective PC architecture. Such a system is providing an effective display analysis tool for color-CRT display designers and manufacturers, and is enabling concise measurement of specification parameters in the application of ergonomic standards.[8]

Notes

[1]Makoto Maeda, "CRT Displays," Seminar M4, *Society for Information Display Seminar Lecture Notes* (May 1992).

[2]David Eccles, Gary Roman, and Jim Held, "HDTV: Good Enough for Data?" *Information Display* (January 1993).

[3]Microvision, SS100 product literature.

[4]Carlo Infante, "CRT Display Measurements and Quality," Seminar F6, *Society for Information Display Seminar Lecture Notes* (May 1993).

[5]"BEAMVIEW" is available from Microvision as an option for the SS100 Display Analysis System.

[6]IBM Technical Disclosure Bulletin, Vol. 25, p. 851 (July 1982).

[7]IBM Technical Disclosure Bulletin, Vol. 28, p. 616 (July 1985).

[8]ISO 9241, Part 3: Visual Displays. ■

Color on Air-Traffic-Control Displays

ATC has evolved from paper strips to electronic displays but has been slow to take advantage of color – or to determine the best ways to use it.

by V. David Hopkin

FLIGHT PROGRESS STRIPS were the earliest widely used tool for air-traffic control (ATC). These strips were standard paper forms on which the controller initially wrote the details of an aircraft's planned flight, and then added notes and updates as the flight progressed. The strips were housed in holders on a board, which was originally the main information display. In combination with appropriate communications facilities, such a board is still the basis of much ATC and is a feasible backup system if more elaborate facilities fail.

On flight progress strips, color coding is employed in two ways. The general direction of each aircraft's flight is denoted by the color of (1) the paper strip, (2) the alphanumerics on the strip, or (3) the strip's holder. Both controller and supervisor write annotations on the strips in different colors, so color also denotes responsibility for actions.

Radar displays give a plan view of the traffic as if seen from vertically above. ATC now generally employs processed displays devoid of clutter, with an alphanumeric label denoting the position of each aircraft slaved to each moving symbol (Fig. 1). The label gives identity, height, and other categories of relevant flight information. Color coding was not available when radar displays and the labels on them evolved, and efficient, safe monochrome codings for all vital operational distinctions had to be devised. Any proposals for color coding must compete with these well-proved monochrome codings.

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Coding ATC Distinctions

Investigators have been studying the application of color coding to ATC displays for some 30 years, but most proposals never progressed beyond the early research stages. A few of these proposals used esoteric technological developments, but most were more prosaic and coded alphanumeric data in different colors.

An early review of alternative applications of color coding on ATC displays identified 16 alternative distinctions for which color coding might be appropriate, but no particular application of color was self-evidently most satisfactory under all circumstances.[1] One reason is that the same information is used differently for different ATC tasks, and no single color-coding scheme can be ideal for every task. Any categorization of the information by color helps some tasks with which it is compatible but hinders others that require cross-color collations or comparisons.

Information and Structure

Color on ATC displays can serve two general purposes. The more familiar purpose is coding the information itself in categories that help the controller perform particular tasks, but color can also structure the information, alleviate clutter, or help the controller find information.

Color is a powerful coding; if it is used, it is likely to be visually dominant. This implies that color should never be employed for operationally trivial distinctions. A color-coded distinction will seem important, whether it actually is or not. Color has the potential to be distracting if it is employed for purposes irrelevant to a particular task. Thus, the dominance of color (or any other powerful coding) can be a benefit or a disadvantage, depending on its relevance to the tasks performed.

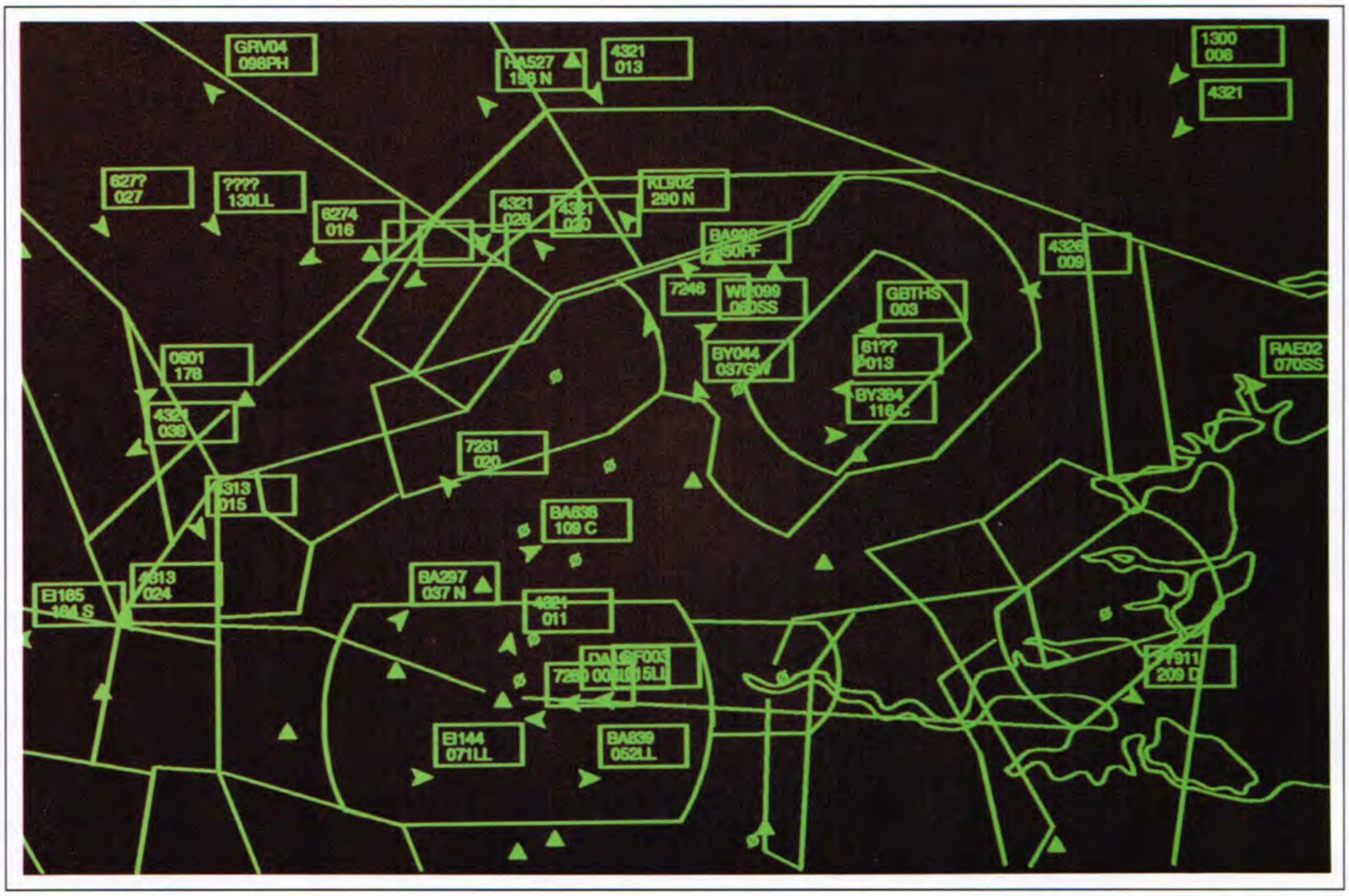
Color can assist searching, provided that the color of the sought item is known, but it can be counterproductive if the color of the sought item is not known. Color can attract attention without being as distracting as other attention-getting codings – such as movement or flashing – and it can be a relatively permanent means of drawing attention to particular items.

Drawing initial attention to an emergency by flashing or movement, and then using color as a permanent reminder of the emergency while it lasts, may be an effective strategy.

In many previous applications, color has been a redundant code – whether intended to be or not – simply because color as a coding was confounded with brightness contrast. Therefore, some of the effects, both positive and negative, attributed to color may instead have been due to brightness contrast. Whether color coding must be used redundantly in ATC remains an unresolved issue.

Early Mistakes

Many of the initial attempts to apply color to ATC displays repeated the mistakes made in



United Kingdom Civil Aviation Authority

Fig. 1: *Radar ATC displays give a plan view of the traffic as if seen from vertically above. This is the London Terminal Area at a particular moment in June, 1993.*

other contexts. A common mistake is to seek high saturation for its own sake, although color is often more efficacious in relatively unsaturated pastel forms. Another mistake is to produce garishness, which is incompatible with the claimed benefit of color as visually attractive. As the technology has developed, it has brought more subtle and aesthetically pleasing applications that discriminate between portrayed differences more sensitively.

Another mistake was a failure to realize that the discriminability of information does not depend primarily on color contrast but on brightness contrast. Some proposed usages, particularly of tabular alphanumeric ATC information, relied too much on color contrast and insufficiently on brightness contrast, with the result that the color actually degraded discriminability compared with monochrome. The lesson to be learned is that color coding is not *necessarily* beneficial, although significant benefits usually accrue if it is used intelligently and according to well-established ergonomic and visual principles.

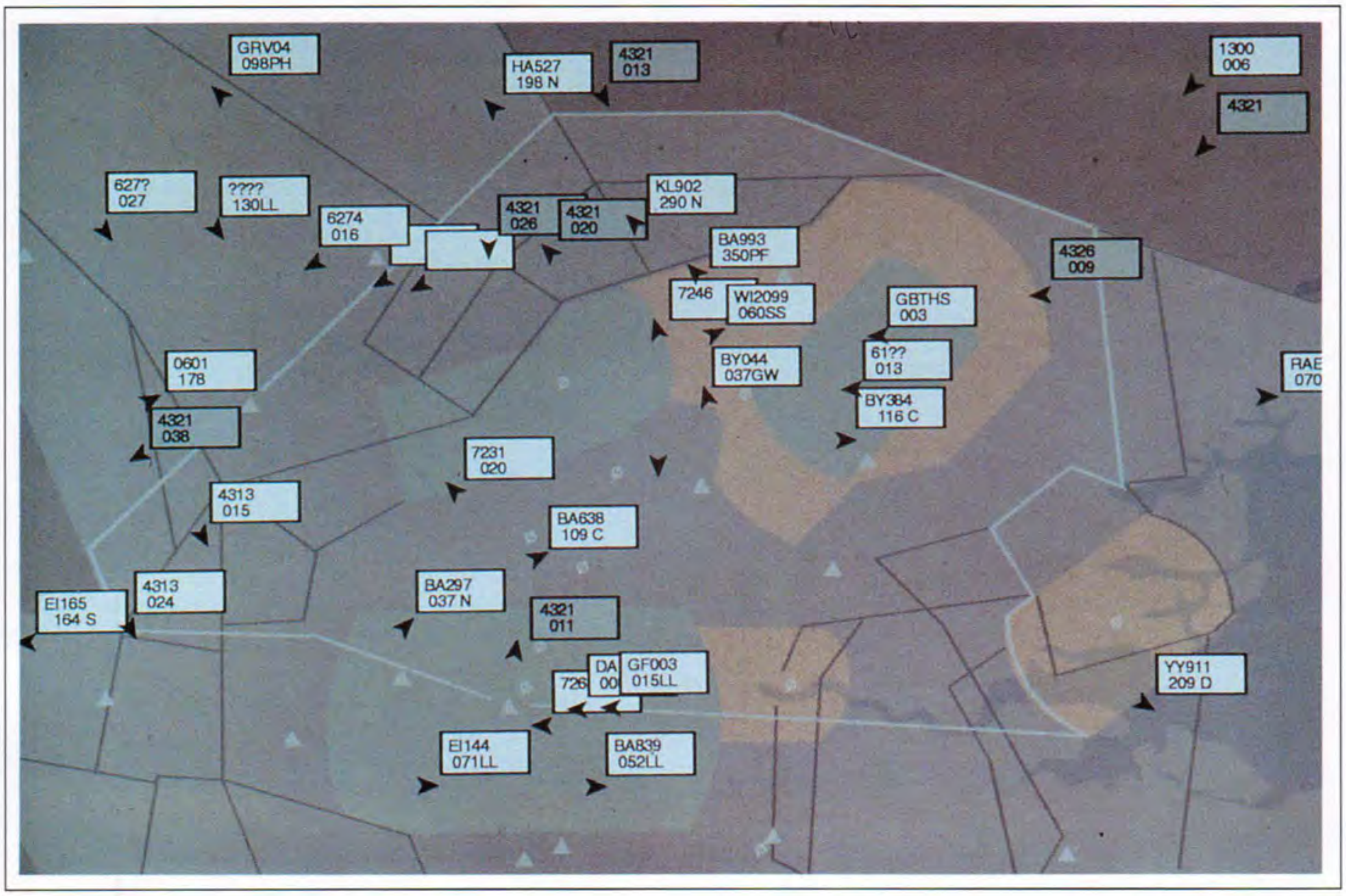
Original Constraints

At first, technological constraints precluded the consideration of some potential advantages of color coding.

For example, it may be beneficial in an emergency for all relevant information to appear temporarily in the same color on every display within the ATC workspace to facilitate searching and cross correlation, but it was not possible to test this idea because not every display could have color coding, or, on those that could, colors that were nominally the same were not recognizable as the same by users.

It was by no means obvious at first that the additional cost of introducing color would be recouped in any tangible form such as increased efficiency or safety. The allocations of meanings to colors must be right the first time, since the re-allocation of new meanings to the same colors could be extremely misleading and a potential source of human error that must be avoided. It was more important to be right than to be quick. To some extent this caution continues, as new principles for the application of color are explored thoroughly before they are actually introduced.

There have been several reviews of color coding applicable to ATC.[2-5] Generally, the broad principles of color coding are applicable, if modified to take account of the multi-



United Kingdom Civil Aviation Authority

***Fig. 2:** Combining color with the principle of transparency allows the portrayal of overlapping categories of area information without using much of the available technical range of brightness contrast. This can produce a less cluttered display, as can be seen by comparing this figure to Fig. 1, which contains the same information.*

plicity of task requirements and the particular physical and visual environments in ATC – environments that sometimes pose severe constraints. For example, the controller in an ATC tower must always be able to see the coded information on the displays, though the ambient lighting may vary grossly – from direct sunlight falling on the display to artificial lighting combined with exterior darkness. Controllers are screened and are not accepted for employment if they have major defects in color vision, for these impair their performance.[5]

Forms of Evidence

In ATC, as elsewhere, the introduction of color coding has often been accompanied both by user certainty of improved task performance and a lack of objective evidence that confirms this improvement actually occurs. This need not imply that one or the other kind of evidence must be wrong, for both may be right. Measures of performance of ATC tasks do not cover every conceivable task aspect. In particular, some cognitive aspects such as increased understanding, re-structured memory, and better information retrieval may not be represented in the performance measures, yet may influence subjective judgments.

Most applications of color coding to ATC have emphasized alphanumeric characters, tabular displays of information, and the categorization of information. More recent applications seek to utilize more fully the potential richness of color as a coding. This has entailed some reappraisal of ATC tasks and information, and of the ways in which color coding could be applied.

Transparency and Information Categories

Researchers are currently evaluating the use of color in depicting three broad categories of ATC information on a plan-view display. The first category covers display backgrounds – mainly permanent information such as coastlines, airways, control zones, restricted areas, and navigation aids. This information must be present and discriminable, but not obtrusive. The principle of transparency allows various overlapping categories of area information to be portrayed without using much of the available technical range of brightness contrast (Fig. 2).

The second category of information contains the main dynamic information used for normal ATC tasks, namely symbols and associated labels that move on the display in

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***Fig. 3:** Researchers are currently examining the use of solid-color blocks for normal air-traffic and emergency information. The approach is controversial because it limits the range of feasible solutions for preventing label overlap – a recurring problem in ATC.*

accordance with aircraft movements. All information must possess sufficient brightness contrast to remain easily readable whatever the background. Generally, it may be appropriate for normal traffic to be portrayed in monochrome – either green or light gray – with color reserved for certain relatively unusual circumstances.

The third category of information deals with emergencies. For much of the time, there would be no information of this third kind on the display, but when it is present it must command attention and be clearly seen. This third information category should have the highest brightness contrast with the background, and must remain clearly visible when superimposed over information in the second information category.

Researchers are currently examining a proposal to use solid-color blocks for the second and third information categories (Fig. 3). This is sufficiently novel to require study. It curtails the range of feasible solutions to prevent label overlap – a recurring problem in ATC, where color alone is not generally sufficient to resolve overlap. Further work will therefore explore solid versus transparent alphanumeric labels. Past research has made it clear that the principle of transparency combined with color for backgrounds is more acceptable to users than the principle of using color blocks instead of colored alphanumerics.

The efficacy of these three information categories depends on an available range of brightness that may be beyond the capabilities of some displays, particularly the largest ones, but future technical advances seem likely to remove this limitation. Meanwhile, it is prudent to choose applications of color coding capable of further refinement and development when these constraints ease.

Which Route for Color Now?

The ATC-display approach using three information categories and transparency for the color coding of information has its origins in the basic principles of human color perception. To depart from the resulting guidelines would violate established visual principles and degrade discriminability and legibility; therefore, the burden of proof rests with anyone who wishes to make such a departure.

The solution expressed in terms of basic principles leaves some flexibility in the choice of actual colors – provided there are no incompatibilities between the different applications within ATC and provided that all solutions are compatible with the ambient lighting, operator eyesight standards, and task and brightness contrast requirements. Thus, the most recent work does not prescribe particular colors but lays down the criteria for choosing colors and the objectives the chosen colors must satisfy, while introducing new principles such as transparency.

ATC systems are built and marketed internationally, and the ways in which the systems portray information must conform to international standards and guidelines. The caution exhibited in the past by the ATC community over the precipitate introduction of color coding in rather crude and garish forms should allow future forms of color coding that will be more subtle, better proved, better matched to the required tasks, and capable of further refinement and development.

Notes

[1]F. R. Eden, L. I. Brown, and R. Edenborough, "Evaluation of Colour Displays," Air Traffic Control Evaluation Unit Report No. 396, U.K. National Air Traffic Services (1973).

[2]D. W. Connolly, G. Spanier, and F. Champion, "Color Display Evaluation for Air Traffic Control," Federal Aviation Administration Report No. FAA-RD-75-39, Federal Aviation Administration, Washington, D. C. (1975).

[3]G. C. Kinney and L. G. Culhane, "Color in Air Traffic Control Displays: Review of the Literature and Design Considerations," MITRE Corporation Technical Report MTR 7728, MITRE Corp., McLean, Virginia (1978).

[4]C. S. Narborough-Hall, "Recommendations for Applying Colour Coding to Air Traffic Control Displays," *Displays*, Vol. 6, pp. 131-137 (1985).

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[6]H. W. Mertens and N. J. Milburn, "Validity of Clinical Color Vision Tests for Air Traffic Control Specialists," Federal Aviation Administration Report DOT/FAA/AM-92/29, Federal Aviation Administration, Washington, D.C. (1992). ■

The Evolution of Display Controllers

Buyers want increasingly sophisticated technology at bargain prices, and they're getting it.

by Jon Peddie

THE EARLY 1990s saw a dramatic shift in the technology, availability, and demand for graphics controllers. In the late 1980s the market was conveniently segmented into desktop office systems using VGA displays and DOS- or UNIX-based workstations with high-performance high-resolution high-priced display controllers. Then the introduction of Microsoft Windows 3.0 rapidly created a demand for higher-performance graphics for office workers. But solutions still had to be cost effective for manufacturers to realize the large market potential. VGA semiconductor suppliers responded to this challenge and introduced faster conventional VGA architectures, which were called super VGA (SVGA).

With the introduction of Windows 3.1, the concept of a graphical user interface (GUI) in a DOS-based office environment became both realistic and almost instantaneously acceptable. The number of Windows users accelerated rapidly, and independent software vendors (ISVs) scurried to make their DOS-based products Windows compatible. That effort exposed the tremendous demands that the Windows applications programmers interface (API) – also known as the graphics devices interface (GDI) – placed on the CPU and graphics hardware.

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The high-performance graphics controllers of this period were based primarily on the Texas Instruments 34020 chip; a few mature

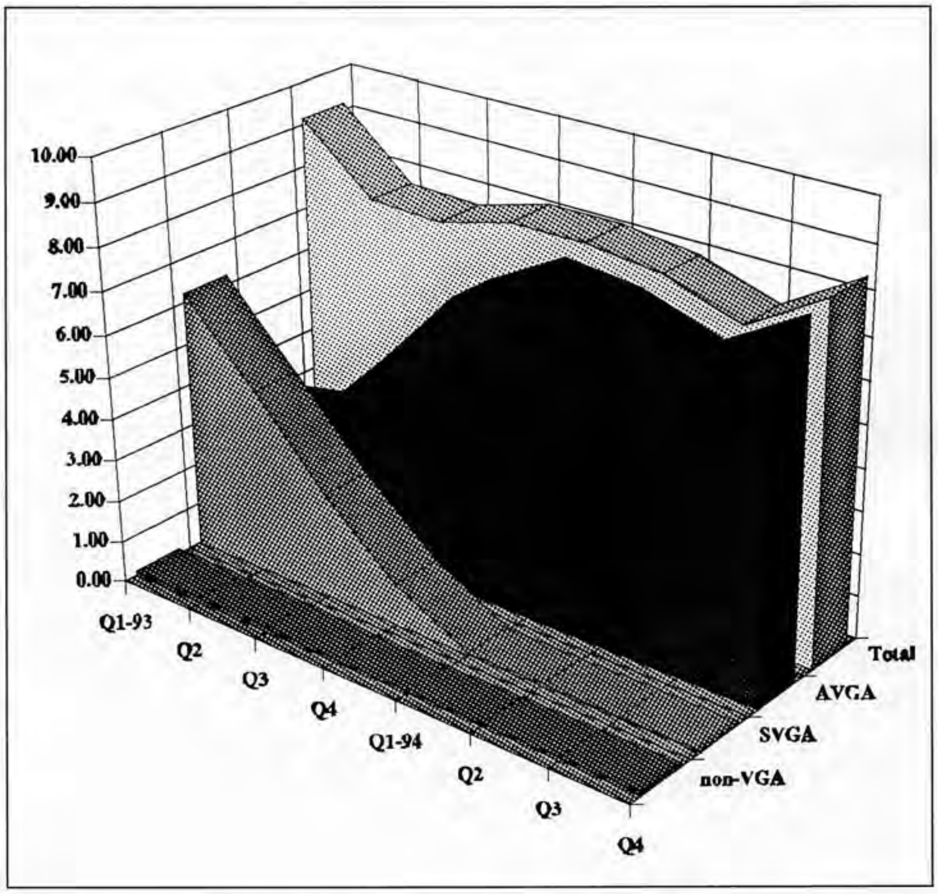

Fig. 1: The market demand for VGA controllers is rapidly changing from the second-generation SVGA types to the third-generation accelerated (AVGA) designs. Sales are in millions of units.

designs were based on the Hitachi 64848; and there were some semi-custom designs based on DSP and ASIC. But these approaches did not meet the marketplace requirements of a mass market and did not offer sufficient GUI acceleration to justify their higher cost. This created a vacuum in the marketplace between the economical low-end SVGA controllers and the expensive high end of CAD controllers.

XGA: The Successful Failure

New designs were proposed, the most talked about being the XGA from IBM. The XGA ushered in a new generation of controllers which are known today as accelerated VGA (AVGA) controllers. IBM introduced the XGA by proposing a new hardware standard, but the landscape of the market had changed and hardware standardization was no longer required or desired.

Following the announcement of the XGA, several companies took existing 8514 features – such as accelerated line drawing and bitBLT capabilities – and incorporated them into conventional VGA controllers. This hybrid arrangement provided VGA register compatibility and consequent compatibility with existing software, and at the same time offered graphics acceleration. Furthermore, these parts were introduced at attractive price points, making it possible to build AVGA boards at a significantly lower cost than conventional high-end graphics boards.

As AVGA boards became available at prices that were from 25 to 60% less expensive than existing TI, DSP, and custom ASIC controllers, CAD as well as Windows users began adopting them. In spite of a recession in the U.S., which was quickly followed by a recession in Europe and Japan, the sales of PCs exploded. Demand exceeded supply, as it does today, and an active retrofit aftermarket developed for the SVGA and AVGA boards.

Today, AVGA products are taking most of the market (Fig. 1). SVGA board and chip demand is declining rapidly, and only the inability of AVGA vendors to meet demand is keeping the SVGA market from collapsing. As AVGA suppliers increase capacity, the SVGA market will all but disappear – just as the EGA market did when VGA became popular. The decline of the SVGA market has been accompanied by a steady decline of the markets for TI-, DSP-, and ASIC-based products. But these products will not completely disappear; they will retain a place in the specialized high-performance niche market.

As the data in Fig. 1 indicate, the forecast for graphics boards of all types in 1993 and 1994 exceeds the forecast for computers. The first of two reasons for this apparent anomaly is that there are still several million serviceable 25- and 33-MHz 386s and 486s in use that do not have AVGA controllers.

The second reason is both ironic and beneficial to chip manufacturers: the inclusion by PC manufacturers of a graphics controller on the motherboard or as a bundled add-in board. PC suppliers understandably want to offer a cost-effective product. To do so, they typically have to choose the lowest common denominator for the graphics controller. Users who acquire these systems quickly learn that the graphics performance is sub-optimal for Windows and seek alternative solutions. They then become consumers in the aftermarket and purchase higher-performance AVGA boards.

The future of this dynamic market is relatively easy to predict, and we can already see the trends that substantiate such predictions. The conventional "faster-and-cheaper" curve applies to this market in a dramatic way. The VGA market has already gone through three generations and is entering the fourth (see The Four Generations of VGA below). These generational stages are marked by improved performance, which is accompanied by wider data paths.

The 64-bit fourth-generation AVGA chips are being announced now and will be seen in products demonstrated at trade shows this coming autumn.

The Four Generations of VGA

VGA controllers have become the undisputed leader in graphics chips, selling in excess of 30 million units in 1993. VGA devices became popular because they offered good resolution with excellent color control and became a software standard. The format maintained its position as a standard because of its inherent ability to be enhanced and expanded. Modern-day VGA controllers have little resemblance to the first unit developed by IBM.

1987: The First Generation
The first chips had an 8-bit data path and VGA screen pixel dimensions (640 × 480) only, and were dumb sequencers with just CRT and attribute controllers.

1989: The Second Generation
The term "super VGA" became the vogue. To the first generation, SVGA added 800 × 600 pixels, and the internal architecture moved to 16 bits. But they were still dumb.

1991: The Third Generation
The birth of AVGA (aka GUI accelerator) provided all of the above, plus extended VGA (EVGA, 1024 × 768), an internal 32-bit architecture, and acceleration features – such as bitBLT and line-drawing engines – copied from the 8514. Various caches and input FIFOs were added, as well as a hardware cursor copied from the original Video Seven board. In the third generation, direct bus interfaces to ISA and VLB became common, and a few special features – such as external sync for genlock, multiple-operand capabilities, and BLT tricks – were added.

During this period some fourth-generation concepts appeared in third-generation parts, notably the integration of the LUT-DAC with the controller.

1993: The Fourth Generation
No popular name has been given to this generation yet, but 4GL-VGA or 4GL-controller may work. Controllers of this generation have the features of the third generation, plus VHR+ (1280 × 1024, non-interlaced), and an internal architecture increased to 64 bits. A direct bus interface to PCI has been added, video ports have been included, and a LUT-DAC integrated with the controller is available on many examples of the class (but not on all because of video bandwidth limitations).

Processors with 64-bit architectures – such as alpha, MIPS4X00, Pentium, and SuperSPARC – are already available, and new memory architectures and devices are now being readied for market. The popular VRAM, which offers added performance because of its synchronous I/O capability, will be challenged by faster DRAM and alternative DRAM structures such as synchronous DRAM, burst-mode RAM, XRAM, and others. As these technologies become available, the interest in user-friendly multi-tasking operating systems will increase. Today, there is no compelling need for a DOS user to move to a more powerful operating system such as NextStep, NT, OS/2, or UNIX. Today, such operating systems only represent unwanted complexity and increased costs. However, by the third quarter of the 90s, the hardware technologies required for multi-tasking operating systems will be in place, and they will be so economical that multi-tasking will provide genuine benefit to the average office worker as well as the CAD user.

A Maturing Market?

The competition in the graphics-controller semiconductor market is intense as the 33 suppliers vie for market share and design wins. As long as the market continues to expand and user demands for graphics performance remain high, it will be an inviting place for new designs and new companies.

By the late 1990s we can expect a minor maturing of this dynamic and sometimes chaotic market, which will result in a thinning of the number of suppliers. However, I would like to conclude by saying that I have been monitoring and forecasting the graphics market since the early 80s as a consultant (and for a decade or more prior to that as a participant), and every year I have forecasted a shake-out in the number of suppliers. Every year I have been wrong, which has prompted me to learn the expression, "He who earns his living by gazing into a crystal ball must be prepared to occasionally eat glass." ■

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show report

SMAU '93

Italian optimism is infectious – even when there's no discernible reason for it.

by Bryan Norris

"RECOVERY IN THE AIR" was the official theme for the 30th International Exhibition of Information Systems, Telecommunications, Office Machines and Equipment (SMAU) held in Milan, Italy, from September 30 through October 4, 1993. Unfortunately there were few, if any, signs that this was true. SMAU '93 was considerably smaller than SMAU '92.

Four halls used in 1992 were empty this year, and the occupied exhibition floor space in the remaining 14 halls was thus reduced 14% to 140,000 m^2. And the number of direct and indirect exhibitors was down around 10% to 1800.

Notable display company absences included Hantarex (the local monitor manufacturer and the largest in Europe), Mitsubishi, Panasonic, and Philips (other than for telecommunications). The last three left it to their distributors, if present (C2000 was absent), to promote their display monitors or not. However, compared to 1992 there was an increased number of visitors – up 15,000 to 183,000 in 1993.

Therefore, in general, SMAU '93 proved to be another of the strong signs that the Italian economy is still far from recovery. Money is extremely difficult to come by in Italy.

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Credit, when available, attracts high interest rates. The common practice of not having to pay bills for 180 days is crippling the local manufacturers and businesses. To fulfill orders, local monitor makers, who should be benefiting from exports tied to competitively low costs because of the favorable exchange rate of the Lira to most other currencies, must, of course, purchase parts. In particular, they must buy display tubes with cash – Yen or dollars – at or before delivery, and before they can make and sell their products. An intolerable burden is imposed on them if they do not receive payment until 6 months later. Hantarex is caught in this vicious loop and is reported to be in serious financial trouble, despite apparent help from local government within Italy and the European Bank of Reconstruction and Development's payments toward costs at its new production plant in Pecs, Hungary.

The cash-flow problems are also having an effect on another Italian norm – the expectation of getting a discount off the price of *anything* purchased. Several suppliers mentioned that at present they only discount *cash* purchases. If the purchaser is unwilling to pay cash but expects the up-to-180-days payment, then there is no discount!

Nevertheless, the exhibitors at SMAU put on a cheery and enthusiastic display of business as usual. "New" monitors were numerous and varied, albeit some were "new" only to Italy. Paradoxically, these included both low-end low-cost 0.39-mm-tubed 14-in. models and high-end innovative "green" power-saving units.

Locally Made Monitors

At $11.70, industrial hourly wage costs in Italy are just half that of Germany (at $22.20); therefore, Italian monitor manufacturers should have an edge over other European producers. It is even true that Hantarex has been competing with locally made products in the Far East. However, it must be remembered that today labor is only a small part of overall monitor production costs. The CRT now constitutes around 70% of the cost – and carries the further disadvantage that a quick payment in U.S. dollars or Yen is required. (There should be plenty of opportunity for a European source of display tubes – no doubt Philips and Sony had this mind when they decided to make CDTs in Europe.) Nevertheless, low labor costs and the lack of transportation costs do mean that a "Made in Italy" monitor does have some advantages.

CA&G is exploiting this, and is also slated to make the low-end monitor for Epson, the Italian distributor for high-end Eizo monitors. At SMAU, CA&G introduced a low-cost VGA/XGA1 14-in. monitor, the VG1431, for 567,000 Lire ($360). CA&G also imports (and showed) new 15-, 17-, and 21-in. monitors made by IDEK.

Formenti of Concorezzo, on the other hand, does make all its (normally OEM) monitors in Italy. Better known as a half-million-unit-a-year color-TV manufacturer, Formenti introduced a completely new range of computer monitors, starting with a low-end VGA/XGA1 14-in. model with a 0.39-mm CDT, and including four 0.28-mm 14-in. models, two 15-in. models, and one 17-in. model – the higher-end units with MPR II.

Note that a 0.39-mm 14-in. CRT monitor is still acceptable in Italy as an introductory model. Taiwanese EMC, Enoch, Machspeed, Tatung, and Trust (Aashima), along with South Korean Samsung, also offered 0.39-mm-tubed 14-in. VGA/XGA1 monitors.

International Makers Are Strong Competition

From Taiwan, low-end VGA/XGA1 14-in. monitors with a 0.39-mm tube are available at about U.S. $165 f.o.b., delivery 2-3 weeks *after receipt of payment*. This equates to Italian dealer prices of around 350,000 Lire ($220). Use of a 0.28-mm tube adds approximately $20, and meeting MPR II low radiation levels a further $20–$30. Other international suppliers offer different forms of competition. Many of the major monitor brand names had a variety of new models at SMAU '93 or included them in their distributors'/dealers' price catalogues.

Apple attracted dense crowds around the presentation of its AudioVision 14-in. Trinitron™ (1.4 million Lire/U.S. $880) video and stereo audio monitor. The live demonstrations naturally included the use of the microphone.

Aydin's new "low-cost" (3.86 million Lire/$2,430) Ranger 20S1 20-in. monitor (from Philips OEM) was included in its distributor IBEM's catalogue.

Cornerstone monitors (displayed by the major vendor of document-management systems in Italy, *nica sistemi*) included the new 24-in. monochrome model with a 2048 × 1538 capability – a true dual-page monitor.

HP had a very low-key "by the way, this is our new 21-in. monitor – the D1199 at Lire 4775K/$3,000" introduction on its large Hall 18 stand and at the CAD/CAM expert distributor display booth in Hall 42. Close inspection revealed two telltale fine-aperture-grill-tube horizontal lines across the screen – just visible on the white background. Yes, revelation! The monitor has a Mitsubishi Diamontron™ CRT in it!

IBM was also keeping the introduction of its new monitor ranges "low key." A 14X (Lire 983K/$620) and 15X (Lire 1189K/$750) were to be found on one sector of the giant stand in Hall 20, but a request for end-user prices produced a basic price list with only the X-range prices on it. Further prices were only obtained once a representative had consulted the in-house notification binder.

NEC demonstrated that it understands the difficulties of selling a 15-in. monitor in the Italian market by announcing a MultiSync Super VGA (72 Hz) 14-in. monitor. Despite NEC's understanding, this unit may still have trouble competing on the open Italian market at Lire 760K/$480. An economically priced 15-in. monitor – the 3V – was also disclosed, together with a range of power-management monitors (to be discussed later).

Circle no. 20

Océ Graphics, which made its debut into monitors just over a year ago in Italy, showed its slightly refined stable of four high-end monitors (one 17-in. model, two 20-in. models, and one 21-in. model, OEM from Philips) but, interestingly, at prices from 19 to 33% down from last year, even more when expressed in dollars.

Zenith Data Systems' (ZDS) new 15-in. monitor announced at the show conforms to Energy Star and power-management requirements to below 8 W. Made in Finland by Nokia/Salcomp, this monitor, of course, meets MPR II low emission levels and runs 1024 × 768 at a "user-friendly" 75-Hz flicker-free rate. In fact, this monitor highlighted an important aspect of the show.

International Theme: Green

Being "green" today can mean one or both of two things. First, the power management increasingly being fitted to new monitors turns them "green" and "environmentally friendly" by progressively cutting power consumption in line with NUTEK and/or Energy Star recommendations.

For example, NEC announced at SMAU its new range of upgraded monitors – including the 15-in. 4FGe ipm and the 17-in. 5FGe ipm models – which have "intelligent power management." Furthermore, the high-end 5FGp 17-in. and 6FGp 21-in. models, due later this year, will also come "ipm" fitted, with new "user-friendly" anti-reflective "Opti Clear" screens.

Secondly, being "green" means making a strong commitment to design and fabrication that allows a product's constituent materials to be largely re-utilized or recycled at the end of its lifetime. At SMAU, the most prominent example of this was illustrated in a large billboard on the Siemens stand, showing how "The environmentally friendly desktop PC (with monitor), the PCD-4L," was made, and what parts could be re-utilized or finally become waste. For example, the reusable plastic materials in this PC and monitor are marked. Power management is in the form of standby and suspend modes. In the standby mode, the PC hard disk is switched off, the clock frequency of the processor is reduced, and the power-saving facilities of the MCM

1502 monitor are initiated. In the suspend mode, the PCD-4L has a minimum consumption of only about 5 W.

At the end of its life, the PCD-4L's waste materials amount to only:

- 8% in the form of plastics,
- 0.005% luminous substances from the glass,
- 1.5% from cable sheaths,
- 1.7% from electrolytic capacitors and batteries, and
- 4.8% mixed plastics from the sub-assemblies,

for a total waste of just over 16%.

It appears likely that this minimum energy consumption and materials wastage will soon become the norm for all new monitors and PCs.

The Italian PC Environment

The excellent and informative 1993 SMAU Observatory on Information Technology gives the installed base for desktop PCs in Italy as 2,860,000 units in 1991 and 3,385,000 in 1992. It reports a yearly shipment growth of nearly 7% from 706,000 PCs in 1991 to 755,000 in 1992. (Portable PC sales rose by 32.5% from 120,000 in 1991 to 159,000 in 1992, reaching an installed base level of 367,000 units.)

There is no doubt that a large part of Italian PC sales was taken by the omnipotent Olivetti. However, it is interesting to see how well the small PC-clone makers prospered over the last year. Not too well, it seems; like many similar operations throughout Europe, they suffered intense competitive pressures from the majors, notably IBM and Compaq. (Compaq showed off its Presario, the PC for all the family, at SMAU.)

Both MPM and Staver Computers, which had medium-sized stands at SMAU '92, were not at SMAU '93, and no one seemed to know how they were faring. Vegas proved to be another costly venture of Hantarex: it was wound up and closed down with considerable losses at the beginning of 1993. At the show, a representative of ASEM stated that they are hoping for a slightly increased PC output in 1993 – in volume, if not value. But it seemed strange that a company that has been bought by Hantarex should be showing a 14-in. monitor from Vestel in Turkey and claim to be Vestel's first major customer. The small company, Uni-bit, now owned by CA&G distributor, D.Top, seemed to be concentrating on promoting a wide range of general computer peripherals at SMAU, rather than PCs from Uni-bit. Only Intercomp gave the impression of coping with these difficult times.

On the other hand, local PC importers, such as Computer Display and Olidata, appeared to be doing well, with increasing turnover. Olidata confirmed that it is investing in an Italian PC plant to assemble its own PCs in the future, but stated at the show that it would *never* make monitors.

The Italian arm of German Vobis proclaimed with gusto the merits of its PCs and PC accessories, notably own-brand Highscreen and NEC monitors, both on its large, crowded stand in Hall 17 and on a section of the HP stand in Hall 18.

Guarded Optimism in Milan

Anyone attending SMAU and talking with the local suppliers could not help but be carried along with the infectious Italian optimism. Although everyone agrees that times are very difficult and may even get worse before getting better, things will be all right sometime in the future. There is certainly a moderate increase in demand for low-cost 14-in. monitors, matching the expanding PC market. Selling the much more expensive 15-in. models at the moment is, however, NOT easy. But there is a growing market for 17-in. monitors to display Windows. The requirement for larger higher-resolution units is subdued but ongoing. ■

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display continuum

continued from page 4

More recently, we have seen the introduction of self-contained projectors that are much brighter and can display better-looking full-color images. Will these be the replacements for the overhead? I think not. They offer new capability, but still miss some of the really nice features of the traditional overhead projector. Have you noticed how much comfort and protection the overhead projector provides to some presenters – like a warm and fuzzy blanket when life gets a bit scary? It makes one almost feel in control of the events at hand. If you forget what you intended to say, you can at least point out each word on your overhead to help get you through. You can even do real-time error correction and add information as your talk progresses. It will indeed be difficult to give up this highly developed support system in exchange for the new features of a computer-driven projector.

And yet, the ability to have a presentation resident in a laptop that can be updated as needed is very appealing. Not only that, it can be in full color, with video added to dazzle the audience, and one doesn't need to worry about how to get transparencies made.

We should stop here for a moment to pay homage to the laptop computer. Without it, we wouldn't even be having this discussion. It's the real driver behind the acceptance of the LCD panel and projection technologies. Who would want to cart around a desktop PC just to do a presentation? This is an excellent example of how seemingly unrelated technologies can create new markets, like the CD-ROM business being driven by computer imaging and not by the family photo album – the scenario Kodak wanted to implement. Or quadraphonic sound, which was supposed to replace stereo but went nowhere until movies and video came along with "surround-sound." Now, everyone wants five or even seven channels for their home theatres.

So here we are stuck between two products, each of which has useful features. Can they be brought into one? YES! And here's my idea-of-the-month: HOW TO DO IT.

The next generation of these products will retain the look and feel of the traditional overhead projector. However, there will be an internal module that replaces the bulb and its housing. This module will provide the capability to project computer images, while still retaining the capability to use traditional transparencies. The module will ideally be a plug-in unit so that the user can select from (1) the traditional quartz-halogen light bulb, (2) the additional capability of a modestly priced monochrome computer-generated display, (3) a full-color slide-show-type display, (4) full-color video at TV resolution, or (5) a "give it everything you've got" full-color high-definition-resolution display. The choice will be dictated by need and by budget. The concept of upgradability will make it possible to buy a modest unit first and then keep up with technology and increasing display needs.

Several existing technologies can already accomplish what I have suggested. It seems to me that the **Texas Instruments** micro-mirror display mentioned in last month's column would be a particularly good choice. The new "smart-slide" technology from **Kopin Corp.** could work as well, or even many of the more traditional LCD panels. I especially like the TI approach because it should be inherently less sensitive to the heat generated by the projector bulb and it is fundamentally more efficient as a reflective device than the absorptive process of an LCD.

If I really let my imagination go, I could see an industry compatibility standard develop so that one could carry a personal display module, along with a laptop, and be able to put on a show at a conference or at a customer's site that is limited only by creativity and the willingness to invest in stuff that can easily be carried around. However, that is truly a stretch into the realm of "wild ideas." The limitation is not technology, it's people. How long has it taken, so far, for us to *not* agree on a standard for HDTV? "We have met the enemy, and they is us." – Pogo

Well, it looks like our analogy to the slide rule was not a perfect one. We've ended up suggesting that the new technology will dramatically change but not eliminate the existing one. But I think in a few years, when you are doing your presentations, it will be difficult for you to look back and remember the days when all you had was a light bulb, some simple optics, and a glass surface on which to place your transparencies.

In the next few years, we can expect to see intense activity by established, as well as new, companies. There will be many new product announcements, the entry of too many new players, the failure of almost as many, followed by a final settling out of two or three dominant manufacturers along with 5–10 niche-market participants. The computer-image display business will grow to be a large one, and several new market segments will evolve that we can't yet name.

What we can see and what I can tell you about are who some of the companies are and what they are doing. That will be the focus of this month's industry news segment.

Let's begin with **Sharp Electronics Corp.** and some information provided by **Joseph Gillio**, their LCD Products Group Marketing Manager. Sharp makes both LCD panels and stand-alone projectors. A panel that I find particularly interesting is the QA-1650, which uses a full-size 10.4-in. high-brightness TFT-AMLCD. It can do both full-motion video and computer-generated images, with 640 × 480 VGA/MacII compatibility. In the projector category, the XG-E800U is an equally capable high-resolution VGA/MacII-compatible video/data projector. Three high-resolution TFT-AMLCDs produce projected images with diagonals up to 200 in. with 560-TV-lines resolution. Sharp is also the predominant LCD supplier for many of the companies listed below.

A recent visit to **In Focus Systems** in Oregon left my briefcase somewhat heavier from a complete literature package given to me by **Steve Hix**. From just counting the data sheets, In Focus now has over 15 products, ranging from LCD panels to projectors to some specialized software. The 7600WS color projection panel configured for workstations is especially interesting. It features 1024 × 768 resolution, a pixel-clock range of 25–100 MHz, a 24,389-color palette, and a 15:1 contrast ratio. In the projector category, the TVT-6000, based on color active-matrix TFT-LCD technology, provides video and/or computer-generated images; resolution is 480 × 440 with a 100:1 contrast ratio.

Proxima Corp. in San Diego prides itself on providing a broad line of desktop projection systems that include LCD projection panels, an LCD projector, and high-performance overhead projectors. Among these are the top-of-the-line Ovation true-color data and video projection panels, the ColorWorks family of moderately priced true-color projection panels, and the Proxima 8300 color multimedia LCD projector with 640 × 480 resolution. They also offer the Cyclops interactive pointer system, which acts like a cordless mouse for computer-based meetings or presentations. Proxima claims a proprietary technology called Active Color Enhancement to improve the performance of its Ovation series of LCD panels.

Brian Runge of **nView** provided me with quite a packet of information, all by fax. nView keeps what they call a "trophy case" of the awards that have been bestowed on them. Among the 20 or so listed is a *MacUser Magazine* Best Display Product of 1992 award for the Luminator LCD projector, and a readers choice award from *Presentation Products* for the MediaPro LCD panel in December 1992. The MediaPro panel is capable of 16.7 million colors with 640 × 480 resolution. With connectors for composite video, S-video, and analog RGB, this panel can be used with nearly any computer or video source. The Luminator LCD is the projector equivalent of the panel and has similar capabilities for color and input sources. nView estimates that in 1993 a total of 175,000 units of various LCD projectors will be produced worldwide by all manufacturers.

Information about **Sayett Group** came to me from **Kathleen Lawler**, Marketing Operations Manager. Sayett began operations as a division of Eastman Kodak Co. in 1984, selling products under the DATASHOW trademark. Currently, Sayett markets several projection and panel products. The MEDIASHOW XC Color LCD Projector utilizes AMLCD technology and provides the highest performance. The DATASHOW PREMIER XC Projection Panel is the overlay product that is the complement to the projector. Sayett prides itself on the ease of setup and ease of use of its products. Improvements such as an automatic lamp changer can be very important if needed in the middle of a presentation.

Telex sent me a summary of their products via **Garry Fisher**. They have taken the multimedia approach one step further by including a built-in audio system. The Telex MagnaByte M2x LCD Presentation System has a palette of 614,125 colors and features 2 W of speaker power, enabling presenters to project sound from videotapes, laser disks, computers, and multimedia software programs. The panel has 640 × 480 resolution. A lower performance monochrome panel is available as the MagnaByte 5090 LCD Computer Projection Panel.

Dukane Corporation's Audio Visual Systems Division was not a familiar name to me until I started working on this compilation. They have a product that appears to integrate the LCD panel with the overhead projector, i.e., it's not an add-on. This is the MagniView Computer Data Projector. It can project data as well as video. It is compatible with all the typical desktop systems, is capable of 2 million colors, and has a resolution of 640 × 480. There are options for standard or wide-angle projection and it even has a built-in lamp-life meter.

3M, which is certainly well known for providing overhead projectors and transparency materials, also has several projection panels available. The most capable product is the Model 5450, which features built-in video and audio capability that allows for integration of full-motion video from VCRs and laser-disk players. The 8.4-in. active-matrix TFT panel displays 2.1 million colors with a contrast ratio of 200:1.

Polaroid has a product called the Professional Presenter DP-2000 LCD Projection Panel. It is also based on active-matrix TFT technology and is capable of video and data inputs. This panel can also be used in rear-projection applications.

Kopin Corp. in Taunton, Massachusetts, has announced its intentions to develop its "Smart Slide" technology into products for projection applications. This technology of transferring a transistor array from a silicon wafer to a glass substrate was described by Ken Werner in the October issue. The financial community has responded with great enthusiasm to Kopin's technology by placing a several-hundred-million-dollar valuation on the company. This will certainly create ongoing interest in the commercial success of this company's products.

With all of these companies vying for position, it's no surprise that alternative distribution channels are also developing. A company that is specializing in selling the products of many of the companies listed above is **Boxlight Corp.** in Poulsbo, Washington. Their catalog shows all products under the Boxlight name. But **Carol Robinson**, who is knowledgeable about the many available choices, told me who their OEMs are. As this marketplace gets more crowded, it's going to be ever more helpful to have someone in at least a somewhat neutral position to help with product selection.

I will close this month's column with an observation about how various companies responded to my requests for information. In general, the smaller companies immediately let me speak to someone who was knowledgeable about their products and were pleased that I was going to be writing about them. The promised information arrived promptly and was usually more than I could use. The two large corporations, 3M and Polaroid, were, on the other hand, not nearly as customer friendly – they were plenty friendly, just not in a very useful way. 3M finally came through by fax after several phone calls and eventually I did receive the promised information in the mail. From Polaroid, I was lucky to get anything at all. When I told them I was doing an article, I was told the information would have to come through a public-relations person. They wouldn't give me a name. So far, no one has called. Is anyone there?

When events are evolving as rapidly as with these technologies, it is very easy to omit one or even several. If I have done that, I would like you to let me know. As always, information, comments, and suggestions for this column are most appreciated. ■

editorial

continued from page 2

New scientists and engineers are best trained by doing basic research, and such training is invaluable for applied research. An understanding is needed that scientists pursuing basic research cannot specify with bureaucratic precision when and how they will attain their goal. As for long-range applied research, early conversion of the labs would provide a true peace dividend.

***Hans A. Bethe** is emeritus professor of physics at Cornell University, Ithaca, New York, and a Nobel laureate. These comments are reprinted from the December 6, 1993 Op-Ed page of* The New York Times *with the author's permission.*

Note

Information Display Magazine invites other opinions on this and related subjects from members of the international display community. The opinions expressed in guest editorials do not necessarily reflect the opinions of the editor or publisher of *Information Display Magazine*, nor do they necessarily reflect the position of the Society for Information Display. ■

Please send new contributions or noteworthy news items to Aris Silzars, Contributing Editor, Information Display, c/o Palisades Institute for Research Services, Inc., 201 Varick Street, New York, NY 10014.

Edited by JOAN GORMAN

Stereoscopic-3D color display

Tektronix, Inc., Wilsonville, Oregon, has announced the SGS 19U and the SGS 19C, two new 19-in. color stereoscopic displays consisting of an easily detachable liquid-crystal modulator with a 19-in. viewing area, a high-resolution color monitor, and four pairs of passive glasses. The SGS 19U is a versatile unit that can be driven in stereo mode either with the normal vertical sync or with an external frame sync. In addition, it has controls that can be used for reversing the stereo view and switching from stereo to normal mode. The SGS 19C display can be used with any stereo-ready workstation or computer that provides a 50–152-Hz frame sync signal to drive the stereoscopic modulator. Both displays can also be used with a scan converter and cameras to create real-time stereoscopic video. Applications for these stereo displays range from photogrammetry to medical to robotics. The SGS 19U and SGS 19C are manufactured and sold through Tektronix Display Products, and are both listed at $8995, which includes four pairs of passive stereo glasses. Delivery is six weeks ARO for either display.

Information: Tektronix Display Products, P.O. Box 500, M/S 46-943, Beaverton, OR 97077. 1-800-TEK-WIDE ext. 5000.

Circle no. 1

Workstation switching device

Lightwave Communications, Inc., Milford, Connecticut, has introduced the Model 5000 ServerSwitch, a switching device that connects up to five Sun Microsystems Workstations or severs to one monitor and keyboard. Up to 25 Sun platforms may be switched by daisy-chaining up to six ServerSwitches. The device may be operated by using the front panel pushbuttons, an optional remote keypad, or any ASCII interface through the RS-232 control port. The ServerSwitch is a microprocessor-controlled switching device with touch switches to select between any one of five Sun Workstations without interruption to the other workstations. The device provides keyboard emulation to all of the remaining unselected processors. All video, keyboard, and mouse channels are routed transparently along with their respective monitor sense lines. In the event of a disconnection or interruption to any input to the ServerSwitch, an error will be displayed on the front panel when that channel is selected. The ServerSwitch Model 5000 is priced at $1950.

Information: Peter Henderson, National Sales Manager, Lightwave Communications, Inc., 84 Research Drive, Milford, CT 06460. 203/878-9838, fax 203/874-0157.

Circle no. 2

Digital cable decoder

Zenith Electronics Corp., Glenview, Illinois, has developed a digital cable decoder that can expand the capacity of digital cable systems to 1000 or more channels. The decoder combines digital video compression and 16-level vestigial sideband (16-VSB) digital transmission technologies, increasing the amount of digital information that can be transmitted by cable-TV systems without additional video compression. It provides 33% more data than proposed 64-QAM (quadrature amplitude modulation) cable approaches at lower cost, and provides twice the data of 16-QAM or 4-VSB systems. Using MPEG (Moving Picture Experts Group) digital compression technology, the decoder will be able to receive as many as 23 movies or nine live video programs (such as sports events) on each 6-MHz channel. The 16-VSB transmission technology, developed as part of Zenith's high-definition television (HDTV) research, will also send two digital HDTV signals on a single 6-MHz analog cable channel.

Information: John I. Taylor, Zenith Electronics Corp., 1000 Milwaukee Avenue, Glenview, IL 60025. 708/391-8181.

Circle no. 3

CD recorder

Yamaha Systems Technology Division, San Jose, California, has introduced the CDR100, the first CD recorder capable of reading and recording data at 1x, 2x, and 4x speeds. The CDR100 handles all four standard formats, including CD-ROM, CD-ROMXA, CD-I, and CD-DIGITAL AUDIO. The compact unit fits a computer's 5.25-in. disc drive bay and plugs directly into the PC power supply. It also hooks easily through a SCSI II interface to the PC, making it suitable for use either as an internal drive or in a compact external-drive product. The recorder can handle multimode options, including disc-at-once, track-at-once, or multi-session, making it useful for a wide range of data from music CDs to CD-ROMs. To make the quadruple-speed recording possible, Yamaha has developed its own laser-head technology and high-precision CD-R discs which are resistant to both write and read errors. Both 8- and 12-cm discs are available according to data-capacity needs. Leading software manufacturers have provided new, easy-to-use mastering software for the CDR100.

Information: Robert Starr, Yamaha Systems Technology Division, 981 Ridder Park Drive, San Jose, CA 95131. 408/437-3133, fax 408/437-8791.

Circle no. 4

Stereoscopic graphics card

RPI Advanced Technology Group, San Francisco, California, has announced the VGA2x™, a PC graphics card that generates virtual-reality images for 10 times less cost than current solutions. The card is designed to support the ImagiNET™ telecommunications system but it can be used for any stereoscopic application. After calling into a graphical interface front end, users move through several menus to access individual synthetic "worlds." Once inside a world, the user can interact with items there and with synthetic representations of other users. Volume pricing for the board is under $1000.

Information: Anthony Ryder, RPI Advanced Technology Group, P.O. Box 14607, San Francisco, CA 94114. 415/777-3226, fax 415/495-5124.

Circle no. 5

Video synchronization and compression

Feral Industries, Mission, Kansas, has introduced the FERAL EFFECT TBC/Synchronizer, designed to synchronize video and produce smooth, clean vertical and horizontal video compression. The FERAL EFFECT is ideal for teleconferencing, ENG/EFP broadcasting, video production, and post-production editing; it allows users to produce "over-the-shoulder" (picture-in-picture) as well as other special effects. It is available both as a board-level product that plugs into any IBM or Amiga PC, or as a one-rack U-high standalone unit. The FERAL EFFECT can size video from full frame down to 1 pixel, position it anywhere on the screen, and specify the amount of time the video should take to reach its final size and position. The FERAL EFFECT allows users to store 10 moves in memory, and a link function can combine stored moves. This full-frame TBC/Synchronizer features digital comb filtering and true 8-bit 4:2:2 processing for 6-MHz-bandwidth high-resolution picture output. It accepts composite and Y/C video, featuring both composite and S-VHS inputs and outputs as well as transcoding between formats, genlock with SC- and H-phase controls, and memorized proc amp level controls. The FERAL EFFECT also features a freeze function for maximum resolution of still images and variable-rate strobe. Software is available for both the Amiga Toaster and IBM Windows.

Information: Feral Industries, 5925 Beverly, Mission, KS 66202. 913/831-1791, fax 913/831-3427.

Circle no. 6

Rear-projection enclosure

Electrohome Ltd., Kitchener, Ontario, Canada, has introduced the Retro III, a self-contained rear-screen-projection enclosure containing a 67-in. (170-cm) diagonal wide-angle screen that produces a brilliant image suitable for areas subject to high-ambient-light conditions, such as boardrooms, control rooms, trade shows, and training facilities. The Retro III meets a wide range of image source, resolution, and brightness requirements and is configurable with virtually all Electrohome projectors, including the ECP 2100, 3000, and 4000 series, as well as the new Marquee 8000 projector. The ECP series offers variable scanning from 15 to 85 kHz, while the Marquee 8000 scans from 15 to 130 kHz. The standard high-resolution wide-angle screen affords 180° viewing. The single-mirror design allows easier focusing and more precise image centering than double-mirror designs. The Retro III can also be fitted with an optional black-matrix screen for creating high-contrast images in situations with extremely bright light conditions. A rear-access door in the base permits quick slide-out projector access or removal. The unit includes space inside for the addition of audio speakers. It features an easily assembled 32-in. (81.3 cm) two-piece stacking design which rolls through standard door openings. The Retro III is immediately available through Electrohome's North American and international dealer network. The suggested U.S. list price is $7295, not including projector; with the optional black-matrix screen, $7895.

Information: Jeff Brum, Marketing Communications Manager, Electrohome Ltd., 809 Wellington Street North, Kitchener, Ontario, Canada N2G 4J6. 519/749-3144.

Circle no. 7 ■

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

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