THE OFFICIAL JOURNAL OF THE SOCIETY FOR INFORMATION DISPLAY

INFORMATION DISPLAY

JUNE 1985

SID '85 SYMPOSIUM
HIGHLIGHTS
HONORS & AWARDS
OUTSTANDING PAPER

Raytheon's airborne CRTs exceed even tough MIL-SPEC requirements.

For an airborne CRT display, reliable operation on board a combat helicopter is one of the toughest tests there is.

MIL-STD-810C requires that helicopter-mounted equipment withstand 5G vibration from 5 to 2000 Hz on 3 axes for 9 hours. But ruggedized Raytheon CRTs pass at 20G: *four times* the required level.

And along with high performance, you get high visibility, too. Raytheon's patented RAYVUE® filter produces multiple grey shades even under intense ambient light conditions.

High reliability and high visibility. That's why Raytheon CRTs have been selected for the AH-64A and the Agusta helicopter systems, as well as for many other fighter and bomber aircraft, ATC, AFV and shipboard applications.

Let Raytheon work with you on your next tough environment display requirement, starting at the design phase. Contact Displays Marketing Manager, Raytheon Company, Industrial Components Division, 465 Centre Street, Quincy, MA 02169, (617) 479-5300.

Raytheon

Merging Pilot and System

...A unique Engineering Challenge.

At over twice the speed of sound, time is critical in obtaining valuable flight data. Pilots require sophisticated display systems that gives them instant access to navigation, target acquisition, threat identification and flight systems information. Making the aircraft and its complex systems an extension of the pilot's will is the challenge you can meet in one of the following professional openings:

Section Manager

Directing a department of 30 engineers and support personnel, you will be responsible for the design of CRT based display systems from concept through production. Display design will include LVPS, HVPS, CRTs, Video and Deflection amps. Your functions will also encompass proposal and budget preparation.

Requires a miniumum of 10 years' display design experience including 2 years at the management level. Excellent communication skills are necessary. A background in military products is helpful.

Display Design Engineer

Responsible for design of CRT display system involving analog and digital circuit design and analysis; specification of CRTs and HVPS; analog and digital video processing; A/D and D/A conversion at rates up to 100Mhz; electronic optics correction, deflection and dynamic focus amps.

Requires BSEE or equivalent with 6 plus years' experience in CRT display circuit design, including elementary thermal analysis, grounding and EMI techniques.

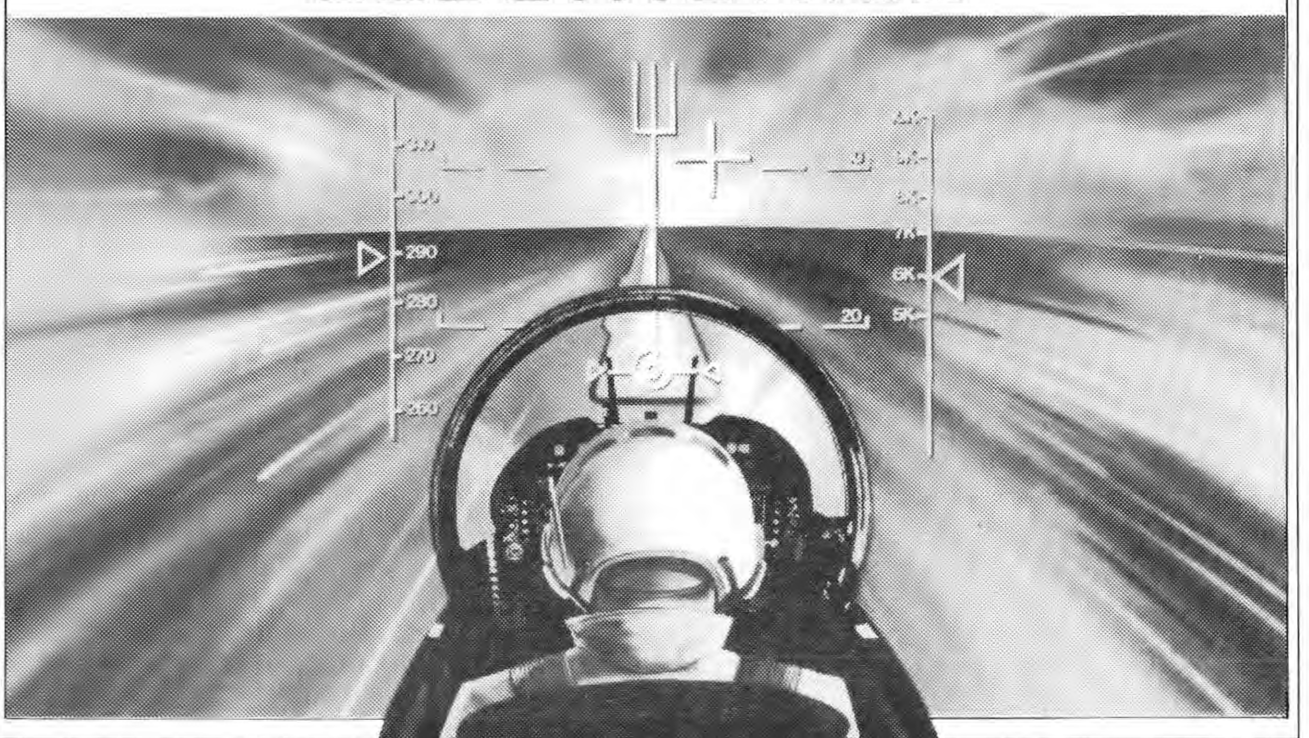
Low Voltage Power Supply Engineer

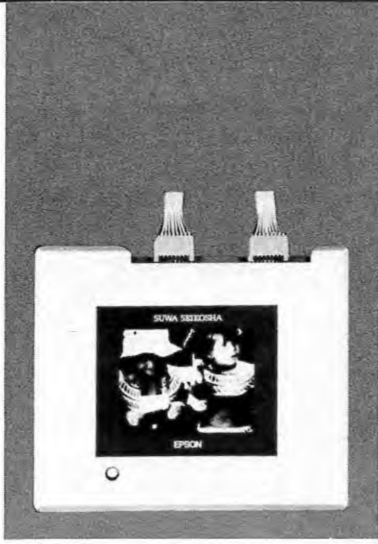
Responsible for design of LVPS that are off-line, pulse width modulated multiple output voltage, 100-500 watts at 85% efficiency operating at frequencies up to 100 Kilohertz. Involves circuit design and analysis, magnetics design and specification, EMI and packaging.

Requires 6 plus years' experience designing LVPS for custom packaging in CRT display systems and BSEE or equivalent. Familiarity with military LVPS, airborne LVPS, system grounding, detailed magnetics design and computer-aided circuit analysis is desired.

Send your resume for prompt consideration to: **Professional Employment, Dept. SJM163, 2701 Orchard Park Way, San Jose, CA 95134.** An Equal Opportunity/Affirmative Action Employer.

KAISER ELECTRONICS





THE OFFICIAL JOURNAL OF THE SOCIETY FOR INFORMATION DISPLAY

INFORMATION DISPLAY

JUNE 1985 VOL. 1 NO. 6

Cover photo: Flat-panel video display exhibits high-quality full-color image on a screen having only 4.25-in. diagonal.—*Suwa Seikosha Co. Ltd, Nagano, Japan.*

FEATURES

DEPARTMENTS

afips
American Federation of Information Processing Societies

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 selecting and specifying components and materials used in the design and development of input and output display systems for various applications such as: computers and peripherals, instruments and controls, communications, transportation, navigation and guidance, commercial signage, 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.

Events

NATIONAL

JUNE 24-26: VIDEOTEX '85, New York Hilton, New York, NY. Contact: Online Conferences Inc., 989 Avenue of the Americas, New York, NY 10018 (212/279-8890) Plaines, IL 60018 (312/299-9311)

JUNE 24-26: 22nd Design Automation Conference, Las Vegas, NV. Contact: Mr. Hillel Ofek, 1080 Marsh Road, Menlo Park, CA 94025 (415/324-0700)

JUNE 25-27: Computer Graphics '85 West. Los Angeles Convention Center, Los Angeles, CA. World Computer Graphics Assn. & National Computer Graphics Assn. Contact: Pam Wellman (703/689-9600)

JULY 10-12: World Computer Graphics'85, New York, NY. Contact: World Computer Graphics Association, 2033 M Street NW, Suite 399, Washington, DC 20036 (202/775-9556); Or—National Computer Graphics Association, 2722 Merrilee Drive, Suite 200, Fairfax, VA 22031 (704/698-9600)

JULY 15-18: National Computer Conference, Chicago, IL. Sponsors: AFIPS and ACM, IEEE-CS, DPMA, SCS. Contact: AFIPS, 1899 Preston White Drive, Reston, VA 22091 (703/620-8900)

JULY 22-26: SCS'85—Summer Computer Simulation Conference and Exhibits, Chicago, IL. Sponsors: The Society for Computer Simulation and IEEE-CS. Contact: Charles A. Pratt, SCS, PO Box 2228, La Jolla, CA 92038-2228 (619/459-3888)

JULY 22-26: ACM SIGGRAPH'85—Twelfth Annual Conference on Computer Graphics and Interactive Techniques, San Francisco, CA. Sponsors: ACM SIGGRAPH (Computer Graphics) and Eurographics. Contact: ACM Conference Management Dept., 11 West 42nd Street, New York, NY 10036 (212/869-7440 x230)

JULY 29-August 2: World Conference on Computers in Education, Norfolk, VA. Sponsors: IFIP TC3 and AFIPS. Contact: Gerald Engel, Dept. of Computer Science, Christopher Newport College, Newport News, VA 23606.

AUGUST 6-8: 1985 Western Plant Engineering, Material Handling & Packaging Show, Anaheim Convention Center, Anaheim, CA. Contact: Marvin Park & Assoc., 600 Talcott Rd., Park Ridge, IL 60060 (312/823-1010)

AUGUST 13-15: Computer Graphics '85 - East, Bayside Convention Center, Boston, MA. Contact: Pam Wellman, National Computer Graphics Assn. (703/698-9600)

AUGUST 18-23: SPIE's 29th Annual Technical Symposium on Optics and Electro-Optics, San Diego, CA. Contact: SPIE, PO Box 10, Bellingham, WA 98227-0010 (206/676-3290)

AUGUST 26-29: 1985 AGM SIGMETRICS Conference on Measurement and Modeling of Computer Systems, Austin, TX. Contact: Herbert D. Schwetman, MCC, 9430 Research Blvd., Austin, TX 78759 (512/343-0860)

AUGUST 27-29: INTECH - Integrated Information Technology, Moscone Center, San Francisco, CA. Contact: Sam Smith, National Trade Productions (703/683-8500)

SEPTEMBER 3-6: Office Automation Third Annual Conference and Workshop, Radisson South Hotel, Bloomington, MN. Contact: Jackie Potts, Office Automation Society International, 2108 C Gallows Rd., Vienna, VA 22180 (703/790-0490)

SEPTEMBER 10-12: Third Annual AVIOS Conference, San Francisco, CA. Contact: American Voice I/O Society (AVIOS), PO Box 60940, Palo Alto, CA 94306 (408/742-2539)

SEPTEMBER 10-12: Seventh Annual Electrical Overstress/Electrostatic Discharge Symposium, Minneapolis, MN. Sponsors: ITT Research Institute and the EOS/ES D Assn. Contact: Les Avery, RCA David Sarnoff Research Center, Route 1, Princeton, NJ 08540 (609/734-3009)

SEPTEMBER 16-18: International Industrial Controls Conference and Expo (IIC '85), Long Beach Convention Center, Long Beach, CA. Contact: Ed Troogstad, Tower Conference Mgt. Co. (312/668-8100)

SEPTEMBER 18-20: FOC/LAN '85 (Local Networks and Fiber Optics), Brooks Hall, San Francisco, CA. Contact: Michael O'Bryant, Information Gatekeepers Inc. (617/232-3111)

SEPTEMBER 19: Fiber Optics: Technology and Applications (Videoconference Seminar). Contact: IEEE Continuing Education Dept., IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854 (201/981-0060, ext. 329)

SEPTEMBER 23-25: SPACE TECH 85 Conference and Exposition, Anaeim, CA. Sponsors: Aerospace and Electronic Systems Soc. of IEEE, American Soc. of Mechanical Engineers, American Soc. for Metals, American Soc. of Quality Control, Computer and Automated

"What is the price of experience? . . .it is bought with the price of all that a man hath . . ."—William Blake

After shepherding your Society Journal through six issues so far this year, and participating in your Annual Symposium last month, we almost feel as though we too are experts on the subject of Information Display.

Let me quickly assure you, though, nothing could be further from the truth. The fact is that our strengths lie in reporting, editing, and publishing information; yours, in the generation of information on what's happening in research and development of display systems and technologies.

For some unfathomable reason (at least it seems so to me), less than 0.2% of SID's active membership, to date, has shown any interest in submitting articles (or even leads to articles or potential authors)—leaving us in somewhat of a vacuum as to what you want and need to read each month.

Our initial, and oft repeated, invitation to ID readers still stands. We'll put your name in print, if you tell us what you are doing—from papers presented at other association meetings relating to information display, articles that have appeared in limited-circulation in-house publications, and speeches delivered at seminars and workshops . . . anything pertaining to display technology and applications that has not yet seen exposure beyond the handful of participants or limited readership that first encountered your words.

Of course, while we're waiting for you to take us up on this challenge of a lifetime, we've gone ahead and done some planning of our own. For the remaining six issues of ID, we've selected some important topics that deserve addressing:

- July - Automotive Displays
- August - Medical Imaging & Instrumentation
- September - Human-Machine Interface
- October - Artificial Intelligence
- November - Military Display Systems
- December - Today's Technology - Tomorrow's Systems (annual forecast of spinoffs from current R&D)

Additionally, beginning next month, we'll bring you special sections on such items as listings of patents recently issued for display systems and technologies; introduction of the-product-of-the-month; profiles of new sustaining members as well as prominent researchers and developers in the field of information display; and much, much more.

Can we count on you for your continued support, input, and response—both reader and advertiser—to make it happen?

Joseph A. MacDonald
Editorial Director

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Events

Systems Assn. of SME, IEEE Computer Soc., Industrial Electronics Soc. of IEEE, Robotics International of SME. Contact: Soc. of Manufacturing Engineers, One SME Dr., PO Box 930, Dearborn, MI 48121 (313/271-1500)

SEPTEMBER 29-October 3: The Human Factors Society 29th Annual Meeting, Baltimore, MD. Contact: Ann Amrhein, Waverly Press Inc., 428 E Preston St., Baltimore, MD 21202.

INTERNATIONAL

JUNE 24-26: The International Electronic Printer, Industry Conference, Brussels, Belgium. Contact: C.A. Pesko Assoc. Inc., Marshfield, MA (617/837-1341)

JULY 29-August 10: Electronic Displays '85 - International Industrial Study Mission to Japan. Sponsor: Technology Transfer Institute - New York; Dr. George W. Taylor, Editor, Electronic Display World, study mission leader. Contact: Hideaki Hashizume, GM, Technology Transfer Institute, One Penn Plaza, Suite 1411, 250 W 34th Street, New York, NY 10119 (212/947-2648)

AUGUST 12-14: International Symposium on New Directions in Computing, Trondheim, Norway. Sponsor: IEEE Computer Soc. Contact: Arnold Meltzer, Dept. of EE and CS, George Washington University, Washington, DC 20052 (202/676-6729)

AUGUST 25-28: Second International Symposium on the Stability and Preservation of Photographic Images, Delta Ottawa Hotel, Ottawa, Canada. Contact: Klaus B. Hendricks, Gen. Chairman, Society of Photographic Scientists and Engineers, 7003 Kilworth Lane, Springfield, VA 22151 (703/642-9090)

SEPTEMBER 2-5: The Third Conference on Human Choice and Computers, Stockholm, Sweden. Co-sponsors: Swedish Society for Information Processing, Central Organization of Salaried Employees in Sweden, and the Swedish Employers' Confederation. Contact: Secretariat, HCC 3, % RESO Congress Service, S-105 24 Stockholm, Sweden.

SEPTEMBER 2-6: Ninth Congress of the International Ergonomics Assn., Bournemouth, England. Contact: Congress Secretariat, Ninth Congress of the International Ergonomics Assn., Meon House, Petersfield, Hampshire, GU32 3JN, England.

SEPTEMBER 3-6: 2nd International Congress on "Logica, Informatica, Diritto," Florence, Italy. Sponsor: Instituto per la Documentazione Giuridic. Contact: ENIC, Via S Caterina D'Alessandria, 12, 50129 Florence, Italy.

SEPTEMBER 10-12: COMPINT 85 - Computer-Aided Technology, Montreal, Quebec, Canada. Sponsors: IEEE Computer Soc. and IEEE Montreal Section in cooperation with ACM SIGDA (Design and Automation) and ACM SIGART (Artificial Intelligence). Contact: Stephen G. Leahey, PO Box 577, Desjardins Postal Station, Montreal, PQ H5B 1B7, Canada.

SEPTEMBER 10-13: 9th Data Communications Symposium, Whistler Mountain, British Columbia, Canada. Sponsors: ACM SIGCOMM (Data Communications), IEEE Computer Soc., IEEE Communications Soc. Contact: W.P. Lidinsky, Room 6B 309, AT&T Bell Laboratories, Naperville Wheaton Rd., Naperville, IL 60566 (312/979-6246)

SEPTEMBER 11-13: EUROGRAPHICS '85: Nice, France. Sponsor: INRIA, The French Governmental Research Institute. Contact: Institut National de Recherche en Informatique et en Automatique, Domaine de Voluceau - Rocquencourt - BP 105 - 78153 Le Chesnay Cedex France.

SEPTEMBER 20-21: Kitayakyushu International Conference on Automation and Robotics, Kitayakyushu, Japan. Contact: K. Noro, Professor and Head, Human Factors Engineering, School of Medicine, University of Occupational and Environmental Health, 1-1 Iseigaoka Yahata Nishi Ku, Kitayakyushu 807, Japan.

SEPTEMBER 24-26: The Artificial Intelligence and Fifth Generation Computer Technology Conference and Exhibition (AI/Europa), Wiesbaden, West Germany. Sponsor: TCM Expositions Ltd. Contact: Jim Hay, Tower Conference Mgt. Co. 331 W Wesley St., Wheaton, IL 60187 (312/668-8100)

COMING IN

OCTOBER

IDRC

Industry News

PEOPLE

Hollis Automation Inc. (Nashau, NH) announced the appointment of H. Terrence O'Rourke as president of the company. O'Rourke has invented and developed a number of the technological advances incorporated into the company's systems, such as the debridging airknife used in the Hollis Model GBS wavesoldering and debridging system.

TEXET Semiconductors (Allen, TX) announced the appointment of Jeffrey A. Hendy as president and chief executive officer. The company manufactures a variety of power control semiconductors, including MOSFETs, bipolars, voltage regulators, and rectifiers at its Texas headquarters and at a similar facility in eastern France.

Plexus Computer Inc. (San Jose, CA) announced the apointment of Paul L. Klein, Jr. as president and chief executive officer. Klein was formerly president and chief executive officer of Braegen Corp. (Milpitas, CA) and president of Memorex Corp.'s Communications Group (Santa Clara, CA). The company manufactures a line of 16/32-bit super microcomputers.

The American Ceramic Society (Columbus, OH) installed Dr. Edwin Ruh as its president, and announced the appointment of W. Paul Holbrook as executive director of the society. Dr. Ruh is visiting research professor at the Center for Ceramic Research at the Dept. of Ceramics, Rutgers University, Piscataway, NJ. Holbrook brings to the ACerS 26 years experience in the ceramics industry, serving most recently as works manager for the Kaiser Aluminum and Chemical Corp.'s Aluminum Div. in Gramercy, LA.

North Atlantic Industries Inc. (Hauppauge, NY) announced the appointment of Robert A. Carlson as president of the newly structured Military Products Div. Carlson, formerly vice president of corporate development at Simmonds Precision Products (Tarrytown, NY), and recently chief executive officer of Millicom, Inc. (New York), will also serve as corporate vice president for North Atlantic, a computer products company. The new division will integrate the engineering, manufacturing, marketing, and sales functions associated with the company's military and instrument products.

Cascade Graphics Development (Santa Ana, CA) announced that its president and chief operating officer, Stephen T. Ball, has assumed responsibility for Cascade's international operations. Ball will integrate the company's US and European activities, coordinate sales and marketing, technology, research and development (Italy), pricing, and OEM agreements. Cascade is a vendor of low-cost, turnkey CAD systems.

AMF Logic Sciences Inc. (Houston, TX) announced the appointment of Michael Teague as president. Spearheading the company's expansion plans, Teague came to AMF Logic Sciences from Houston Instruments, where he was Director of Marketing and Sales. AMF currently enjoys a 90% share of the seismic graphics market.

Quadratron Systems Inc. (Encino, CA) has named John J. Theiss president and chief executive officer, succeeding Karl Klessig, who continues as chairman of the board. Theiss was recently president of Cardkey Systems. (Chatsworth, CA), a computer-based securities management systems company and a division of Fairchild Industries. Quadratron software currently is part of office information management systems offered by leading computer manufacturers.

ORGANIZATIONS

Eastman Kodak Co. (Rochester, NY) has announced the merger of Eikonix Corp. (Bedford, MA) as a wholly-owned subsidiary unit in Kodak's Commercial and Information Systems Div. Chief among Eikonix products is the Designmaster 8000 digital graphic arts system, and electronic prepress system for producing color separations for the printing and graphic arts industry.

Sanders Associates (Nashua, NH) has agreed in principle to purchase the AEC (Architectural, Engineering, and Construction) division of Personal CAD Systems Inc., a manufacturer of computer-aided design (CAD) software. The division will become part of the CalComp Group of Sanders Associates.

Language Processors Inc. (Waltham, MA) has received a $16-million contract to supply its integrated family of high-level compilers on AT&T's UNIX PC system. LPI's family of compilers is a super-microcomputer programming language that provides features (normally found only in compilers offered with much larger computers) such as Poluglot Programming, which enables a software developer to use more than one language in a single program.

THORN-EMI Electronics Ltd. (Middlesex, England) has established an Electro Optics Division to address the electro-optic activities previously carried out within its Defense Systems Div. During the last 18 months, the company has received several major contracts for the development and supply of electro-optical equipment, including its observer thermal imaging system (OTIS), its hand-held thermal imager (HHTI), and the initial phases of development of a short-range, air defense alerting advice (ADAD).

Philips Telecommunicatie Industrie B.V. (The Netherlands) and Kyocera (Japan) have formed a joint venture Japanese company called Kyocera and Philips Data Communication Network Corp. (Tokyo) to market initially the Philips Wide Area Network SOPHO-NET to Japanese customers. Kyocera is a "High-Tech" company specializing in ceramic applications in electronics and automotive industries, with a significant interest in office automation.

Intergraph Corp. (Huntsville, AL) has formed a wholly-owned subsidiary in Japan with its local distributor, Mutoh Industries Ltd., to provide an increased level of support to Mutoh and its customers. Integraph is a manufacturer of interactive computer graphics systems.

FIFTH
ANNUAL
INTERNATIONAL
DISPLAY
RESEARCH
CONFERENCE

HYATT ISLANDIA
SAN DIEGO, CA

OCTOBER 15-17

Literature

Power Protection
A 46-page, illustrated catalog details power protection products including power conditioners, power line monitors, uninterruptable power systems (UPS), standby power sources (SPS), and power supplies. Product information is augmented with performance charts, diagrams, and mechanical specifications detailing the basic operating characteristics of the equipment. The catalog explains power disturbances and contrasts various power protection alternatives for preventing those disturbances from affecting equipment. A two-page glossary of power conditioning and power supply terms is included.
SOLA, Unit of General Signal, 1717 Busse Road, Elk Grove Village, IL 60007 (312/439-2800)

Photosensitive Devices
Revised 21-page catalog includes specifications and reference data on intensified solid-state-array cameras, photodiodes, photomultipliers, image intensifiers, and accessories.
ITT ELECTRO-OPTICAL PRODUCTS DIV., PO Box 3700, Fort Wayne, IN 46801 (219/423-4341)

Miniature Halogen Lamps
This 20-page catalog lists products reflecting recent developments in miniature halogen lamps and halogen lamp holders. Each halogen lamp is specified in detail for mechanical dimensions, voltage, current, color temperature, radiation output, spectral distribution and life-in-hours. The catalog includes standard bi-pin mount lamps and dichroic reflector lamps as well as details on the regenerative halogen cycle principle. A section on special lamp holders, designed and manufactured to resist high temperature conditions created by halogen lamps, specifies material, terminations, physical size and contact types that the holder will accommodate.
GILWAY TECHNICAL LAMP, 165 New Boston Street, Woburn, MA 01801 (617/935-4442)

Indicator Lights
A 48-page, catalog and technical user's guide covers a broad selection of LED, neon, and incandescent lamp indicators. An expanded section on a wide variety of LED indicators for both panel and on-board mounting is included along with units with Extra-Super-Brite LEDs. Another major section in the catalog covers relampable Tiny-Mite and Mini-Slide sockets and pilot-light assemblies. The former indicator is designed around the subminiature wedge-shaped incandescent lamp, while the latter uses miniature slide-base incandescent lamps. Included are recommendations on how, when, and where to select the best type of indicator for any design. Full-size photographs, dimension drawings, mounting information, and technical specifications and ratings are given for all the indicator lights shown.
INDUSTRIAL DEVICES INC., Edgewater, NJ 07020 (201/224-4700)

Computer Products
An 88-page catalog provides selection of peripheral switching and data communications products for users of ADDS, Burroughs, Data General, Data Pathing, DEC, Hewlett-Packard, Honeywell, IBM, NCR, Prime, TI, Wang and many other types of computer hardware.
DIGITAL CONTROLS CORP. 2779 Orchard Run Rd., Dayton, OH 45449 (513/435-5455)

RF Testing
This 12-page booklet presents a line of RF testing accessories including broadband antennas, TEM cells, field-sensor systems, leveling preamplifiers, fiber-optic telemetry systems, directional couplers, power combiner/dividers, matching transformers, computer interface modules, and system assembly kits. The bulle-

tin, containing current information on these products and obsoleting previous literature on some, provides features, advantages, illustrations, performance specifications, and dimensions of the equipment.
AMPLIFIER RESEARCH, 160 School House Rd. Souderton, PA 18964-9990 (215/723-8181)

Open-Frame Switchers
Product descriptions, electrical/mechanical specifications, and price information are included in a 12-page brochure covering 49 open-frame switching power supplies. System outputs range from 40 to 150 watts. Switchers have from one to five outputs and are designed for application in industrial systems and instruments, small business systems, data processing equipment, and office products.
COMPUTER PRODUCTS INC. Compower Div., 2220 Lundy Ave., San Jose, CA 95131 (408/942-1600)

Printed Circuit Boards
CTS Circuits is the title of a six-page, four-color brochure that describes the advanced capabilities and technical expertise of CTS Printex for processing high-density double-sided or multilayered circuit boards, whether for commercial or military applications.
CTS CORP., Elkhart, IN 45514 (219/293-7511)

Power Supply
A 28-page, short-form power supply catalog provides electrical/mechanical specifications, features, and ordering information on lines of AC/DC linear and switching power supplies and DC/DC converters.
COMPUTER PRODUCTS, Power Conversion, 2981 Gateway Dr., Pompano Beach, FL 33069 (305/974-5500)

Graphics Projector
Full-color, six-page brochure describes Model 700 graphics projector, which uses a liquid crystal light valve as its key element for transferring information from a low-intensity cathode-ray tube to a high-brightness xenon arc lamp. Also discussed are a wide variety of applications for the unit, such as displaying computer-generated graphic and alphanumeric information on a large screen for viewing by large audiences. Specifications are included.
HUGHES INDUSTRIAL PRODUCTS DIV., Projector Marketing, 6155 El Camino Real, Carlsbad, CA 92008 (619/438-9191)

Electrostatic Discharge
This 12-page catalog of anti static products features descriptions and pictures of such items as wrist straps, grounding devices and monitors, packaging, instrumentation, table mats, flooring, and protective shielding devices; as well as custom options for tote boxes and trays.
WESTEK, 400 Rolyn Place, Arcadia, CA 91005 (818/446-4444)

LISP Dialect
The 12-page, full-color brochure entitled *Productivity Plus*... emphasizes the numerous enhancements and extensions of basic LISP functionality provided by the ZETALISP-PLUS environment and the LMI Lambda LISP machines that support it. ZETALISP-PLUS offers a foundation of nearly 10,000 compiled functions and over 30,000 symbols. It is the first LISP machine implementation to offer CommonLISP, the new industry-standard LISP dialect. There is no operating system as such within the LMI ZETALISP-PLUS environment—the entire operating environment is either written in LISP or in microcode. All of the system functionality is directly accessible to programmers.
LISP Machine Inc., 6033 W Century Blvd. Los Angeles, CA 90045 (213/642-1116)

SID "Best Paper" displays full-color LC video panel

In their award-winning paper—*4.25-in. and 1.51-in. B/W and Full-Color LC Video Displays Addressed by Poly-Si TFTs*—Suwa Seikosha researchers describe a breakthrough in flat-panel design that permits them to develop miniature, full-color video displays having excellent image quality

The researchers, headed by Shinji Morozumi, approached the design working with a liquid crystal panel driven by an active-matrix method of MOS transistors and TFTs. By combining color filters and the LCD panel as a light valve, and utilizing the TFT arrays, the researchers were able to easily obtain a full-color display.

One of the major problems researchers had to solve was elimination of filcker that resulted from scanning the small panel at rates slower than could be the case with conventional-sized displays.

In an NTSC system, one frame of 1/30 sec consists of interlacing two fields. Each has 525/2 scanning lines every 1/60 sec. With LCDs, driving must be done by alternating positive and negative video signals. And, because the LC panel under development had 480 scanning lines, driving it in the same way as the original NTSC signal necessitated using a frequency of 1/15 sec, which causes a visible flicker.

To overcome this annoyance, the researchers developed a new driving method for the 480 scanning lines. In their system, pairs of scanning lines in an odd field consist of the 1st and 2nd, 3rd and 4th ... 479th and 480th scanning lines; while in the even field pairs consist of the 2nd and 3rd, 4th and 5th ... 478th and 479th scanning lines. The same video data is applied sequentially to each scanning line of the pair through a common data line.

"Best Paper" Team: *Researchers cited for their oustanding technical paper presented last year at SID '84, include: left to right, seated—Toshiyuki Misawa, Kouichi Oguchi, Shinji Morozumi; standing—Ryosuki Araki and Hiroyuki Oshima.*

Panel construction

The LC panel consists of five parts: two polarizers, an upper glass substrate with a color filter layer and a common electrode, a lower glass substrate with TFT arrays, and the liquid crystal material.

Color flters consisting of the primary colors—R.G.B.—and corresponding to the pixels are arranged diagonally by color in mosaic patterns to ensure high color resolution. The color filter and the LCD panel are combined as a light valve, to control the transparency of backlighting and achieve full-color display.

Researchers used a dual-type, poly-Si TFT because of its low OFF and high ON current (high carrier mobility), which makes it suitable for integration of both the matrix elements and the peripheral drivers. Low OFF current is necessary for high display contrast and low power consumption of the drivers; high ON current is essential for high-speed operation of the drivers.

Typical charactristics of the dual-gate poly-Si TFTs indicate that the OFF current for the matrix element is less than 1×10^{-12}A; while the ON current is about 5×10^{-6}A.

The panel's liquid crystal material has such high reliability that researchers were unable to record any change in its characteristics over a six-month or more period, at 60F and 90% humidity.

Panel specifications

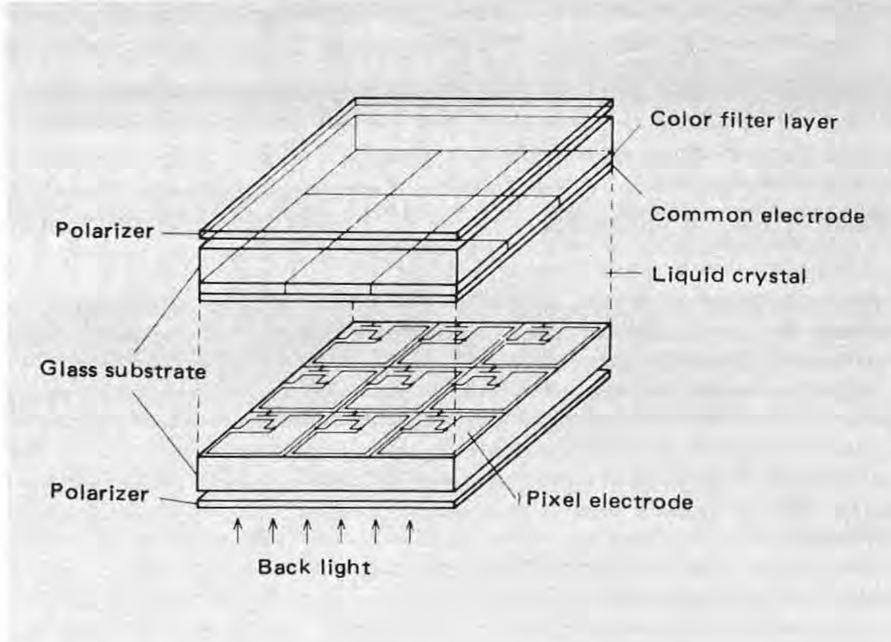
4.25-in. panel—TFT arrays in this panel consist of 480 pixels on an ordinary glass substrate, with a line pitch of 180 μm for the X-direction; 135 μm for the Y-direction. The display size is 86.4 mm x 64.8 mm; its diagonal is exactly 4.25 in.

Researchers investigated both stripe and diagonal mosaic filters for the flat panel display. The latter type, showing superior color resolution, were used. They were imbedded inside the panel's electrode. Eight LSI chips, each of which has 120 output pins, drive the panel, but are not included on the same substrate—to avoid degradation of the yield.

1.51-in. panel—This smaller LC panel, suitable for such applications as TV watches and Video Camera viewfinders, has a 180 x 210 matrix, with a line pitch of 170 μm for the X-direction; 110 μm for the Y-direction. Display area is 30.6 mm x 23.1 mm, with a 1.51-in. diagonal. In this smaller LC panel, all X- and Y-driver circuits and TFT pixel arrays are integrated on the same substrate to reduce costs and to make the system extremely compact.

Each of the panel's upper and lower X-drivers has 180-bit shift registers and sample holders; and each of the left and right Y-drivers has 210-bit shift registers. X-drivers occupy an area only 1.5 x 23.1 mm^2; while Y-drivers occupy 1.2 x 30.6 mm^2. Outputs of the upper and lower sample holders are commonly connected to each other through data lines; with the left and right shift registers commonly connected to each other through gate lines.

Researchers investigated shift registers of both complimentary (Pch and Nch) static type and (Nch-MOS) dynamic type with boot-strap. They found the maximum operating frequency in both types to be more than 2MHz at 16v, with power consumption almost the same. The Nch-MOS driver, however proved easier to fabricate, using simpler processes and circuits. On the other hand, CMOS drivers showed a wider range of operating frequency.



	4.25″ diag.	1.51″ diag.
TFT	Poly Si TFT	Poly Si TFT
Display area	86.4mm x 64.8mm	30.6mm x 23.1mm
Diagonal size	108.0mm	38.34mm
Number of pixels	480 x 480	180 x 210
Pixel size	180μm x 135μm	170μm x 110μm
Liquid crystal	TN	TN
Display type	B/W & full-color	B/W & full-color
Gray scale	over 15	over 15
Drivers	8 LSI chips	Integrated on the substrate
Driving voltage	±4.0V (Data line) 16V(Gate line)	

Specifications and performances

(This article was based on the paper prepared by Shinji Morozumi, Kouichi Oguchi, Toshiyuki Misawa, Ryosuke Araki, Hiroyuki Ohshima, Suwa Seikosha Co. Ltd., Nagano, Japan—SID '84 DIGEST, p. 316.)

SID '85 Symposium

SID '85, the Society's Annual Symposium, Seminar and Exhibition, held in Orlando, FL, last month, fulfilled all expectations as to professional and technical quality of papers presented, number of registered participants, and number of display exhibitors—even to setting new records of 988 attendees and 62 exhibitors.

Presentation of papers got underway Tuesday morning (April 30) following the Society's Annual Business Meeting, presided over by Dr. Ifay F. Chang, President. Bernard J. Lechner, RCA Laboratories (Princeton, NJ), delivered the keynote address—*High Definition TV*—in which he discussed the requirements for HDTV with respect to current state-of-the-art TV technologies.

Providing an overview of present TV systems and their resolution limitations as background, Lechner outlined requirements for HDTV, resulting from the trend towards larger screen sizes—along with other advances in TV technology. He examined in detail four proposals for improvements in TV systems. Comparing parameters of the two true HDTV systems proposals with NTSC and PAL systems pointed up the signficant increases in studio bandwidths required for HDTV.

"Although current technology can achieve the necessary increase," said Lechner, "HDTV probably will not be used before the end of the decade; and then, only for TV and movie production. Delivering it to the home will have to wait until fiber optic networks are in place."

Two invited papers rounded out the first morning's general session:

- *Visual Simulation: The Unsolved Problem*, David L. Peters, The Singer Co. (Binghamton, NY)
- *Ultra-Large-Screen Color Display*, Akio Ohkoshi, Sony Corp. (Tokyo, Japan)

In his paper, Peters provided a brief rundown of visual devices used in flight simulators from early screen projection systems, through large optical simulation facilities, to current extremely complex wide-angle collimated display devices for multi-user applications. Expanding on today's research efforts into new frontiers for simulator displays, Peters discussed several different approaches now under development by government research groups—including a recently demonstrated eye-controlled image direction system that is being studied by the Link group. He concluded with projections for tomorrow's needs and expectations for the development of a full 3-D simulation system produced by computer-controlled holography.

In the final paper of the morning, Dr. Ohkoshi discussed the development of an ultra-large-screen color display—the 40m x 25m Jumbotron—that is a key attraction at EXPO '85, at Tsukuba Science Center, some 30 miles northeast of Tokyo. (See ID, May

DR. Akio Ohkoshi, Sony Corp.

1985, p. 20) He provided details on the 6,300 high-voltage VFDs, each comprised of 24 tri-color light-emitting diodes (Trini

Lites) that are at the core of the system, as well as on the system's drive circuitry that makes up the huge TV screen.

Within the 17 sessions that took place during the Symposium's three-day run, some 96 speakers from the US, Japan, France, England, The Netherlands, Switzerland, Germany, China, and Canada presented technical papers covering five broad categories:

- Display Systems & Technologies (CRT and Flat Panel)
- Printing Technologies
- Human Factors
- Projection Displays
- Large-Screen Components/Materials

The traditional special author interviews, following each day's sessions, were enthusiastically attended by large numbers of Symposium participants eagerly seeking one-on-one conversation with participating authors as well as hands-on working demonstrations of prototype products and research models described in the days' papers.

Not everything was relegated to daytime, however. On Tuesday evening, four concurrent panel discussions were well attended by participants anxious to engage in an informal exchange of information on such topics as:

- Active Matrix vs Multiplexed-Addressed Flat Panels
- Color Flat Panel Display Prospects
- Competitive Workstation Printing Technologies
- Human Factors Issues in Input Devices

In this month's issue of ID, we review some of the 52 papers delivered in the nine sessions related to Display Systems and Technology. Then, in the July issue, we'll cover some highlights of the remaining 45 papers presented in the sessions on Printing Technologies and Human Factors.

One of the highlights of the auspicious gathering in Orlando was the Annual Luncheon, at which the society presents its annual award for the best paper delivered at the preceding year's symposium (see p.16). The winning paper—*4.25-in. and 1.51-in. B/W and Full-Color LC Video Displays Addressed by Poly-Si TFTs*—prepared by a team of researchers from Suwa Seikosha Co. Ltd. (Nagano, Japan) was judged outstanding by last year's attendees (see ID April, 1985, p.13) from among 93 papers presented at SID '84. In making the award to Shinji Morosumi (representing the team), Awards Chairman Peter D.T. Ngo cited the paper for its significance and completeness of technical results, clarity of presentation, and quality of visual aids.

A highly informative and visually exciting luncheon address on Graphics for the Entertainment Industry concluded the session. In his presentation, Bill Kovacs, Co-founder and Vice President, Wavefront Technologies (Santa Barbara, CA) provided slide and video supplements that traced the progress made over the past 10 years in the development and use of computer graphics for movies, TV and home computer screen.

Outstanding Contribution: *Peter D.T. Ngo, Awards Chairman, presents the SID Best Paper Award to Shinji Morozumi, accepting on behalf of his co-researchers from Suwa Seikosha Co. Ltd., Suwa City, Nagano, Japan. The team presented the winning paper "4.25-in. and 1.51-in. B/W and Full-Color LC Video Displays Addressed by Poly-Si TFTs" at last year's SID '84 Symposium, in San Francisco, CA.*

Flat-Panel Displays

• **Liquid Crystal Devices**—Commenting on the papers delivered in the session he chaired, Allan R. Kmetz, AT&T Bell Laboratories (Murray Hill, NJ) cited a steady decline in the number of active-substrate papers presented—from a peak two years ago to this year's presentations, the lowest since 1981—while the number of ordinary LCD papers remained at a consistently high level through this period, reaching a five-year high at SID 85.

Three of the five papers presented reinforce the fact that the diversity in electro-optic effects and classes of liquid crystal materials can yield new display concepts having inherently better performance—without resort to the considerably added cost of an active substrate.

In their paper, *24 x 80 Character LCD Panel Using the Super-twisted Birefringence Effect*, a team from Brown Boveri Research Center (Baden/Dättwil, Switzerland) reported on a new display that can be retrofitted into present TN display modules, offering a dramatic improvement in image quality. The display described by T. J. Scheffer and others used Berreman's bistable LCD, rigorously optimizing cell parameters and polarizer angles for multiplexed operation. The SBE display has 270 x 540 lines in a double matrix design and a multiplexed duty cycle of 1/135. Pixel size is 0.40 mm x 0.40 mm with 50 μm separation lines resulting in an active viewing area of 121.5 mm x 243.0 mm. A 10 x 6 font is used for the alphanumeric characters.

The authors pointed out that the SBE display is not suitable for applications that require gray scale, full color capability, and response time fast enough for moving pictures. It is, however, ideally suited for applications where large-area displays of high complexity, high contrast, wide viewing cone and low power consumption are required, such as for portable personal computers.

The paper presented by a team from Seiko Instrument & Electronics (Chiba, Japan) describes a full-page display that operates with refreshed multiplexing at low voltages in a 12-in. diagonal cell only 2 μm thick.

An Application of Chiral Smectic-C Liquid Crystal to a Multiplexed Large-Area Display, by T. Harada and others, outlines the researchers' attempts to overcome the problems that have restrained the widespread use of those liquid crystals in large area displays. Their paper describes the dot-matrix display panel they fabricated, having 640 x 400 pixels in the area of 260 x 162 mm² and driven by 1/400 duty multiplexing.

A new kind of Liquid Crystal Display was described by W.A. Crossland, Standard Communications Laboratories (Essex, England) in the paper *An Electrically Addressed Smectic Storage Device*, co-authored with S. Canter, ITT Courier (Tempe, AZ). The display is based on dynamic scattering and dielectric reorientation in smectic A liquid crystals. These electro-optic effects are capable of achieving excellent viewing characteristics, and any number of pixel rows can be addressed with no degradation of the optical performance.

This type of device is aimed at realizing a first-generation of simple, electrically addressed liquid crystal storage displays that avoid the limitations of fast scan multiplexing. The display described is believed by the authors to be the first liquid crystal flat panel display capable of competing directly with standard monochrome CRT visual displays in terms of screen size and resolution. It has major advantages over CRTs in terms of image quality, flat panel format, and on-screen memory capability.

• **Liquid Crystal Technology**—As this session's chairman, Paul R. Van Loan, Hewlett-Packard (Corvallis, OR) pointed out, "One of the characteristics of a mature technology is the steady evolutionary development of improved performance, incremental advances that open up new areas of application or new materials."

And, as three of the seven papers in this session proved, LCD has reached that level of technological maturity.

A team of researchers from Asahi Glass Co.(Yokohama, Japan) headed by Kazutoshi Sawada, presented the paper *Double-Layered Guest-Host Display for Automotive Use.* It describes a polarizer-free response to the automotive industry demands for high display brightness and wide temperature range of operation.

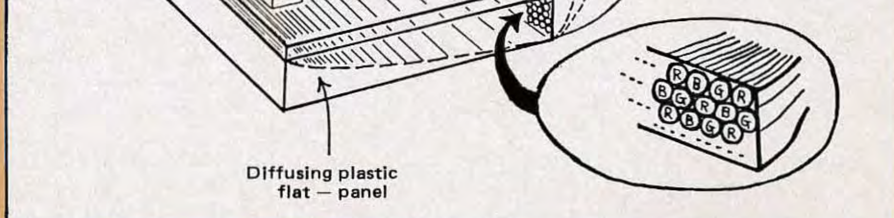
The authors developed an automotive dashboard using a back lighting, double-layered, cholesteric guest-host panel. In each cell of the DGH panel, right-handed and left-handed cholesteric mixtures were filled separately. The response time was short enough to enable recognition of numeral changes at −30°C. Because of its high contrast, wide viewing angle and good brightness (four levels of gray scale), this system could expand the use of liquid crystal displays for automotive applications, as well as for large size information boards with static drives.

In his paper *Polymer Encapsulated Nematic Liquid Crystals for Display and Light Control Application,* author James L. Fergason of the Taliq Corp. (Mountain View, CA) described a new species of LCD in which the liquid crystal is sandwiched between electroded mylar films. This produces a flexible yet sturdy display that requires neither polarizers nor edge seal.

The operating principle of these Nematic Curvilinear Aligned Phase (NCAP) devices is similar to that of other liquid crystal displays in that surface interactions are used to effect the alignment of the liquid crystal in the field-off state. The system's curvilinear interfaces between the polymer and liquid crystal phases cause a non-parallel alignment of the liquid crystal molecules that results in the scattering, or, with the addition of pleochroic dye, absorption of unpolarized light. Upon application of an electric field, a parallel alignment is effected and scattering or absorption of light is dramatically reduced.

The obvious advantages of such a display are its simplicity of construction; simple extension to very large sizes—greater than 1 sq. ft; excellent viewing angle; low power consumption; high brightness; adaptability to non-planar geometries and to odd shapes; and strong environmental properties—such as resistance to sunlight, moisture and thermal variations. Disadvantages still to be resolved are high driving voltage, compared to other LCDs; the need for controlled lighting for the scattering displays; and the lack of a high level of multiplexing.

The last paper in this session, *A Full-Color Field-Sequential LCD Using Modulated Backlight,* by H. Hasebe and S. Kobayashi, Tokyo University of Agriculture and Technology (Tokyo, Japan), presented a novel contribution to full color flat panel displays, based on channeling the light from three monochromatic CRTs through a fiber-optic light guide into a planar diffuser. The LCD uses a flat backlight panel connected to three RGB monochrome CRTs through a bundle of plastic optical fibers in conjunction with liquid crystal black shutters—such as TN, TB, or ferroelectric LC cells.



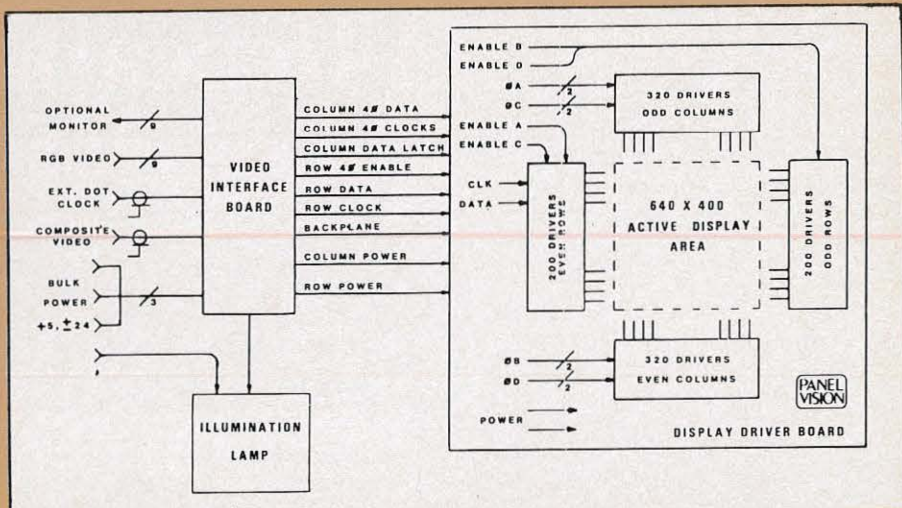
The configuration provides field sequential primary colors, spatially modulated by an LCD matrix. The results include a white luminance level of 30 fL and a tunable birefringent, twisted nematic, or ferroelectric element having a response time of 1 ms or less.

TN and TB shutters produce a flicker-free full color display having an area of 10 cm x 10 cm and strobing line of 10. With an active matrix-driven cell, or multiplexed cell with ferroelectric LC, lines up to 100 through 200 can be realized.

Flat-Panel Displays

• **Active Matrix and Thermally Addressed Displays**—Chaired by Donald E. Castleberry, General Electric (Schenectady, NY), this session explored several of the leading approaches to overcoming the limitations of the multiplexed twisted-nematic liquid crystal display, including adding an additional switching means such as thin-film transistors or thermal addressing.

According to Castleberry, "The thin-film transistor (TFT) approaches can be differentiated by the semiconductor material used ... each material system having its advantages and disadvantages, and consensus on the preferred material has not yet been established."



One of the six papers presented at this session, *Full-Color TFT-LCD with Phase-Change Guest-Host Mode*, describes a large polysilicon TFT display using a guest-host liquid crystal to increase the brightness and viewing angle.

A research team from Suwa Seikosha Co. (Nagano-ken, Japan), under the direction of Shinji Morozumi, developed the full-color display in which the polarizer has been eliminated, thus reducing the bright back-lighting normally required for such displays.

According to the researchers, the 5.13 in. diagonal TFT-LCD with PC-GH mode was developed for applications exposed to transmissive room light. The display's contrast ratio is 1:3.8, depending on the herical pitch and the amount of dye. The average transmittance in "ON" state is about 25%. The driving voltage for data line is +8 volts; for gate line, 24 volts.

What may be the largest integrated circuit ever attempted—a 5 in. x 8 in. active-area, Cadmium-selenide TFT-driven liquid crystal display was described by a team from Panelvision Corp. (Pittsburgh, PA) headed by F.C. Luo. Their paper, *A 640 x 400 CdSe TFT-LC Display Panel*, discusses the system's addressing scheme, system design, and display performance. The process uses five photolithographic mask levels, utilizing only conventional thin-film depositions and photolithography. The display is integrated into a system with a user-friendly interface. When connected to a personal computer through the RGB video interface port, the system replaces the CRT.

A prototype liquid crystal display, addressed thermally with a laser light pen, was described by a team from Hitachi Ltd. (Ibaraki, Japan) in the paper *Thermally Addressed Liquid-Crystal Flat Display with Laser Light Pen.*

In their paper, Y. Nagae (and others), explained how a semi-conductor laser light pen as well as the usual electrode heating method can be used to write directly on the display panel. Information generated by external equipment or ROM is displayed by using the heating pulses in a line-at-a-time sequence.

The prototype model has a 180 x 125 mm^2 display area with four lines/mm resolution. There are 720 vertical transparent electrodes and 500 horizontal heating electrodes, providing 360,000 pixels. All written information can be read out electrically by detecting the capacitance of each pixel—with readout time for the full display panel 0.8 sec.

• **Plasma and Vacuum Fluorescent Displays**—Larry F. Weber, University of Illinois (Urbana, IL) chaired this session in which three papers on AC plasma displays and two on VF displays explore some of the challenges in solving such problems as economical and practical matrix addressing of these devices, ways of achieving higher brightness and efficiencies, as well as techniques for designing full-color flat panel displays.

AC Refresh Plasma Display, presented by O. Oida and others, NEC Corp. (Kawasaki, Japan) describes how researchers solved the problem of increased power consumption that results from increased number of scan electrodes associated with large capacity plasma displays.

The NEC team developed a driving circuit based on the phase selection technique and constructed an ac refresh (from memory) plasma display having 640 x 400, 640 x 200, 720 x 350, and 512 x 256 pixels—comparable to CRTs—that makes full graphics display possible on a flat thin screen.

Futaba Corp. (Tokyo, Japan) researchers led by T.L. Pykosz, presented a paper entitled *Color Graphics Front Luminous VFD*, which describes a color graphic VFD that uses front luminous Vacuum Fluorescent technology. This graphic VFD is capable of displaying patterns in full color, from RGB colors that are coated separately on the anode as stripes.

The FLVFD presents the image, which can be observed through the phosphor, transmissive anode and supporting substrate. This structure eliminates the visual disturbances by the internal electrodes, thus allowing a finer pitch. The display is driven by a single matrix system.

• **Electroluminescent Displays**—This technical session, chaired by Aron Vecht, Phosphor Products Co. (London, England) offered six papers covering developments in large ACEL TF devices and color ELTF displays; assessments of the problems involved in attempting to obtain stable luminescence under high-field conditions; and the challenges researchers face in their attempt to improve drive circuitry for EL panels.

A new electrode architecture for EL panels was presented by Planar Systems Inc. (Beaverton, OR) team, led by R.T. Flegal. Their paper, *A Large-Area Electroluminescent Display* presents the design considerations for a system that reduces the power consumption for a large EL panel by a factor of two, compared to presently available systems.

In addition, this electrode architecture provides the circuit designer with a factor of eight increase in the time available to charge a column electrode. This additional time is then available to implement further power reduction schemes, such as resonant drive.

Using a 7 x 9 pixel array for character formation in an 8 x 12 cell, this EL panel can display 33 rows by 80 characters; an alternative 5 x 7 format in a 6 x 10 cell permits 40 rows of 106 characters to be displayed.

A paper by researchers at Tottori University (Tottori, Japan) demonstrated the potential for using alkaline-earth sulfides in multi-color thin film EL devices. Presented by S. Tanaka, the paper *Multi-Color Electroluminescence in Alkaline-Earth-Sulfide Thin-Film Devices* describes how EL devices made from alkaline-earth sulfides doped with rare-earth show luminances of 100, 650 and 350 cd/m^2 for red, green and blue respectively, with the observed luminous efficacy strongly dependent upon the film deposition temperature. These initial results are quite encouraging for this early stage of the investigations.

The ability to achieve high contrast in large-area displays (9-in. diagonal) is described in a paper by researchers at Matsushita Electric Industrial Co. (Osaka, Japan). *AC Thin Film EL Display with $PrMnO_3$ Black Dielectric Material*, authored by Atsushi Abe and others, explains construction of the TFEL panel consisting of a stable black dielectric material backing layer in contact with the ZnS:Mn phosphor film that reduces the saturation brightness by a factor of 2. High contrast ratios of 100:1 in 1000 1x ambient attained with the device hold good promise for potential application on both character and graphic displays for information terminals.

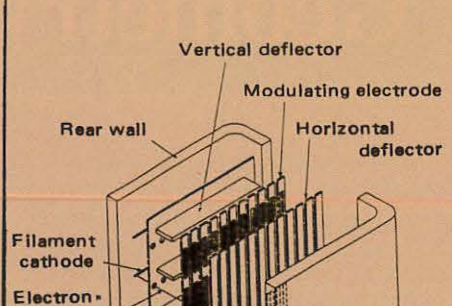
Cathode-Ray Tube Displays

• **CRT Displays**—Although papers on flat-panel display technology easily outnumbered those on CRT technology (by 4:1), nevertheless there were several papers showing " . . . extensive innovation in the overall structure of the CRT to achieve full-color flat display, sophisticated numerical analysis of deflection yokes and fields to minimize display errors, and electron gun development to improve the quality and lower the cost of color CRT display systems," according to session chairman William A. Hamilton, Raytheon Co. (Sudbury, MA).

Of the seven papers presented in this session two covered approaches that yield a flat color CRT.

One paper reported on the progress achieved on a flat channel multiplier CRT that has a 12-in. diagonal and is only 3 in. thick. In their paper, *Progress of the Flat Channel Multiplier CRT*, D. Washington and others, Philips Research Laboratories (Redhill, England), the researchers compare their first results using a flat (folded beam) deflection system with recent development of the larger display. The first flat sealed-off monochrome tubes have been made, and the feasibility of achieving full-color has been demonstrated using smaller area demountable displays.

The other paper describes a 10-in. diagonal CRT less than 2.6 in. thick that uses a new drive/deflection system that produces a full color TV image comparable to conventional color picture types. Presented by Masanori Watanabe and others, Matsushita



Electric Industrial Co. (Osaka, Japan), the paper, *A Color Flat-Panel Display Using Matrix Drive and Deflection System*, details the basic structure of the panel display, which has a drive consisting of 15 directly-heated filament cathodes and 200 strip modulating electrodes with vertical and horizontal deflectors aligned corresponding to the cathodes and electrodes respectively. The panel's screen consists of 3000 picture cells and achieves 400 x 480 pixel presentations.

High-Resolution Electron Gun Designed for a New Generation of Color Data Display Tubes, presented by Hsing-Yao Chen, RCA Video Component and Display Division (Lancaster, PA) described the design of a new electron gun that uses the lower aberration main lens of the COTY system, an improved beam forming region, and a focus refraction lens. According to the author, these new features result in a gun that provides better corner resolution, improved convergence performance, and minimized convergence/focus interaction. These improvements result from:

A closer beam-to-beam spacing that allows a better in-line gun/yoke convergence performance

A refraction lens design that reduces the convergence shift due to focus voltage change

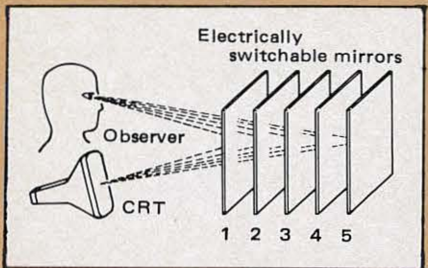
A zero free-fall design that reduces the thermal convergence drift.

• **Display Systems**—Other papers of note on CRT technology were presented in this session chaired by Paul T. Breen, The MITRE Corp. (Bedford, MA). Among these was one on a high definition color CRT monitor developed for military applications, one on a very high definition color display for TV, and one on a CRT display system that provides a three-dimensional image.

New Precision Color CRT Monitor for Military Applications, by Seymour Berkoff and Anthony N. DeLorenzo, Hazeltine Corp. (Greenlawn, NY) describes a recently developed fully militarized color display monitor using a shadow mask cathode ray tube that provides color display equalling or surpassing that of the monochrome original. The 19-in. monitor produces a visual resolution of 1280 x 1024 at 50% modulation depth, and provides seven colors to meet military requirements for color-coding display data.

A Flicker-Free 2448 x 2048 Dots Color CRT Display, presented by Kunio Ando and others, Hitachi Ltd (Yokohama, Japan), describes the development of a super high resolution full color 19-in. CRT display to meet growing CAD/CAE workstation demands. According to the authors, the flicker-free device is capable of displaying more than 4 million dots at non-interlaced scanning mode. Brightness is about 70 cd/m^2.

And *A Field-Sequential Discrete Depth-Plane Three-Dimensional Display*, presented by Thomas S. Buzak, Tektronix, Inc. (Beaverton, OR), describes a new approach toward solving problems associated with earlier 3-D displays. This prototype display produces a real 3-D image with full vertical, horizontal, and headmotion parallax; and it is also capable of doing full color while remaining relatively compact.



The system uses a series of electrically switchable mirrors, stacked one in front of the other. Each mirror consists of at least two LC cells. Together, they act as an electrically switchable mirror for circularly polarized light. Each mirror can be switched into one of the two states—reflecting or transmitting. Switching from one plane to another can be accomplished in 0.2 milliseconds.

When an image from a CRT is reflected from the stack of mirrors, the apparent distance of the image from the observer is a function of the position of the nearest reflecting mirror.

Other display papers of interest included:

- *Projection Display Systems*—Session chairman, Stephen R. Black, Evans & Sutherland Computer Corp. (Salt Lake City, UT).
  - —*A Portable Projection CRT Terminal*
  - —*A Compact High-Resolution Image Projector and Printer Using a Laser-Addressed Liquid-Crystal Light Valve.*
  - —*A 54-in. (5:3) High-Contrast and Brightness Rear-Projection Display for High-Definition TV*
- *Large Screen Components and Materials*—Session chairman, John J. Stapleton, Visionary Technology Inc. (East Brunswick, NJ).
  - —*A Continuous Very Large-Area Liquid Crystal Color Display*

The first paper, presented by R.I. Feigenblatt and I.F. Chang, IBM (Yorktown Heights, NY), described the construction of a transportable CRT display using off-the-shelf projection technology. The prototype uses a commercial Kinescope with electron optics, and a custom-designed commercial 50-mm lens. By allowing distortion, which can be compensated by predistorting the electronic raster, high resolution is available (even in the field corners) and a lens resolution of 1000 diagonal lines is achieved. By folding the optical path with two beam-turning mirrors, the researchers obtained a projected, flat 12-in. active diagonal display in a compact carrying case that folds down to only 5 x 15 x 20 inches.

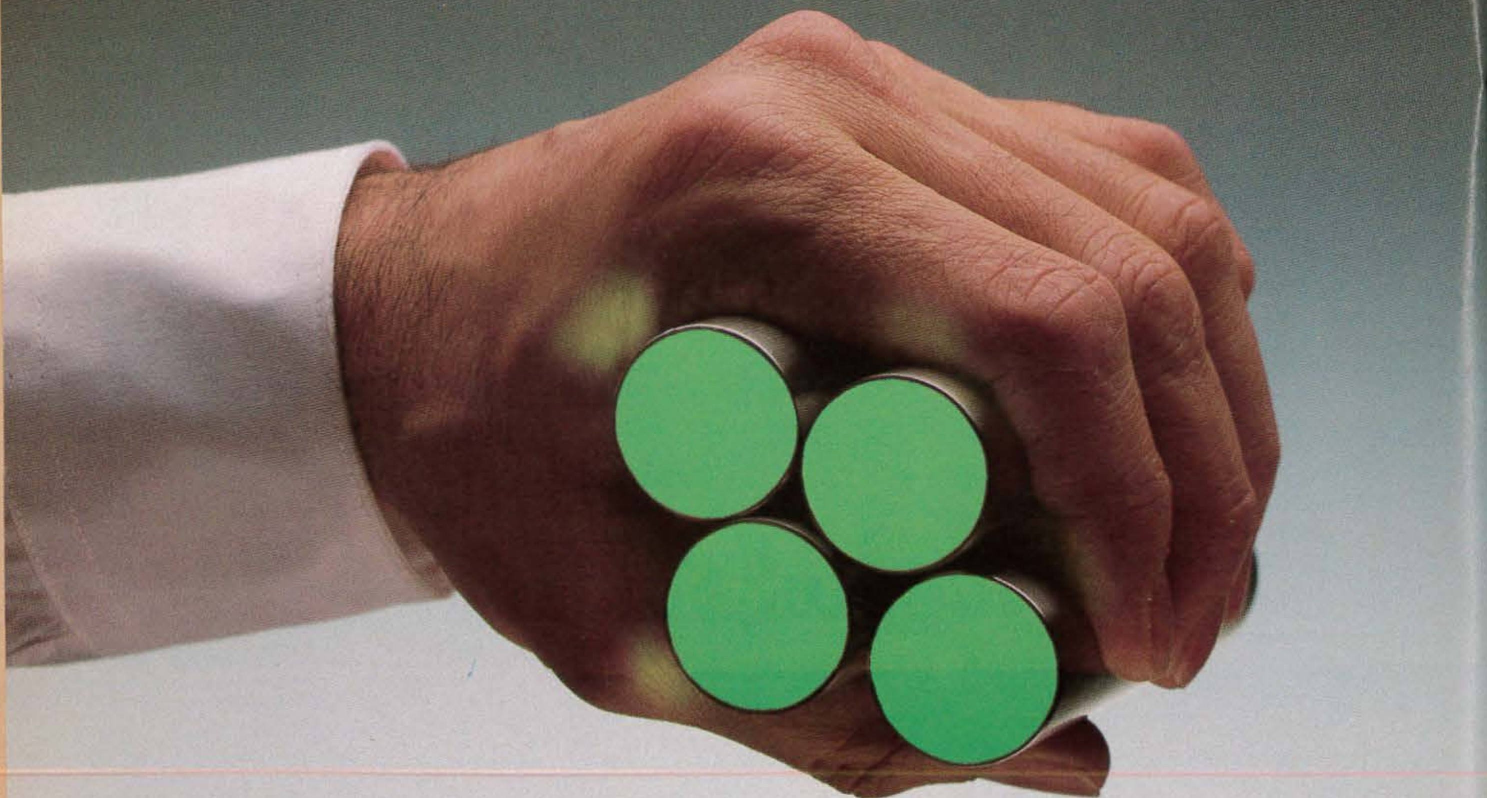
In the second paper, K. Kubota and others, NEC Corp. (Kawasaki, Japan), describe a compact high resolution combination projector/printer that uses a semiconductor laser-addressed liquid crystal light valve. This system not only can display 2000 x 2000 pixels, 8 ft. x 8 ft. screen image, but also can print an A-4 size image simultaneously. The system has a personal computer interface. Hard copies of the projected image are obtained by indicating the number of copies desired and then activating the starter button.

The third paper, by Kunio Ando and others, Hitachi Ltd. (Tokyo, Japan), describes a 54-in. rear projection display for High Definition TV that uses a newly developed 9-in. electromagnetic focusing type high resolution projection tube. The phosphor screen is spherical and convex toward an electron gun, thus eliminating field curvature caused by the projection lens. Peak brightness of the device is about 340 cd/m^2. Resolution is 1000 lines horizontally and 750 vertically. According to the authors, extremely high-contrast images are displayed even in brightly-lit rooms.

The final paper in this review, by Hideki Matsukawa and others, Matsushita Electronic Components Co. and Asao Takada, Matsushita Communication Industrial Co. (Kanagawa, Japan) describes the development of a large color video display system comprised of liquid crystal panel units (201.5 mm high, 268.5 mm wide and 83.0 mm thick), which are stacked in multiple blocks within a display structure, having three-wavelength type fluorescent tubes for rear lighting of the display. Specially designed light guides are used to eliminate the grid pattern resulting from the assemblage of multiple panels, thus creating a continuous screen image.

N.B. *The Digest of Technical Papers—1985 SID International Symposium*, May 1985, is available from SID HQ, 8055 W. Manchester, #615, Playa del Rey, CA 90293. $40.00 for members; $50.00 for non-members.

Our new CRTs are quite a handful.



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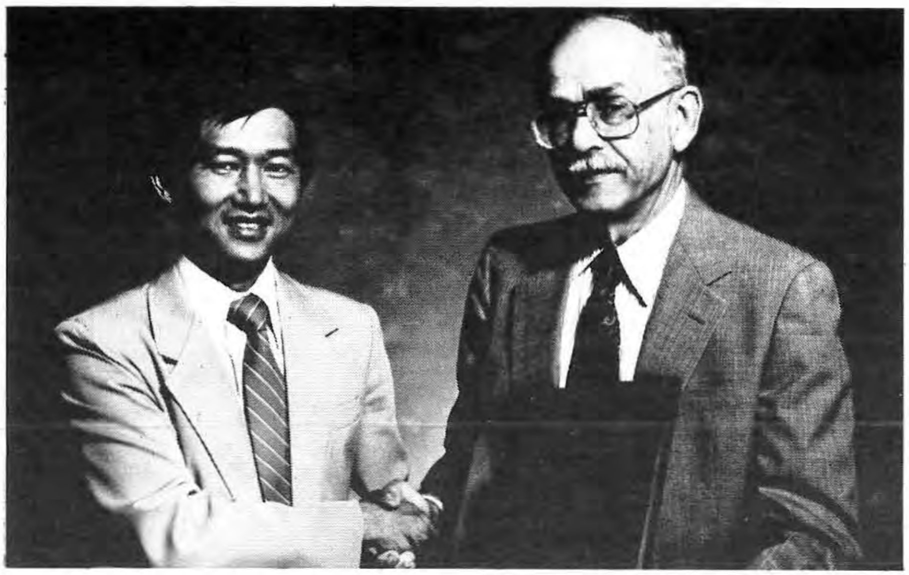
Litton Electron Devices

SID '85 Honors and Awards



Sol Sherr, Westland Electronics, Ltd., Old Chatham, NY, recipient of SID's 1985 Beatrice Winner Award for "distinguished Service to the Society."

Peter Pleshko, IBM Corp., Kingston, NY, recipient of SID's 1985 Francis Rice Darne Memorial Award for "technical and leadership contributions in the development and manufacturing of high information content ac plasma displays."

Allan R. Kmetz, AT&T Bell Laboratories, Murray Hill, NJ, recipient of the 1985 SID Fellow Award for "contributions to the understanding and application of liquid crystal displays."

C.J. Gerritsma, Philips Research Laboratories, Eindhoven, The Netherlands, recipient of the 1985 SID Fellow Award for "contributions and leadership in flat-panel display research."

Study focuses on display terminal requirements

The introduction of Visual Display Terminals, or Units (VDTs or VDUs), into everyday working life has often led to complaints of poor working conditions.

A recent report, prepared by CIE (the International Commission on Illumination) Technical Committee 3.1: Visual Performance, explores the visual aspects of the VDT in the workstation and makes certain recommendations for further study and application. The report is in three parts:

- Part One—examines the nature of VDT work.
- Part Two—discusses the health aspects of VDT work.
- Part Three—considers the visual requirements of VDT work.

This article presents the report's conclusions to Part Three—focusing on the visual requirements of the display unit itself. Subsequent articles in ID will focus on the environmental and user requirements.

Character formation

For most VDTs, the characters of the display are constructed from a matrix of dots or short lines (Fig. 1), and are generated by making different dots or lines in the array luminous.

The legibility of different characters depends on the number of dots or lines in the matrix and their spacing. Too few dots or lines in an array, widely spaced, will result in poor legibility. For dot-matrix character generation, a 5x7 matrix is the minimum acceptable for character discrimination; while for line-matrix generation, a 4x5 matrix is the minimum acceptable. Of course, larger matrices (such as 7x9 or 9x13) obviously will produce more legible figures.

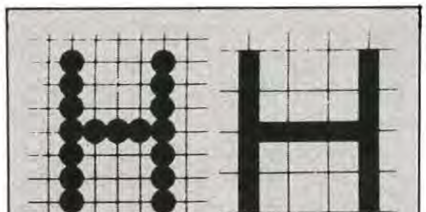


FIG. 1

FIG. 2

But, even with a larger matrix, the standard positions of the dots or lines may lead to oddly shaped characters. To overcome this problem, various techniques of character enhancement have been developed.

One commonly used technique is to double the horizontal dimension of the matrix, changing the dot matrix from say 5x7 or 7x9 to 14x9, without changing the physical size of the matrix. (Fig. 2) The extra dots in the horizontal dimension allow curved lines to be formed that result in a more natural appearance for some characters.

Character size

Given that the character is formed from a matrix of dots or lines, there remains the question of character size.

For either matrix, optimum legibility occurs between a minimum and a maximum size. Characters smaller than the minimum size cannot be easily identified; while those exceeding the maximum size are too large, thus reducing the readability for groups of characters with individual characters tending to break down into assemblies of dots or lines.

Character size is most usefully expressed in terms of the angle subtended by the character at the operator's eye. The preferred character size is in the range 15 to 22 min arc, for the character height with the other dimensions of the characters being in the proportions shown in Fig. 3. Within this range, the optimum character size varies with the method of character generation. Cruder characters require smaller sizes if the elements of the character are not to be discriminated.

Intercharacter spacing

Spacing between characters has an important effect on the ease of reading of a display. If intercharacter spacing is very small, characters are crowded and not easily identified; if spacing is large, then only a few characters can be identified for each fixation—thus reducing the operator's reading speed.

To ensure adequate discrimination between individual characters, their spacing should be not less than 20% of the character height; and to ensure good readability, character spacing should be not more than 50% of the character height (Fig. 3)

Upper- and lower-case letters

Generally, text containing upper-case letters only is more difficult to read than is text (occupying the same space) containing upper- and lower-case together, or lower-case letters alone.

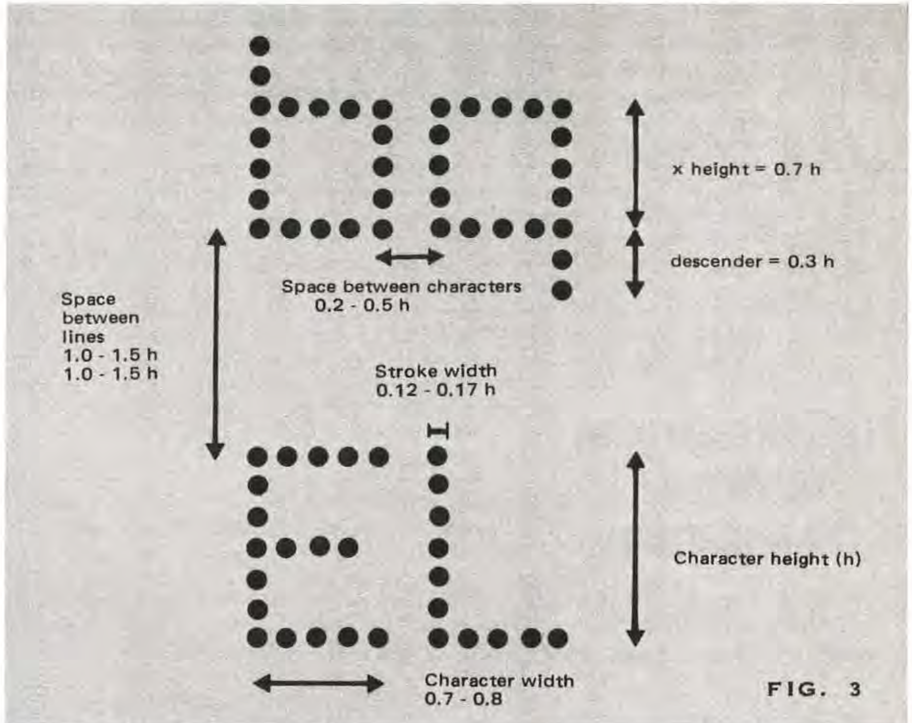
The reason is that ascenders and descenders in the lower case letters tend to give each word a distinct outline so that it can be perceived as a unit, rather

than as a collection of letters. Text displayed in conventional upper- and lower-case letters is unquestionably easier to read.

But, it is essential that descenders in one row of text reach below the baseline of the characters and that they not overlap or become entangled with the ascenders from the row below. Small dot- and line-matrices, however, may not allow both upper- and lower-case letters to be formed clearly. Thus, another reason for using matrices larger than the required minimum.

Line spacing

To avoid ascenders and descenders of successive rows of text becoming mixed and yet be able to retain a reasonable display capacity on a given screen size, both minimum and maximum line spacing specifications exist. In general, line spacing should not be less than 100%; and not greater than 150% of the character height. (Fig. 3)



For a given viewing distance, the character height can be obtained from the angle subtended by the relationship: character height (mm) = 0.0003 x angle subtended (min arc) x viewing distance (mm).

Format

The recommendations already given on character formation and character size are specific to VDTs and are based on the particular mechanism used to create the characters—that is dot- or line-matrix. Other recommendations, pertaining to VDT display format, are based on conventional rules of good typography. This is essential to remember when considering spacing between words, justification of text, line length, and so forth.

Contrast and luminance

Once the size of the characters is fixed, their visibility is largely determined by their contrast with the background. This contrast is most conveniently expressed as the ratio of the luminance of the character (L_c) to the luminance of the background (L_b).

Expressing contrast as a simple ratio L_c to L_d gives equal weight to both positive and negative contrast; positive contrast being when the character luminance is greater than the background luminance, and negative contrast being when the character luminance is less than the background luminance. The conventional expression of luminance contrast

$$\frac{L_c - L_b}{L_b}$$

allows a range of -1 to infinity and hence does not give equal weight to positive and negative contrast.

By far the most common form of display is positive contrast, in which light characters are seen on a dark background. Measurements of task performance and operator preference at various positive contrasts indicate that there is an acceptable range of positive contrasts from 3:1 to 15:1.

Contrasts below 3:1 are difficult to see, while contrasts above 15:1 lead to complaints of excessive brightness. A value in the range of 5:1 to 10:1 is the preferred contrast ratio.

To obtain an estimate of character contrast, it's necessary to quantify both the background luminance and the character luminance. These can be measured with a conventional luminance meter. Care should be exercised when measuring character luminance, partly because the luminance of the character varies across its profile, and partly because the luminance of both background and the character depend on the luminous flux reflected from the display screen.

This would tend to indicate that it is not appropriate to recommend a precise luminance for character and background. Nonetheless, measurements on a number of positive contrast VDT screens, in realistic settings, have shown a range of background luminances of between 3 and 2.5 cdm^{-2} (including ambient light).

Some evidence suggests that for the preferred range of contrasts (5:1 to 10:1) the lower contrasts are preferred with higher character luminance; and the higher contrasts with lower character luminances. On this basis, a conservative range of character luminances is 30 to 125 $cd\ m^{-2}$.

There are considerable advantages to be gained from increasing the background of a positive contrast display, if this can be done without excessively reducing the contrast of the display. A higher background luminance will reduce conspicuity of reflections from the screen and diminish the differences between the display luminance and the luminance of other surfaces in the visual field. Alternatively, a negative contrast display (one in which the characters have a lower luminance than the background) can be used.

Some experience indicates that negative contrast displays, which approach the appearance of conventional printing, lead to better task performance and are considered more comfortable. Recent studies, however, have shown that there is not much difference in task performance between positive and negative contrast displays. The preferred

contrasts are similar for both positive and negative displays.

Blur

Although contrast of character is an important influence on its visibility, character blur also must be considered. Where the edge of the character is sharply defined, then the form of the character is more easily identified; but when the edge of the character is blurred, the form of the character is not easily seen and adjacent characters may run together, thus reducing the visibility of the display.

At low character luminances, the characters on most VDTs are sharp, but, as the luminance of the character increases, it is common for the degree of blur and character spreading to also increase. Good quality VDTs permit the luminance of the character to be adjusted by the operator without seriously increasing the degree of blur and character spreading.

Character color

For monochrome displays, the colors most commonly used for characters are white, green, and amber—usually seen against a gray or black background, in positive contrast. There is little difference between these character colors with regard to both visual performance and user preference.

For polychrome displays, not more than six to eight different colors should be used. Among the reasons for limiting the number of colors in a display are: Using a large number of colors for discrimination of information may lead to confusion; giving colors, which have a common association, another meaning can lead to confusion; and adjacent strongly chromatic colors tend to produce conflicting cues for accommodation.

Instability

One of the more obvious ways that VDT-presented material differs from conventional printed material, is the instability of the display image. Display stability has an important influence on the comfort of the operator.

Instability of the display can take various forms, the most common being flicker, jitter and swim.

- *Flicker*—periodic dimming and brightening of a part of the display. The extent to which this occurs is determined by the type of phosphor used in the display screen and the rate at which the display is refreshed. If the character is not refreshed frequently enough, its luminance will vary sufficiently for the flicker to be visible. Whether the flicker becomes visible is determined by many factors, among them being luminance of the display, modulation of the flicker, area of the display and age of the observer.

Some of these factors can be controlled, such as reducing luminance to eliminate flicker; but this may produce other undesirable effects, namely reducing the visibility of information displayed. The best solution to this problem is to eliminate it at its source. This means selecting a VDT with a suitable combination of refresh rate and phosphor persistence. A refresh rate of 50 Hz is the minimum acceptable for positive contrast displays. Higher refresh rates are necessary for negative contrast displays because the higher luminance of the background tends to increase the visibility of any flicker.

- *Jitter*—adjacent lines in the raster are treated as members of two different "fields" that are refreshed in succession. This interlacing technique means that the luminance of adjacent raster lines can change suddenly and thus give rise to a jittering effect.

Jitter is a rather different form of instability that occurs only with a particular form of VDT. The factors affecting the visibility of flicker, however, also affect the visibility of jitter. To eliminate jitter, either each line has to have a refresh rate greater than 50Hz, or the separation between adjacent lines in the display has to be slight enough for them to be resolved.

- *Swim*—slow movement of the whole image. Refresh rate and persistence of phosphors are not important factors, since swim is not caused by a variation in luminance at a fixed point, but rather by a movement of luminance across the screen. Swim is usually caused by an instability in the power supply to the display and it can only be eliminated by careful stabilization of the power supply.

All three types of instability, flicker, jitter, and swim can cause discomfort to VDT operators. Reduction of these nuisances can only be done by selecting a good quality VDT with a suitable phosphor, a high refresh rate, and a well stabilized power supply.

(*Vision and the Visual Display Unit Work Station:* Publication CIE Number 60—1984. Although this report has been approved by the majority of the CIE Technical Committee, it is NOT an official CIE recommendation. The latest CIE Proceedings, or CIE Journal, should be consulted regarding the current status of this report and possible subsequent amendments. Commission Internationale de L'Eclairage, Bureau Central de la CIE, 52 Boulevard Malesherbes, 75008 Paris, France.)

President's Message

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

Our 1985 International Symposium at Orlando, Florida, was a great success by every measure. The symposium had 988 in attendance, of which 484 were SID members, plus 62 exhibitors and their personnel. Among the 114 presentations, impressive breakthroughs in liquid crystal displays and flat panel displays, plus advances in printing technologies, stirred up some excitement. I would like to congratulate Jim Price, Conference Chairman, Aris Silzars, Program Chairman, and their entire program committee for an excellent program, and thank the Palisades Institute staff for running a very smooth operation.

Bettye Burdett, our office manager, happily counted 235 new members who signed up at Orlando. On behalf of SID, let me take the opportunity in this column to formally welcome you new members to our Society. I would also like to urge you to get involved in our chapter activities. For the next couple of months, each chapter will be formulating their technical program and membership activities for the 1985-86 program year. The procedures are usually as follows:

1. The chapter chairman will appoint a program chairman, a newsletter editor, and an annual meeting coordinator.

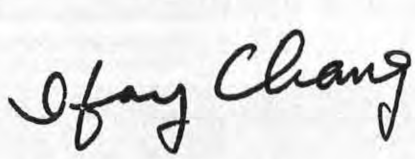
2. The program chairman's job is to solicit and schedule speakers and/or company visits for the entire program year.

3. The newsletter editor's job is to distribute the program to all chapter members. In addition, the newsletter editor writes up a review of each meeting and sends it to Joe MacDonald, Information Display editor, for publication.

4. The annual meeting is a technical and social event for the chapter, where new officers will be inaugurated. The coordinator's job is to select a site and program for the event and to obtain local sponsors if needed.

As a chapter member, new or old, you can volunteer to serve in those jobs, or volunteer to be a speaker, sharing your work or expertise with your fellow chapter members. It only takes a phone call to get involved. I urge all the chapter officers to make an effort to contact and solicit new members for your chapter activities. Please remember that new members are like new blood to our society, and we need them to keep us vital.

I would like to emphasize again that I welcome submission of technical papers and news items. As an advisory editor for ID, I'll determine its appropriateness for publication, as well as provide editing if necessary.



SID '85 Seminars: Two, one-day tutorials, wrapped around the Society's Annual Symposium, provided more than 400 participants with a broad range of information on display systems and technologies:

- Display Technology Fundamentals—covered CRTs and architecture, plasma displays, LCDs and active-matrix addressing, and electro-luminescence.
- Display Systems and Applications—covered human factors and avionics, graphics and image processing, voice entry and I/O for display, and projection systems and local area networks.

This year's seminars, under the co-chairmanship of Howard L. Funk, IBM Corp. (White Plains, NY) and Larry F. Weber, Univ. of Illinois (Urbana, IL), included speakers from both the US and Europe, chosen for their knowledge and experience in respective fields of information display technology.

For information on the published Seminar Lecture Notes, contact the Society for Information Display, 8055 W Manchester Ave., Playa del Rey, CA 90293.

Bay Area: New Chapter Officers
Chairman—Gus Carroll
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Treasurer—Jim Becker

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Mid-Atlantic: New Co-Chairman, Publications Committee

Leslie Gerding, AT&T Information Systems (Holmdel, NJ) has been appointed Co-Chairman, SID Publications Committee, succeeding Dr. Peter D.T. Ngo. Lynn Maldoon serves as the other Co-Chairman.

San Diego: April 23, 1985
Speaker: Fred Ishii
Sony, San Diego
Topic: *Development history of Sony's new beam-index CRT—"The Indextron"*

Mr. Ishii, currently manager of the CRT Engineering Support Group at Sony's Rancho Bernardo Mfg. Facility, has been with Sony for 15 years. During that time, he worked for four years in Sony's Tokyo HQ R&D Display Div., with two years devoted to beam-index projects, including the design of deflection yokes for the beam-index tubes. His presentation at the meeting was followed by a demonstration of several other Sony High Resolution developments and a tour of the highly automated Trinitron CRT factory in San Diego.

Minneapolis-St. Paul: April 19, 1985
Speaker: George Huard
CPI Cardiac Pacemaker Corp.
Minneapolis, MN
Topic: *Remote readout and programming display for implant heart stimulation.*

Mid-Atlantic: *April 9, 1985*
Speaker: *Lawrence L. Hope*
Program Manager
Electronic Display Products
GTE Products Corp.
Salem, MA
Topic: *One-meter-square multi-color thin-film electroluminescent display*

Mr. Hope reported on GTE's progress toward developing a one-meter-square, multi-color, thin-film electroluminescent display. He discussed some of the problems that researchers have encountered, such as step coverage, driver ICs, and phosphor efficiencies, and provided insight as to possible solutions now being applied. Working with 42-in. glass substrates, GTE researchers buried the indium-tin oxide bases in channels to avoid step-coverage problems in subsequent thin-film coatings. Although driver ICs for such large displays are still a major concern, one popular commercial driver IC is available that can drive about a one-square-foot area of EL. But, Hope pointed out, perhaps the greatest obstacle is full color, with present phosphor efficiencies about 3 lumens/watt for yellow; 1.5 for green; less than 1.0 for red; and below 0.1 for blue.

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Tektronix

Prazdny, Kvetoslav
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Reeder, Paul A.
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Olson, Jean
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Kogyo K.K. Kenkyusho

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NTT Ibaraki Elec.
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Shimojo, T.
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Presidential Awards Deadline

Nominations for the National Medal of Technology are now being accepted—through July 31, 1985. These medals awarded periodically by the President of the United States, recognize individuals and companies for outstanding contributions in promoting US technology or technological manpower.

Any US citizen, or US-owned company is eligible for nomination, with the number of recipients dependent upon the number of deserving nominees. No more than 12 medals will be awarded on any one occasion. Instructions and nomination forms are available from: Philip Goodman, Exec. Dir., National Medal of Technology Nomination Evaluation Committee, Room 4824, US Dept. of Commerce, Washington, DC 20230.

Display Conference

Leading contributors to display research are invited, and encouraged, to attend the Fifth Annual International Display Research Conference, to be held October 15-17, 1985, at the Hyatt Islandia, San Diego, CA. The 1985 IDRC Conference, presented jointly by SID, IEEE Electron Devices Society, and the Advisory Group on Electron Devices, will feature submitted and invited papers on research and development aspects of display work. In keeping with this emphasis (and tradition), there will be **NO** exhibition of commercial equipment, and there will be **NO** parallel sessions. (For more information, contact: **Palisades Institute for Research Services, Inc.** 201 Varick Street, Room, 1140, New York, NY 10014 (212/620-3371).

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313/280-1900

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Pittsburgh, PA 15238
412/963-9635

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Canada M1B 1M8
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Production Editor

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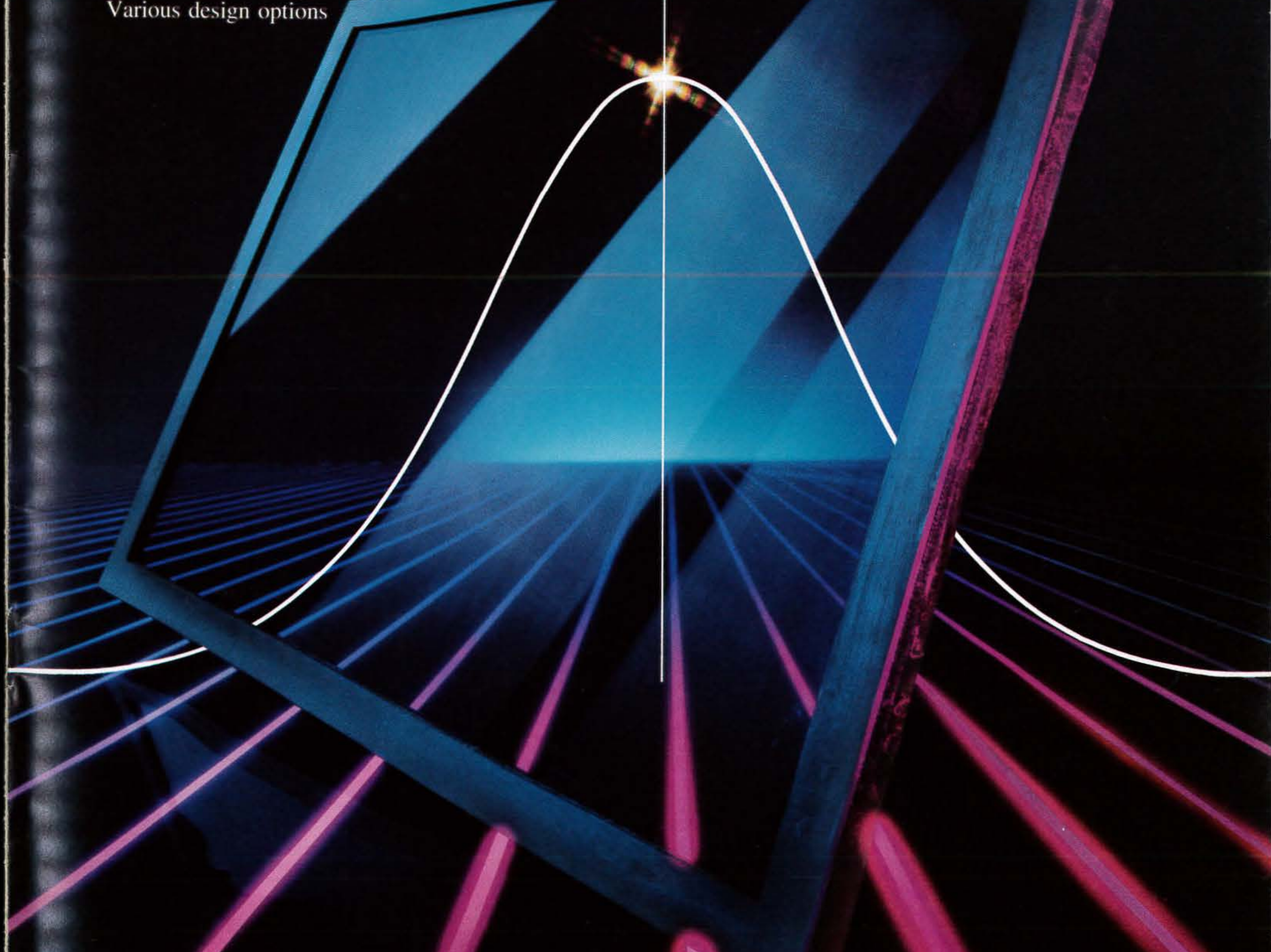

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