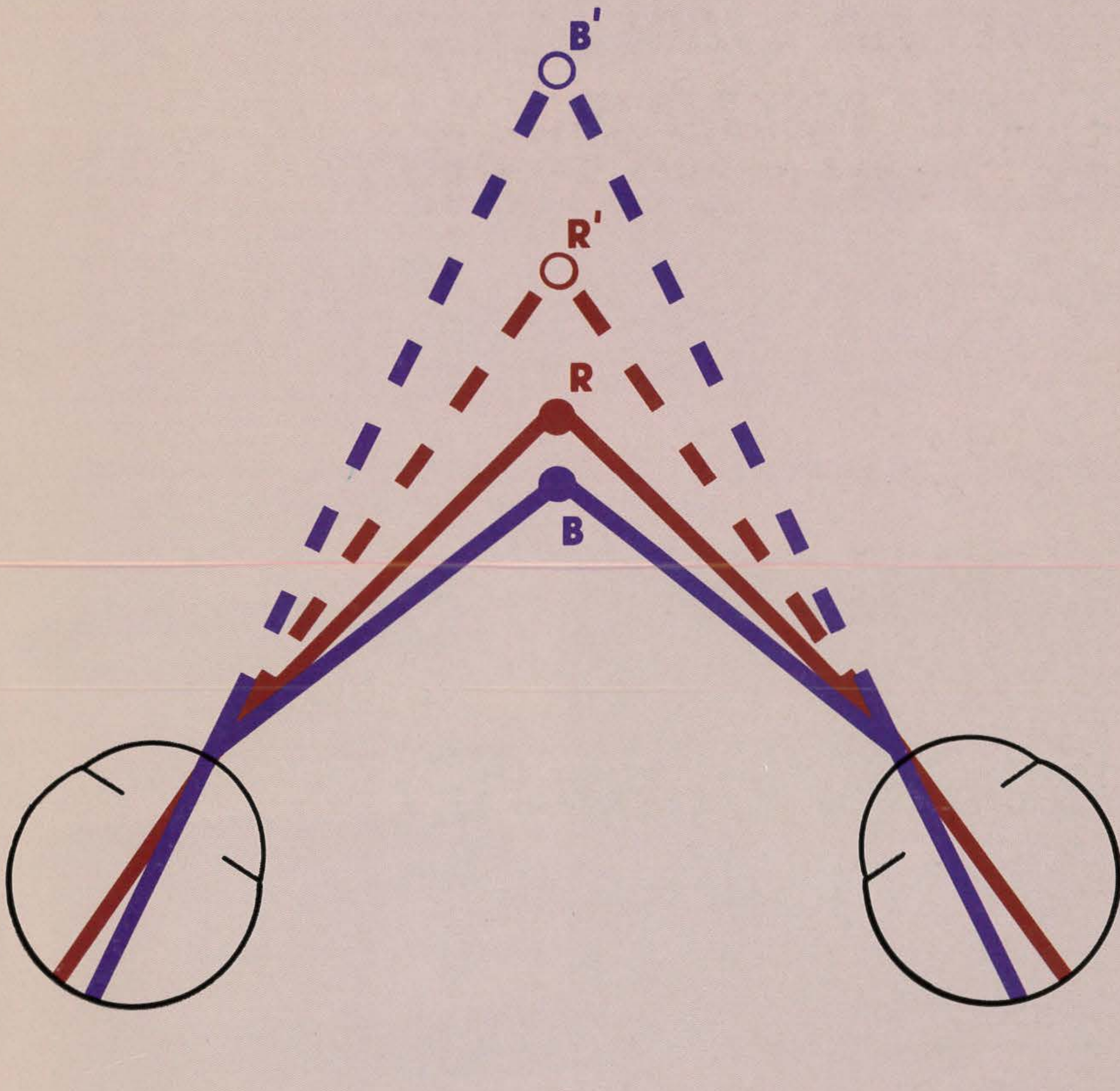
THE OFFICIAL JOURNAL OF THE SOCIETY FOR INFORMATION DISPLAY

INFORMATION DISPLAY

SEPTEMBER 1985



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Events

NATIONAL

OCTOBER 7-8: Electromagnetic Pulse (EMP) Design & Test—Short Course, Philadelphia, PA. Contact: Greg Gore, R&B Enterprises, 20 Clipper Road, West Conshohocken, PA 19428 (215/825-1965)

OCTOBER 10: Electrostatic Discharge (ESD) Control—Short Course, Philadelphia, PA. Contact: Greg Gore, R&B Enterprises, 20 Clipper Road, West Conshohocken, PA 19428 (215/825-1965)

OCTOBER 13-16: Topical Meeting on Multilayer Ceramic Devices, American Ceramic Society, Electonics Div., Marriott Inn, Orlando, FL. Contact: John B. Blum, Dept. of Ceramics, Rutgers University, Box 909, Piscataway, NJ 08854 (201/932-4367)

OCTOBER 14-17: Info '85, NY Coliseum, New York, NY. Contact: Cahners Exposition Group, Jennifer Patchell (203/964-0000)

OCTOBER 14-16: 1985 ACM Annual Conference—The Range of Computing/Mid 80s Perspective, Denver Hilton Hotel, Denver, CO. Contact: Dr. Schlesinger, Association for Computing Machinery, 11 West 42nd Street, New York, NY 10036. (212/869-7440)

OCTOBER 15-17: 1985 International Display Research Conference, San Diego, CA. Co-sponsors: IEEE Electron Devices Society, the Society for Information Display, the Advisory Group on Electron Devices. Contact: Palisades Institute for Research Services, IDRC, 201 Varick St., New York, NY 10014 (212/620-3388)

OCTOBER 17-18: Electromagnetic Pulse (EMP) Design & Test—Short Course, Boston, MA. Contact: See above, October 7-8.

OCTOBER 18-20: Computers in Education, Sheraton Centre Hotel, New York, NY. Contact: Carole Dornblasser, Conference Management Corp. 17 Washington Street, PO Box 4990, Norwalk, CT 06856-4990 (203/852-0500)

OCTOBER 20-24: Computer Graphics Atlanta (CGA '85), Georgia World Congress Center, Atlanta, GA. Contact: CGA '85, 2033 M Street NW, Suite 333, Washington, DC 20036 (202/775-9556)

OCTOBER 21-23: Computers in Aerospace V Conference, Hyatt Regency, Long Beach, CA. Sponsor: AIAA Computer Systems TC in cooperation with ACM. Contact: Melvyn J. Brauns, Ford Aerospace MS V03, 3939 Fabian Way, Palo Alto, CA 94303 (415/852-4188)

OCTOBER 22-23: Eighth Annual Newport Conference on Fiberoptic Markets, Sheraton-Islander Inn, Newport, RI. Contact: Janet Roche, Kessler Marketing Intelligence, America's Cup Ave. at 31 Bridge St., Newport, RI 02840 (401/849-6771)

OCTOBER 23: Electrostatic Discharge (ESD) Control—Short Course, Boston, MA. Contact: See above, October 10.

OCTOBER 23-25: Symposium on Expert Systems in Government, McLean, VA. Sponsor: IEEE-CS. Contact: Marshall Abrams, Mitre Corp., 1820 Dolley Madison Blvd., McLean, VA 22102 (703/883-6938)

OCTOBER 26-27: ISECON '85—The Information Systems Education Conference. The Sheraton Houston Hotel, Houston, TX. Contact: Data Processing Management Association, 505 Busse Highway, Park Ridge, IL 60068-3191 (312/825-8124)

OCTOBER 28-30: Second Annual ACM Northeast Regional Conference, Boston, MA. Sponsor: ACM Northeast Region. Contact: Bryan Kocher, 250 Edge Hill Rd., Sharon, MA 02067 (617/863-5100)

OCTOBER 29-30: Second Annual Conference on Flat Information Displays, Red Lion Inn, San Jose, CA. Contact: Murray Disman, Pres, International Planning Information, 1259 El Camino Real, Suite 324, Menlo Park, CA 94025 (415/364-9040)

OCTOBER 29-31: Laboratory Instrument & Equipment Conference & Exhibition (LAB-CON/New England) Northeast Trade Center, Woburn, MA. Sponsor: Research & Development Magazine. Contact: Margaret Young (312/668-8100)

NOVEMBER 4-7: Seventh IEEE Symposium on Mass Storage Systems, Tucson, AZ. Contact: Bernard T. O'Lear, NCAR, PO Box 3000, Boulder, CO 80307 (303/497-1268)

NOVEMBER 4-7: SENSORS '85—Conference on Sensors for Untended Manufacturing, Society of Manufacturing Engineers, Detroit, MI. Contact: Society of Manufacturing Engineers, One SME Drive, PO Box 930, Dearborn, MI 48121 (313/271-1500)

NOVEMBER 6-8: American Ceramic Society, Glass Div. Meeting, Corning Hilton, Corning, NY. Contact: James E. Shelby, Alfred University, Alfred, NY 14802 (607/871-2470)

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Cover photo: Diagram of the chromostereopsis due to prismatic distortion. The blue light (B) is proximal to the red light (R), but the blue is perceived as farther away (B) than the red (R). *(Reprinted with permission from J. Walraven, Displays 6, 35-42, 1985).*

FEATURES

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American Federation of Information Processing Societies

DEPARTMENTS

INFORMATION DISPLAY (The Official Journal of the Society for Information Display) is edited for corporate research and development management; and engineers, designers, scientists, and ergonomists responsible for design and development of input and output display systems used in various applications such as: computers and peripherals, instruments and controls, communications, transportation, navigation and guidance, commercial signage, and consumer electronics.

Editorial covers emerging technologies and state-of-the-art developments in electronic, electromechanical, and hardcopy display devices and equipment; memory; storage media and systems; materials and accessories.


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"Knowledge consists in understanding the evidence that establishes the fact, not in the belief that it is a fact."

—Charles T. Sprandling

It's that time of year again when your Journal's editor must sit down to map out next year's editorial calendar.

Because of the diversity of reader disciplines and range of display technologies that we must address each month, we really could be publishing a much larger magazine than the one you are now reading—on the order of 64 pages plus would be more like it—just to record the rapidly changing technology in the display industry.

Expanding editorial content and supporting it with an abundance of colored graphics is the dream of every professional editor. With restrained budgets, however, we all learn somehow to make do with less—always with the hope that someday soon we'll get the opportunity to see that big colorful issue come off press.

Meanwhile, in an attempt to overcome this handicap (which by the way, confronts every editor whether on a large or small publication) we've come up with an editorial calendar for '86 that purports to pack 64 pages of information into 32 pages—without sacrificing technical facts or figures nor testing your type reading skills.

To begin with, we've structured the '86 editorial calendar around individual display and related technologies; tied specific issues of ID to particular industry meetings and exhibits pertinent to the display industry; and expanded our coverage of end-user applications of display systems. Beginning in January, you'll find each issue of ID will contain shorter, but more,technical articles (with full details on obtaining more complete textural material). And, we'll be covering along with flat-panel, CRT, graphics, and human factors, such related topics as electronic imaging, machine vision, storage devices, and input systems—all as part of the total information package.

We believe this effort will better provide more readers and more advertisers with more information on the display industry and thus satisfy a greater range of interests. Still, the ultimate success of our efforts resides with you—whether researcher, designer, or manufacturer of display systems.

You must become more involved in providing the input that will enable your Journal to grow in content and prestige. Here's our plan to help you plan your contributions over the next 12 months:

Issue	Application Article	Product Feature
JANUARY	Business & Scientific Displays	LCDs
FEBRUARY	Commercial Signage/Displays	CRTs
MARCH	Information Storage Technology	VFDs
APRIL	Automotive Electronic Displays and Information Systems	Graphics
MAY	SID '86 Annual Symposium-Exhibition	
JUNE	Medical Imaging/Instrumentation and Documentation	Machine Vision
JULY	Printing Technologies	ELDs
AUGUST	Communication Systems	Electronic Imaging
SEPTEMBER	Avionics Display Systems	Gas-Plasma Displays
OCTOBER	Electronic Imaging	Storage Devices
NOVEMBER	Human-Machine Interface	Input Devices
DECEMBER	Today's Techonology—Tomorrow's Systems (Annual Review & Forecast)	

Joseph A. MacDonald
Editorial Director

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Events

NOVEMBER 11-14: 1st International Conference and Exhibit on Computer Workstations, San Jose Convention Center, San Jose, CA. Contact: IEEE Computer Society, 1109 Spring Street, Suite 300, Silver Spring, MD 20910 (301/589-8142)

NOVEMBER 13-15: 1st Videotext Engineering and Technology Forum, Meridian Hotel, San Francisco, CA. Contact: Cynthia Parsons, OnLine Intl., 989 Avenue of the Americas, New York, NY 10018 (212/279-8890)

NOVEMBER 17-22: Imaging Science & Technology Show and Exhibit, Society of Photographic Scientists, Fall Symposia, Marriott Crystal Gateway, Arlington, VA. Contact: David A. Fatora, M.F. Graphics, 12700 SE Crain Hwy., Brandywine, MD 20613 (301/372-1245)

NOVEMBER 18-19: Electromagnetic Pulse (EMP) Design & Test—Short Course, Washington, DC. Contact: See above, October 17-18.

NOVEMBER 18-22: Tutorial Week Washington '85, IEEE Computer Society, Hyatt Crystal City, Arlington, VA. Contact: Martez A. Camilleri, IEEE Computer Society, PO Box 639, Silver Spring, MD 20901 (301/589-8142)

NOVEMBER 18-22: Tutorial Week San Francisco '85, IEEE Computer Society, Cathedral Hill Hotel, San Francisco, CA. Contact: See above, November 18-22.

NOVEMBER 21-22: Ninth Annual Western Educational Computing Conference, California Educational Computing Consortium, Oakland, CA. Contact: Alexia Devlin, CECC, San Francisco State University, Accounting Data NADM-358, 1800 Holloway Ave., San Francisco, CA 94132.

INTERNATIONAL

OCTOBER 14-17: COMDEX Europe, RAI Congress & Exhibition Center, Amsterdam, The Netherlands. Contact: Aileen Vogt, The Interface Group (617/449-6600)

OCTOBER 28 - NOVEMBER 1: Computer Graphics Korea, World Computer Graphics Assn. & Korean Trade Promo Corp. (KOTRA)., Seoul, Korea. Contact: World Computer Graphics Assn. (202/775-9556)

OCTOBER 28 - NOVEMBER 1: SYSTEMS '85, Munich Fair Center, Munich, W. Germany. Contact: Jerry Kallman (201/652-7070)

NOVEMBER 4-8: Composants Electroniques '85, Parc des Expositions - Paris Nord, Paris, France, US Dept. of Commerce. Contact: Joseph Burke (202/377-5014)

NOVEMBER 11-14: Sixth Chilean Electrical Engineering Conference, IEEE Chile Section and Chilean Computer Science Society, Santiago, Chile. Contact: Marcelo Guarini, VI Electrical Engineering Conference, Universidad Catolica de Chile, Casilla 6177, Santiago, Chile.

NOVEMBER 18-21: Canadian Computer Show & Conference, Canadian Information Processing Society, Toronto International Center, Toronto, Canada. Contact: Robert Grainger (418/252-7791)

NOVEMBER 18-21: CommuniTech & Computer '85 Malaysia, Putra World Trade Center, Kuala Lumpur, South East Asia. Contact: CommuniTech & Computer '85 (01/486-1951)

NOVEMBER 25 - DECEMBER 6: 2nd International Technical Symposium on Optical and Electro-Optical Applied Science and Engineering, Palais des Festivals et des Congres, Cannes, France. Contact: Society of Photographic & Instrumentation Engineers, PO Box 10, Bellingham, WA 98227.

Educational Computing

Original papers are solicited from all academic disciplines and research areas in educational computing for presentation at the 1986 National Educational Computing Conference (NECC '86) to be held June 4-6, San Diego, CA. Actual experiences with computer use in the classroom at all levels of education, including minority institutions, two-year and small four-year colleges and pre-college environment are encouraged. Of particular interest are papers and projects prepared by students at the secondary, undergraduate, and graduate levels.

In addition to the contributed papers, there will be special sessions involving invited speakers who will participate in survey and tutorial sessions and panels that focus on the current status of educational use of computers at the national level and projections for the future.

Authors should submit an original manuscript and four copies (double-spaced, maximum 15 pages) to:

NECC '86
University of San Diego
School of Education, Alcala Park,
San Diego, CA 92110

Deadline for submittal and nominations is November 1, 1985.

Systems Simulation

Abstracts of papers on Recent Advances in Simulation of Complex Systems are now being accepted for the Japan Society for Simulation Technology Conference to be held July 15-17, 1986 in Tokyo, Japan.

Topics of the conference include: Simulation and Modeling of Systems, Simulation Methods, Model Validation, Simulators and Hardware, Simulation in Artificial Intelligence, Simulation and Modeling Theory, CAD/CAM, Decision Support Systems, and Computational Mechanics.

A three-page abstract of a paper to be presented at the conference should be submitted to:

Secretariat JPSST
c/o Union of Japanese Scientists
and Engineers
5-10-11, Sendagaya, Shibuya-ku
Tokyo 151, Japan
03/352-2231

Deadline for submittal: November 1 1985.

PAPERS ON DISPLAY

Information Display is soliciting original articles that cover all aspects of display technology and applications—display systems, sensing and imaging instrumentation, printing technologies, input/output devices, interactive graphics, storage media, and human factors engineering.

In addition, special issues of ID are being developed for calendar year 1986, for which relevant articles are being accepted:

- **Display Systems—Impact of Evolving Technologies on Future Consumer Products. Submit NO LATER than September 25, 1985.**
- **Industrial Instrumentation—Measurement, Analysis, Testing, and Control Systems. Submit NO LATER than October 25, 1985.**

Notes for contributing authors and specifications for submitting manuscripts can be obtained from the Editor of ID. Address all inquiries and submit contributed articles to: The Editor, Information Display, 310 East 44th Street, #1124, New York, NY 10017.

AFIPS: Appointments, awards, and aspirations

The American Federation of Information Processing Societies (AFIPS) recently appointed Egils Milbergs Executive Director and Chief Operating Officer of the organization. AFIPS is a federation of eleven scientific and educational professional societies in the information processing field, of which the Society for Information Display is a charter member.

Prior to joining AFIPS, Milbergs was Deputy Assistant Secretary for Productivity, Technology, and Innovation, US Dept. of Commerce; and also served as Executive Director of the President's Commission on Industrial Competitiveness. At the Commerce Department, Milbergs was instrumental in promoting new approaches to American technological competitiveness, such as cooperative research and development programs, a new patent policy for commercializing Federally-supported research and tax incentives for research and development.

Recipients of the 1985 AFIPS Annual Awards include:

- Harry Goode Memorial, to Dr. Carver A. Mead, Professor of Electrical Engineering, California Institute of Technology for his pioneering contributions to research and education in the field of very large scale integration (VLSI) circuit design.
- Education, to Dr. John Hamblen, Professor of Computer Sciences and formerly Chairman of the Department of Computer Sciences, University of Missouri-Rolla, for his accomplishments and continuing efforts in the evaluation, development and promotion of the academic discipline of computer science.

The AFIPS-Fortune Magazine Product of the Year Award is a newly created award to recognize the impact computer products have had on the economic welfare of the country, as well as the growth of the computer industry. Awards will be given annually to the outstanding product of the year in three categories: computer hardware, computer software, and computer systems.

Nominations for these and other 1986 AFIPS Awards are now being solicited. Deadline for submitting nominations is December 1, 1985. Contact: AFIPS Communications Department, 1899 Preston White Drive, Reston, VA 22091 (703/620-8914).

Government-industry panel examines information issues

To address areas of importance to the field of information processing in America, AFIPS has formed a high-level panel of experts selected from government and industry. The panel will examine and analyze issues of domestic policy as related to information and communications technologies.

Flexible LCD material promises lighter displays

A new flexible plastic LCD, 0.015-in. thick and weighing only 2 oz/ft^2, can be custom-produced up to 16 in. wide in unlimited lengths for computer displays, readout panels, and other electronic equipment.

Developed by Polaroid Corp., the plastic LCD can be manufactured with standard seven-segment fonts, custom graphics, or combinations of standard and custom symbols down to a minimum picture element (pixel) size of 0.01 in.—with the number of visual elements on a single display limited only by current multiplexing technology.

The plastic LCD material is combined with a proprietary anti-reflective coating that produces an increased viewing field and enhanced contrast over that of glass LCDs. The thin plastic sandwich can be bent to a 2-in. radius without affecting operating characteristics for curved displays in specialized applications. Low power requirements, about equal to glass LCDs, make the plastic LCD suitable for battery-powered equipment.

POLAROID CORP., Norwood, MA (617/ 446-4567

For information circle Reader Service #39

Awards to honor inventors of the year

The *World Almanac Book of Inventions* is giving all inventors the opportunity to be included among the ranks of Thomas Alva Edison, Alexander Graham Bell, and other great inventors whose creations have changed the course of history, in a contest open to all inventions for which a patent has been issued between January 1, 1983 and February 26, 1986.

Winners will have their inventions featured in next year's edition of the *Book of Inventions* that brings together over 2000 inventions—past and present—that have shaped the world. With this prize comes a lifetime subscription to the World Almanac and a commendation suitable for framing.

Entries must be received by midnight, March 7, 1986, and be accompanied by a photograph or drawing of the invention and a photostat of the front page of the "patent copy." Winners will be announced June 1, 1986. Contact: Inventions, % World Almanac Publications, 200 Park Ave., New York, NY 10166.

Standards groups launch co-op information effort

Two major world organizations responsible for producing international standards have joined forces to provide urgently needed standards for the field of Information Technology.

This co-operative venture brings together existing standardization work in the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), covering the information technology sector—microelectronics, telecommunications, computing and information processing. Primary objective of the program will be to develop international standards to facilitate interconnection and communication among a wide variety of equipment, such as personal computers, word processors, and a host of other industrial, commercial and domestic systems.

Joint-venture licensed to promote new optical disc

A joint-venture company owned by Plasmon Data Systems, Inc. (Royston, UK) and Kuraray Co. Ltd. (Osaka, Japan) has been set up in Japan to market Plasmon's optical disk technology.

Unlike other "write once" optical discs that rely on "hole blowing" in a thin film of exotic metals, such as tellurium—and are known to be difficult to manufacture—the Plasmon Disk, by using a fine surface microstructure, can raise the sensitivity to low power lasers of even the most stable metals, such as platinum. This results in an extremely simple product configuration and one that is readily producible.

The concept for the new optical disk was generated and developed jointly by Plasmon and PA Technology (Hightstown, NJ) in PA's European and US laboratories.

Perception, use of color displays

Two of the three sessions on Human Factors presented at SID '85 in Orlando last May (Information Display, June 1985, p.16) offered papers on the perception and use of color for displaying information electronically.

In the first session—**Perception of Color Displays**—chairman Louis D. Silverstein, Sperry Corp. (Phoenix, AZ), noted that color offers a number of distinct advantages for display design. "First, are the obvious aesthetic benefits of color, supported by the general preference for color over monochromatic presentations; and second, color provides the potential for greatly increasing information coding capability and flexibility, as well as for reducing visual search time on complex displays. A third advantage," he said, "is derived from the addition of chromatic contrast, which can increase the visibility of displayed information and also reduce luminance requirements."

He reminded, though, that incorporation of color in information displays does not come without penalties in cost and complexity. "Moreover, increased complexity is manifest on both sides of the display-observer interface. The fact that color processing will have a major impact on display system hardware is obvious. Perhaps less obvious are the demands that color processing places on perceptual mechanisms of the human observer.

"Human color perception is an extremely complex multi-dimensional process; and it is worthwhile remembering that color is not a direct property of an object or of physical energy, but rather refers to the perceptual experience of the human observer."

Silverstein further pointed out that in addition to the energy characteristics of the visual stimulus, color perception is determined by such factors as the general level and quality of adaptation of the observer, the size and duration of the stimulus, visual parameters of other objects in the field of view, the absorption characteristics of the ocular media and binocular interactions. Variations in all these factors are relevant to the perception of complex multicolor display presentations.

One of the five papers presented in this session, an invited address, provided a survey of perceptual problems in color display imagery. Another paper described experimental investigations of color stimulus size; while a third paper presented the results of measuring the effects of multicolor imagery on visual accommodation.

In his address, *Perceptual Problems in Display Imagery*, J. Walraven of the Institute for Perception (Soesterberg, The Netherlands), reviewed a variety of phenomena that may turn up on a color display. The survey is intended to provide designers of color displays with an overview that may better prepare them for matching the display's imagery to the idiosyncracies of the human visual system.

The paper covers phenomena related to peripheral color vision, defective color vision, various luminance effects, chromatic induction, assimilation, chromatic aberration, and color stereoscopy, among other known observances. The author points out the relevance of perceptual color artifacts for those involved in managing color on color coded displays (control rooms of industrial plants, avionics, digital maps, and so forth).

For information circle Reader Service #40

Effects of Color on CRT Symbol Legibility, by David L. Post, Air Force Aerospace Medical Research Laboratory, Wright-Patterson AFB, OH, outlines an experiment that involved the presentation of symbols, individually at a small angular subtense and then incrementally enlarged to meet various legibility criteria. According to Post, "The purpose of the experiment was to explore certain relationships between viewing angle subtended and symbol size, and color perception."

Ten subjects, possessing 20/20 visual acuity (corrected where necessary) and normal color vision, participated in the experiments. Subjects underwent training before each experimental session to assure that they could recognize all symbols and hues. Although 39 colors were used, subjects named only their hues (blue, cyan, green, white, yellow, red, and purple). For training, the colors were presented as $114' \times 114'$ squares at a viewing distance of 30 in.

(0.782 m) with ambient illumination essentially zero.

During the experiment, 10 symbols from a set proposed for airborne use were presented twice in all 39 colors to each of the 10 subjects, yielding 7800 trials. For each trial, a symbol was presented at an angular subtense of 3′ that the subject increased in 0.5′ steps by pressing the switch until three criteria were met:

- Threshold legibility—Symbol was named correctly.
- Hue naming—Hue was named correctly, or not.
- Comfort legibility—Symbol's legibility was subjectively satisfactory.

The computer noted the subtense as each criterion was met, according to the experimenter's commands. Thus requisite angular subtense was used as the measure of legibility.

Among the study's findings of significant effects were:

- **Threshold legibility**—the main effect of symbol accounted for almost all the variation attributable to statistically significant effects. The main effect of luminance was small and detrimental. The main effect of chromaticity was even smaller, seeming to have had no practical effect on the minimum legible subtense.
- **Comfort legibility**—The main effect of symbol predominated. The comfort-legibility ANOVA does not account for as much of the variation as the threshold-legibility ANOVA. Apparently, the preferred subtenses were more variable than the threshold requirements.
- **Hue naming**—The main effect of chromaticity was the most important.

The author cautions that because this study used black background, generalization of the findings to luminous and possibly chromatic backgrounds may be inappropriate. Given this, the results indicate that chromaticity has little practical effect on legibility for CRT symbology, while purity has a major impact on recognition of symbol hue.

Other findings indicate that white seems representative of worst-case chromaticity, as far as legibility is concerned, and thus it appears that angular subtense requirements for other symbol sets' legibility can be based safely on results for white symbols. Given that the apparent difficulty of recognizing white was caused by the use of many desaturated colors, it seems that chromaticities other than the three phosphor primaries and white should not be expected to yield reliable absolute recognition of symbol hue.

For information circle Reader Service #41

(Continued on p 14 . . .)

For information circle Reader Service #9

For information circle Reader Service #10

(... continued from p 13)

Stimulated by reported visual complaints experienced by VDT operators and the increasing number of multicolor CRTs in the work environment, research was performed to investigate the effect of chromatic aberration on visual accommodation while viewing chromatic targets presented on chromatic backgrounds.

In their paper, *Accommodation During Color Contrast*, Daniel T. Donohoo of Texas Instruments (Austin, TX) and Harry L. Snyder of Virginia Polytechnic Institute & State University (Blacksburg, VA) describe an experiment in which five observers with 20/20 uncorrected visual acuity and normal color vision participated.

The experimental design consisted of 12 full factorial within-subject designs that held either the foreground or the background constant, while manipulating the foreground wavelength, the background purity, and the foreground purity. In the first set of experiments, the background wavelength was held constant while the foreground wavelength was controlled at five levels, foreground purity at two levels, and background purity at two levels. When the foreground wavelength was held constant, background wavelength (five levels), foreground purity (two levels), and background purity (two levels) were controlled.

The design was repeated for each of the 12 conditions. Each subject received three replications of the 120 target/background combinations presented. And each observer was asked to fixate on a crosshair that displayed in the center of the CRT, obtain focus on the crosshair, and then maintain focus for a minimum of five seconds for each target/background condition.

Accommodation data were collected using an SRI Dual Purkinje Eyetracker equipped with an infrared optometer. The observers' accommodation was collected at the rate of 25 times per second.

Results of the experiments together indicate that when observing chromatic targets on chromatic backgrounds, the effect of accommodation response may not be of the amplitude that would have been predicted by earlier research. As a consensus, the requirement to refocus to clearly view the information presented on the screen is not as large or as frequent as might have been predicted from data derived observation of characters made of spectral colors.

Primarily, this is due to the wideband nature of the CRT phosphors when compared to the spectral colors and a less disparate group of colors when compared to the dominant wavelengths used in the other studies. The requirement to refocus may be minimized by avoiding a very few target/background combinations, primarily those with high purity blue backgrounds. All other combinations were within the observers' assumed depth of field so that no refocusing was indicated.

When chromatic targets were presented on chromatic backgrounds, the observer tended to focus the target in front of the image plane. These results could not have been predicted from the data reported in the literature and suggest a more complex mechanism is involved in controlling monocular accommodation under the conditions of color contrast.

High purity blue backgrounds apparently caused a disruption in the accommodation response, suggesting that high purity blue not be used as a background color.

Although chromatic aberration affects the observers' accommodation response, the experiment's data suggest that by avoiding a very few target/background combinations the effects can be controlled within the observers' depth of field.

For information circle Reader Service #42

Although many computers come equipped with color displays, few word processors put color to use in the editing process. Traditionally, color has not been used for the task of editing. According to researchers at MIT, however, color can be of valuable use in word processing tasks.

For information circle Reader Service #11

In their paper *A Color-based Text Editor*, Mitsuo Saito and Walter Bender of MIT's Architecture Machine Group (Cambridge, MA), the authors point out some distinct advantages of using color in word processing tasks.

"By underlying color to indicate deletion, the word processor, which normally leaves no evidence of a change, provides a log of edits. Multiple authors, previously distinguished by handwriting or margin notes, can be distinguished by the use of color. And, new dimensions of electronic word processing are also made possible, such as indications of spelling and grammatical errors, and temporal distinctions."

The text editor used in the experiment was a modification of the EMACS monochrome text editor, in which color was used to indicate the source of newly inserted text; including newly typed, moved from another place, or once deleted and restored. Color saturation is tempered in proportion to the age of revision. The older the edit, the closer to the monochrome of the original text.

A primary design constraint was to retain all of the functionality of a standard monochrome word processor while adding color functionality to avoid a situation where a user would have to choose between functionality provided by color and other performance factors such as screen update speed and legibility. A secondary constraint was that all color functionality must be automatic, that users need not learn new commands or modify their style of editing to make use of color.

The EMACS editor was selected for the study because it runs on a large variety of machines, both personal computers and mainframes, under many operating systems, and is adaptable to most displays. The computer used was a SUN Microsystem 68000-based workstation, with an 8-bit Datacube frame buffer on the workstation's Multibus serving as a color display terminal.

Proportionally-spaced characters in the system use four levels of grayscale and can be displayed to resolution of up to 120 characters per line. The frame buffer has an 8-bit in, 24-bit out, color lookup table that provides subtle control over the hue, value and chroma of both the foreground and background colors of the text. Color information is stored alongside the text to maintain a correspondence between color and character strings, and with the text buffer, format was extended to include the color information in the buffer.

Color is specified by ESC, ASCII 27, followed by an attribute character, a capital letter. The specified color is effective until a different color is specified, or the end of line comes.

To maintain an edit history, any deletions from the original text are indicated by a change in the background color of the screen where the deletion has taken place. This is done by surrounding words to be deleted by the deletion attribute, rather than removing them from the document.

The screen update, upon encountering the deletion attribute, changes both the foregound and background color while displaying subsequent text. Foreground is darkened the same as the background, making the deleted characters invisible.

Cursor position is also affected by the deletion attribute. After the display of deleted characters, the cursor is moved back to the start of the deleted region. Any text following the deleted region is overlayed on the deleted text.

An attribute of "hiding" deleted text is that it can be restored to the document simply by changing the encapsulating attribute character. Restored text is treated like other revisions: displayed in a color that distinguishes it from the original document. Similarly, text that has been moved from one place to another is displayed in color.

The color related facilities of color EMACS are:

- Original text stored in a file appears as white.
- Newly-inserted text from the keyboard appears as yellow.
- Moved or copied text from other part of a file appears as green.
- Once deleted text and then restored again appears as red.
- Dark background means the deleted text is hidden behind foreground text.
- Colored background (brighter in proportion to the number of deleted strings that are overlapped) indicates changes.

Human factors influence effective use of color in information displays

With demand for color-based video display systems on the rise and all indications pointing to color displays becoming the standard display technology, it is extremely important for designers of such systems to have a sound knowledge of how the eye processes color information.

To this end, a two-stage, opponent-color model was used to interpret the effects of optical and physiological factors on perceived color in visual displays. The general model provides investigators with a framework for calculating certain influencing factors such as: the effects of visual adaptation, successive and simultaneous color contrast, retinal eccentricity, stimulus size and duration, and external illumination.

While this general interpretation framework should, in principle, provide the basis for predicting perceived color under all conditions described in this article, no such quantitative theory currently exists. Some of the difficulties in the development of a comprehensive color theory involve: incomplete knowledge of the spatial and temporal changes that occur for each color mechanism as a function of eccentricity, lack of understanding of how perceived color is affected by the pattern of simulation on the rest of the retina, non-linearities in the intensity-response functions of the color mechanisms, transformations of receptor outputs appearing to be intensity-dependent at second-stage mechanisms, and possible interactions among second-stage mechanisms.

by Terry Benzschawel
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T.J. Watson Research Center, IBM
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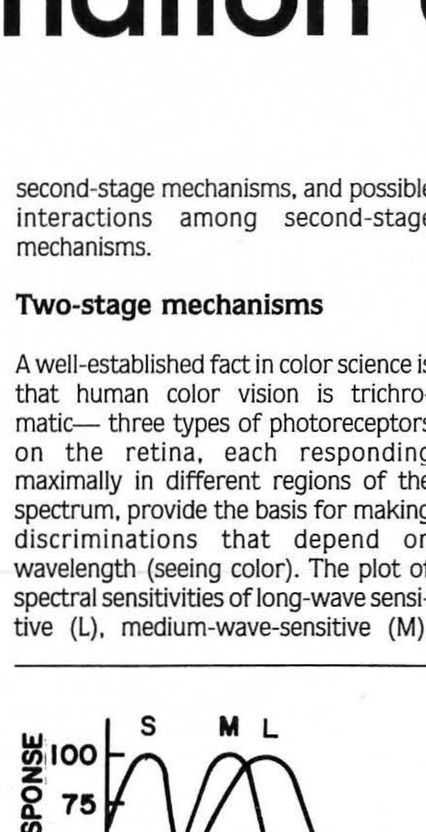
Two-stage mechanisms

A well-established fact in color science is that human color vision is trichromatic— three types of photoreceptors on the retina, each responding maximally in different regions of the spectrum, provide the basis for making discriminations that depend on wavelength (seeing color). The plot of spectral sensitivities of long-wave sensitive (L), medium-wave-sensitive (M),



and short-wave-sensitive (S) photoreceptors indicates considerable overlapping and the impossibility for stimulating only one type of photoreceptor with a single wavelength (Fig. 1).

While much of the psychophysical data on color vision can be interpreted in terms of this simple three-receptor theory, it has become apparent from such studies, as well as from studies of responses of nerve cells in the primate retina and visual pathway, that it is not the photoreceptor alone that provides the physiological substrate for color. That is, the photoreceptors appear to feed antagonistically (input from one receptor type cancels that from another) into two spectrally opponent mechanisms; and to sum their outputs within a third non-opponent system. It is the outputs of these second-stage mechanisms, whose physiological substrate is presumed to reside in lateral interactions at the outer and inner synaptic layers of the retina, that provide the neural code for color perception.

The schematic diagram of a general two-stage color theory shows how the receptor outputs are combined (Fig. 2):

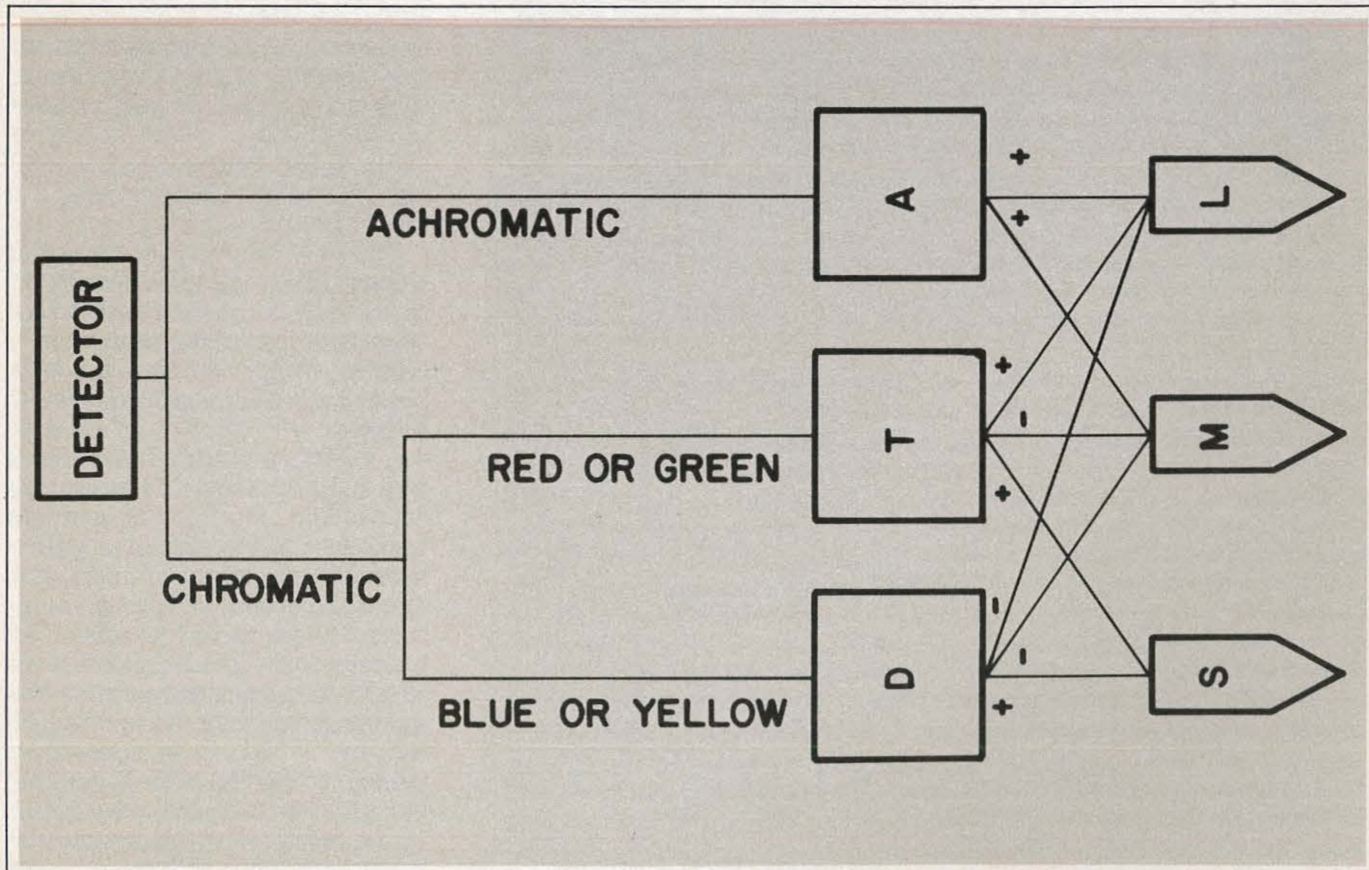
- "A" (for achromatic) is a non-opponent luminance system that outputs a white signal in response to input from both "L" and "M" receptors.
- "T" (for titanopic) is an opponent luminance system that receives input from all three receptor types. "T" signals red, if weighted input from "S" and "L" are greater than that from "M"; and green, if input from "M" is greater than that from "L" and "S".
- "D" (for deuteranopic) is also an opponent system that receives input from "L" and "M" of opposite polarity from "S". The "D" system signals blue if input from "S" is greater than that from "M" and "L"; or yellow, if input from "L" and "M" is greater than that from "S".

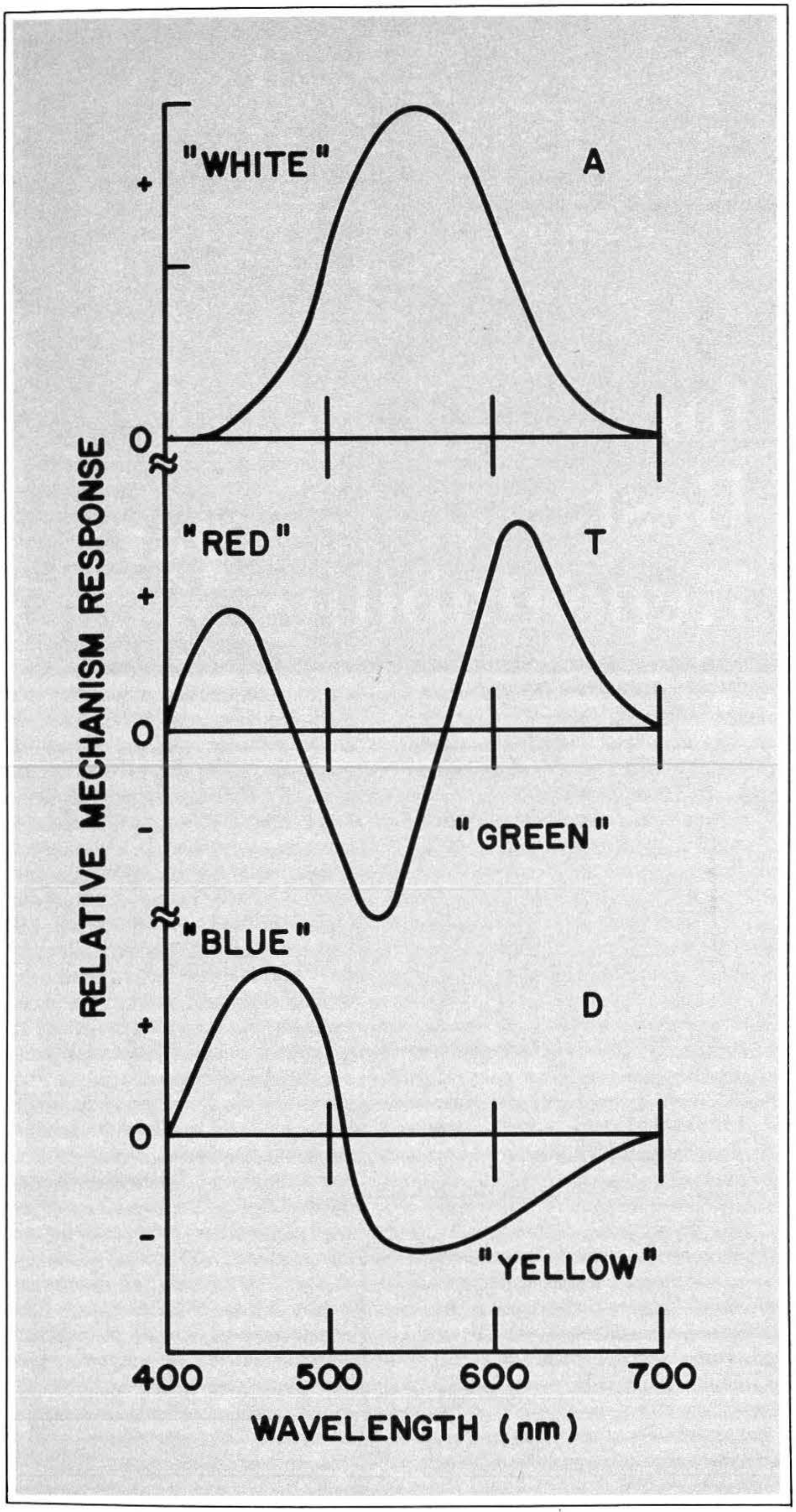
Responses of the second-stage color mechanisms can be plotted as functions of a wavelength (Fig. 3):

- "A"-system response is an all positive-value curve.
- "T"-system response for wavelengths of about 470 nm and 570 nm(crosspoints) is zero and is reversed in polarity on either side. "D"-system has only one crosspoint in the spectrum at about 505 nm.

If one stimulates with a single wavelength of 505 nm, output from "D" is zero, but "T" signals green, while "A" signals white. In fact, such a stimulus is called *unique green*, because it contains no blue or yellow component. Similarly, *unique blue* (which contains no red or green component) occurs at the short-wave "T" crosspoint; and *unique yellow*, at the long-wave "T" crosspoint. There is also a *unique red* (one that contains no blue or yellow component) but it cannot be produced by a single wavelength.

Understanding how the eye pro-





cesses color in a single spot on an otherwise dark background, however, is only the starting point from predicting accurately what colors will be seen in visual displays. Perceived color is not only determined by the spectral characteristics of the patch of light in question, but also is dependent upon its size, intensity, the spatial properties and luminances of the objects around it, the retinal area stimulated, the intensity and spectral properties of the illumination in which it is viewed, and a host of other factors.

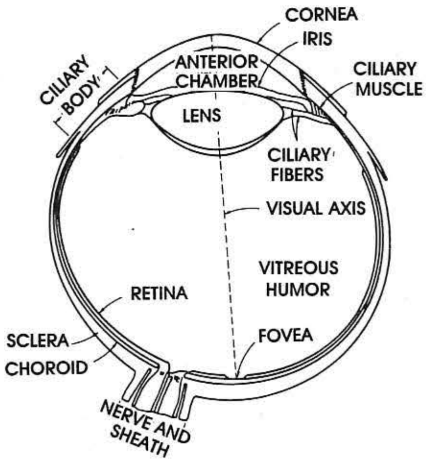
While the effect of many of these variables on perceived color are well-understood, some of the effects remain unresolved.

Chromatic abberration

The optics of the human eye serve to focus light that passes through the transparent cornea onto the back of the eye, which is lined with photoreceptors (photosensitive receptors) of the visual system (Fig. 4). While most of the focusing power of the eye resides in the cornea, which has fixed refractive power, the ability to produce sharp images on the back of the eye of objects at varying distances is accomplished by changing the shape of the lens—contracting the ciliary muscles to move the eyes either inward or outward. This process of adjustment, called "accommodative vergence", is color-dependent.

Because of this chromatic aberration, different wavelengths (colors) reflected from objects at a given distance require different degrees of accommodation—especially when viewing colors on a display system. This results from several factors:

- First, since the refractive index of a given material is wavelength-dependent, only light of a single wavelength can be in focus at any given time. Thus areas of different chromaticities on a CRT display will require changes in accommodation to bring them into focus. Since the amount of refocusing required depends on the spectral purity of the colors, these effects can be reduced by desaturating (adding some white) colors at the spectral extremes (blues and reds).
- Second, when two objects at the same distance but of different colors



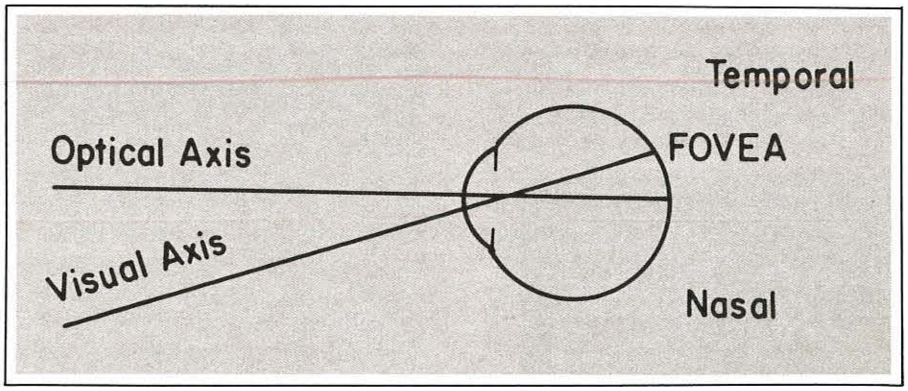
are viewed binocularly, they often appear to be located at different distances. This illusion, also a consequence of the chromatic aberration of the eye, is called chromostereopsis. For example, if one views binocularly red and blue targets of the same depth, most people will see the red target in front of the blue one (Cover photo).

The traditional explanation for this effect is that the visual axis of the eye differs from the optical axis (Fig. 5). Although the optical axis is perpendicular to the cornea, pupil, and lens, the visual axis, having its focus at the fovea, is located temporal to the optical axis. Consequently, when one views an object, light entering the pupil along the visual axis will strike the cornea, pupil, and lens obliquely at a point nasal to the optical axis.

Prismatic distortion of light entering the eye off the optical axis causes light of short wavelengths to be refracted more than that of long wavelengths. Thus for red and blue objects at equal distances, the blue object will be imaged more nasally than the red one—and thus perceived as being more distant than the red.

This explanation of chromostereopsis only partly explains the phenomenon, however, since some people see the reverse (blue in front of red), or experience no effect at all, or observe a reversal from red in front of blue to blue in front of red, as intensity is decreased.

As for problems in accommodating different wavelengths, the effects of chromostereopsis can be minimized by using colors of lower saturation. In addition, because pupil diameter decreases with increased illumination, the effects of chromostereopsis can also be minimized by using brighter backgrounds.

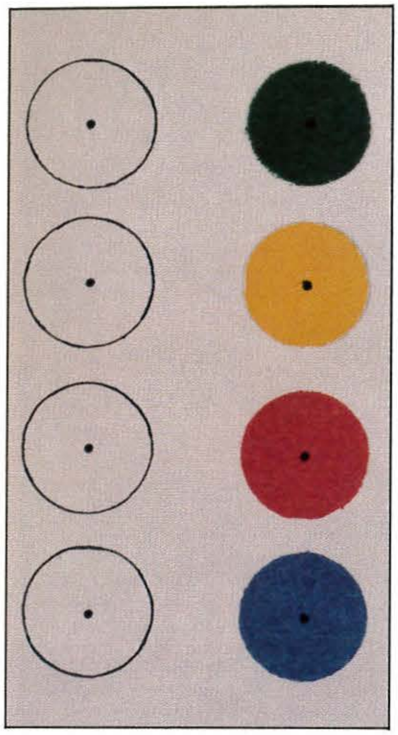


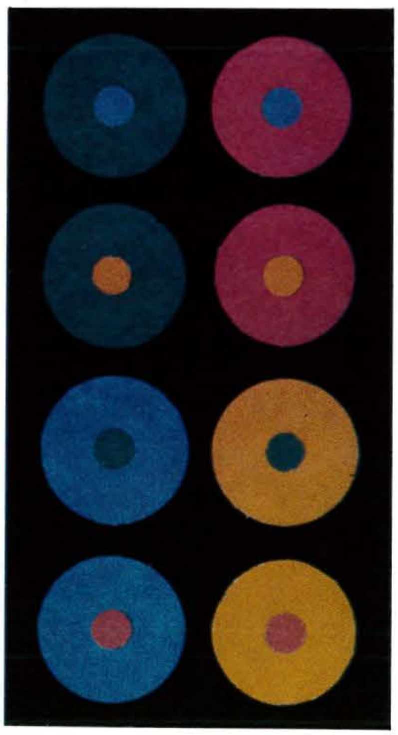
Chromatic induction

Perceived color of a light is not only dependent upon its spectral composition, but upon the distribution of light that stimulates other retinal regions as well as the light that has stimulated the eye in the relatively recent past. The influence of these variables on the appearance of visual stimuli is called *chromatic induction.*

For example, consider a display having two rows of small circular fields of identical chromaticities upon backgrounds of different colors (Fig. 6). Even though the special compositions of the light reflected from the small disks in each row are identical, the spots on each side of the figure differ in appearance when viewed against different colored backgrounds.

Further, the perceived color of light stimulating a given area on the retina is also dependent upon the special compositions and intensities of lights that have stimulated there previously. For example, consider a display having two rows of small circular fields with a small black dot at the center of each field: one row is composed of white circles, the other





one of colored circles (fig. 7). If one first looks at the area inside the white circle at the top left, then stares for about 20 seconds at the small black dot at the center of the green circle at top right, and goes back to the small black dot at the center of the white circular area—it will likely appear reddish. After allowing a few seconds for the eye to recover, this procedure can be repeated for each of the other three sets of fields (allowing the eye sufficient recovery period between viewing each target) with the resultant apparent viewing in each case of its complementary color.

This demonstration should be sufficient to prove that chromatic induction effects must be taken into consideration to predict perceived color in displays.

The simple two-stage color model (described previously), however, is not adequate to predict these effects. But, the model can readily be extended to incorporate chromatic induction effects. The spatially- and temporally-induced hues are complementary to those producing the effects. That is, stimulation with lights that appear blue induces sensations of yellow and vice versa, with the same complementary relation holding for red and green. To predict accurately what will be seen, one must incorporate space- and time-dependent interactions in equations that describe the outputs of the "A", "T", and "D" chromatic mechanisms.

Another aspect of chromatic induction, called *chromatic adaptation*, is generally associated with prolonged (order of minutes) exposure to a particular illuminant.

Traditionally, chromatic adaptation effects were believed to consist mainly of pigment bleaching in the receptors. Accordingly, these effects could be modelled as proportional adjustments of the "S", "M", and "L" receptor responses. This type of receptor adjustment multiplies the output of each receptor type by a coefficient between 0 and 1.0, with values of coefficients inversely proportional to their sensitivity to prevailing illumination.

And more recently, gain control mechanisms within the receptors have also been implicated in the adaptive process. These gain control mechanisms serve to center the response range of the receptor on the prevailing level of stimulation.

In addition, it has become apparent that chromatic adaptation effects also occur within second-stage color mechanisms. That is, under chromatic adaptation, the "T" and "D" mechanisms shift their spectral response ranges such that the illuminant stimulates at their respective crosspoints.

By this process, objects tend to retain their normal color (perceived in white light) despite large variations in the special properties of the illumination in which they are viewed. Pre-receptoral and post-receptoral adaptive changes are of critical importance in the maintenance of stable object colors in a variety of illuminations.

These adaptive effects are useful for allowing one to view displays in various spectral environments while preserving, for the most part, the apparent colors of areas on the display.

Object size and intensity

As visual stimuli become small (less than about 15 min of arc) it becomes difficult to discriminate among them based on differences in blueness or yellowness. And, as the stimuli become even smaller, discrimination along the red-green dimension also fails.

Similar effects occur in the temporal domain. That is, single pulses of light having short durations (below about 100 ms) will appear to be desaturated (white) relative to their appearance when presented for longer durations. Increasing the flash duration beyond 100 ms first enables discriminations along the red-green, or "T" dimension, with further increases in duration allowing blue-yellow discriminations to be made.

With regard to display of visual information, color coding is only useful if the objects are well above the spatial and temporal resolution limits of the color mechanisms. Thus, for display applications in which good color discrimination becomes important, the information should be coded with sufficient size and duration to enable that discrimination.

In terms of the general two-stage framework developed, the luminance or "A" system has higher spatial and temporal resolving power than the "T" and "D" color mechanisms. This is why it is possible for small or brief targets, or both, to be detectable even though their colors cannot be identified reliably.

In addition, the "T" system has demonstrated higher spatial and temporal resolution limits than the "D" system (blue-yellow discrimination becomes poor faster as stimulus size and duration is decreased than does red-green discrimination). Thus, information that is small or of short duration is best encoded for display in terms of luminance related variables (shape, brightness), whereas color-coding should be reserved for larger and longer targets, with the additional consideration that red and green targets are resolved more easily than are blue or yellow ones.

Retinal eccentricity

The resolving power of the eye is highly dependent on the retinal area that is stimulated. That is, the fovea has the highest density of cone photoreceptors and is the retinal area of highest acuity.

In retinal areas off the fovea, cone receptor density decreases monotonically with eccentricity, resulting in a falloff in acuity. Paralleling this decrease in cone density is a rise in the number of rod receptors. The rods mediate vision at low light levels and are absent from the foveal region.

The importance of the rational inhomogeneity is that if a light is presented to the peripheral retina, its color will, in general, appear to be different than the same light presented to the fovea. Such effects are generally believed to be directly related to the changes in the retina receptor mosaic.

Rod receptors mediate vision in low light levels (such as at night) and because many rods sum their outputs at the same second-order visual cell, the rod system is very sensitive to light. Rods, however, have a poor temporal response. A consequence of the high degree of spatial summation within the rod system is that rod-mediated spatial resolution is poor. Finally, because there is only one type of rod pigment, rod-mediated vision is colorless.

While there is some evidence that rod signals at intensities just above the cone thresholds can interact with these cones to produce color signals, their effects on perceived color of peripheral stimuli appear minor. Desaturation of the apparent color produced by a light that is moved into the periphery can be compensated for by increasing the size of the stimulus. Thus, the theoretical framework can be expanded to account for each effect merely by applying eccentricity-dependent spatial and temporal parameters on mechanism responses, rather than by adding rod-cone interactions to the model.

For display of visual information, the decreasing responsiveness of the color mechanisms with eccentricity implies that in addition to the spatial and temporal considerations discussed, one must take into account the effects of the retinal location at which the information is displayed to determine the parameters necessary for effective display of that information.

Effective use of color

Studies applying the two-stage color perception model indicate:

- Short-wavelength dominant lights should not be used to code small or brief information, because the "S"-cones do not feed the luminance system, which has the highest spatial and temporal resolving power. For example, it is best that blue not be used to display alphanumeric characters under normal conditions. As background stimulus, however, blue is fine. In addition, age-related changes in the spectral transmissivity of the lens of the eye serve to attenuate short-wavelengths more than long ones, making even less effective the information coded with short wavelengths.
- To avoid problems due to optical aberrations of the eye, it is best to avoid simultaneous displays of focal information using highly saturated colors. Use of desaturated colors will not only reduce the amount of refocusing required to view clearly different areas on the display, but also minimize color stereoscopic depth effects.
- To obtain the most saturated gamut of hues that can be produced on a display, it is necessary to view the display in an otherwise dark environment. Where additional light sources

(Continued on p. 34 . . .)

Touch screen
Series of low-cost touch screens, called TOUCH COMMAND, resemble thin, metalized mylar sandwiches that require only 5v @ 5 ma operating voltage, and produce 256x256 touch points. Screens have designed non-glare/non-smudge, neutral density surfaces that produce no color distortion. TOUCH COMMAND is a fully integrated device that uses a simple 5-pin standard connector. It is available in all standard CRT sizes, or custom made to individual specifications.

KENNEDY TECHNOLOGY, San Diego, CA (619/268-8555)

For information circle Reader Service #61

Television projector
The Talaria RJ4500 system features a GE light valve for high light output with high contrast television projection pictures. Lens objectives are available in any one of four throw distance-to-screen size ratios, depending upon room dimensions, with no degradation or loss of brightness. Picture size varies from 4 ft to greater than 24 ft for front or rear projection. Aspect ratio is 4x3. An optical system automatically adjusts for any of the three most often used TV scanning and encoding standards. All color projectors designed for 525 or 625 line operation have built-in video switchers and accept composite video or RGB video inputs. Signals accepted by Talaria projectors include output from tape, video, cassette and video disc players, off-air TV tuners, video cameras, telecine, satellite receivers, closed-circuit TV systems and most computer-generated displays that provide television compatible signals, including alphanumeric and graphic data.

GENERAL ELECTRIC CO., Syracuse, NY (315/456-2152)

For information circle Reader Service #62

Optical coatings software
A software package combines the ability to design multi-layer optical coatings for either dielectric or conducting substrates with a printout of the performance of the coating over a specified spectral range. The design software features the ability to automatically optimize the coating design using various constraints, thus reducing coating design time to hours instead of days. The system is currently available on Apple II+, IIe, IIc and IBM PC.

DAVID F. TAYLOR, JR., Santa Ana, CA (714/751-8897)

For information circle Reader Service #63

Dot-matrix display
A programmable four-character, dot-matrix display, designated the PD 3435/PD 3437, uses the latest in SMT and silicon gate CMOS. Each character is 0.27 in. high, has a luminous intensity of min. 50 μcd/dot @ Vcc = 5 v DC and is surface-mounted on a ceramic dual in-line substrate. The device offers high-efficiency, red/orange (PD 3435) and green (PD 3437), ± 50-deg viewing angle, and is end-stackable in 0.590-in. x 1.400-in. modules. A control register accessible through the data bus is utilized to activate the device's software controlled functions that include: 3-level brightness control plus blanking, highlight capabilities, intercharacter blinking, and a lamp test that turns on all the segments at half brightness without disturbing the internal character memory.

Price: PD 3435, $34/K; PD 3437, $37.50/K.
SIEMENS COMPONENTS INC., Cupertino, CA (408/257-7910)

For information circle Reader Service #64

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A high red response, remote process ¾ in. dia vacuum photodiode, is a direct replacement for the F4014 (S20) in those applications that require detection and timing of ultra-fast light phenomena having red and near-infrared spectral content. The device has a luminous response greater than 230 microamperes/lumen and at least 1% quantum efficiency at 800 nanometers.
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TELEVISION EQUIPMENT ASSOC., South Salem, NY (914/763-8893)

For information circle Reader Service #66

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For information circle Reader Service #67

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AMPEREX ELECTRONIC CORP., Smithfield, RI (401/232-0500)

For information circle Reader Service #68

(Continued on p 29 . . .)

Large flat color screen displays video and computer images

A large-area color LCD screen, only 0.4 m deep (including frame), has been developed by engineers at Mitsubishi Electric Corp., Tokyo, for displaying information generated either by video equipment or by computer graphics.

The display system, called "Crystal Color", consists of a series of self-contained modules that can be custom-assembled to meet specific requirements. Each module (60 mm x 460 mm) contains a 2-in. TN LCD panel with 8 x 64 pixels configured in a rectangular array, 7.2 cm on center; specially designed fluorescent lamps for backlighting; and driving circuits for controlling pixels responding to the digitized picture signals received from a video controller.

Each pixel contains individually addressable red, green, and blue subcells and the color of each subcell is set by an optical filter. To obtain optimum color clarity, each subcell is specially treated with optical dyes that are applied using sophisticated printing technology. This process provides the following primary color characteristics, based on the 1931 chromaticity coordinates:

Red — x = 0.65, y = 0.32
Green — x = 0.26, y = 0.67
Blue — x = 0.13, y = 0.10

The LCDs of each subcell are controlled to 64 grey levels by a static drive method to assure natural colors and to gain a wider viewing angle.

Kikuji Yagishita, Mgr.
Systems Planning & Coordination
Mitsubishi Electric Corp. Tokyo, Japan

Crystal Color *system in a multi-purpose meeting room has 1.2 m x 1.8 m display screen.*

TN-type LCDs were chosen because of their very fast response time of 30 ms, enough to create smoothly moving picture images on the screen. Then to gain better color quality and improve luminance, specially designed fluorescent lamps are placed behind the LCD panels that selectively emit red, green, and blue light energy.

A screen brightness of 250/cd/m^2 and low diffuse reflection characteristics permit the Crystal Color system to be used in almost any lighting environment. Viewing angle, from a horizontal plane, is approximately $\pm$ 50 deg; and viewing distance is more than 3 m for the picture of characters and graphics generated by the computer—more than 6 m for video pictures. Power consumption of the display is approximately I kW/m^2.

The Crystal Color display system consists of two main sections. The first, the operation control network, is composed of any standard audio and video equipment and a computer system that regulates character messages and graphics pictures to be displayed on the screen. The second section is composed of the audio/visual components, including the screen and speaker system. A video controller in the display unit converts standard analog TV signals into digital form and simultaneously stores the computerized signals into memory while sending both, or each, signal to the driving circuits of the LCD screen.

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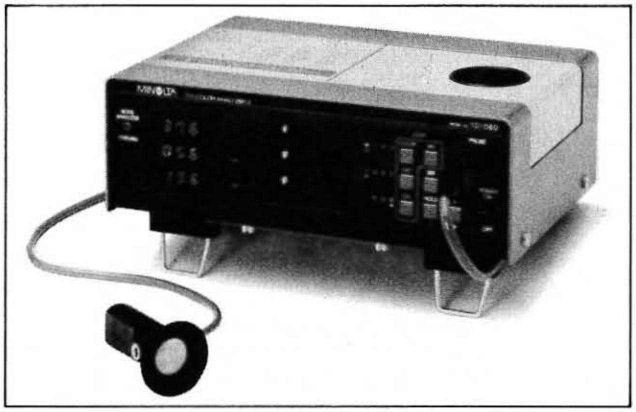

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The *Directory of Consultants in Computer Systems* lists more than 2,500 reference-qualified professional computer consultants and consulting companies. All listings are arranged alphabetically within state headings and include most of the following information: Name, position, company, address, telephone; hardware expertise by brand and model; operating system experience; software applications expertise, computer language most used, machine language expertise; client references; years of experience; affiliations and industry associations; and number of consultants on staff. Price: $75.

RESEARCH PUBLICATIONS, 12 Lunar Dr., Drawer AB, Woodbridge, CT 06525 (203/397-2600)

For information circle Reader Service #19

Optical disk drive

A WORM (Write-Once-Read-Mostly) optical disk storage system, designed to be integrated into personal and small computers and workstations, is a 5¼-in. double-sided, 400M byte removable cartridge system that offers more than 200M bytes on-line storage. The 5984 optical disk drive features: storage equivalent to 100,000 letter-size pages of text; pregrooved media that provide faster access and up to twice the storage capacity of flat media; disks that can be updated through a proprietary "pointer field," efficiently linking previously stored information with new data.

OPTOTECH, Colorado Springs, CO (303/570-7500)

For information circle Reader Service #52

X-ray resist

Negative X-ray resist, Baker XR-15, is formulated, analyzed and VLSI-processed to remove defect-causing particulates. The resist can be used to resolve 1.0 μm and smaller lines and spaces, as well as isolated lines down to 0.3 μm in width. It has excellent sensitivity to soft X-rays (longer than 5Å) with a sensitivity to the tungsten M-line (7Å) of 9 mJ/cm². The plasma etch resistance of Baker XR-15 is 2-3 times better than polymethylmethacrylate (PMMA) now used for X-ray work. Product Number 6390 is available in 100 ml, quart, and gallon sizes.

J.T. BAKER CHEMICAL CO., Phillipsburg, NJ (201/859-2151)

For information circle Reader Service #53

DC plasma displays

Compact 4-line x 20" character alphanumeric DC plasma display, Model 3402-05-080 features 5 x 7 dot matrix characters, a bi-directional ASCII interface, and software-controlled dimming. The module requires only +5v DC for operation and consumes only 4W of power. Outline dimensions are 6.5 in. (165.1 mm) by 3.6 in. (91.4 mm) by 1.75 in. (44.5 mm).

Price: $457.00 (quantities of 100).

IEE, Van Nuys, CA (818/787-0311)

For information circle Reader Service #54

Large, high-definition displays

With an aspect ratio of 1 to 1 and a face glass curvature of 3,300 mm dia, a 28-in. monochrome CRT, meets the high definition display requirements for extremely high information density applications, such as CAD/CAM workstations, medical diagnostic image analysis, and processing of large and complex drawings for mechanical works. The system has a horizontal resolution of 2,210 dots and display capability for 70,000 alphanumeric characters (8×8 dots per character).

A wide-format 28-in. color version, having a 3 to 5 aspect ratio with horizontal resolution of 1,680 dots and display capability of 33,600 alphanumeric characters is suitable for graphic display applications where color quality and resolution requirements are critical.

SONY MANUFACTURING CO. OF AMERICA, San Diego, CA. (619/487-8500)

For information circle Reader Service #55

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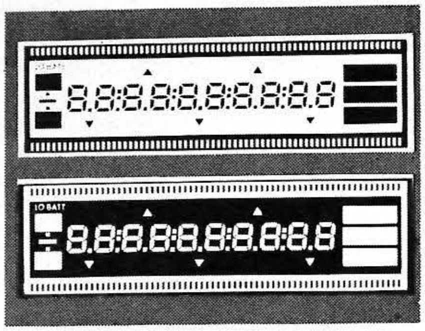

LCDs for custom applications

A low-cost, LCD for custom display applications features 10 digits .5-inches high, and has 9 decimals, four colons, plus and minus signs, low battery indicator, arrows to point to annunciator/flanges on front panel, rectangular light valves of two sizes, direct drive of 96 segments for custom interface to three standard drive circuits, and contacts on 0.100-inch c-c. These LCDs have high visibility in high ambient light, a wide viewing angle, low power and a wide operating temperature range. Options include dark display with white elements or clear, with black elements. LCDs are also available in multiple colors, dichroic, transmissive, reflective, or transflective. Price: from $14.95 each (10,000 quantity).

UCE INC., Norwalk, CT 203/838-7509

For information circle Reader Service #56

Helmet-mounted CRT

Miniature cathode-ray tube (CRT) package for helmet-mounted head-up displays (HMHUD), outputs light at 1700 cd/m^2 without degrading other performance parameters, thus enabling the display to be clearly visible against a bright background. The 1-in. tube has a fiber optic faceplate with a curved inner surface and a plane outer surface that corrects pincushion distortion and provides an interface to the external optics. Weight of the sealed package is only 90 grams, thus enabling the CRT to be mounted easily on a pilot's helmet.

THORN EMI Brimar Ltd., Greenside Way, Chadderton Industrial Estate, Middleton, Manchester M24 1SN, UK (061/681-7072)

For information circle Reader Service #57

Touchscreen interface

PC Touch, touchscreen interface, plugs into an IBM through PC/XT/AT slot and connects a telephone modulator cable to a 1000 x 1000 point resistive screen. Software provided with the system includes an authoring package, a custom touch pad creator, touch up menus. It is fully compatible with Microsoft mouse programs, and with most video disc controllers. Price: $249 (electronics only).

Touch Technology Inc., 107 Gilbralter St., Annapolis, MD 21401 (301/269-6181)

For information circle Reader Service #58

For information circle Reader Service #21

2-D drafting program

AutoCAD 2, a 2-D drafting program for the Victor 9000 microcomputer, includes dynamic dragging of objects, multiple linetypes, isometric aids and attribute capabilities, which makes it possible to create parts lists and bid estimates with an optional Bill of Materials Reporting System. One of the input devices supported by AutoCAD 2 is the TOUCHPEN that allows a user to draw and make menu selections directly on the monitor. Prices: AutoCAD 2, $2,000; TOUCHPEN, $795; and Bill of Materials Reporting System, $500.

Sun-Flex Co. Inc., 20 Pimentel Court, Novato, CA 94947 (415/883-1221)

For information circle Reader Service #59

Fishing rod LCD

A liquid crystal display device, mounted on a fishing rod, displays a fish symbol and the actual pull on the line when a fish has been hooked. Once that value is displayed, the fisher can set the correct friction drag on the reel to prevent losing the hooked fish.

Key to the system is an accurate TI "Hall Effect" proximity sensor. A permanent magnet is mounted against the fishing rod at an exact distance from the temperature-compensated sensor. Initial calibration linearizes the load deflection relationship for different rod diameter and materials.

As the rod deflects from a strike, the sensor determines the distance and transmits it to a Hitachi 8-bit microprocessor that translates the information into functional data using customized software. A threshold level of 0.3 lbs (or kg) is the starting point of the software that tells the fisher with a piezo buzzer that a fish has been hooked.

Software features that can be accessed with the device's touch-sensitive keyboard include setting a new threshold level for tolling or casting; measuring and displaying actual weight of fish caught (± 0.05lb); fish power (fish fight), fight time, and hardest hit. The device can be calibrated in any unit of measure. Price: $59.95

OUTDOOR ELECTRONICS, 605 Northridge Drive, W. Lafayette, IN (317/743-4864)

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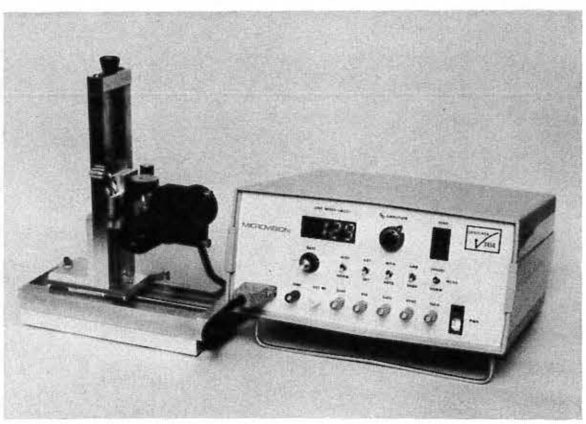

President's Message

SOCIETY FOR INFORMATION DISPLAY
8055 West Manchester Avenue-Suite 615
Playa Del Rey, CA 90293 - 213/305-1502

In the 1984 October issue of our Journal, I reported on my trip to Las Vegas for the NCC '84 Conference sponsored by AFIPS and several of its constituent societies. The meeting was very successful in all aspects. This year's NCC '85 Conference, held in Chicago, July 15-18, however, did not have as big a turnout. Both the number of exhibit booths and attendees were down, reflecting somewhat the economic environment of today's computer and electronic industries.

Computer peripherals, however, still commanded a great deal of attention at the conference. Several interesting printer products were demonstrated and there were numerous displays of terminals and workstations. It's very comforting to note that the SID industries (displays and printers, in particular) are occupying more exhibit space each year at the NCC. This should not be surprising to us, as we have seen the growth of such exhibits in our own conference each year. We have an early indication that our San Diego Conference next year will have an even larger number of such exhibits than did our Symposium in Orlando this year.

After a long search, AFIPS finally appointed an Executive Director, Egils Milbergs; and a Director for Government Activities, John Clement. The Government Activities Committee—GAC—deals directly with issues such as VDT ergonomic standards, safety, and so forth, which have a great impact on our Society. Both Elgis and John have impressive credentials. Their service to AFIPS, and indirectly to SID, will commence immediately. I would like to congratulate our AFIPS representative, Howard Funk, Chairman of GAC, for getting his committee organized so quickly, as well as for finding such a capable director for leading the government activities for AFIPS.

And, I would also like to commend Bettye Burdett, our Office Manager, who created a very positive image for SID at the NCC show. This was her second year managing the SID booth at the NCC show. I personally saw our booth frequently being visited by conference attendees. Many indicated their intent in joining our society and purchasing our publications. Thank you, Bettye, for doing such a fine job for us. And a special welcome for all new members to a very dynamic, professional society.

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(...continued from page 21)

must be used, it is best for color-rendering purposes to use the minimum amount of external illumination required to perform the task effectively—while insuring that the source is positioned such that its veiling luminance on the display is minimal. As a general rule, the image of the lamp should not be visible as a reflection on the display.

• In choosing an illuminant, it is wise to avoid sources that are highly chromatic as deviations from color constancy are most pronounced in spectrally restricted illumination. The "D" mechanism has shown to be better at discounting changes in illumination than the "T" system. Thus, for color constancy to hold in non-neutral illumination, the color rendering properties of the lamp must be better for reds and greens, than for blues and yellows.

• For a given set of lighting and display conditions, improvement can be made in the gamut of saturations that can be produced by placing opponent colors next to each other. That is, reds and greens, and blues and yellows, placed side by side will appear to be of higher saturation than when viewed alone. Thus, where information on two adjacent colored fields is to be presented, those regions will be more easily distinguished if they are coded in opponent colors rather than non-opponent ones (red-yellow or green-blue, for example).

• When presenting information to the peripheral retina, it is important to consider the decreased spatial resolving power of peripheral color mechanisms. Thus for peripherally presented materials, larger targets are necessary than those required to convey the same information to the fovea. Since the temporal response of the "A" mechanism of the eye, however, is better in the peripheral retina of the fovea, flashing targets in the periphery are particularly effective for gaining an observer's attention. Of course, once foveal fixation of the target is achieved via eye movements, the same rules for color-coding would apply as those for foveal vision.

• In considering the use of color for a particular display application, it is important to remember that about 8% of males and 1% of females have some form of color deficiency. Since most of these individuals lack only one of the "S", "M", or "L" receptor types, colors that differ in their abilities to excite at least two of the receptor types ought to be discriminable by almost all color deficient observers. The most general solution to the problem of color coding displays, when a sizeable portion of the user population is color deficient, is to use redundant coding. That is, any information in a display that is coded by color should also contain some luminance or shape code. □

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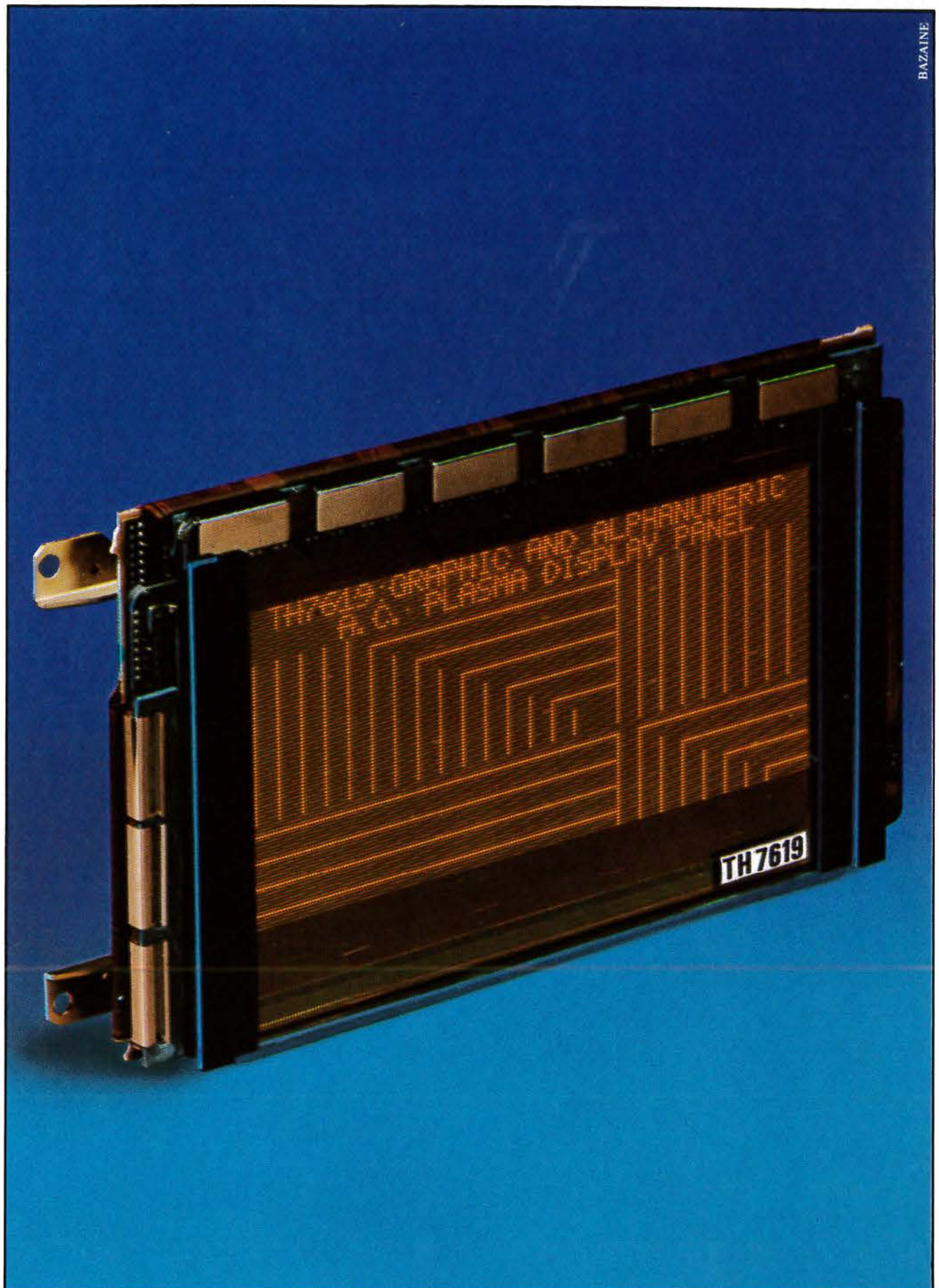

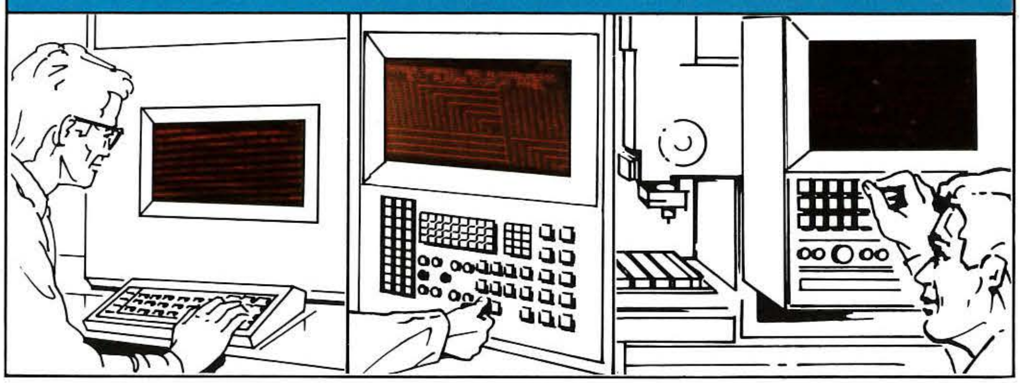

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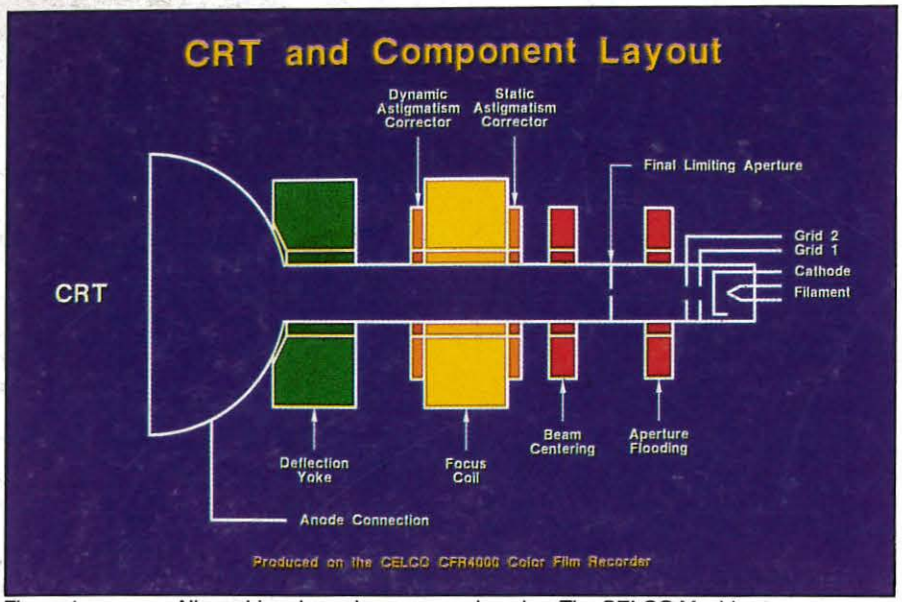


Figure 1 All graphics shown here are produced on The CELCO Machine (CFR4000 CRT Color Film Recording System) at CELCO in Mahwah, NJ.

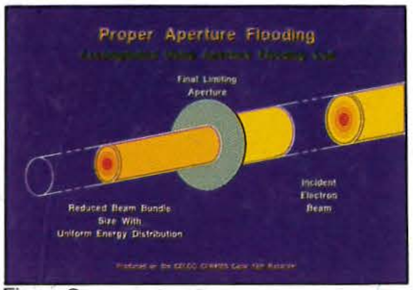


Figure 2

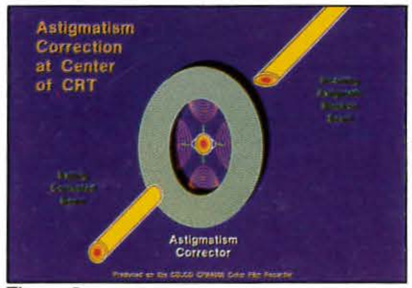


Figure 3

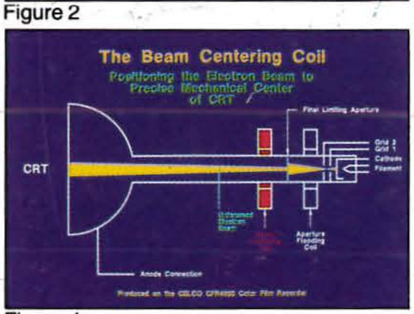
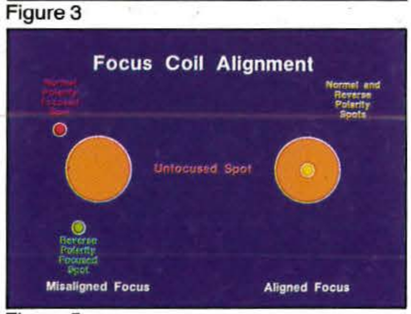


Figure 4



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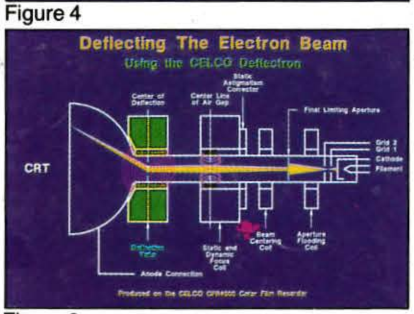

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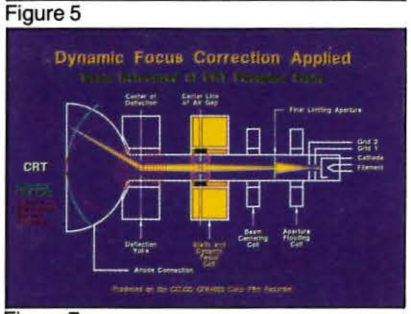

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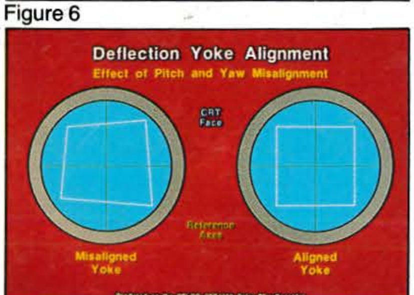

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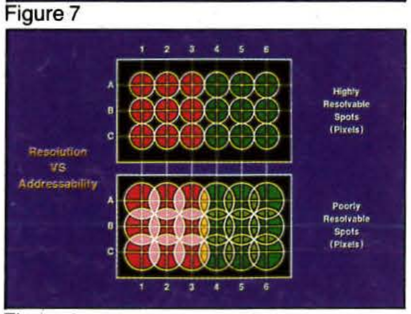

Figure 9

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1150 E. Eighth Street, Upland, CA 91786 714-985-9868

CELCO's Electron-optical techniques produce ultra-high-resolution CRT displays.

Absolute control over the size, shape and position of the scanning electron beam spot is necessary to produce an ultra-high-resolution CRT display. For example, the CELCO CFR4000 CRT Color Film Recording System yields over 7500 resolvable points across the CRT face with resulting image content in excess of 31 million picture elements per field. This system is presently providing theatre-quality imagery to the rapidly growing computer graphics industry for computer animation and other computer image generation techniques of recent development. Other applications include imagery for oil exploration and analysis and other geological interpretations and LANDSAT.

Proper selection and use of cathode-ray tube, deflection yoke, magnetic focus lens, astigmatism correction, centering and aperture flooding coils is the foundation of your high resolution CRT display.

Figure 1 indicates the proper position of the magnetic components on the CRT neck.

Figures 2-8 depict uniform aperture flooding, focusing of the divergent beam, astigmatism correction and deflection from center to the 63 million other positions of addressability (on the CELCO Machine) without distorting spot shape or size. Figure 9 illustrates the difference between resolution and addressability.

For a more detailed discussion, please circle reader service number below to reserve your free copy of "Electron-optical techniques for an ultra-high resolution color film recorder", (delivered before SPIE, January 1984) by John Constantine, Jr., CELCO Vice-President and Yoke Designer. Or call CELCO today with your display requirements: 201-327-1123. Ask for Doc Christaldi, Engineering Sales Manager.

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For information circle Reader Service #27