Volume 4 Number 5 September/October 1967

Information Display

Journal of the Society for Information Display

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the cover

Use of the Cathode Ray Tube and the on-line or analog computer is becoming increasingly more involved in the graphic imagery of today's advanced technology. Here, TRW artist Bob Shepard has illustrated the flight path of the cockatoo bird, as it might be drawn by a X-Y plotter from computer-generated data outputs.

Information Display

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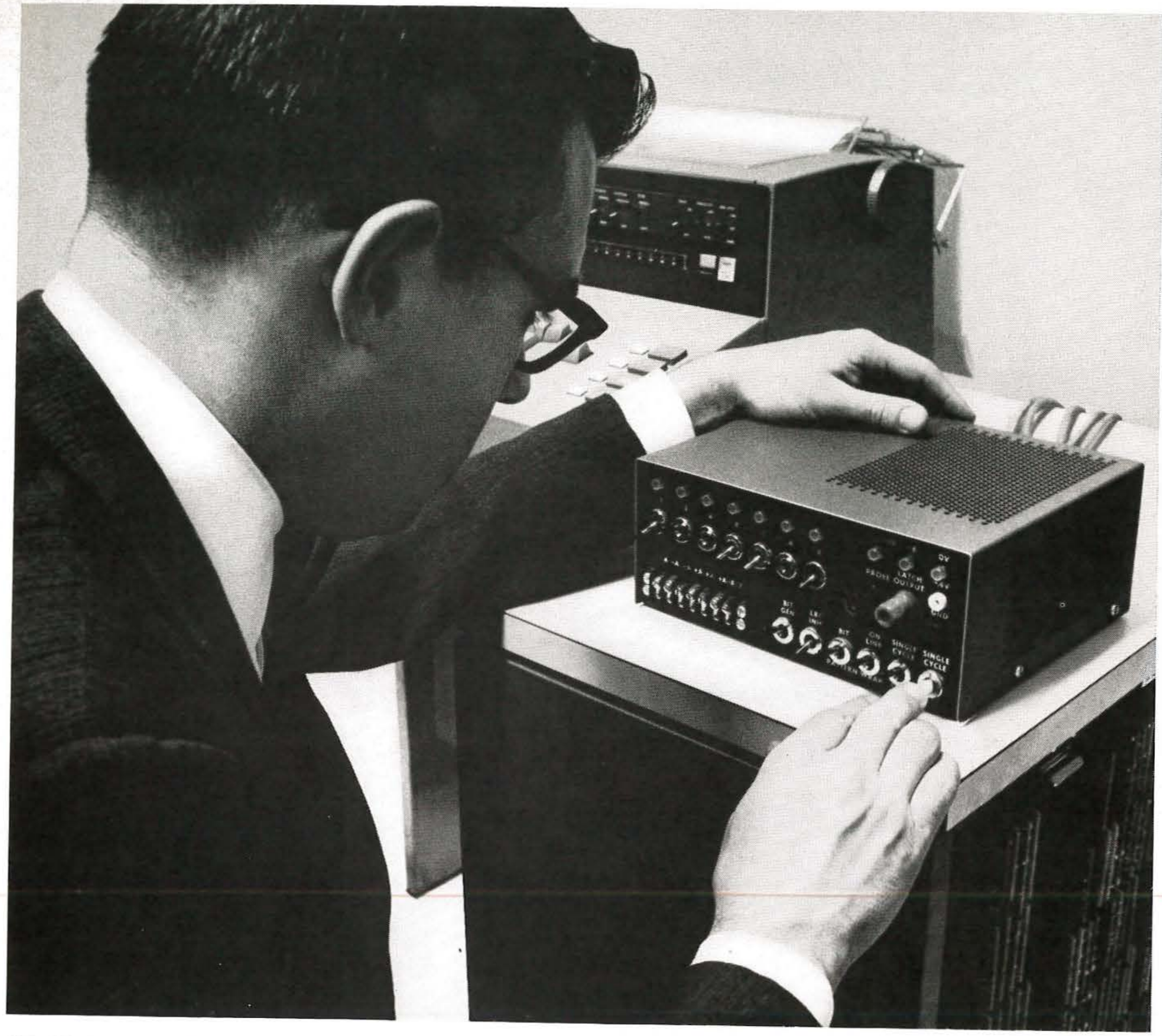

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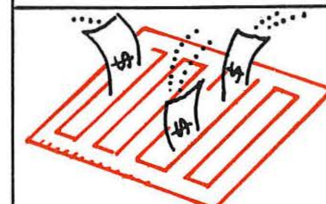

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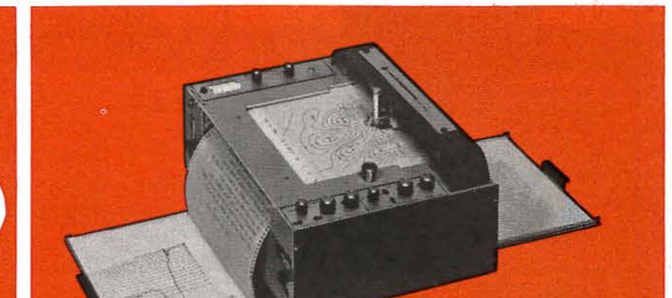

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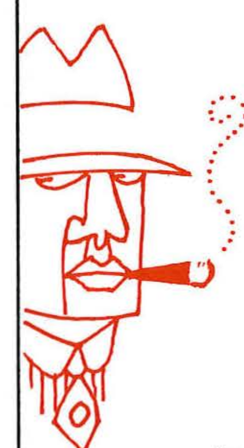

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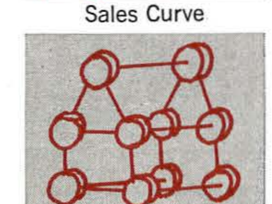

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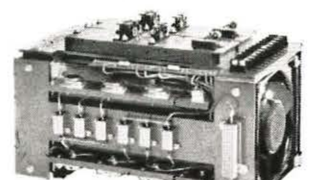

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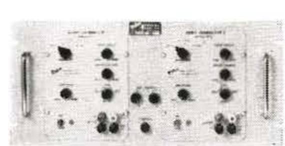

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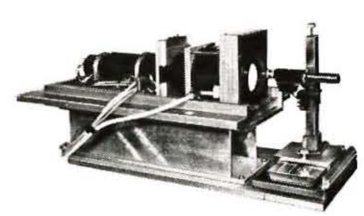

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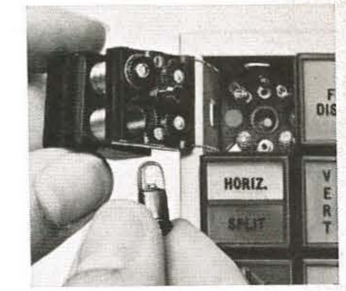

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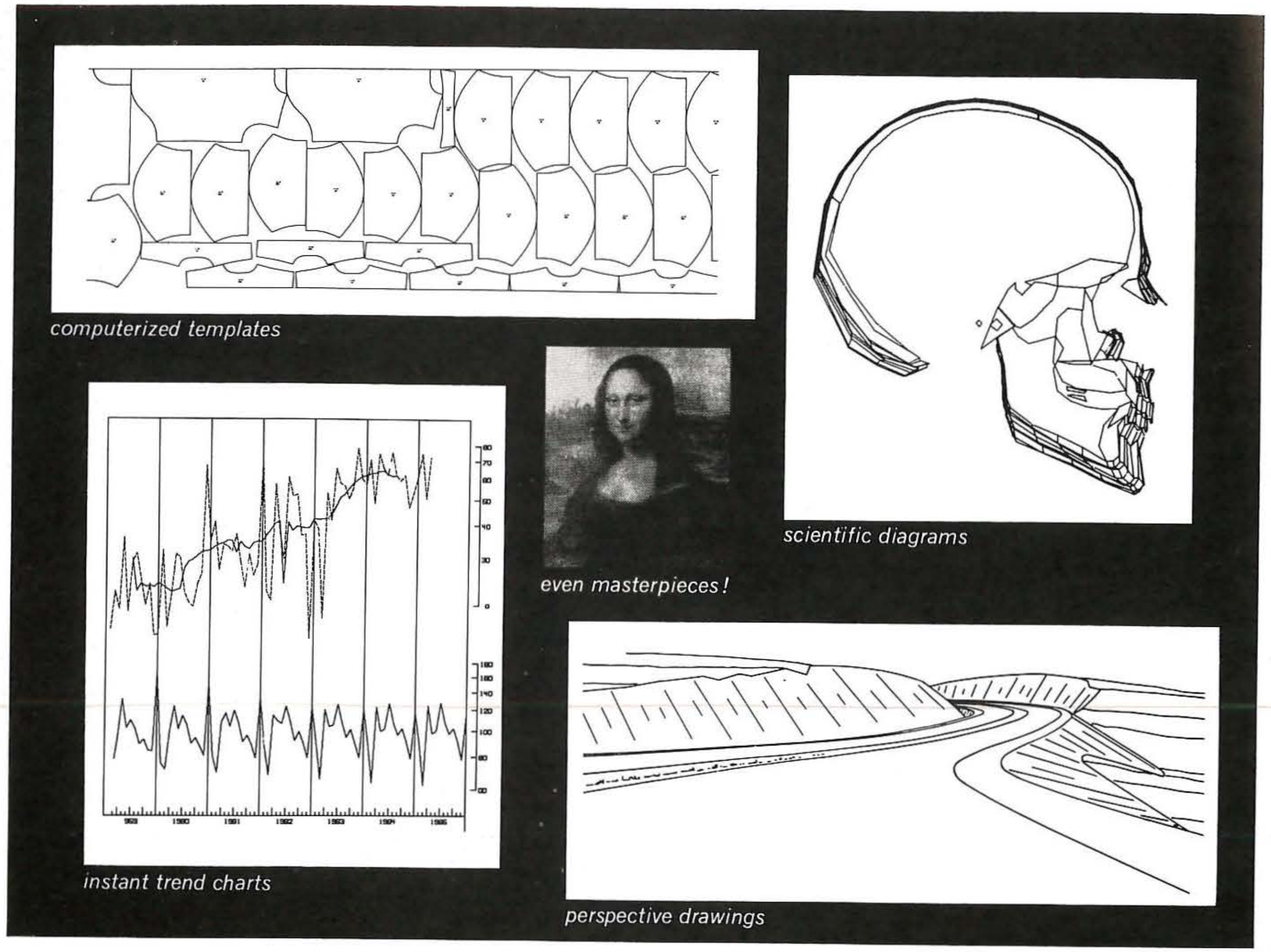

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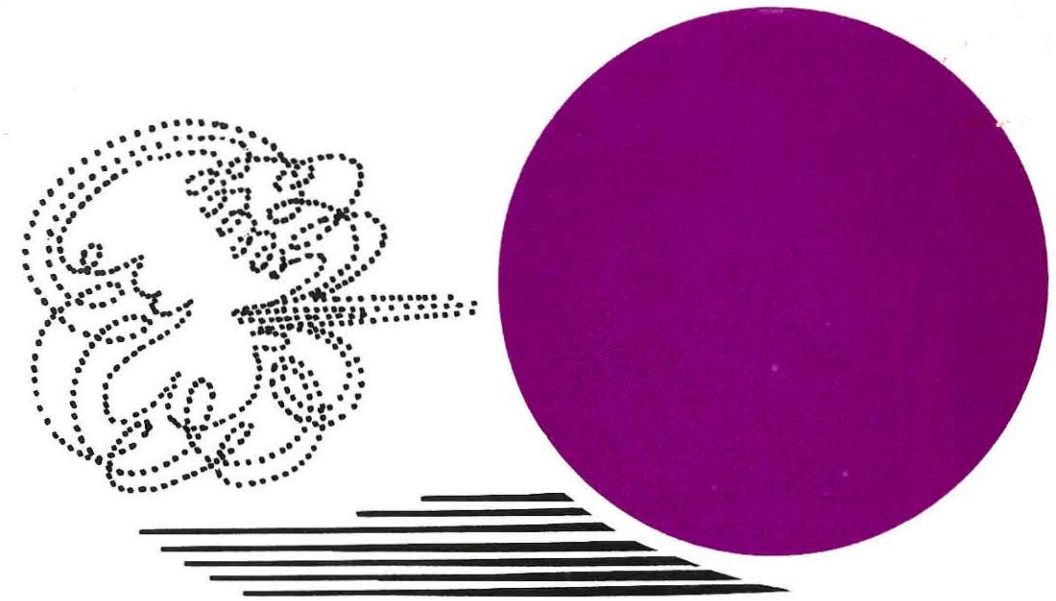

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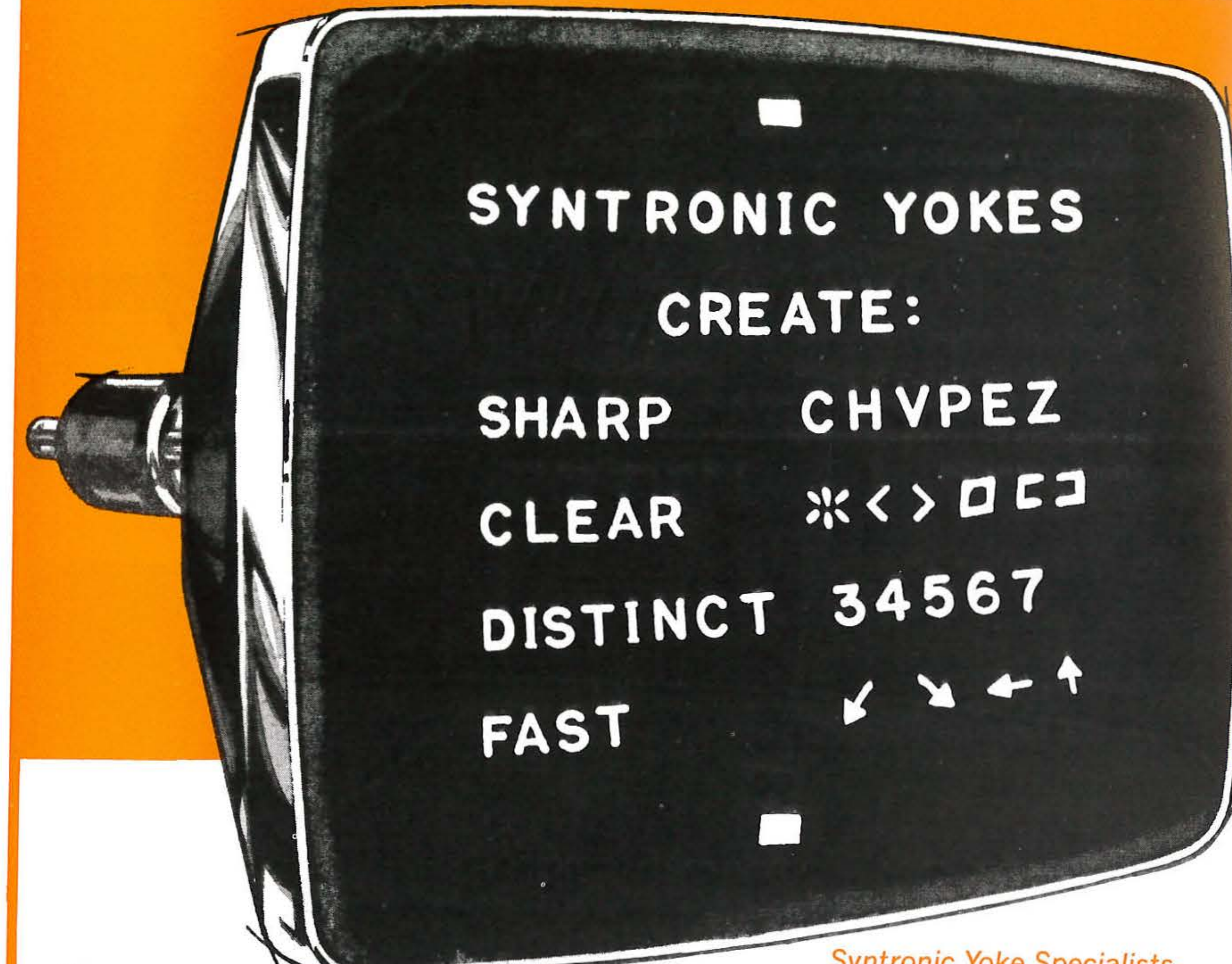

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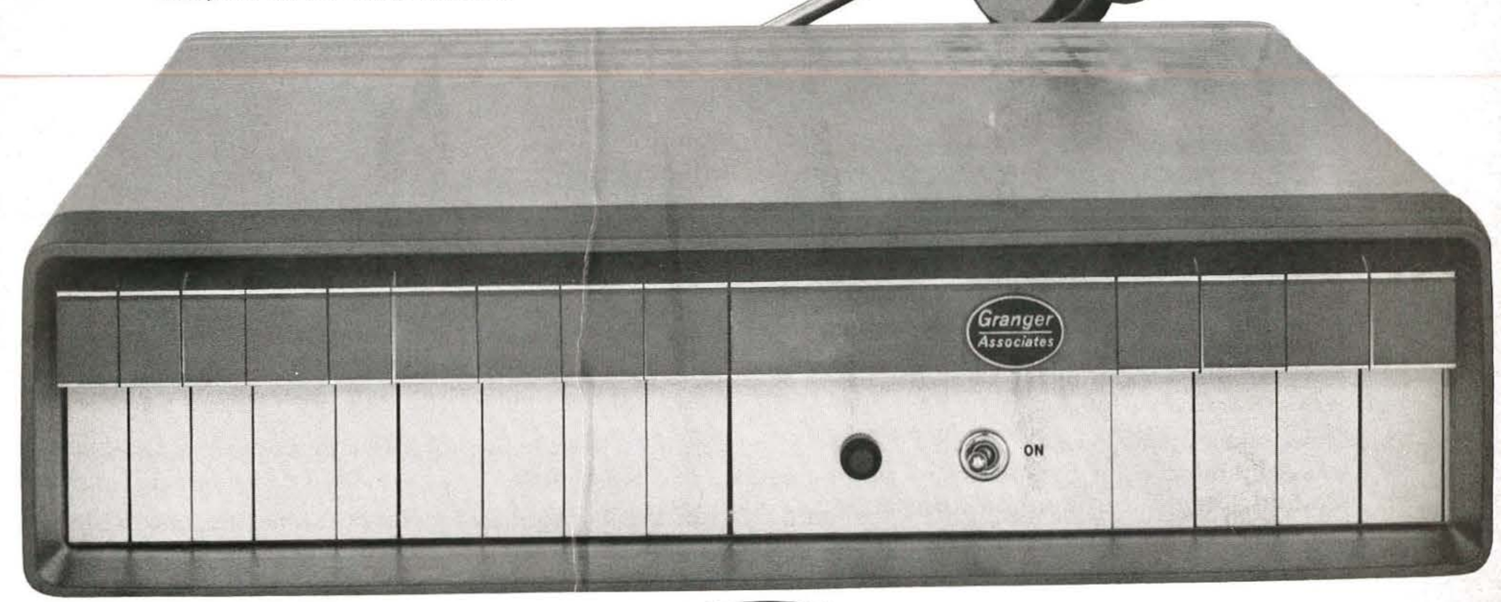

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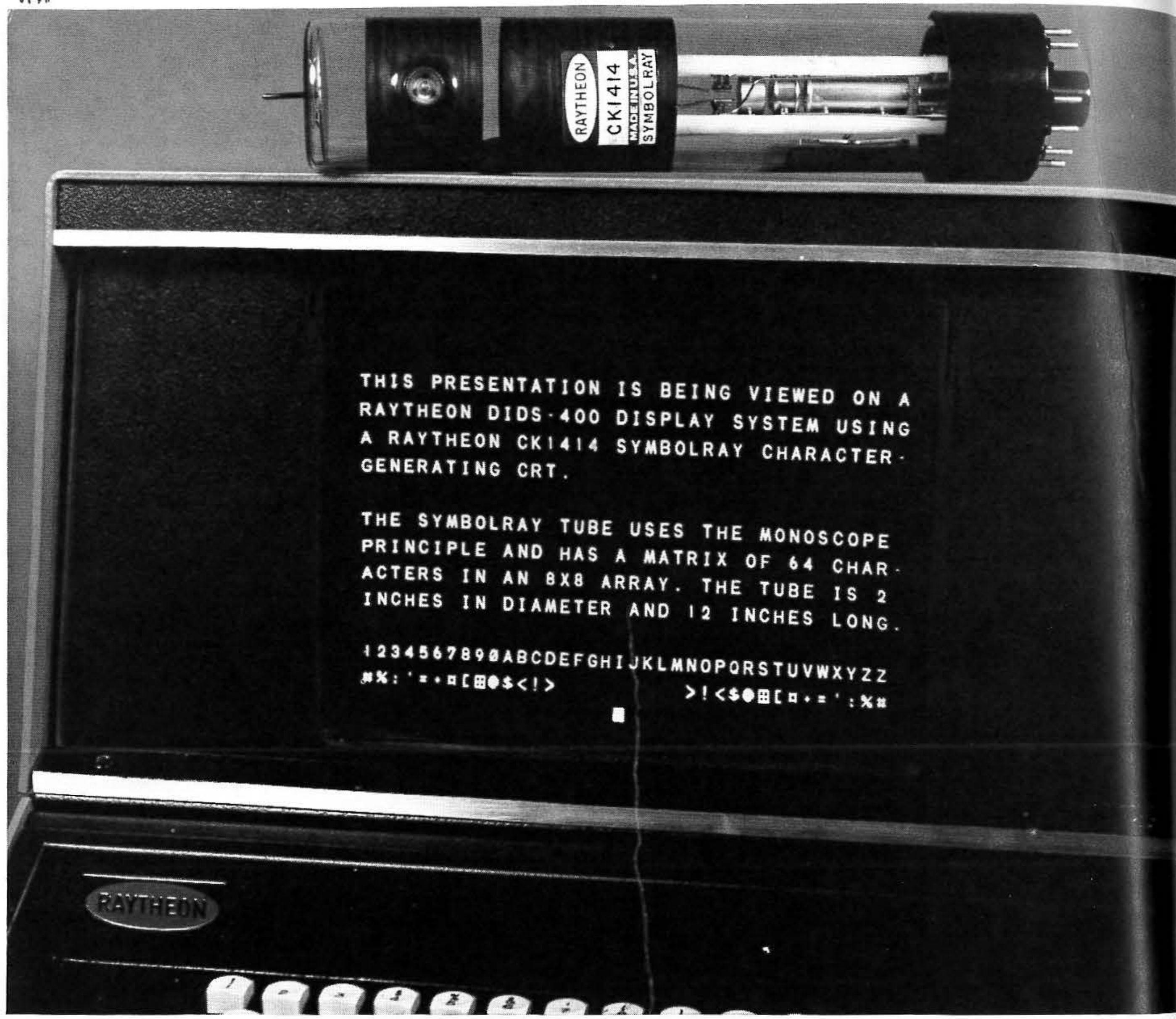
Data Display Devices from Raytheon



The presentation you see above was generated by a Symbolray* Cathode Ray Tube identical to the one lying on the console. A new type of monoscope, the Symbolray can generate alphanumerics from electrical signals for cathode-ray display or for hard copy print-out. The presentation here is shown on a Raytheon tube (CK1415) used in a Raytheon DIDS-400 display system.

An economical method of generating characters. Priced at less than $100 in quantities of 1,000, the Symbolray provides a more economical method of generating electronic displays than using large numbers of circuit cards.

The output of the Symbolray operating as a monoscope is obtained by electrically deflecting the electron beam to desired characters on the target and scanning them sequentially with small raster. The display cathode ray tube on which this output is viewed is scanned in synchronism. When the Symbolray method is used in conjunction with buffer-memory techniques, full messages can be displayed—as shown above. The Symbolray tube uses electrostatic deflection and focus, and is available in designs with 64 and 96 character matrices.

Raytheon's wide range of Dataray* CRTs cover the screen sizes from 7 to 24". Electrostatic, magnetic and combination deflection types are available for writing alphanumeric characters while raster scanning. Raytheon also offers combination deflection or "diddle plate" types and all standard phosphors. Or, Raytheon can meet your special CRT design requirements.

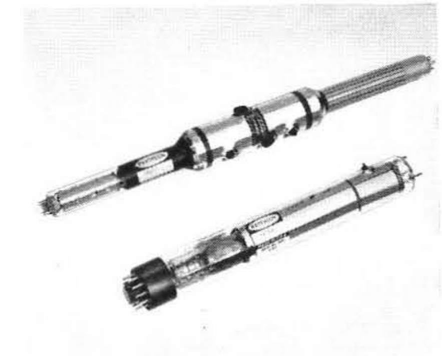
For more information—or a demonstration—call or write your Raytheon regional sales office.

New Raytheon Projectoray* Tube produces more than double the light output of standard projection-type cathode ray tubes. The tube's light output is 30,000 foot lamberts, which results in a light level of 15-foot lamberts on a 3' x 4' lenticular screen.

The tube's expected minimum operating life is 500 hours—20 times the life of a standard projection tube.

The Projectoray's high light output and long life are due to its novel design. The design incorporates liquid cooling of the phosphor backplate. This allows the phosphor to be energized with a very intense electron beam. At high beam levels, very high peak light output is obtained. The light image is projected through a 5" optical window in the face of the tube. The electron gun is set at an angle to the phosphor and the deflection system compensates for keystone effects.

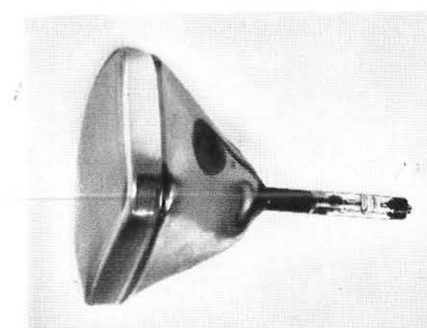
Datavue* Side-View Tubes. New Type CK8650, with numerals close to the front, permits wide-angle viewing. These side-view, in-line visual readout tubes display single numerals 0 through 9 or preselected symbols such as + and − signs. Their ⁵/₈"-high characters are easily read from a distance of 30 feet. Less than $5 each in 500 lots, they also cost less to use because the bezel and filter assembly can be eliminated and because their mating sockets are inexpensive.



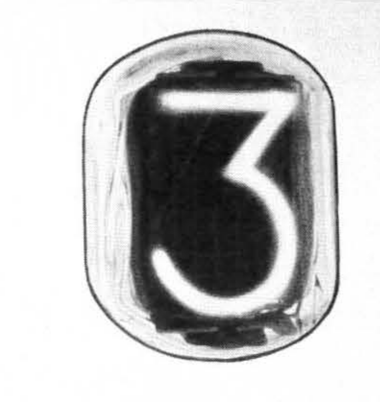
Recording Storage Tubes. The miniature tubes shown here are Raytheon's single-gun (CK1518) and dual-gun (CK1519). They provide high resolution, long storage, and fast erase capability.

Raytheon electronic input-output storage devices feature the above capabilities and immediate readout. Information can be written and stored by sequential techniques or by random-access writing. Complete, gradual or selective erasure is possible.

Raytheon storage tubes are readily available for applications in radar scan conversion, slow-down video, signal processing, signal enhancement, time delay, and stop motion.



Dataray* Cathode Ray Tubes. Raytheon makes a wide range of industrial CRTs—including special types—in screen sizes from 7" to 24". Electrostatic, magnetic, and combination deflection types are available for writing alphanumeric characters while raster scanning. All standard phosphors are available and specific design requirements can be met. Combination deflection or "diddle plate" types include CK1395P (24" rectangular tube), CK1400P (21" rectangular), and CK1406P (17" rectangular).



Datavue* End-View Tubes. Raytheon makes round (CK8421) and rectangular (CK8422) Datavue indicator tubes on automated equipment capable of high production rates and top quality. The CK8422 rectangular tube is also available with decimal point, ± symbols, and in other special versions. Both round and rectangular types fit existing sockets and conform to EIA ratings. These ultra-long-life tubes are designed for 200,000 hours or more of dynamic operation.

Send Reader Service Card for literature on the:

Symbolray CRT	11
Projectoray CRT	12
Datavue Indicator Tubes	13
Recording Storage Tubes	14
Dataray CRTs	15

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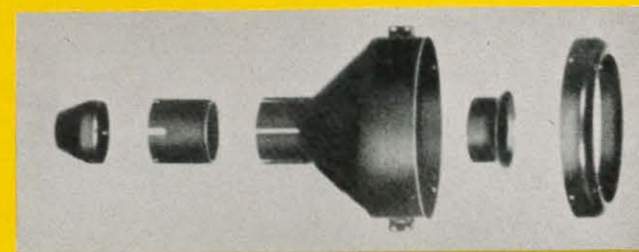
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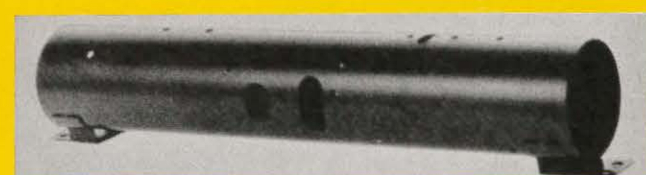
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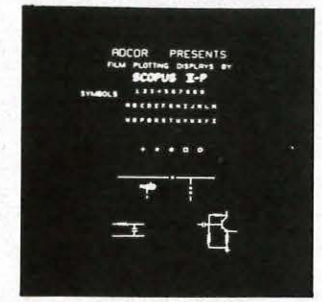
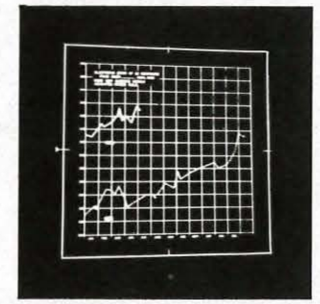
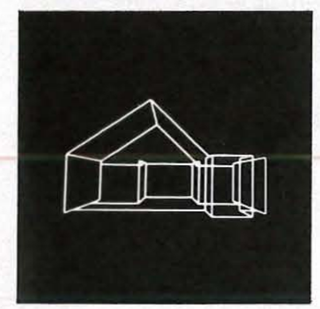
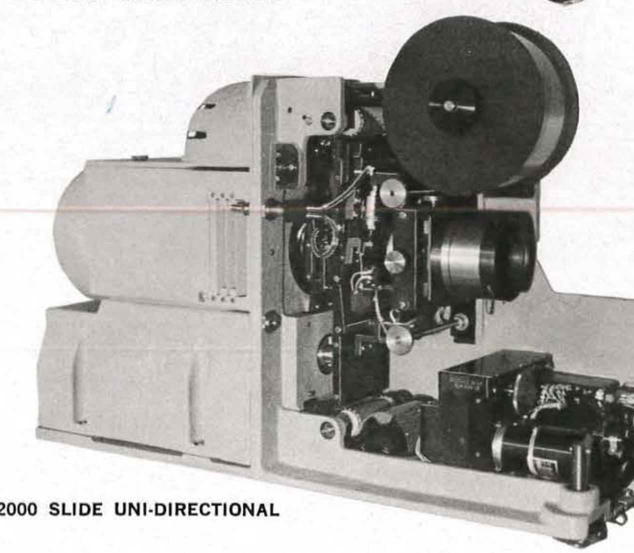


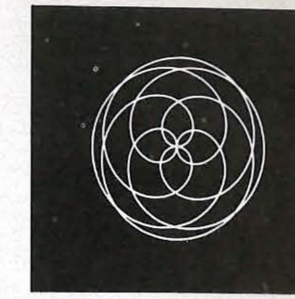


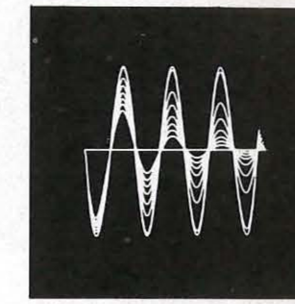


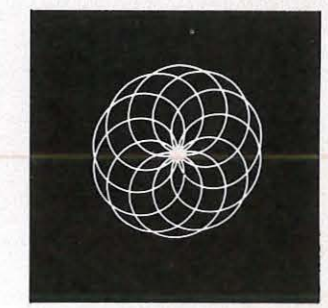
Actual photos taken of 7 foot by 7 foot display screen.


100 SLIDE RANDOM ACCESS


2000 SLIDE UNI-DIRECTIONAL







Actual photos taken of 7 foot by 7 foot display screen.

The new SCOPUS II offers:

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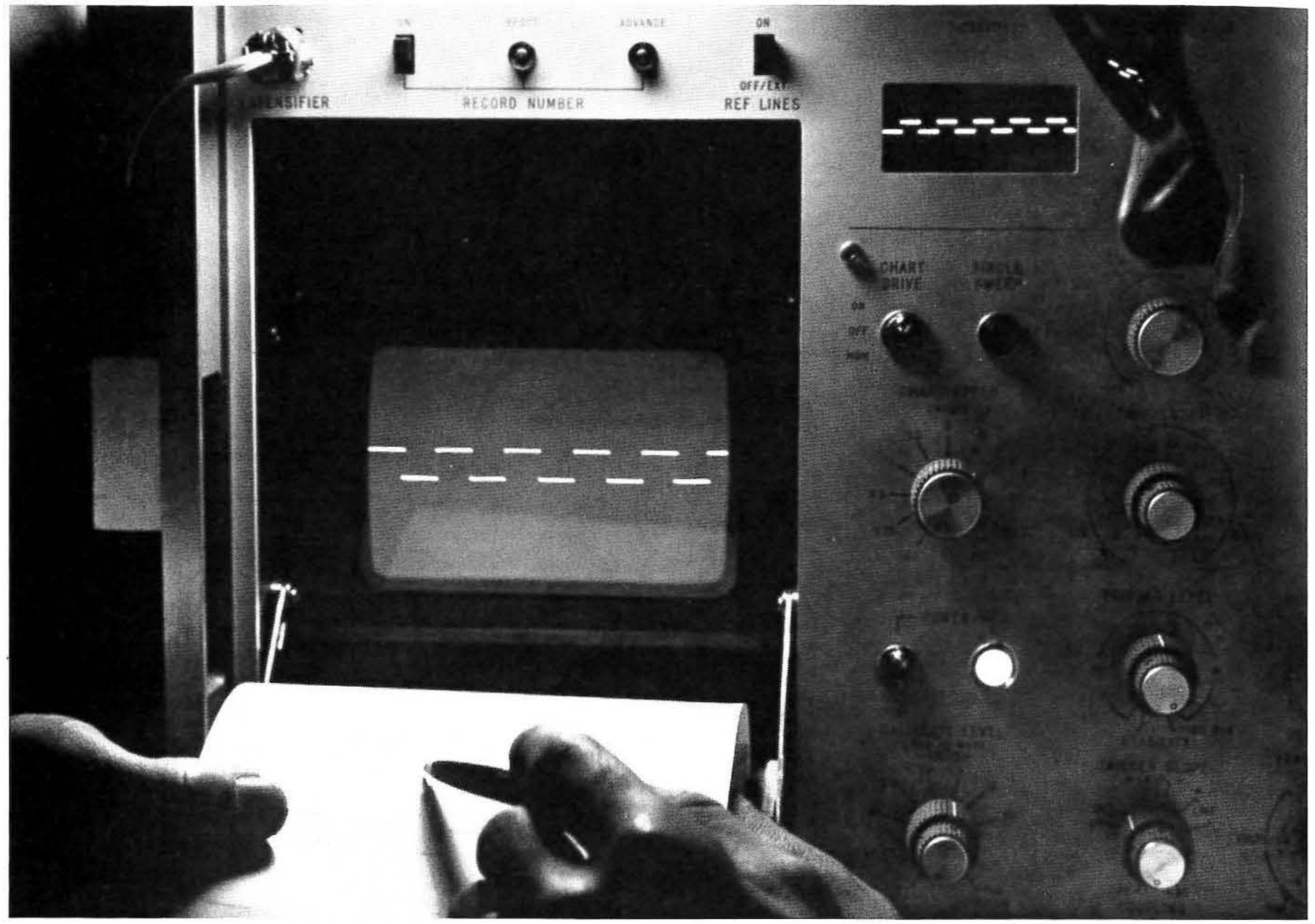
New fiber-optic CRTs.



They direct-record 1 MHz signals.

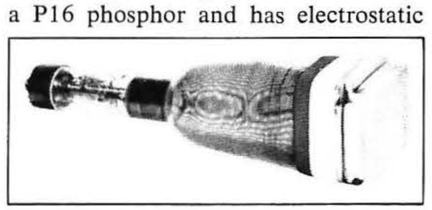
A new Sylvania fiber-optic CRT enables Honeywell's Test Instruments Division to make an oscilloscope with recording speeds nearly 100 times faster than previous instruments. It can record responses of from dc to 1 MHz.

Honeywell's Model 1806 Visicorder is a single-channel, 4-axis unit. It uses the electron beam of the fiber-optic CRT to record continuous transient data on standard oscillographic paper.

Sylvania's new SC-4082E CRT has an improved electron gun for initial fine spot resolution. Spots have a diameter of 4 to 7 mils—compared to 15-30 mils for conventional scopes.

This tube contains more than 35 million fibers—each of 10 to 15 micron diameter. They retain the initial small spot size as it's conducted from the face of the CRT to the recording film.

The SC-4082E has the world's largest fiber-optic faceplate—3 x 5". It uses a P16 phosphor and has electrostatic focus and deflection. Helical resistor post-deflection acceleration gives it high writing rate and high deflection sensitivity with minimum distortion.



Sylvania has designed a world of high-resolution CRTs. With fiber-optic faceplates and with full faceplate arrays. There's a variety of sizes and types—using magnetic or electrostatic deflection and focus. And with various screen phosphors—aluminized or non-aluminized. Fiber size range: 4 to 75 microns, depending on application.

Sylvania Electronic Components Group, Seneca Falls, New York 13148.

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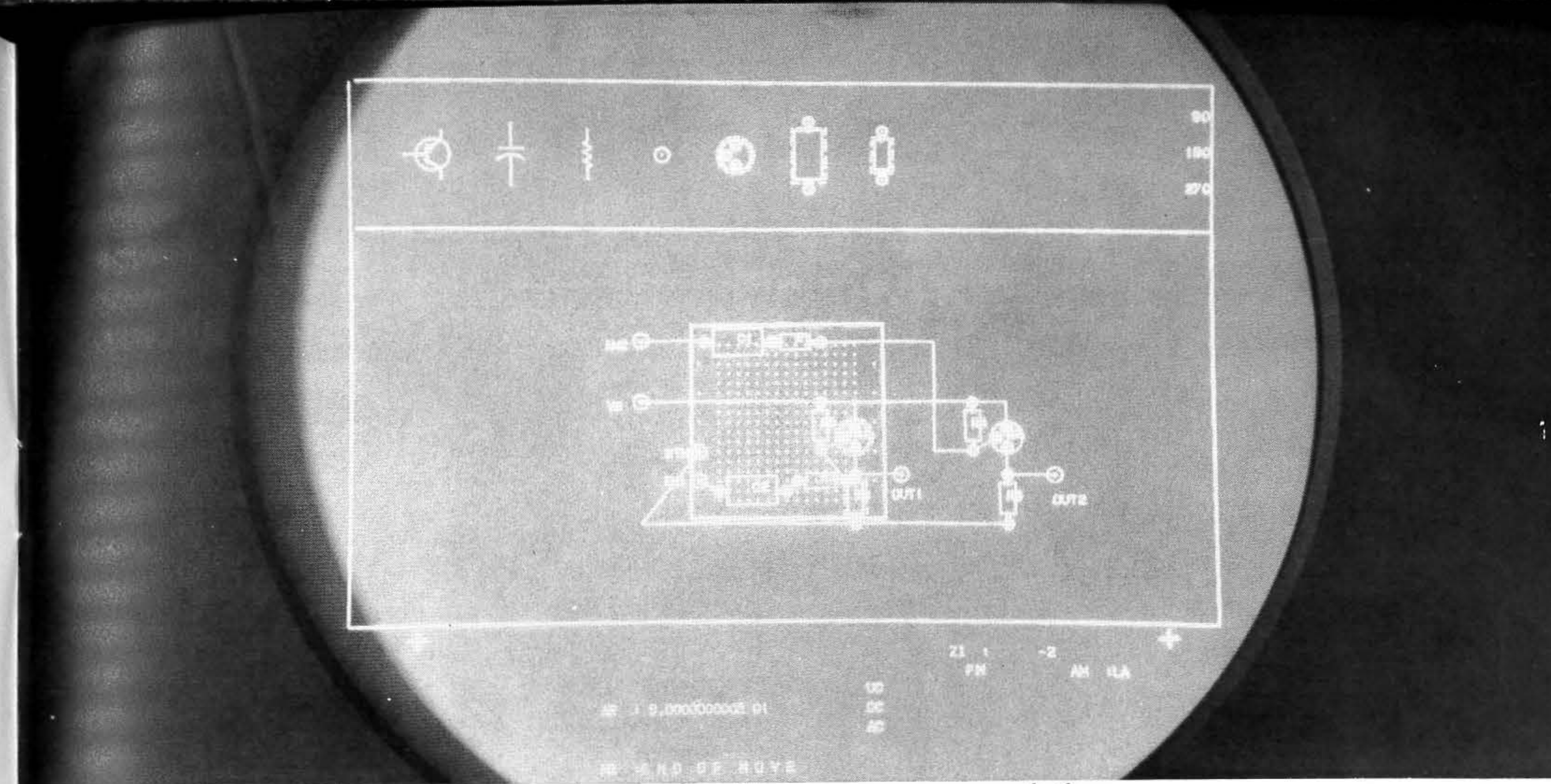
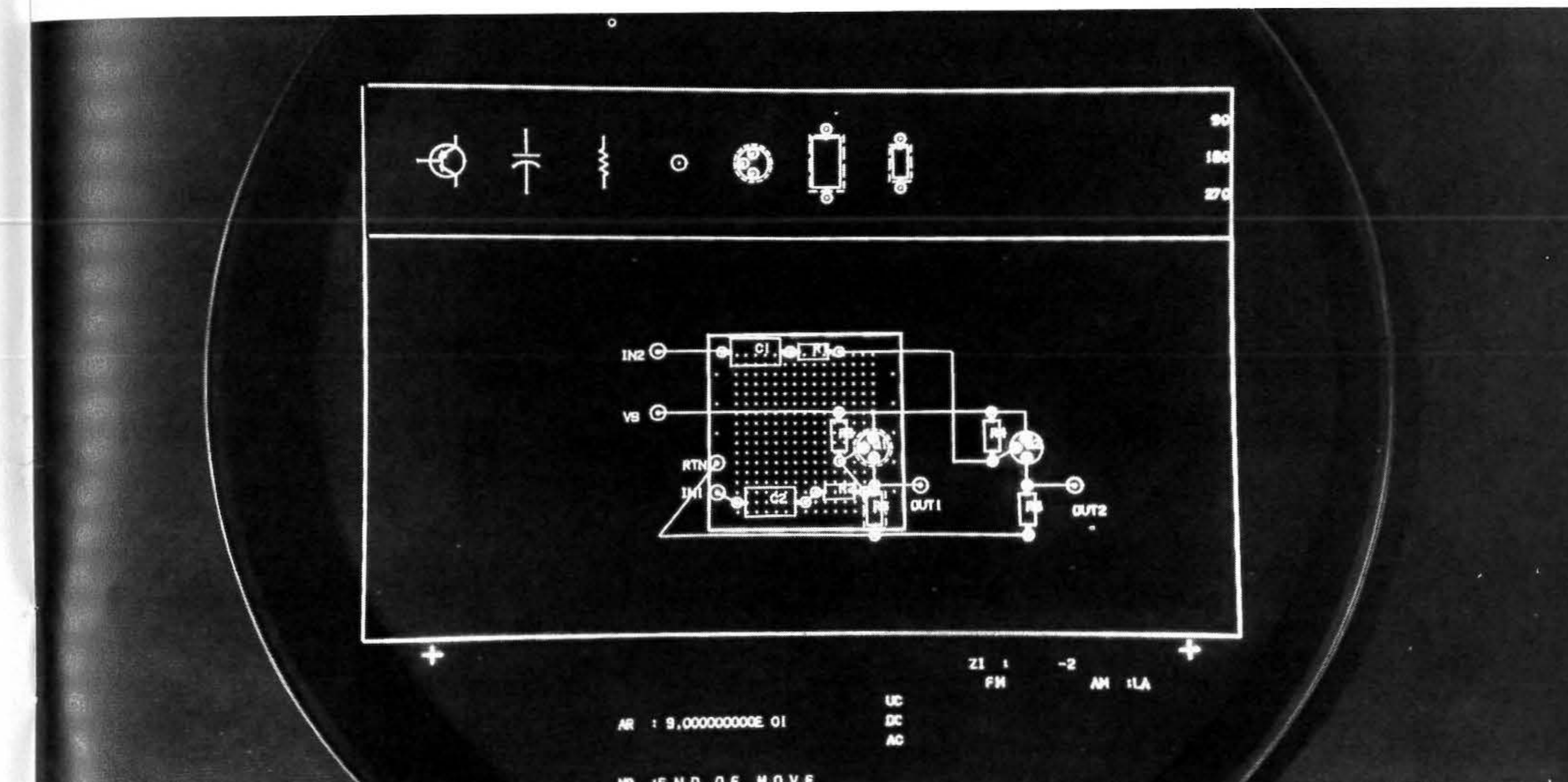


Readouts clear up problems.



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It's never a problem to read readouts if they're equipped with Polaroid circular polarizers. Our polarizers improve readability from every angle by increasing contrast. In daylight. Or even in brightly lighted rooms.

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Computer-Driven Large Screen Displays

A battlefield commander sees a tactical situation developing on a 10 x 10 ft. display in front of him.

A bank president and board of directors view multi-colored graphs of the previous day's transactions displayed on a 100 sq. ft. display.

The mayor and chief of police for a large metropolitan area study a multi-colored 12 x 12 ft. display of the dynamic flow of traffic superimposed upon the map of the city.

The captain of a naval vessel sits in his combat information center and watches a multi-colored large screen display of the battle situation.

The above situations are feasible, but the question to be posed to the Information Display community is: when will the appropriate large screen display hardware become available? Some hardware is available today, but many improvements must be made in order to make the equipment more suitable to military and commercial applications. Military applications require a higher degree of reliability, maintainability, transportability, and cost effectivity than is presently available. Commercial applications dictate lower initial and lifetime costs. Future military and commercial applications will also specify faster writing speeds in order to make the displays more adaptable to computer control. The challenge to improve existing devices or develop new ones is very formidable.

Existing large screen display methods do not approach the performance of the CRT. Comparatively, the CRT offers greater flexibility, higher reliability, faster writing times, higher resolution, and a more erasable picture than large screen displays. The major problem associated with the design of a large screen display is the amount of energy required for a large viewing area. A 20 ft. lambert presentation on a 100 sq. ft. large screen display requires 100 times the luminous energy (lumens) as a one sq. ft. CRT display of the same brightness. As the required energy increases so do the cost and technological problems. The inadequacies of present-day large screen displays are due to the lack of solutions for the technological-economic problems.

Present-day projection systems employ glass slides, plastic film, oil film, solid state light valves, lasers, and special CRT's. Film systems involve photographic, thermoplastic, photochromic, and dielectric film techniques. With film techniques, information is deposited on the film by electronic means and then projected on a screen by controlling the transmission or diffraction of a fixed light source. In scribing systems, an initially opaque slide or film is electromechanically scribed and a fixed light source projects the image on a screen. The oil film modulator uses a fixed light source and an electronically deformable oil film to produce a display. With the light valve approach, a fixed light source is modulated by an electrically sensitive solid state device, projecting an image on the screen. The laser projection system uses a laser light source modulated and deflected by special materials. In cathode ray tube projection systems a special CRT is used to project information.

There are also non-projection large screen displays which employ a controlled source of light. One method uses a crossed-grid electroluminescent panel in which discrete elements are controlled. The thin film light emitter uses semiconductor diode materials in a manner similar to the electroluminescent panel. An array of minute gaseous cells or incandescent lamps can also be used with a crossed-grid approach. All these methods employ discrete light sources in which the resolution is determined by the size and spacing of each individual element.

One non-projection large screen display approach is the digital plotter. No integral light source is used, but the plotter relies on room illumination to produce a visible display.

As can be seen, a large variety of large screen display techniques have been employed. The great variety of approaches must be a clue to the inadequacy of available techniques. At the present time the laser display is generating a considerable amount of interest; will this be the "ultimate" large screen display? The gaseous discharge tube array has aroused interest too, will it find general use? Or will it take a number of different types of large screen displays to satisfy all customer requirements?

Where does the multi-colored display fit in? Certain large screen techniques are more adaptable to color than others. The addition of color enhances the display presentation, but increases the cost. The customer will have to decide if he wants a color presentation, but the trend is heading toward at least a three-color large screen display.

The computer-driven large scren display field is wide open today, waiting for industry to come up with higher performance, lower cost techniques. It will take a good deal of money and manhours to accomplish this task. The question remains — can anyone in the Information Display community afford to develop an acceptable large screen display? Or, can they afford not to?

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The Command and Control Display System for NORAD

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ABSTRACT

This paper on the Command and Control Display System for NORAD describes the hardware and operational features of a large wall-display system presently used by the U.S. Air Force at Cheyenne Mountain in Colorado, U.S.A. A brief description of the Combat Operation Center is given, and the type of information which the display system is capable of presenting for the NORAD Commander-in-Chief and his battle staff is epitomized. The primary concern in this paper is with the theory and operation of the Camera Processor Projector Unit; however, brief attention is given to the operation of this unit in conjunction with a central computer and an electronic basic display unit. The generation of seven-color projection displays from black and white film is described, and the details of processing this film within 10 seconds are set forth. The major components of the CPPU and their particular operating features are explained, and a representation of each of the modules is furnished. Details of the redesign of a new interchangeable xenon lamp module are discussed, and the problems in designing a shield to protect the fragile condenser optics are noted. Some of the advantages and disadvantages of the CPPU are pointed out. A summary of detailed operating characteristics and engineering data regarding the function of the CPPU are presented in an Appendix.

INTRODUCTION: NORAD OPERATION

Deep inside the solid rock of Colorado's Cheyenne Mountain in the center of the United States there has now been created a means by which man can view the overall battle situation of the entire North American continent. The name of this installation is the North American Air Defense Command's Combat Operations Center (NORAD-COC). This vault-like site contains many small display consoles and a large wall display. By their use the Commander-in-Chief, known as CINC-NORAD, and his battle staff can observe and evaluate reports on air-breathing threats and on the status of NORAD forces. In addition, from remote electronic surveillance equipment these observers receive inputs from the Ballistic Missile Early Warning System. Thus, through the advantages of the panoramic view furnished by all these types of information, CINC-NORAD and his staff can make command decisions and can execute them quickly and effectively.

The Command Post (CP), where the battle staff sits, is arranged on three levels to give all persons a direct view of the 12-foot by 16-foot rear projection screen. A view of the CP showing the seating and the screen is given in Figure 1. Here, by the touch of a button, a seven-color display can be updated automatically or "on demand" as often as every 10 seconds.

One might ask, "Why was a 'real time' display system not chosen?" Actually, real time systems were proposed at the time, but they were unacceptable since they could not match the operational capability of a camera processor projector system having only a 10-second delay for updating.

The NORAD Large Group-Display System can be described as a computer-controlled, seven-color, high-resolution, rapid-processing, large-screen projector. It is capable of presenting map outlines, a large variety of specialized symbols, and tabulated "alphanumerics" (letters and numerals used singly or in combination) — all in contrasting or coded colors. The combinations of displayed information are limited only by the repertoire of map outlines, symbols, and characters which have been programmed into the memory of the computer.

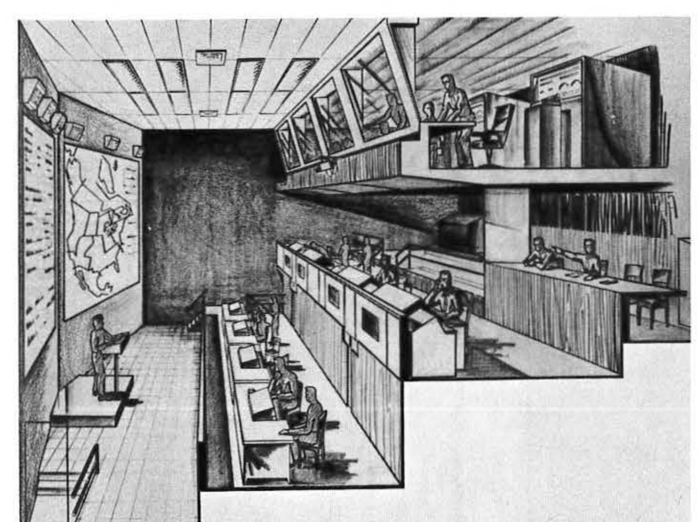

FIGURE 1: NORAD Combat Operations Center, Command Post

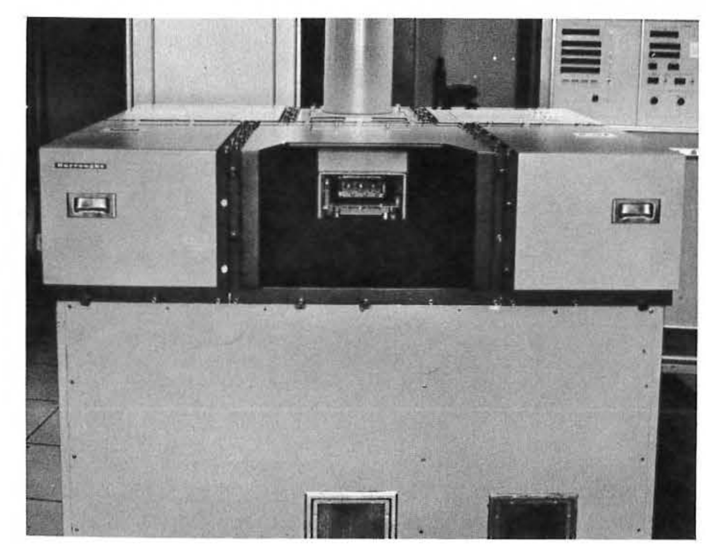

FIGURE 2: Large Group-Display Equipment

The Large Group-Display Which Generates Seven-Color Projections

The Large Group-Display System equipment, shown in Figure 2, consists of two major units: (a) the Basic Display Unit (BDU), which contains the display generation and control equipment and (b) the Camera Processor Projector Unit (CPPU), which produces the large-screen projected image. This paper is primarily concerned with the Camera Processor Projector Unit, hereafter referred to as the CPPU. However, a few comments about how the BDU fits into the system are in order. A representation of the Large Group-Display System is presented in Figure 3.

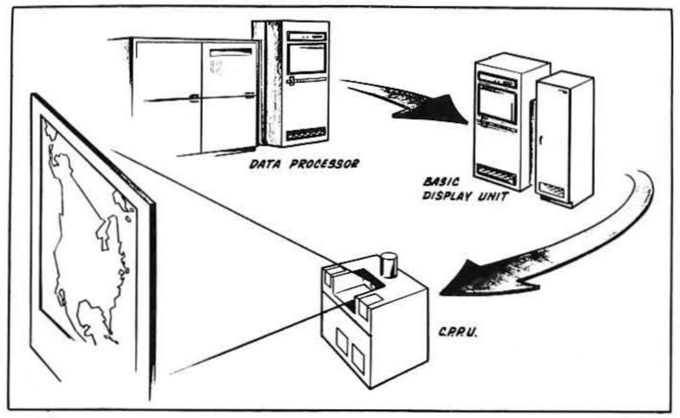

FIGURE 3: Information Flow Through Large Group-Display System

In the operating mode, the BDU receives color-coded display information from the computer; this information has been identified by appropriately coded words and is then stored in the BDU memory. Upon receipt of the computer command to go into a display cycle, the BDU extracts this stored information from its memory, converts it from digital to analogue format, and displays it on a 5-inch cathode ray tube (CRT). Since the ultimate projected display is to be in seven colors, the full data load stored in the BDU is displayed on the CRT in a three-sequence color cycle. This means that three distinctive patterns of information are sequentially presented on the CRT and photographed on the three-frame film chip in about 700 milliseconds. Refer to Figure 4 for a representation of the arrangement of the components of the CPPU and of the film path through the equipment.

In the creation of these three images, the three shutters of the three-frame camera will open and close for each color cycle so that the appropriate frames will be exposed to obtain the primary and secondary color combinations. Upon completion of this color exposure cycle, the film-processing cycle for the CPPU is initiated. The film is developed by a conventional silver halide bleach reversal process, after completion of which all three film areas will be projected simultaneously on the screen through three separate lenses and three primary color filters — red, blue and green. Mixing or adding the primary colors in *pairs* produces magenta, cyan and yello, whereas mixing *all three* primary colors will produce white on the screen. This gives a total of six distinct and contrasting colors and white.

Actually, the composite seven-color projection image is generated from three black and white negatives like the three frames noted in Figure 5. Although these patterns are made on black and white film, when they are projected they are individually illuminated by light passing through a different primary color filter. These three images, if projected side by side, would appear as three separate pictures in the three primary colors as shown in Figure 6.

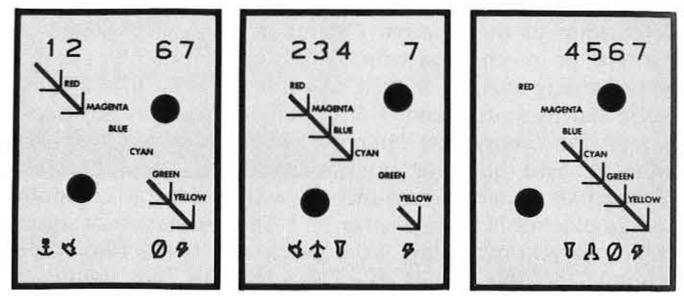

FIGURE 5: Three-Frame Black and White Film Chip

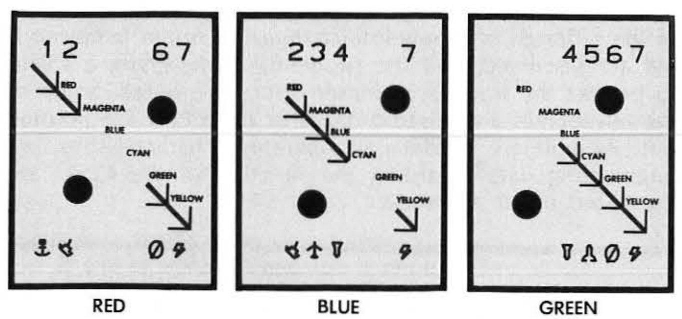

FIGURE 6: Three-Frame Film Chip in Primary Colors

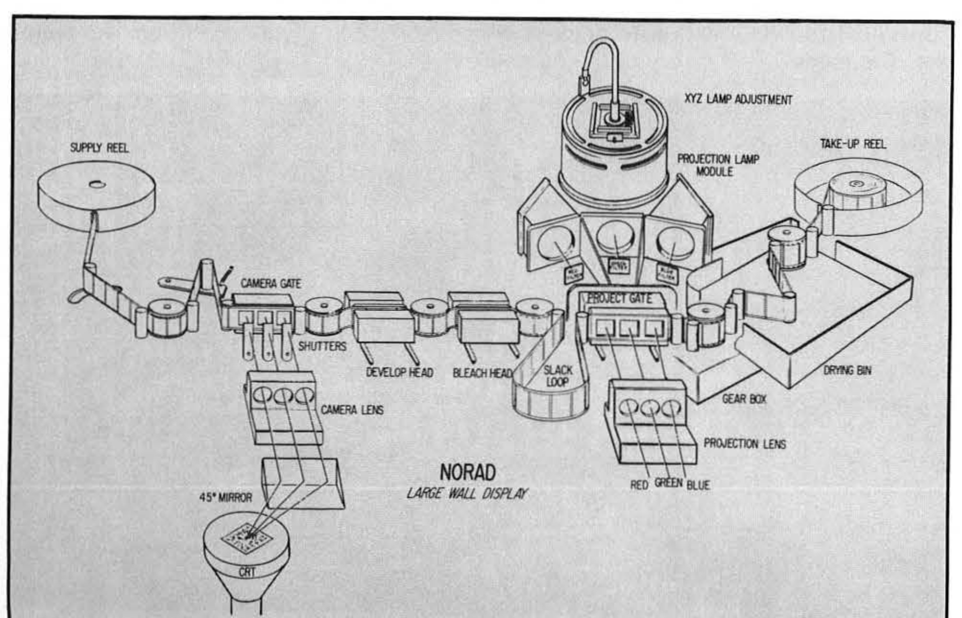

FIGURE 4: Schematic Diagram of Camera Processor Projector Unit

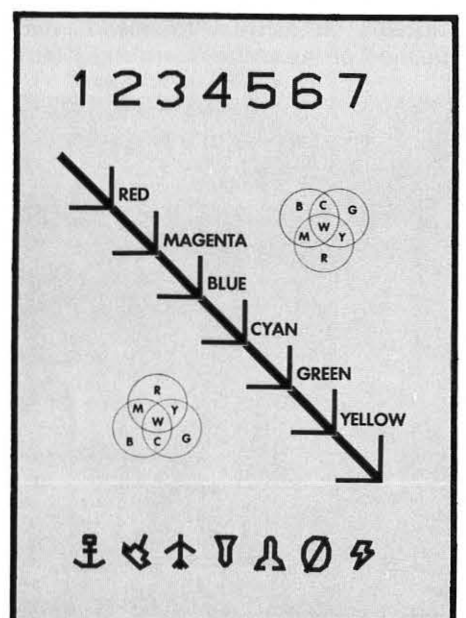

FIGURE 7: Composite Seven-Color Display

However, when a three-frame film chip is inserted into the projection gate of the CPPU, each frame is individually projected by a separate lens in such a manner that all three patterns fall precisely on top of one another. As a result, the composite seven-color display is achieved as shown in Figure 7.

General Description of the CPPU

For an understanding of how the Camera Processor Projector Unit photographs and processes the black and white film, it will be helpful to refer again to Figure 4. The function of this unit is to photograph the CRT image on 35-millimeter film, chemically develop the film, reverse the background, and then to project the three images perfectly on the 12-foot by 16-foot rear projection screen. A delay of only 10 seconds will occur between the updating signal and the updating itself. While the new display is being photographed and processed, the old display is kept on the screen continuously until about 1 second before the new display is projected. During this 1-second interval, or "blink-time," a shutter interrupts the projected light path while the two films are being interchanged.

For projection purposes, the symbols, characters, and lines appearing on the film are transparent, whereas the background is kept generally dark and opaque. This process is achieved chemically by the following four steps:

STEP 1: FIRST DEVELOPMENT

After the film has been exposed in the camera, it is drawn into a developing head for 4 to 6 seconds while the exposed areas are converted to opaque silver; this conversion produces a negative image.

STEP 2: BLEACHING

The film is next drawn into a second processing head, where it is held for another 4- to 6-second interval, during which the opaque silver images are dissolved or bleached. The result is that the photographed data appears as a clear transparent area. The background of the film, however, which has not had its emulsion exposed to light, still contains unexposed silver halide.

STEP 3: FLASH EXPOSURE

When the film is drawn into the projection station, it is exposed to the extremely bright light of a 5000-watt xenon lamp, with the result that the remaining silver halide on the background of the film is exposed, or "flashed."

STEP 4: SECOND DEVELOPMENT

Within a split second the "flashed" background is developed. This action causes the exposed silver halide to produce an opaque background. Since no further bleaching action takes place, the background remains dark.

No intermediate or final washing is used, nor is the film fixed, since it is not kept for record purposes. Actually the wiping action of the head seals permits very little carry-over or contamination of the chemicals. As a result, films do not show signs of deterioration or yellowing even after 6 months. The resulting film density will produce an image having a contrast ratio in excess of 100:1.

The Film Drive

After the BDU has presented its three-color cycle on the CRT and the three camera shutters have exposed the film, the CPPU receives a signal to start the processing cycle. A timing element then provides a sequence of signals necessary to produce the following events:

A continuous drive system imparts the necessary intermittent motion to the sprockets by means of a Geneva mechanism.

The sprocket drive pulls the film from the camera gate and positions it in the develop head, where it is permitted to remain for 4 to 6 seconds.

A second film transfer moves the same three frames into the bleach head, where they again remain for 4 to 6 seconds. While the new chip is being processed, the old display is kept in the projection gate and visible on the screen. The slack loop has developed to about the size shown in Figure 4.

During the next 1-second interval the following sequence of events takes place:

a. First a light shutter, not shown in Figure 4, interrupts the light path and blanks out the display for approximately 1 second.

b. While the old film chip is pulled out of the projection gate, the newly processed film chip is transferred from the bleach head and accurately positioned in the projection gate.

c. An optical vacuum plate pulls the film chip flat at the rear while the second develop and rinse bath is applied to the film emulsion.

At the end of this 1-second interval the shutter is again opened, and the new image is projected on the screen.

Film Splicer

Although not shown in Figure 4, there is an electronic film splicing module, which allows the operator to make a quick splice of the end of one film spool to the beginning of a new spool. During continuous operation the splicer eliminates the need to shut down the machine, drain all the heads, rethread the new film through the gates and heads, and then reestablish the flow of the chemicals. A new roll of film is spliced onto the end of the old roll while the previous projection is still being viewed on the screen. Before the next film can be processed, it is necessary to update the film rapidly three times in order to clear the exposed (fogged) film. This updating takes only 30 seconds; the total operation can be accomplished in 5 minutes; then the machine is again ready for normal operation.

Chemical Supplies and Pumps

The chemical system consists of two chemical banks, each of which has three tanks. Each bank contains 2-liter tanks of developer, bleach, and rinse solutions good for 12 hours of operation. When the first bank is exhausted, a solenoid valve automatically draws chemicals from the second bank for another 12 hours of uninterrupted operation. The depleted tanks can then be refilled and the cycle repeated for continuous operation. Circulation of the chemicals is achieved by a pump which draws the fluids through the heads under negative pressure. The negative pressure system is used to prevent spillage of liquids in the event a head seal or tubing connection were to fail.

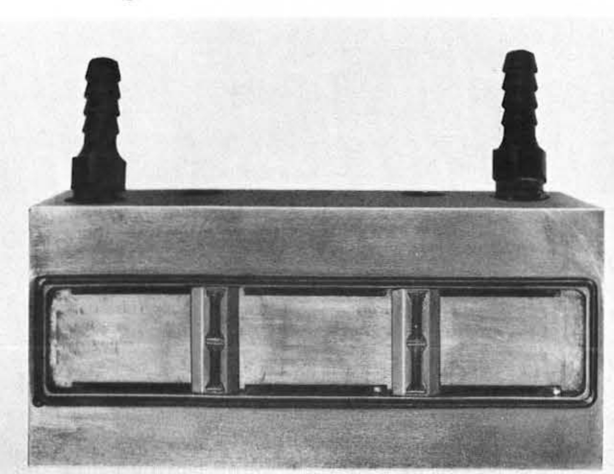

FIGURE 8: Develop/Bleach Processing Head

Film Processing Heads

The processing heads which apply the developer and bleach solutions to the film emulsion are fitted with ultrasonic transducers which vibrate for intermittent periods. This action aids in effecting uniform processing of the film and also prevents the buildup of excessive residues around the rubber seals. A picture of the processing head without the ultrasonic vibrator is shown in Figure 8. Each processing head contains three cavities, one opposite each exposed area of film. These are designed to permit the proper amount of processing chemicals to flow uniformly across the film emulsion from bottom to top. This upward flow of chemicals prevents any air bubbles from being trapped in the chambers and from thereby reducing the effectiveness of the chemical reactions. A pressure platen applies slight pressure to the back side of the film and thus helps to confine the solutions within the rubber seal surrounding the processing chamber. The chemicals flow through the heads at the rate of approximately 17 liters (4 gallons) per hour and are kept at 60 degrees Centigrade (140 degrees Fahrenheit).

Projection Head Assembly

After the film is removed from the bleach head, it is drawn into the projection head, a device shown in Figure 9. This unit is a precision assembly which asures that the seven-color projection system operates without excessive color fringing; that is, the assembly causes the three images of the film chip to be projected precisely on top of one another. Thus there is no overlapping at the edges.

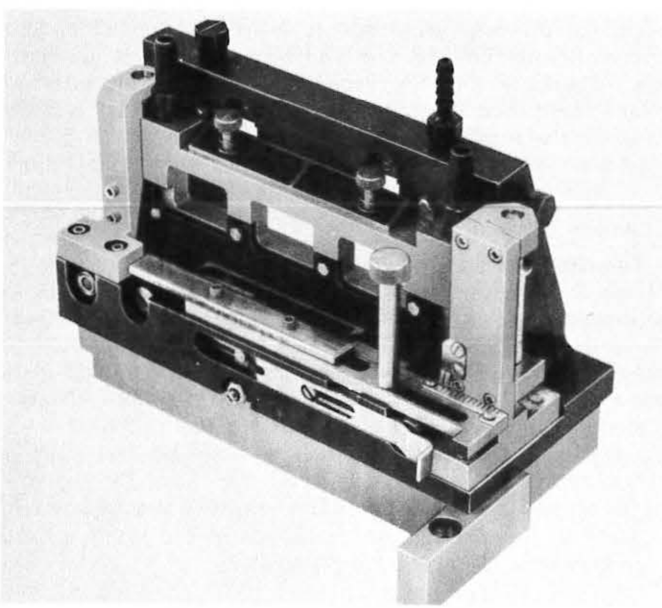

FIGURE 9: Projection Head Assembly

Lamp Cooling Requirements

For proper lamp operation the manufacturer notes that the recommended air velocities must be maintained around the three critical regions of the lamp, namely the upper and lower lamp seals and the bulb itself. Insufficient air velocities around these regions will cause the seals to get too hot and result in premature failure. Too much air or cooling will cause the arc to be unstable and produce a nonuniform light.

Calculation of initial air flow and aperture size were made in order to arrive at an empirical design for the lamp housing. This information was then used in the design and fabrication of a full-scale plastic model of the lamp assembly. The model included a dummy lamp and the necessary top and bottom supporting structures, three simulated lens cells, and the actual blower unit intended for the final design. The transparent test model, shown in Figure 11 was then used to take air velocity measurements with the aid of a pitot tube and static pressure gage. A fan was used to supply an air flow of 270 cubic feet per minute. Special restricted-throat sections of varying sizes were made and tested to provide the increasing air velocities required at the critical areas from the bottom to the top of the lamp. With a constant fan speed it was possible to modify the size and the shape of the open areas at the various critical regions surrounding the lamp until the required air velocities were attained.

In addition to satisfying the cooling requirements specified for the lamp itself, it was also necessary to dissipate the radiated energy which strikes the inner walls of the lamp housing. This dissipation was accomplished by means of a series of segmented annular openings along the inner walls of the lamp housing. These openings provided a curtain of cooling air from the bottom to the top of the module. After the proper air flow was established inside the plastic model, the experimentally determined dimensions were incorporated into the design of the actual lamp module.

Design of a Protective Lamp Shield

To establish the requirements for a shield which would protect the condenser optics, it was first necessary to analyze, and then to simulate, the effects of a catastrophic lamp failure. The violent failure of an operating lamp having 30 atmospheres of internal pressure very closely resembles an explosion; thus the analytic approach was used to calculate the equivalent energy of this explosion in terms of energy release of TNT. These results were then converted into equivalent amounts of black powder which could readily be packaged and discharged electrically inside a simulated glass bulb.

In general, the transmission of energy of an exploding lamp occurs in various forms, but flying particles, shock waves, and thermal radiation are the most important hazardous effects. From the appearance of the damaged lens systems resulting from earlier lamp explosions, it was concluded that shock waves were the most damaging agent and that flying particles and thermal shock were only of secondary importance. These assumptions, however, were proven incorrect in one of the series of explosion tests which were conducted for this purpose.

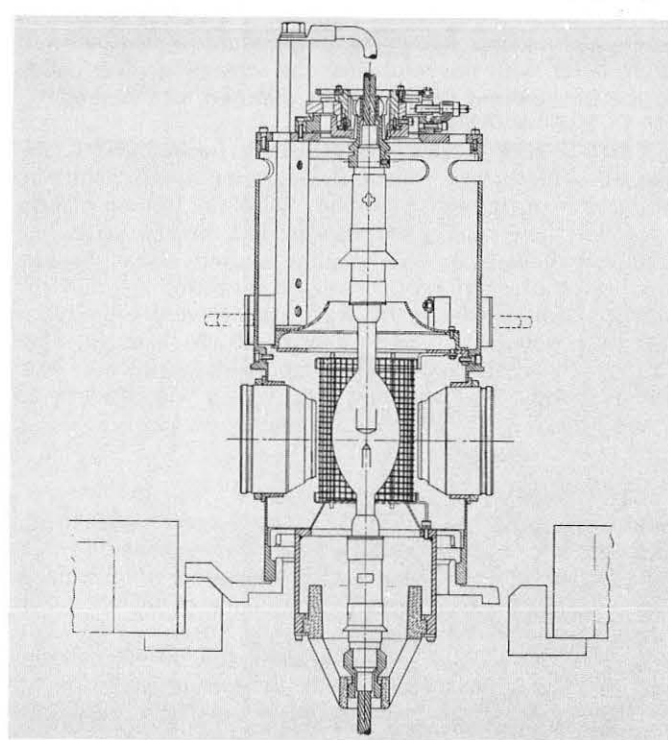

FIGURE 10: 5000-Watt Interchangeable Xenon Arc Lamp Module

Three approaches were employed to obtain estimates of the released energy during the failure of the bulb.

Method I used knowledge of the power consumption of the bulb and made assumptions about the energy distributions for heating, excitation of the xenon atoms, and for ionization of the gas column.

Method II employed the Helmholtz free energy functions and assumed no change in internal energy.

Method III took into account only the pressure potential between the initial and final state of the bulb.

Based on different assumptions, these determinations gave different estimates of the energy released, which varied from 1.25 to 3.40 grams of black powder. In spite of the dispersion, however, these estimates provided a good basis for the experimental simulation.

Experimentation

For the simulated explosion tests, a number of dummy pyrex bulbs were designed and blown to provide the flying glass particles. One and 2-gram black powder electric squibs in combination were then sealed into the dummy bulb to facilitate detonation from a safe distance. For each test, the charged dummy bulb was placed inside a cylindrical housing fitted with three lens cells to simulate the actual lamp module as closely as possible. The protective shield under test was then placed around the lamp and in front of the lens cells. Detonation of the black powder charge shattered the bulb and propelled the flying glass particles into the protective shield. The results of this impact determined how well the shield could contain the flying glass fragments and prevent them from damaging the fragile lens cells. The purpose in designing the shield was to create a device which would contain or impede all flying glass particles large enough to damage the exposed lens cells and yet permit smaller, harmless particles to go through the shield. At the same time the protective shield was to have a minimal effect on the light transmitted from the bulb, passed through the optical system, and displayed on the screen. Different protective shield configurations were tested, each with varying charges of black powder ranging from 1 to 3 grams.

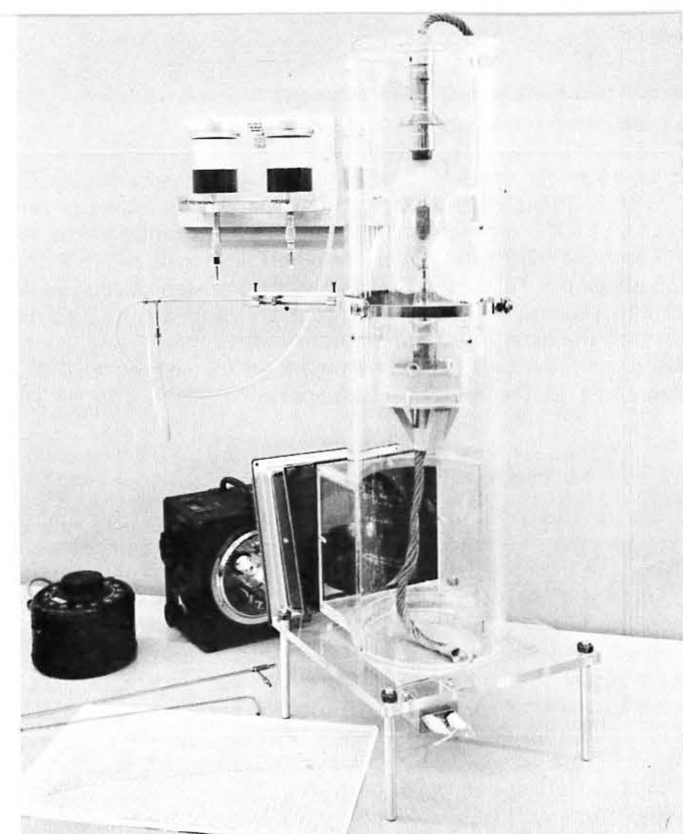

FIGURE 11: Transparent Model of Xenon Lamp Housing

After 12 tests, one shield design was found to be satisfactory. This was a spirally wound cylinder made of stainless steel wire having a diameter of 0.011 inch and welded at every joint into a 3/16-inch mesh. The proper control of the heat for the weld was very important so that the wire would not be burned or weakened unnecessarily. The resulting cylinder was 3-3/16 inches in diameter, 6 inches tall, and was fitted with four vertical 1/8-inch stainless steel rods welded to it. The final screen assembly, shown in Figure 10, was then held in place by a special top and bottom adaptor which was secured to the lamp housing.

Three Axis Orthogonal Adjustment

Because of the high temperatures produced in the lamp module, it is necessary to be able to adjust the arc center of the operating lamp *after* the assembly has become thermally stabilized. In addition, any adjustments which are made must not induce any strains in the glass envelope, as these would result in the premature failure of the lamp.

To satisfy the above conditions, a special three-axis adjusting mechanism shown in Figures 10 and 12 was designed around a spherical joint attached to the top of the lamp. This joint, which supports the total weight of the lamp, is free to pivot about its own center while being translated along any axis of the three-axis adjusting mechanism. This freedom of motion is essential to the lamp in the hot operating condition so as to eliminate any twisting or unnecessary straining of the lamp stem. The bottom of the lamp is fitted with a ball-shaped adaptor which permits the lamp to pivot and also freely slide up and down inside a loosely-

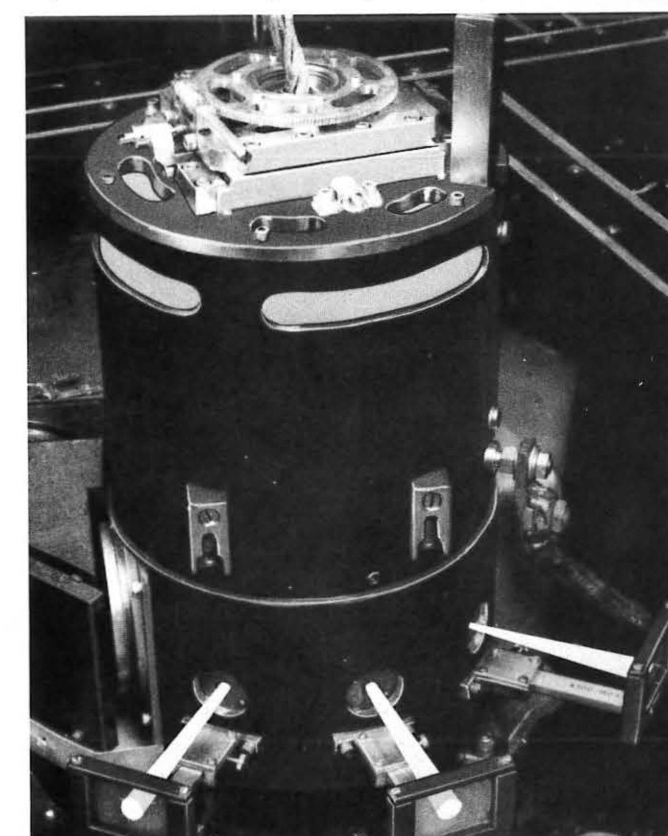

FIGURE 12: Rear View Photograph of Xenon Lamp Module

fitting, fixed ceramic bore (the bottom lamp insulator) while adjustments are being made at the top.

Adjustments made to the arc center by moving the top of the lamp along any of the axes of the three-axis drive mechanism can readily be observed on the small projection screens provided at the rear of the lamp module. These screens, which can be seen in Figure 12, present an image of the arc itself as it is projected through a pinhole aperture in the rear of the lamp housing. Once the correct position of an arc image has been outlined (traced or drawn) on the three small screens, it is a simple matter to reposition the arc center of the same lamp or any replaced lamp in the same three-dimensional space. Such adjustments of the three-axis adjusting mechanism are made with the aid of a small crank inserted through the muff, or chimney, which surrounds the lamp module when it is operating on the machine.

Interchangeable Lamp Module

Because of the constant requirement to keep downtime at a minimum and to permit the quick replacement of an expended (or exploded) xenon arc lamp, it was necessary to provide a second interchangeable lamp module, complete with lamp and condenser optics, in a standby condition. For this purpose, a mobile cart shown in Figure 13

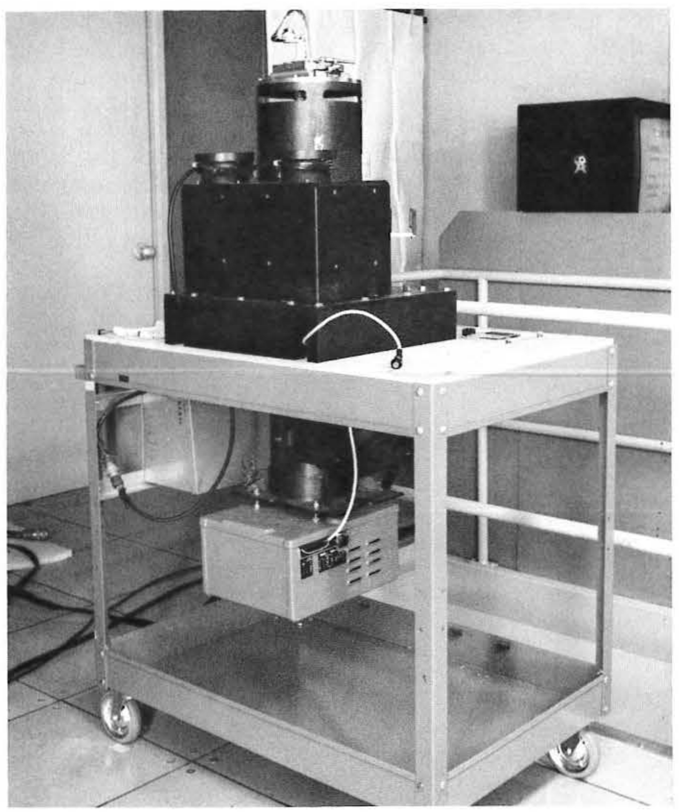

FIGURE 13: Spare Lamp Module on Mobile Cart

was designed on which to mount the interchangeable lamp module on a mounting identical with the one used on the CPPU. The cart is provided with the same air blower, power connections, high-voltage ignition circuit, and lamp operating controls used on the primary equipment. With this arrangement the entire lamp module assembly can be checked and aligned to assure its proper functioning long before it will be required on the machine. In this ready-to-use condition, the module, once checked, is protected with a cover and placed near the prime equipment.

Removal and replacement of a lamp module on the CPPU is expedited by the use of a large indexing key and three simple hold-down clamps. Only two electrical connections are needed to reconnect the lamp into the operating circuit. Once the lamp is reconnected, the CPPU covers can be put on and normal operation resumed.

Ozone Hazard

Cooling air flowing around an operating xenon lamp which is radiating intense ultraviolet energy results in the generation of ozone, an unstable but highly toxic gas. The concentration of ozone is kept at a safe level by a tight air duct which extends around the lamp module and which is kept under slight negative presure. A special electrical interlock assures that the fans will always be operating before the lamp is ignited and also that they will run for twenty minutes after the lamp has been turned off.

Xenon high-pressure arc lamps are ideally suited for this type of large-screen projection system because they provide an extremely bright light source from a very small and very stable arc. They are always ready for ignition and provide a light source having a color spectrum which closely resembles natural daylight.

Operational Use

The foregoing information refers to the seven-color CPPU which is presently in daily use at NORAD. Figure 14 shows

FIGURE 14: NORAD Large Wall-Display Presentation

a situation display which is typical of those seen by CINC-NORAD; it includes a background map, superimposed notations, and summary data. As an operational piece of equipment, the CPPU was designed to work reliably for 22 hours per day. In actual operation it often exceeds this design objective. Trained maintenance men are needed to service the unit. Detailed operating chaarcteristics and related engineering data are summarized for reference in the Appendix at the end of this paper.

CONCLUSION

Up to this point the discussion has covered the major components required for a seven-color projection system using rapid processing films and chemicals. Simpler three-color machines of this type would require the same components but would eliminate the need for critical positioning of the film to achieve precise projection of images. As a result these machines would be less expensive. Likewise a machine using color film projection or only black and white projection would be further simplified in that it could use single-cavity processing heads and much less film for each updating. In addition, it would use a smaller light source and only a single optical system for the camera and the projector. Such machines would use considerably less chemicals and much less power and would permit the use of a simplified Basic Display Unit to provide the necessary electronic inputs.

The future refinements of film processor projectors will see great improvements. These will include reduced machine size, reduced updating time, and elimination of "blink" time. The new machines will supply "hard copy" of the displays for handout, they will be able to recall past presentations, and they will use little or no film and considerably smaller amounts of chemicals.

APPENDIX

Camera Processor Projector Unit Characteristics
425L Program, NORAD

Operating Features	
Updating time	8 to 13 sec, depending on freshness of chemicals
Blink time	Approximately 1 sec
Optical Ratios	
CRT to camera	2.25 in. x 3.00 in. (5.72 cm x 7.62 cm) to 0.687 in. x 1.00 in. (1.75 cm x 2.54 cm)
Film to screen	0.687 in. x 1.00 in. (1.75 cm x 2.54 cm) to 12 ft x 16 ft (3.66 m x 4.88 m)
Display	
Available colors	Red, blue, yellow, green, cyan, magenta, and white
Symbol size	2.88 in. x 2.16 in. or 1.44 in. x 1.08 in.
Maximum number of symbols	1500 symbols and 500 lines
Brightness	10-ft lambers over 75% of screen for white characters
Contrast ratio	In excess of 100:1
Color fringing	Less than 0.12 in. (0.31 cm) over 12-ft x 16-ft (3.66-m x 4.88-m) screen
CRT type	5 CEP 11 aluminized-magnetic deflection
Repertoire	128 symbols
Symbol generation time	58.5 μsec to 117 μsec, depending on character size
Writing speed	1250 in. per sec (31.75 m per sec) 1 line or symbol
Film	
Type	35-mm Recordak Positive. Estar base, perforated SP 714
Chemicals	
Develop, bleach, and rinse	4 liters each per 24-hr operating period
Head temp and flow rate	Develop, bleach and rinse: 137° to 141°F (58° to 61°C) at 4 gal per hr (17 liters per hr)
Lamp Module	
Lamp	Osram XBO 6500 w/1 high-pressure, short-arc lamp operated at 5000 watts
5000-watt operating characteristics:	
Operating voltage	40 VDC
Operating current	125 amp
Light intensity	23,000 candles
Luminous flux	230,000 lumens
Average brightness	65,000 candles per cm^2
Arc size	2.3 x 9 mm
Bulb dia	2.401 in. (61 mm)
Lamp length	20.275 in. (515 mm)
Bulb temp	800°C
Seal temp	230°C max
Operating pressure	30 atm
Cold pressure	Several atm
Lamp adjustments	Controlled independent XYZ orthogonal adjustments on strain-free top bulb support made while lamp is burning. Strain-free bottom bulb support with no-friction slide and rocking capability
Arc position verification	3 pinhole projectors with calibrated screens to verify 3-dimensional arc positioning within .010 in. (0.25 mm)
Module Replacement time	10 minutes
Igniter	Osram B-6500/SP with 50,000-volt starting pulse. 12-in. x 10-in. x 6-in. (30.5-cm x 25-4-cm x 15.2-cm) size; 15-lb weight
CPPU Reliability	
Inherent MTBF:	179 hr based on SPERD tests Dec 1965
Inherent MTTR:	0.23 hr.
Machine Size	
Dimensions	62 in. x 54 in. x 55 in. (157 cm x 137 cm x 140 cm), excluding stack
Power Consumption	
Lamp:	5000 w
CPPU circuits and BDU inputs:	8000 w

ACKNOWLEDGEMENTS

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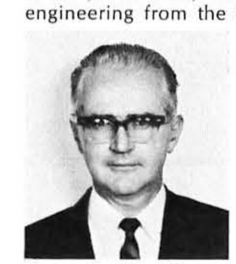
THE AUTHOR



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The Relative Legibility of Uppercase and Lowercase Typewritten Words

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ABSTRACT

The relative legibilities of common words typewritten in all-uppercase and all-lowercase letters were studied in three experiments. Human subjects identified the words shown one at a time for a short period. All-uppercase printing was found to be significantly more legible than all-lowercase in all three experiments. The "word-form" of all-lowercase words was not found to influence word identification. The use of uppercase letters is recommended for displays.

SECTION I
INTRODUCTION AND BACKGROUND

The designer of system displays has a special problem in legibility whenever a display does not provide the ordinary contextual meaning, the spacing and punctuation, and does not have the high resolution of the printing press to aid the viewer's reading. The display designer needs every advantage he can get, and any reasonably attainable increase in legibility is worth having. (See Ref. 10 for a discussion of current problems.) Many displays use all capital letters, but since the average reader is trained to read lowercase printing, it may be possible to make gains in display legibility by using lowercase symbols. Therefore, it is worthwhile to determine whether lowercase letters are more legible than uppercase letters for reading tasks like those found with system displays.

There are several reasons for suspecting that lowercase symbols are better. Several investigators have reported that lowercase printing is read faster and more accurately than is all-uppercase printing.[2, 15, 17, 18, 20] Tinker has repeatedly drawn attention to the effects of lowercase wordform in making words more legible.[12, 13, 16, 17] The difference in word-form between a lowercase and uppercase word is shown in Figure 1, in the manner of Tinker. It is conceivable that word-form would help lowercase words retain superior discriminability when they are seen alone or out of the context of common phrases.

At the same time, there are several experiments in which the uppercase letters and words were found more legible. Tinker,[16, 17, p.59] Paterson and Tinker,[13] Berger,[1] Hodge,[8, 9] and Forbes, Moscowitz and Morgan[6] all found that capital letters and words in all capitals were correctly perceived farther from the eye than were lowercase letters or words. Hodge[9] also found that words in all capitals were of superior legibility to words printed with an initial capital and the rest of the letters in lowercase. Berger disagrees with Tinker on the benefits of lowercase word-form; "*Form* of words as such due to differences in grouping of constituent letters appears *to have no specific influence upon* [the distance threshold of recognition] *of words*."[1, p.222] (italics his). These findings support the contention that uppercase letters would be better for use in systems wherever unordinary reading tasks are involved.

There are also experiments which support neither uppercase nor lowercase printing. Crook, Hanson and Weisz,[5] in an elaborate study of several typographical variables, found that "Capitals could be read more readily than lowercase when occupying the same printing area." (See their Abstract and Figure 1.) Unfortunately, they used one kind of task for lowercase and another kind of task for uppercase, which makes a direct comparison depend upon a weighted "legibility score" they developed. Fox[7] compared lowercase printing with all-capital printing in which the capitals were of the same size, and occupied the same line distance, as the smaller lowercase. He found no significant differences between the two letter cases in speed and accuracy of reading when the subjects were instructed to read for comprehension alone. He also found no differences in comprehension when the subjects were instructed to read as rapidly as possible, and no differences in average rate of reading. Paterson and Tinker[13] showed headlines to subjects with the exposure held constant at 180 milliseconds. They reported no difference between uppercase and lowercase letters. Tinker[19] studied the rate of eye blinking while reading text printed either in all-uppercase or in all-lowercase letters. His data show more blinks when reading the lowercase letters, but the differences were reported to be not statistically significant. Hodge[8] found no difference in the distance threshold of confusion between the large and small lowercase letters, concluding that the legibility of lowercase letters depends largely upon the smaller details of their construction. Since his conclusion in this regard is probably applicable to the uppercase letters also, one is left to guess about the relative perceptibility of detail in uppercase letters.

In addition to differences in experimental results, there are differences of opinion. The two extremes are represented by Tinker[17] and Hodge.[9] Tinker wrote, "The use of all capitals should be dispensed with in every printing situation."[17, p.65] Hodge wrote, "The data were interpreted as indicating that, for optimal performance, single-word instrument panel labels should be printed in all uppercase letters . . .", and he noted "The lack of agreement between these findings and a large portion of the legibility research literature . . .".[9, p.66] There are opinions between these extremes all of which make it clear that the issue is not resolved.

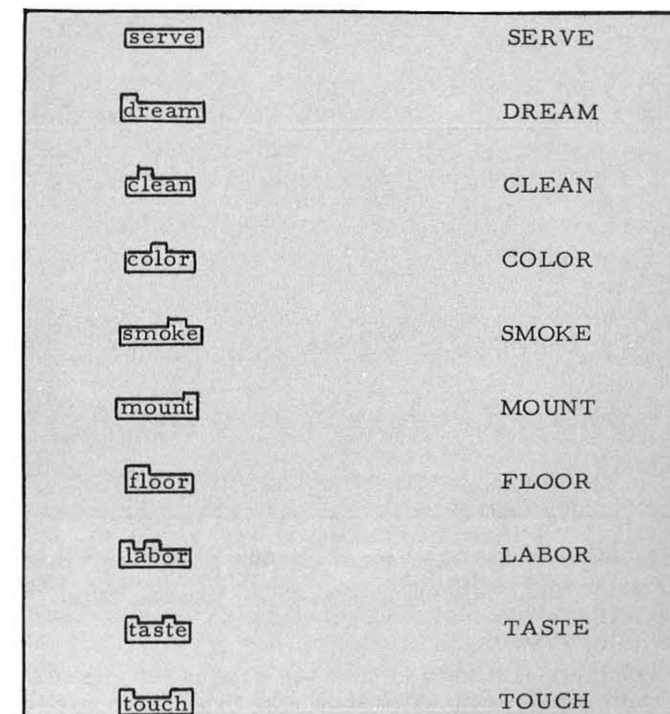

FIGURE 1: Showing word-form, after Tinker, of words in all lowercase letters (left), and their counterparts in all uppercase letters (right). These ten word-forms were those of Experiment 3, and the words above were taken from the lists used and are shown here with the same type face.

Part of the confusion has arisen because different writers use the term "legibility" with different meanings. As Cornog, Rose and Walkowicz point out, "In the legibility literature, there is much confusion and overlap in the usage of the terms legibility, readability, perceptibility and visibility."

"In general, legibility refers to the characteristics of printed, written or other displayed meaningful symbolic material which determine the speed and accuracy with which the material may be read or identified."[4, p.1, 2] Obviously, if "more legible" means "superior performance in all reading situations," then the argument will go on forever.

Yet, the data of the literature are in agreement on at least two counts. There seems to be no doubt that first, standard text is read more rapidly and accurately in lowercase than in uppercase printing, or that second, capital letters and words are read at a greater distance than lowercase *of the same point size.*

STAND YOUR GROUND. DON'T FIRE UNLESS FI
Stand your ground. Don' fire unless fired 1234567890
12 point Bernhard Gothic Medium

STAND YOUR GROUND. DON'T FIRE U
Stand your ground. Don't fire unl 1234567890
14 point Bernhard Gothic Medium

STAND YOUR GROUND. DON'T
Stand your ground. Don 1234567890
18 point Bernhard Gothic Medium

STAND YOUR GROUN
Stand your ground. 123456
24 point Bernhard Gothic Medium

STAND YOUR GRO
Stand your grou 123456
30 point Bernhard Gothic Medium

FIGURE 2. Showing the symbol sets for different point sizes in one style. Taken from *A Specimen Book of Types* by permission of The Lexington Press, Inc., Lexington, Mass.

Point size is a term for the size of a set of uppercase and lowercase symbols as shown in Figure 2. It is clear from inspection of Figure 2 that the letters of a given point size are of different heights and various widths (see Figure 3 for other type faces). Since the distance at which a letter can be correctly perceived is proportional to the size of the letter (within rather narrow limits), a comparison of uppercase and lowercase letters or words using a *given point size*, and using the distance of correct perception as the measure of legibility, is biased in favor of the uppercase letters. Thus, it is easy to understand the results of experiments like those of Hodge.[8, 9]

It is also easy to understand why the lowercase letters are found to be more legible when the measure is speed of reading. One reason is that subjects have much more reading experience with lowercase printing than with uppercase printing. A second reason is that the letters' widths in lowercase are smaller, and the denser printing puts more words to the inch and requires fewer inches of visual scan per word or phrase. Furthermore, many experiments on speed of reading use a standard English text, such as newspaper articles or common sentences. In this circumstance, the redundancy of words and phrases enhances ease of scanning lowercase printing more than uppercase because more print is scanned per inch with the smaller lowercase printing, and the more print scanned, the more likely is the seeing of a redundant word or phrase. Thus, experiments on speed of reading find that lowercase printing is more legible than uppercase in precisely those situations best suited to give lowercase printing the advantage.

What about the reading situation of a visual display in a military system? Which form of printing has the advantage there? The question of interest may be answered in part by experimenting on the speed and accuracy of word recognition under reading and viewing conditions similar to those found with displays. This paper reports two such experiments. In addition, the effects of wordform on speed and accuracy of identification of lowercase words were examined in a third experiment. The experiments and their results are described below; greater detail is given in the original paper from which this article is taken.[11] The results and conclusions for each experiment are discussed after the description of the third experiment.

s m i l e	S M I L E
B E C O M E	b e c o m e
C H I E F	c h i e f
a c c e p t	A C C E P T
r a t h e r	R A T H E R
F I F T Y	f i f t y
K N O W N	k n o w n
o u g h t	O U G H T
R E P O R T	r e p o r t
e i g h t	E I G H T

FIGURE 3: Showing the first ten words from the two lists, and with the type face, of Experiment 1.

SECTION II
EXPERIMENT 1

Purpose

This experiment compared the recognition time of subjects reading common words typed in uppercase letters with the recognition time for the same words in lowercase letters. Since each word was seen in isolation and in a random sequence, there was no redundancy between words, as there would be in a normal sentence, but there was redundancy between letters, of course. It was assumed that the amount of redundancy in the words approximated the redundancy found in many system displays, and that the results of the comparison would apply to these system situations.

The words were shown at random in two lengths (five letters and six letters), and in the two letter cases. Thus, the subject did not know in advance which word, nor which letter case, would be shown next. Each word was shown for 100 milliseconds, and each subject was told, before his data were taken, that the experiment was a study in perception time.

Apparatus

Sixty common five-letter and six-letter words[14] were typed with one space between each letter on a length of white adding machine tape with an IBM standard electric typewriter with a carbon ribbon. A second list (List 2) of the same words was typed in the same manner as List 1, except that in List 2 the words which were in lowercase in List 1 were in capitals, and the words which were in capitals in List 1 were in lowercase (see Figure 3).

The words were shown in a Gerbrands tachistoscope to each subject. Each field was illuminated by white fluorescent lamps, and was painted flat white. A small rectangle, larger than the word, was drawn in the center of the pre-exposure field to allow the subject to fix his eyes where the words would appear. The subject saw a lighted field all the time, with a brief exposure of the word in the center of a white field preceded and followed by a plain white field with a rectangle in the center. The brightness of the pre-exposure field was 7.5 ft-L, and the white part of the tape in the test field surrounding the words was 9 ft-L. A timer started when the subject pressed the button, and stopped when the subject spoke into a microphone. Equipment delays were negligible.

The height of uppercase letters subtended 13 minutes of arc at the subject's eyes. The height of the tall lowercase letters subtended 13.5 minutes of arc, and the 13 small lowercase letters subtended 9.5 minutes of arc. These visual sizes were, therefore, well above threshold size.

TABLE I

Mean response times and errors for both letter cases in Experiment 1.

	Mean Response Time in Seconds	Number of Errors	Percentage Error
Uppercase	.552	21	1.5%
Lowercase	.576	23	1.5%

Procedure

The subjects, 30 MITRE employees, were tested one at a time. Each subject was instructed to call out each word as quickly as possible, and to guess if he was not sure of a word. The subject looked into the tachistoscope, and when his eyes were fixated on the rectangle and he was ready to see the word, he pressed a button. The experimenter recorded the reaction time to each word and whether the response was correct or incorrect, and advanced the tape to the next word, after which the subject again pressed his button when he was ready to see the next word. Half of the subjects were shown List 1 and the other half List 2; subjects were assigned to lists at random.

Results and Conclusions

The mean response times and errors are shown in Table I. The difference between the means is statistically significant (correlated $t = 4.44$, $p < .005$), but the difference in frequency of error is not.

Conclusion 1. Common words typed with one space between adjacent letters are recognized more quickly when printed with all-uppercase letters than with all-lowercase letters, there being no difference in accuracy.

enough	ENOUGH
dance	DANCE
PRESS	press
change	CHANGE
MOMENT	moment
STRIKE	strike
HONOR	honor
watch	WATCH
THING	thing
voice	VOICE

FIGURE 4: Showing the first ten words from the two lists, and with the type face, of Experiment 2.

SECTION III
EXPERIMENT 2

Purpose

The second experiment was done to see if the results of the first experiment depended upon the inter-letter spacing, which may have favored the uppercase words. Therefore, the words were typed on an IBM Executive typewriter with Modern type and a variable inter-letter spacing whose typed output looks more like regular printing (see Figure 4). In most other respects, this experiment repeated the first one.

Apparatus and Procedure

The apparatus and the procedure were the same as in Experiment 1 except that a new list of 60 five-letter and six-letter words was compiled.

Twenty-seven of the 30 subjects in Experiment 1 served as subjects in Experiment 2. Fourteen subjects saw one list and thirteen saw the other, again being assigned at random.

Results and Conclusions

The mean response times and errors are shown in Table II. The difference between the means is statistically significant (correlated $t = 2.00$, $p < .05$). The error frequencies were too small to permit statistical analysis. If the errors in Experiments 1 and 2 are pooled (uppercase = 24, lowercase = 34), the difference is not statistically significant ($X^2 = 1.72$, $.10 < p < .20$).

Conclusion 2. Common words typed with style and spacing similar to ordinary print are recognized more quickly when printed in all-uppercase letters than in all-lowercase letters, there being no difference in accuracy.

TABLE II

Mean response times and errors for both letter cases in Experiment 2.

	Mean Response Time in Seconds	Number of Errors	Percentage Error
Uppercase	.525	3	0.4%
Lowercase	.534	11	1.7%

SECTION IV
EXPERIMENT 3

Purpose

This experiment on the effects of word-form was suggested to the authors by some of Tinker's comments. He wrote, ". . . total word-form is more important in perceiving words in lowercase than in all capitals where perception occurs largely by letters. This conclusion is supported by the fact that words in lowercase yielded more misreadings than words in capitals. In the lowercase print, the incorrect word frequently had a total configuration or form similar to that of the stimulus word."[17, p.59, 60] Also, ". . . 'word-form' is absent when printed in all capitals."[12, p.25] It follows that the influence of word-form can be studied by examining the distribution of errors made when subjects read words in lowercase.

This is to say that if words in lowercase are of, say, 10 different word-forms (see Figure 1), and are shown to subjects who make errors in reading the words, then the words which were given in error should be words whose form is the same as the form of the word that was actually shown when the error was made. At least, the errors made should be distributed proportionately more to the same form than to different forms.

If (a)the subject were shown words in both uppercase and lowercase in random sequence, and (b) the same guessing procedure were followed for both cases, and (c) each word appeared in both cases, then his erroneous responses to uppercase words could be used as an indicator of his guessing preferences. Since each word would be in both uppercase and lowercase letters, the uppercase words fall into two classes, those whose lowercase counterparts are of the same word-form as the word shown, and those whose lowercase counterparts are of different word-form. Therefore, the subject's distribution of errors made for uppercase words (which lack word-form) is the best estimate of his guessing preferences *in the absence of word-form.* This distribution is thus the distribution expected to occur without the effects of word-form, and it may be compared directly to the distribution which occurred with the lowercase words where the effects of word-form should appear.

The hypothesis is that when the subject guesses wrongly, he chooses a lowercase word whose form is the same as that of the lowercase word shown.

If each word, in both letter cases, were first shown to the subject at an exposure time too short for ready recognition, and if the time were increased by small steps until correct identification occurred, a sample of erroneous responses would be generated. Finally, the exposure time required for correct recognition of uppercase words could be compared to that for lowercase words as another way of examining the comparative legibilities of the two letter cases.

Apparatus and Procedure

Of the 20 test words, two words of each of 10 word shapes were chosen. The term "word shape" here refers to the distribution of tall letters and small letters in a word typed in lowercase, which give the word a characteristic outline, after Tinker.[17] The 10 word shapes used in this experiment are shown in Figure 1. Four practice words had shapes different from any of the test words.

The test list was typed as in Experiment 2 (see Figure 1). Each word appeared once in lowercase and once in capitals, the order of words on the list being random with respect to letter case, word shape or alphabetic order. Two other lists, given to the subject as a reference to choose from in responding, contained the same words; all the words were typed in capitals on one list, and all were in lowercase on the other list. The reference lists contained four words (two test words and two extra words) of each of the ten word shapes.

TABLE III

Total erors made by all subjects in Experiment 3 when the words were of the same or different word-form than the word actually shown. The errors made with uppercase were taken as the correction for guessing preferences.

	Same Word-form	Different Word-form
Uppercase	28	187
Lowercase	46	239

The words were shown in the tachistoscope as described previously. Seven subjects, all screened for 20/20 visual acuity, were tested. Each subject was told, before data were taken, that the experiment was a test of guessing preferences, and not to worry about making errors. Each word was shown several times in succession, with each exposure of the word 2 milliseconds longer than the last exposure, until the subject guessed the word correctly one or two times. The subject was required to guess at each exposure

TABLE IV

Errors made by all subjects in Experiment 3 on the trial immediately before a correct word identification when the words were of the same or different word-form than the word actually shown. The errors made with uppercase were taken as the correction for guessing preferences.

	Same Word-form	Different Word-form
Uppercase	18	105
Lowercase	26	102

of a word, choosing a word from the two reference lists before him. Each word was shown at least two times and not more than eight times. The subject's response was recorded for each word at each exposure time it was shown.

Results and Conclusions

The errors made by all subjects were pooled, and are shown in Table III. With the distribution for uppercase errors as the expected frequencies, the distribution of lowercase errors to same or different word-form was not significantly different from chance ($X^2 = 2.52$, $.10 < p < .20$).

Another, and similar test of the same hypothesis was made for those errors which immediately preceded a correct word identification (see Table IV). Again, the distribution of lowercase errors to same or different word-form was not significantly different from chance ($X^2 = 3.34$, $.05 < p < .10$).

TABLE V

	Exposure Time in Milliseconds			
	4 and 6	8	10	12 and 14
Uppercase	59	39	12	11
Lowercase	22	48	33	19

Conclusion 3. Word-form, as defined here, has no significant effect on the recognition of lowercase words seen in isolation.

The frequencies of occurrence of the first correct word identifications for both uppercase and lowercase words are shown for different exposure times in Table V. The data for 4 and 6 milliseconds, and for 12 and 14 milliseconds were too small for a Chi Square analysis. The distribution shown in Table IV is significantly different from chance expectancies ($X^2 = 29.77$, $p < .01$), and indicates that words in all-uppercase letters were recognized correctly at shorter exposure times than were words in all-lowercase letters.

Conclusion 4. Common words seen in isolation are recognized more quickly when printed in all-uppercase letters.

SECTION V
DISCUSSION AND RECOMMENDATION

The time required by subjects to recognize words and speak them correctly was shown by the first two experiments to be shorter for uppercase than for lowercase printing. The third experiment substantiated these two findings by showing that correct word identification occurs at a shorter exposure time when the words are printed all in uppercase letters. These findings were made when the words were seen free of the usual contextual cues and visual scanning habits. It appears that, for applications other than ordinary printing, the uppercase letters are to be preferred.

Since the actual differences in response times were all small, it might be argued, on the basis of the literature, that lowercase is to be preferred because of the advantages of word-form. This argument is unsound in view of the results of the third experiment. Here, not only was there no significant effect of word-form, but the uppercase words were seen at shorter exposure times. Finally, since the occurrence of errors in all three experiments was in favor of the all-uppercase printing, the superior legibility of all-uppercase words in this study seems unambiguous.

It is recommended that uppercase letters be used in those applications other than ordinary printing. Such applications are found in many military, government, and commercial displays.

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Means for improving apparent television resolution

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ABSTRACT

A means is described for improving the apparent resolution of a television system without an increase in bandwidth. The technique depends on the short term temporal integration characteristics of the observer's visual system and involves a minimum of electronics. By use of a suitable switching time delay in one of the oscillators, the raster lines are displaced by a discrete fraction of the height of one line at the start of each frame, while maintaining precise interlace at both camera and monitor throughout both fields of the frame. Tests for accuracy of recognition of random alphabetic characters indicated improvements over a standard raster scan as great as 75% for the smallest characters employed.

INTRODUCTION

Video space communications are and will continue to be power limited. Because of the direct relationship between power and bandwidth, bandwidth limitations must necessarily be imposed. Commercial television is also bandwidth limited, but for a different reason. The available channel widths have been limited in order to permit a reasonable number of competitive channels within the total amount of electromagnetic spectrum available.

Transmission bandwidth in turn determines the total number of picture elements which can be transmitted per unit time. Getting the most possible information out of these elements thus becomes a matter of utilizing them most advantageously. For the time frame during which they were established, the present RETMA standards represent a surprisingly good first approximation of requirements necessary to provide the home viewer with a reasonably good picture. The 30 Hertz frame rate avoids objectionable flicker, and the use of two interlaced fields per frame avoids differential vertical brightness of the picture.

Since the establishment of these standards, a number of techniques have been developed for bandwidth reduction for special purposes. Before categorizing these, some further discussion is required. Television ordinarily implies repetitive random presentation. Therefore, a technique applicable to a single picture is not necessarily equally applicable to multiple pictures which must present continuous imagery without objectionable flicker or discontinuities, "continuous imagery" in this case meaning frames presented at rates above the visual flicker threshold of the observer.

For a single picture, it becomes appropriate to consider that major changes in gray or hue level do not occur between every element, and that therefore, bandwidth can be conserved by transmitting information only when a gray level or hue change has occurred. For a simple cartoon character displayed on a standard TV raster, this could result in a major reduction in bandwidth. For pictorial material, the bandwidth reduction which might be possible could vary widely. To transmit continuous imagery via multiple frames would thus require that the number of gray scale or hue changes for each frame be counted; from this, a probable number of raster lines which could be transmitted be approximated, a second count of changing elements made with this number of raster lines to make certain that the available bandwidth has not been exceeded (in which case, higher order approximations would be needed), and the picture finally transmitted. The complexity of the equipment required to do this is not parsimonious.

For continuous imagery, other techniques requiring less in the way of brute force mechanization have been tried. Systems involving irregular interlace for example, are typified by those of L. F. Mayle[1] and P. M. G. Toulon.[2] Neither of these have any compatibility with present broadcast standards, and both are subject to regular line "crawling" which provides an annoying distraction. More recent variations of these techniques have been introduced by Dr. Deutch of Brooklyn Polytechnic Institute,[3] and E. Smierciak of the ITT Industrial Laboratories[4]. Both of these latter systems have concentrated on obtaining a major reduction in bandwidth while avoiding flicker and maintaining some graceful degradation of picture quality, as opposed to our aim of improving picture quality while maintaining existing bandwidths.

The most successful technique thus far developed for increasing picture quality for a given bandwidth has been that of aperture correction as employed by CBS Laboratories. This method takes into account the fact that the electron beam is moving at all times, and that there is a measurable delay in the phosphor response and decay. Thus, if three successive picture elements are stored, it is possible to modify the signal for the middle element before it is transmitted, so as to take into account the correlation from previous and following elements. A major improvement in gray scale rendition and in sharpness thus occurs. Horizontal aperture correction is relatively easy to achieve, since it is necessary to store and compare only three elements at any one time. Vertical aperture correction is, on the other hand, extremely difficult, since all picture elements in three scan line (approximately 1200 elements for a standard 525 line system) must be stored to allow the comparison.

The technique which we have studied resulted from the casual observation that a single frame of motion picture film when viewed under a magnifier has surprisingly poor resolution when compared with the apparent quality of the pictures projected at normal frame rates on a large theater screen. Under the hypothesis that at least some of this apparent difference resulted from the random grain structure of the photographic emulsion and the ability of the human visual system to perform a short term temporal integration of the information in different frames to piece together the most probable picture content, it appeared that this phenomenon should be equally applicable to television.

If one thinks of the TV raster as a "grain" (not to be confused with the phosphor grain, which is orders of magnitude finer), existing RETMA standards dictate that the raster should appear in the same position on each successive frame, and this then does not yield the same effect as that occurring with motion picture film. Instead of using the existing 0° phase relationship between horizontal and vertical oscillators continuously, it merely becomes necessary to change to a new phase relationship at the start of each frame and to maintain this precise relationship throughout both fields of that frame, again changing to a new phase relationship at the start of the next frame. Furthermore, this is required at both the camera and monitor in order to maintain the correct positional relationships of imagery.

This serves to displace the raster by a fraction of the width of a raster line on each successive frame, so that the visual system can perform a temporal integration of the different information in the different raster "grains."

Systems Implementation

It is possible to implement the desired change in the position of the raster in a number of ways including (1) using a suitable switchable time delay network in one of the oscillators, (2) disconnecting the ground on the vertical oscillator and adding a small bias voltage at this point, the amount of the bias being changed every frame and kept fixed for both fields of that frame, or (3) using camera and picture tubes having both electrostatic and electromagnetic deflection, so that one deflection system can be used in the normal manner and the other can supply the addi-

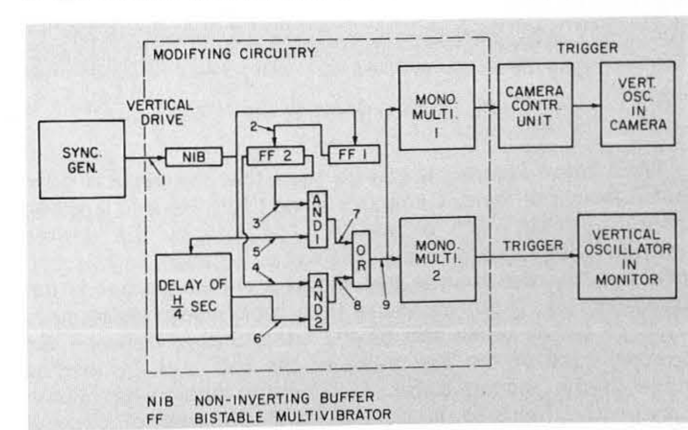

FIGURE 1: Block diagram of modified closed circuit T.V. system

tional deflection required in the horizontal or vertical (or both) planes. For our research, we used the first of the above-listed techniques.

The available system consisted of a Dage Model 91 Camera, a Dage Model 420 Camera Control Unit, a Dage Type 431 Dual Transistorized Synchronizing Generator, and a Miratel Model LV14M Monitor.

The circuitry described below illustrates the method by which we modified this system in order to obtain the desired phase shifts between frames while maintaining the interlaced fields within each frame. For explanatory purposes, a simple frame sequence (the series of inter-frame phase shifts) has been chosen for illustration. However, once the block diagram of Figure 1 is understood, it becomes an easy matter to visualize which additional blocks would be required to set up any frame sequence desired.

For what follows; H is the duration of one scanning line, which in a 525 line system is 63.492 usec, and V the duration of one field, which in a 30 frame per second system is 16.689 msec.

The raster configuration of the illustrative system possesses twice as many lines as it would normally, and the lines are equidistant from one another. In other words, each two frames interlace in the same manner as each two fields interlace. Figure 1 represents the black box added to the existing closed circuit television system to provide the desired raster configuration, and shows the relationship of this black box to the balance of the system. Figure 2 presents numbered waveforms corresponding to the numbered locations in Figure 1.

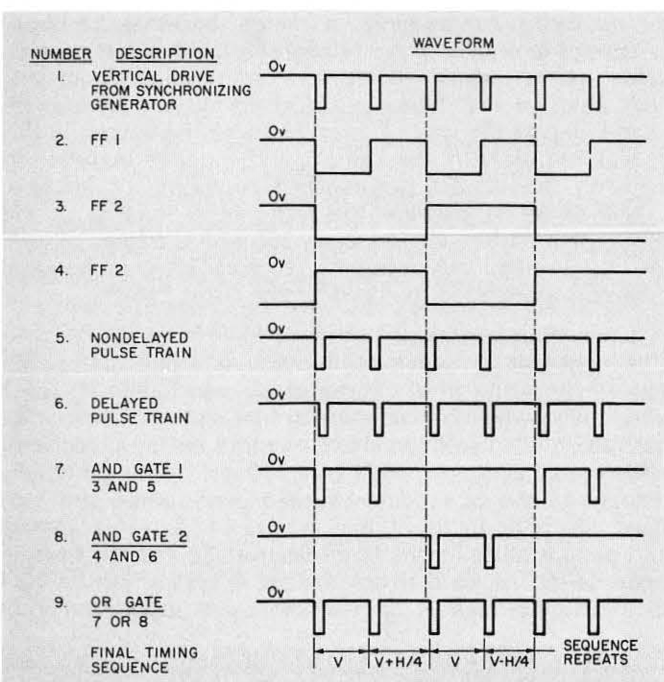

FIGURE 2: Waveforms correspondence to the numbered locations in Figure 1.

From these Figures, it can be seen that the vertical drive pulse from the Sync. Generator is first formed into a group of pulse trains, each of which is delayed by the desired amount with respect to the original pulse train. In this particular case, one train is not delayed and the other is delayed by H/4. These trains are then broken into pulse pairs, each of which retain the 63.492 usec. timing between the leading edge of the first pulse of the pair and the leading edge of the second pulse. This timing relationship allows consecutive fields to interlace in their formation of a frame. The various pulse pairs are then recombined into a pulse train which has the desired inter-pulse-pair timing, allowing the frames to be shifted with respect to one another and, in this case, the frames to be interlaced. The newly formed pulse train is now split into two trains. Both trains receive final shaping by a monostable multivibrator before proceeding to their respective vertical oscillators — one in the camera and the other in the monitor.

System Test

Rather than using standard resolution charts and relying on purely subjective judgment as to the amount of resolution attained with the modfied versus unmodified system, it was decided to test the ability of experimental subjects to identify small capital letters presented on the monitor. For this purpose, a series of cards, each containing one hundred random capital letters, was prepared using a Leroy lettering guide. These cards were photographically enlarged and reduced to yield the desired increments in character size, placed 45" in front of the camera and evenly illuminated at 400 foot candles. Experimental subjects were given the task of identifying the characters on the monitor which was located on the other side of a partition. Ambient illumination at the monitor was maintained at 1.7 foot candles, and the tube brightness and contrast adjusted to yield a highlight brightness of 4 foot-lamberts and a character brightness of 0.75 foot-lamberts. Subjects were given complete liberty to select their viewing distance.

During preliminary tests, several scan variations were presented. All of the experimental scans showed significant improvement over the standard scan. Furthermore, no experimental scan showed significant improvement over any other experimental scan. For this reason, the later and more comprehensive test was limited to a comparison of the standard scan and the H/4 scan previously described. Five female subjects were used and material presented in counterbalanced order as to type of scan, so as to eliminate any effects due to practice. All subjects started with the largest character size and viewed progressively smaller characters on each trial. No time constraints were placed on subjects. Each subject was tested with a total of seven different character sizes on each of the scan patterns.

Test Results

The mean improvement in recognition accuracy for the experimental scan over the standard scan for the five subjects at each of the character sizes used is depicted in Figure 3. As might be anticipated, for the larger characters where recognition is relatively easy, there is little improvement. However, when the task becomes difficult, improvement in recognition may be as great as 75% when data are corrected for chance effects. A *t* test for difference in means gave a value well beyond the .9995 level of significance, and it should further be noted that all subjects performed better on the experimental scan.

Several video engineers who viewed the monitor expressed concern over the apparent lack of system stability, as evidenced by the shifts in raster position. Of the five subjects, on the other hand, only one noted a difference between the experimental and standard rasters without being directed to look for such a difference. Of the remaining four subjects, each of whom had an opportunity at the end of the test sequence to repeatedly shift between the two rasters, one subject was completely unable to discern any difference. Finally of the four subjects that did become aware of a difference, two indicated a mild preference for the standard raster, one a mild preference for the experimental raster, and the last subject had no preference.

The effect here then was that rather than viewing materials behind fixed bars, all portions of the material could be seen at one time or another as as the bars changed location. To some extent, the effect resembled that achieved

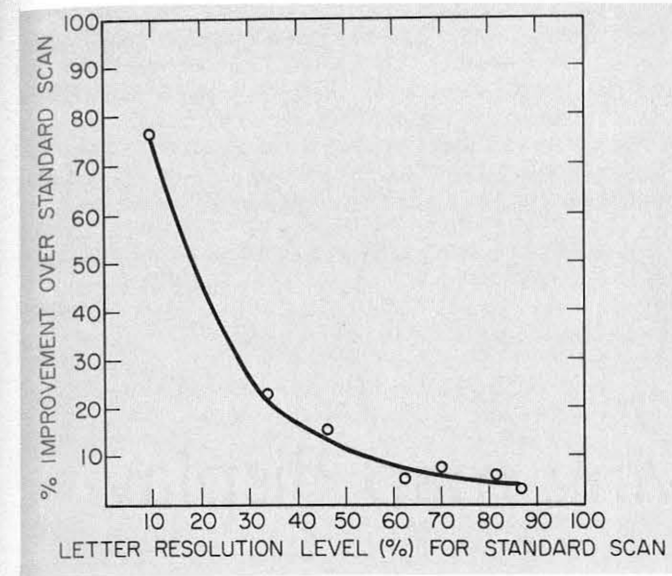

FIGURE 3: Improvement in recognition level for experimental scan over standard scan. All data corrected for scores attributable to guessing.

with the Wobbulator principle[5] wherein a high frequency, low amplitude signal is imposed on the vertical oscillator of the monitor so as to reduce the apparent sharpness of the scan lines. It should be noted, however, that the use of the Wobbulator principle results in a decrease rather than an increase in resolution since information is displaced from its true position on the tube face. To utilize this principle at both camera and monitor synchronously, bandwidth would have to be increased radically to provide the required synchronizing signal.

As again might be anticipated, improvements in recognition accuracy were not constant for all letters; rather, major improvements resulted from reduction of confusion between somewhat similar letters, such as P and R, O and Q, or Y and T. Limitation of test material to such easily confused letter pairs could easily increase the measured differences between the scanning systems.

CONCLUSIONS

At the very least, this study has demonstrated that the human visual system can, in fact, perform short term temporal integration, and that differences between scanning systems can be quantified with a high degree of accuracy providing that stationary test patterns are employed. With moving imagery only subjective data are available in that we have satisfied ourselves that there is no objectionable ghosting or other obvious picture defect when such moving imagery is presented using the modified scan.

It should scarcely be necessary to belabor the point that the improvement in resolution obtained here is confined to the vertical dimension. The combinaiton of this with horizontal aperture correction, however, remains a distinct and easily implemented possibility, so as to improve picture sharpness in both dimensions.

It should further be pointed out that the technique is equally applicable to color systems providing that a monitor is employed wherein the dimensions of the color dot matrix pattern are appreciably smaller than the height of a raster line.

The alphanumeric character sizes used in the test ranged in height from two to four standard raster lines. The use of alphanumeric characters of these sizes is certainly not recommended for normal viewing; rather, the use of extremely small characters provided a convenient means for testing system performance. For absolute identification of such characters, existing standards recommend that vertical height sould encompass at least seven raster lines.

While our work has been limited to the use of a closed circuit system in which identical changes were made in the signals to camera and monitor, it sould also be pointed out that there should be applicability to commercial TV transmission, and no requirement for modification of home receivers. It should merely be necessary gradually to change the phase between horizontal and vertical oscillators during the lines normally lost during vertical retrace. If the sync signals were appropriately modified at the transmitter to accomplish this, any reasonably well-regulated home TV receiver should follow this, since most such sets have relatively free running oscillators. Another approach that would produce a raster that is closer to the one that was actually tested in the laboratory would be to modify the equalizing and serration pulses to produce an interframe phase shift of H/4. It should be noted that, as yet, this has not been attempted by this laboratory and, therefore, may or may not be feasible.

Finally, the degree to which the modified scan may be expected to improve the recognizability of detailed imagery must certainly be a function of the specifics of that imagery, and any final evaluation must thus await broader use of scan modified systems. In view of the simplicity of the required circuitry and the absence of any grossly annoying picture deficiencies, it is hoped that wider usage may be made of this principle.

ACKNOWLEDGEMENT

The authors wish to acknowledge the assistance of Mr. Ernest Gaiser in design of the circuitry and Mr. Albert Paradise for assistance in Systems Test for this research.

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THE AUTHORS

EDWIN H. HILBORN received a B.A. in General Science with a Chemistry major from Cornell University in 1936 and an M.A. in Experimental Psychology from Duke University in 1956. He has been employed either as a high-polymer chemist or an engineering psychologist successively at Eastman Kodak, Martin-Orlando, ACF Electronics, ITT and General Dynamics. Since its inception in 1964, Mr. Hilborn has been employed at the NASA Electronics Research Center, working primarily on display devices and fluidics.

Mr. Hilborn is the author of numerous articles and one book, and currently holds 21 patents, with others pending.

LLOYD E. STEVENSON received his B.S. in Electrical Engineering from the University of California in 1966. Since graduation, he has been employed in the area of display devices at the NASA Electronics Research Center in Cambridge, Mass.

The case for the moving map display

by S. N. ROSCOE,
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Hughes Aircraft Company

WHY MAP DISPLAYS

To the best of my knowledge, optical moving-map displays were first proposed in 1949 by a group of pilot-psychologists at the University of Illinois Aviation Psychology Laboratory as a superior means of presenting the aircraft position information made available by the new rho-theta radio navigation system then known as DME-Omni. Laboratory simulation experiments at the University of Illinois and flight evaluations of experimental units by the former CAA at Indianapolis during the early 1950s were sufficiently successful to confirm the optimistic hopes of the investors and proponents. An example of typical results is shown in Figures 1 and 2.

In all of these tests no pilot ever became lost while flying with a map display. Private pilots and even non-pilots using map displays could navigate as well as experienced instrument pilots using conventional instruments. Perhaps even more surprising was the finding that pilots controlled airspeed, altitude, attitude, and heading significantly better under IFR conditions when using a map display, presumably because less attention was required for navigation tasks.

Based on these findings and special operational requirements associated with the SAGE air defense ground environment, the United States Air Force adopted an optical map display as part of the MA-1 aircraft and weapon control system in the F-106 all-weather interceptor. These systems have been in routine operational service throughout the 1960s (Figure 3). During these years the reliability and serviceability of map displays have become comparable to those of other basic aircraft displays. As a bonus, Air Defense Command pilots have saved several F-106s by making instrument let-downs and low-altitude IFR approaches following complete communication and radio navigation system failures by using the map display in its dead-reckoning mode

While effective for its intended purposes, the map display in the F-106 performs only a few of the many functions of which such flexible devices are potentially capable. By using the map display as a means of displaying the results of certain MA-1 system self-test routines, it was discovered that the map display provides an extremely effective means for flight crews and maintenance personnel to communicate with their on-board computers.

The use of a map display to show self-test routines and to provide a means for the crew to talk to an on-board computer was more fully exploited in the map display and associated controls of the ASG-18 fire control and navigation system originally intended for the F-108. The development of this advanced system was continued following the cancellation of the F-108, and it has been undergoing Air Force flight evaluation in the YF-12A at Edwards Air Force Base for the past three years. The use of the map display for the manual insertion of aircraft, target, destination, and TACAN station position coordinates has also proved to be a simple and effective way for the crew to talk to the ASG-18 system in flight.

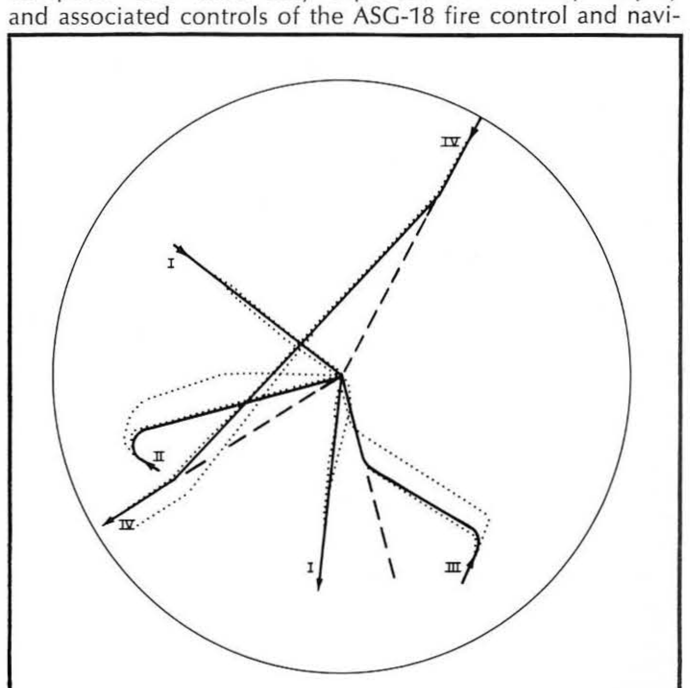


FIGURE 1: Flight Path Recordings of the best and worst solutions to four terminal area navigation problems flown by instrument pilots using a map-type pictorial navigation display.

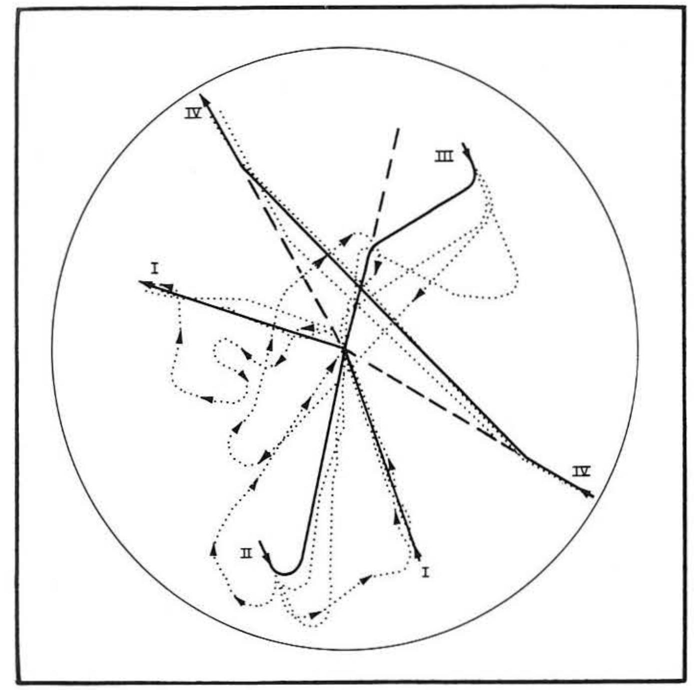


FIGURE 2: Flight Path Recordings of the best and worst solutions to four terminal area navigation problems flown by instrument pilots using conventional symbolic flight displays.

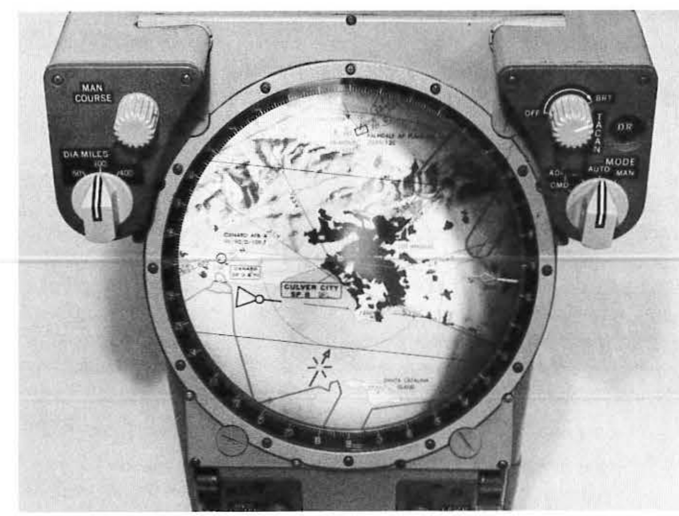


FIGURE 3: The Hughes MA-1 Map-type Pictorial Navigation Display in operational service in the Convair F-106.

Despite the success of map displays in interceptor aircraft, their potential value is even greater in tactical aircraft. During the development and flight testing of tactical radar and navigation systems at Hughes Aircraft Company, it has become evident that the full effectiveness of high-resolution surface-mapping radar is realized only when used in conjunction with a moving-map display.

The greatest single aid an operator can have in interpreting a radar ground map is knowing what he is looking at or, more precisely, the relative position of what he is looking for. Such knowledge can be achieved through intensive pre-flight study of charts, aerial photographs, radar imagery, etc., or by in-flight reference to such materials. The use of electronic markers on the radar display, showing the expected position of navigation checkpoints or pre-planned targets, may also be effective in limited applications. But by far the most effective aid to the operator is to present on a moving-map display the relative positions of the principal surface objects that should be visible and identifiable on the radar display. While a great deal of improvement in charting techniques is required to take full advantage of this mode of operation, impressive progress is being made, particularly by the USAF Aeronautical Chart and Information Center.

In tactical aircraft, the value of a moving-map display as a primary cockpit navigation device is greatest when flying devious routes at extremely low altitudes. Under such circumstances, the range of visibility is severely limited even under ideal weather conditions. Even a slight departure from a pre-planned flight path can result in a missed checkpoint and possibly a disoriented crew. With the highly accurate self-contained navigation sensors now available, pre-planned point-to-point navigation is effective with standard flight instruments, but far greater tactical flexibility is afforded if the outputs of such sensors are presented directly to the crew in terms of continuous, instantaneous position on a moving-map display.

Thus, an optically-projected moving-map display, used in conjunction with appropriate cockpit controls, appears to be a most effective device developed to date to assist an aircrew in performing the following functions:

1) Low-altitude tactical navigation, particularly at night or in poor weather and when departures from pre-planned routes are advantageous or required.
2) Interpretation of surface-mapping radar or other high-resolution, real-time, imagery-producing sensors.
3) Updating self-contained navigation systems by reference either to visual or radar position fixing.
4) Initiating and interpreting in-flight system self-test routines or performing the same tests on the ground.

In addition to these four principal functions a number of incidental functions may be provided at little cost. Among these are the display of check lists and other procedural instructions, maintenance information, and terminal area traffic procedure diagrams.

Map Display Design Isues

Critical issues in the design of map displays fall into several major categories including:

1) What shall be presented, i.e., the information content.
2) How it shall be presented, i.e., the rules for encoding information.
3) How the display shall be supported, i.e., questions of chart logistics.

WHAT SHOULD BE PRESENTED

The information required on charts is highly mission dependent. It seems to me obvious that the information required by the Air Defense Command in the F-106 or the YF-12 is quite different from that needed by the Tactical Air Command in the F-111A which in turn is differnt from that most suitable for a heavy logistics transport such as the C5A. The emphasis that some place on the use of photographic copies of standard charts in map displays is unfortunate in my opinion. I fully realize that developing complete new chart series for various major classes of missions is an extremely expensive undertaking, but I believe that the improved results will warrant the expenditure.

In tactical aircraft, for example, the types of data that must be presented represent two distinct classes. The first class consists of relatively unchanging long-lead-time materials such as map presentations of theater areas, terminal areas, and aircraft and test procedures. The second class consists of tactical data which requires a quick reaction-time capability if it is to serve as a truly useful mission aid. Items such as current data on defensive deployments in tactical areas and readily available display of alternate attack and departure corridors offer a potential for invaluble assistance to the combat crew. This means a requirement for a storage capacity sufficient to hold the unchanging items and a technique that permits daily changes in the stored material.

HOW INFORMATION SHOULD BE PRESENTED

The optimum characteristics for electronically generated or optically projected charts differ greatly from those for charts printed on paper. These differences also warrant the preparation of special charts. Optimum charts for optical projection in the cockpit environment and for use in tactical operations differ from conventional flight charts in content, symbology, scale, print size, contrast, and color.

To be most effective the charts should be relatively uncluttered, bold in their lettering and other symbology, and of high resolution and contrast. Charts of at least two, and possibly as many as four, different scales should be provided: at least one to a relatively gross scale for enroute navigation and the other to a scale approximately four or five times as fine for local area operations such as position fixing, weapon delivery, traffic control, and landing. Each type should contain only information related specifically to its intended operational use, to avoid cluttering the chart and allow the use of a bold format. A single master chart to a third scale encompassing the entire operational area and showing the location and identity of all charts available in the display is also highly desirable.

Map displays create the greatest single source of light generated within the cockpit at night, even when dimmed to the same level as other displays. The total luminous flux emitted by the display can be reduced at least an order of magnitude by the use of negative white on black charts (white figures on a black background). If the preservation of dark adaptation at night is important, as it surely is in tactical aircraft, then the advantage of this type of presentation is very great. This type of presentation can also be used with particular advantage in conjunction with color coded dynamic symbols.

If the map display is to be most effective as a flight instrument or as an instrument for assisting the operator in the interpretation of high-resolution imagery from real-time surface-mapping sensors used in locating targets and navigation checkpoints, then the map presentation must be oriented relative to the aircraft's flight path or heading. When the momentary function of the display is to present alphanumeric information such as radio frequencies, runway headings, place names, or terrain elevations, then it is equally important that the printing be right side up to minimize operator reading errors. These combined requirements call for a dual mode of presentation providing either heading-up or north-up map orientation.

Another classic question is: what should move, the aircraft symbol or the map? Obviously there are advantages and disadvantages to both schemes. Ten years ago I was positive the aircraft should move against a fixed map as it does on practically all early map displays built during the 1950s. Now I am almost equally convinced that, on balance, having the chart move provides more really important advantages. The biggest single advantage is that it reduces the frequency with which charts must be changed by the crew. Even if charts were changed automatically, frequent chart changing is objectionable, and operating near the edge of a fixed chart restricts the field of view about the aircraft.

HOW MAP DISPLAYS SHOULD BE SUPPORTED

This is a most important problem in terms of its implications for display design. Unfortunately it is a topic about which I have more questions than answers. For many reasons map display systems should be designed to employ microfilm charts rather than hard copy paper charts or full scale film transparencies. Microfilm is much easier to transport and handle, and a far greater chart capacity can be provided in a display employing microfilm.

The difficult questions have to do with where and how the charts are to be produced with timely updating and how they are to be distributed to their worldwide users with a minimal delay. For most aircraft/mission applications charts might be updated as infrequently as perhaps once a month. In this case they could be produced by a central agency and distributed in microfilm cassettes by air mail or military air transport. But consider the case of the tactical aircraft requirement to display such data as current defensive deployments on the map display charts. Here a rapid reaction is required, and techniques thus far proposed for meeting this requirement are something less than attractive.

DISPLAY EFFECTIVENESS

The consideration of what constitutes an effective map display is vital. A tactical crew operating at low altitudes and high speeds in enemy territory simply does not have the time to physically manipulate currently available maps in the process of verifying aircraft position. The problem is almost as difficult for an all-weather interceptor pilot or a logistics transport crew. A truly effective map display should provide information at a glance with a bare minimum of operator interaction. This readily available information should be presented in a form which facilitates the correlation of displayed position with visual sightings and/or with sensor presentations. It is this provision of not only a single indicator of aircraft position, but the corroboration of one indication with a second or third which provides the navigational assurance that can significantly enhance the success of a mission.

S. N. ROSCOE has had more than 20 years of experience in the field of engineering psychology, and in fact was the first human factors engineer in the electronics industry with a doctorate in engineering psychology. Joining Hughes in 1952, he formed the Cockpit Research Group to develop the advanced controls and displays required by the Hughes fire control and navigation systems. Before coming to Hughes, Dr. Roscoe was Assistant Professor of Psychology at the University of Illinois, where he engaged in contract research related to flight displays and controls. During World War II, he was a pilot in the Air Force.

At Hughes, Dr. Roscoe has been a participant in and the director of several major display and control programs. He was active in the development of the Hughes MA-1 and ASG-18 fire control systems and made major contributions to the displays and controls used in those systems. Dr. Roscoe has been primarily responsible for the advent of operational map-type horizontal situation displays in military aircraft and for the use of dynamic simulation as a design tool in developing radar displays and other high resolution image producing sensor systems. He served as Technical Director of the display and control portion of the Apollo Spacecraft proposal of the McDonnell-Chance Vought-Hughes-Lockheed team.

ID Readout

NEW FAMILY

Philco-Ford Corp. has entered the desk-top computer terminal field with a family of small and low-cost information display and entry products. Dr. Walter B. LaBerge, Philco-Ford v/p and general manager of its WDL Division, said the products will be assembled and marketed by WDL's Philco Houston Operations, situated near Houston and adjacent to the Manned Spacecraft Center (MSC). Philco Houston is a major support contractor to MSC. The products are "for use in any system in which operators are called upon to make computer-assisted decisions," said Robert T. Benware, Philco Houston's director.

Using one of the terminals, an operator may enter data into a computer, view data collected by a computer, or request a computer to undertake various calculations, he explained. "The terminals also eliminate the 'language barrier' we commonly assume to exist between men and their computers," Benware said. Communications are in plainly written English and in formats already familiar to operators.

A typical unit consists of three elements — a typewriter-like keyboard, a TV monitor, and associated electronics for generating and storing messages.

Benware explained operation of one of the displays:

An operator types out his message on the keyboard. As he types, the message appears simultaneously on the unit's TV monitor. When he completes the message, he reviews it for accuracy, then depresses a button to dispatch it to a computer. The computer signals him via the unit when it has accepted the message. If his message is a request for data, the information is flashed to him immediately on the model's TV monitor — in plain English and in familiar business or operational formats.

LOCKHEED TO APPRAISE BUDDING COMPUTER GRAPHICS TECHNOLOGY

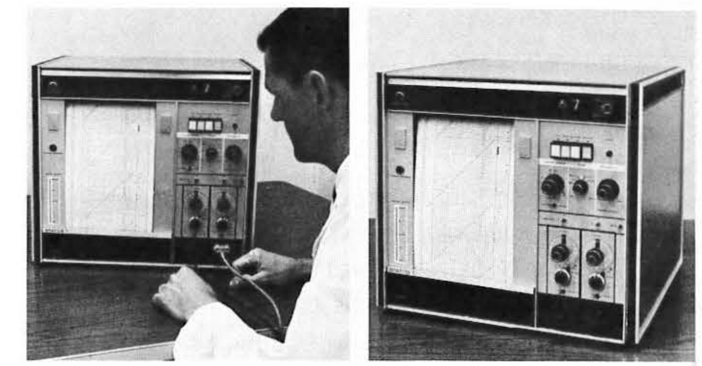
A major movement to explore the promise of the familiar television screen for the nation's space effort has been announced by *Lockheed Missiles & Space Co.*

The Sunnyvale firm said it has won a $67,590 contract from NASA's Marshall Space Flight Center to analyze the young field of "computer graphics" with an eye to NASA use.

"We're at the Wright Brothers stage in computer graphics," says Eugene K. Fisher, LMSC head of Computer Aided Design. "Our object is to provide the best man-computer relationship possible."

The government's Huntsville, Ala., space center began investigating computer graphics in 1964, and since then has been working independently to improve its skills. The new contract with NASA/Marshall offers the first rigorous test of those skills. In preparing for the Marshall project, Fisher's group studied application of computer graphics to design of electronic circuitry — in which an engineer using a light pen can outline a complex circuit directly on the TV screen — and also to the design of hypersonic re-entry bodies, structural dynamics and trajectory analysis.

NEW RECORDER PRINTS WITH NO MOVING PARTS IN WRITING PROCESS



An entirely new system of data recording and immediate visual presentation — combining electrostatic printing and integrated digital electronic circuits — has been developed by *Varian Associates*, Palo Alto, Calif., for use in aircraft, aerospace and the military. The new Statos I recorder prints data in direct writing form with a frequency response to 3,000 cycles per second with no moving parts, ink, arcing or heat in the recording process. According to the Varian Recorder Division, the accuracy, simplicity of operation and high frequency response make the new instruments ideally suited for recording such phenomena as missile vibration, temperature, pressure, shock, acceleration and telemetry data.

The same recording breakthrough has resulted in a 50-channel event recorder, called Statos II, for continuous logging of sequence of relay operations, radar timing and telemetry.

TRI-NATION SYSTEM

A mockup of the multi-purpose data display consoles to be used in a tri-nation Air Defense Ground Environment (ADGE) system was given its first public showing at the Belgian AF's Aerospace Electronics show. *Hughes Aircraft Co.'s* Fullerton, Calif., div. designed and built the console for Belgium, the Netherlands and West Germany. It is typical of multiple units to be installed in underground, bunker-type sites in the three nations to provide an air defense system. A similar system has been purchased by the Swiss government and the Japanese Air Self Defense Force. The system now being installed in the three nations will become part of the $308 million NATO Air Defense Ground Environment network, scheduled to provide early warning and weapons control over a system extending from Norway to

Turkey. The ADGE system will provide surveillance and detection, identification and tracking of potential air threats as well as provide "to the target" control of each nation's interceptors. Each site utilizes long-range radar; advanced digital display consoles, and an integrated communications data link net for instant voice and digital communications between installations. The NADGE program is headquartered in England. In addition to Hughes, members are France's *Thomson Houston-Hotchkiss Brandt;* England's *Marconi Co.,* West Germany's *AEG Telefunken,* and the Netherlands' *N. V. Hollandse Signaalapparaten.*

REMOTE LABORATORY CHROMATOGRAPHS TIES INTO A SINGLE CENTRAL COMPUTER SYSTEM

Atlas Chemical Corp., Wilmington, Delaware, has placed on-line a computer controlled chromatograph data acquisition and reduction system. The system handles the data reduction requirements of 24 chromatographs in two separate laboratories located more than a mile apart.

Developed by *Realtime Systems Inc.,* N.Y., the new system represents the first successful installation processing chromatograph signals from a remote location via telephone circuits. An SDS 92 general purpose digital computer provides the data reduction requirements for both laboratories. Realtime Systems Inc. furnished all of the hardware and software plus complete system implementation, installation and start-up.

The system includes the equipment for monitoring and digitizing signals from both thermal conductivity and flame ionization detectors. The computer program integrates response peaks, resolving overlapped peaks and shoulders and stores the results in the computer memory. The memory also stores data such as names and properties of hundreds of compounds being analyzed, along with the specifications of dozens of different analysis methods. By referring to stored information, the computer interprets collected data and types out a complete analysis report. The report identifies compound names, the amounts present in the sample, relative response factors and relative retention times. Automatic instrument calibration by internal or external standards is incorporated.

LOW-COST DISPLAY ON THE WAY

Results of a recent development at *MIT* makes the goal of a low-cost graphic display for time-shared computers closer, according to the institute's Electronics Systems Laboratory. The MIT display console was designed for Project MAC, research program on time-shared computers. It sends and receives both alphanumeric characters and drawings. The display includes a direct-view CRT, typewriter keyboard, and a simple graphic input device. Laboratory engineers speculate that the prototype terminal could be built in large quantities for about $5000 each. John Ward, ass't director of the systems laboratory, says that for graphic display, image storage is more promising than the "continuously refreshed" CRT display. High speed electronics for rewriting the picture are not needed, while conventional displays must be refreshed by redrawing 30 to 40 times a second to eliminate flicker. The display uses a standard high resolution Tektronix five in. storage tube, a 94-symbol standard keyboard, an electro-mechanical input device called the "mouse," and a control unit. The control is connected to a telephone line, providing analog voltages to drive the display screen and establishing the format for the keyboards and graphical input signals to be sent to the computer.

1967 INTERNATIONAL ELECTRON DEVICES MEETING

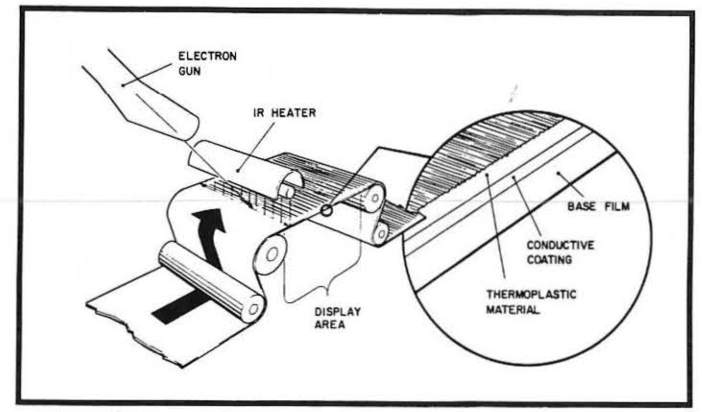
Integrated Electronics will be the subject highlighting the keynote session of IEEE's 1967 International Electron Devices Meeting (IEDM) to be held this year at the Sheraton Park Hotel in Washington, D.C., October 18-20.

Setting the stage for this important aspect of the conference, the opening session will feature invited papers in four major areas of technology covering both digital and linear developments. The session will not only provide coverage of important technological approaches to integrated electronics, but also important applications to military, industrial, computer, and consumer electronics.

In the digital area, two papers will cover large-scale integrated technology; one on MOS and one on bipolar design. The MOS paper will describe recent developments, including four-phase design techniques and will discuss MOS application to industrial equipments such as desk calculators and peripheral computer gear. The bipolar LSI paper will describe recent developments and applications to general purpose computers.

One of the papers covering the linear area will be devoted to microwave integrated electronics involving hybrid technology and its application to phased array radar systems. The other paper will describe developments in linear integrated circuits for consumer applications.

REAL-TIME AERIAL RECONNAISSANCE RECORDER-DISPLAY



A real-time airborne recorder-display system has been developed and delivered to the U.S. Air Force by *General Electric's* Electronics Laboratory under the sponsorship of the *Air Force Avionics Laboratory,* Dayton, Ohio.

Utilizing a thermoplastic recording technique, the equipment permanently records radar, infrared, and electro-optical information in a strip map form. Within milliseconds after actual recording, this information is projected optically on a rear-projection screen for real-time, in-flight viewing. A ground-based display, delivered with the airborne equipment, permits replay of the airborne tapes so that detailed, post-flight evaluations can be made.

The thermoplastic recorder-display provides higher resolution, wider dynamic range, real-time display capability, and elimination of chemical film processing. The recorded image, projected in real-time on the screen, contains approximately 8000x 5000 picture elements in a 3 x 2 in. area of the thermoplastic tape.

IMAGE ORTHICON BLASTS OFF

A *General Electric* image orthicon flew a "first" during the Gemini 2 flight. The 3-in. magnetic I.O. was a highly specialized tube developed by the Pickup Tube Operation, Syracuse, N.Y., for an image intensification experiment — one of several performed. The experiment, employing a television camera and recording system, was designed to investigate a method of making possible identification of earth features by an astronaut in night time. Image orthicons, although superior to videcons in sensitivity at low light levels, have not until now been considered suitable for TV cameras in space applications. Development of a tube with a delicate, ultra-thin target that will withstand shock, vibration and stresses encountered in every phase of the flight, opens the way for all types of space video operations using IO's. The tube performed as planned and survived the handling and the flight without physical or functional damage.

INFO68 — 9TH ANNUAL SYMPOSIUM

Planning Activities continue for the *Society's* 9th Annual Symposium, to be held in Los Angeles at the Ambassador Hotel, May 22-24, 1968. The symposium's planning committee, directed by Chairman Lou Seeberger, has issued a call for papers in the area of Medical, Civil, Educational, Military and Entertainment display applications and/or systems.

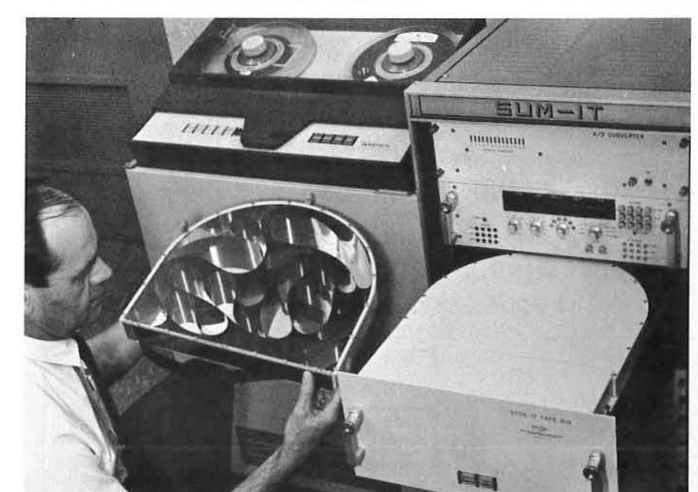
A Logo incorporating the symposium theme INFO 68, which was designed by Publicity Chairman Jim Belcher, has been incorporated in specially designed symposium letterheads for use by committee members.

Current activities of the symposium committee are focused in the areas of Registration Planning. This activity, which is headed up by Sam Davis, is pursuing methods to facilitate registration of the 600-700 engineers and scientists who are expected to attend the symposium next year. Preregistration will be encouraged by use of both reduced registration fees and a surprise registration gift.

Other major activities are being conducted in the Programs area where Chairman Bob Woltz, is conducting a search for both keynote and luncheon speakers.

Next year's symposium is also planning to use more sophisticated Audio-Visual Aids, according to Dave Morgan, who is directing that phase of the activity.

COMPUTER-COMPATIBLE SYSTEM



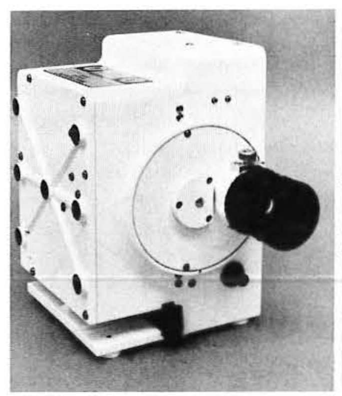
A new system which saves data processing time by making seismic digital recordings computer-compatible, before they reach the processing center, was recently placed on the market by *Mandrel Industries, Inc.,* a subsidiary of *Ampex Corp.,* Redwood City, Calif.

James E. Buescher, manager of Mandrel's electro-technical labs division, said the SUM-IT System solves a traditional problem encountered in processing seismic data obtained from "low energy surface sources," as opposed to the conventional methods using buried dynamite charges.

"Before such seismic data is fed into computers for processing, the seismic recordings must be strengthened and clarified. This is accomplished by compositing, or adding up, seismic field records, a process called summation," Buescher explained.

Field summation using anlog methods has already been done. However, with the advent of digital recording, this summation necessarily moved to the computer centers. This meant tying up equipment at the computer level to process large numbers of digital tape recordings. The SUM-IT System performs this summation digitally in the field and at the same time the system is recording the original data. In this way predetermined numbers of composite records are ready for the computer when they reach the processing center.

'QUICK-TRIGGERED' CAMERA HELPS SCIENTISTS STUDY COSMIC RAYS



A balloon-borne cosmic ray detector equipped with a "quick-triggered" 35 mm camera that automatically photographs "events" or spark trails 24 miles above the earth is serving as a laboratory for *University of Rochester* scientists.

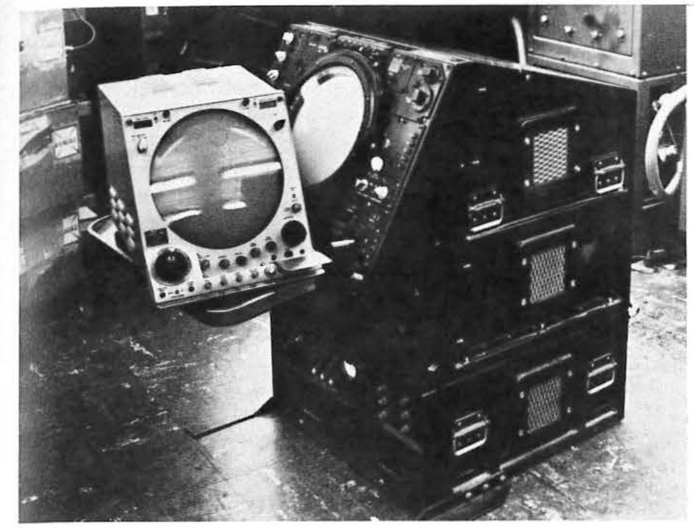
During the past two years the University's researchers have taken their high-flying spark chamber to Texas, India and Australia to study cosmic rays at the top of the earth's atmosphere. The studies are conducted under a research grant from the *National Science Foundation* and the *AF Office of Scientific Research.*

Encased in a 125-lb., egg-shaped canister, nicknamed "Humpty Dumpty," the cosmic spark chamber is carried to an altitude of 125,000 ft. by helium-filled balloons that measure 200 ft. across and have a volume of three million cu. ft. After each flight, which lasts 10 to 18 hours, the padded canister is parachuted back to earth.

The camera which provides the scientists with a complete record of the "events" of each flight was made by the Flight Research Division, *Giannini Scientific Corp.,* Richmond, Va.

The balloon-suspended spark chamber, designed by J. G. M. Duthie, assistant professor of physics, and Robert A. Majka, electrical engineer at the University of Rochester, was developed specifically for the study of gamma rays. The gamma rays are detected by the charged particles they produce in a piece of lead on top of the spark chamber.

MIRAGE DESIGNED FOR COST EFFECTIVENESS



A new display, the Microelectronic Indicator for Radar Ground Equipment (MIRAGE), recently delivered to the Air Force by *General Electric's* Heavy Military Electronics Dept., will provide hundreds of thousands of dollars in Cost Savings over the next few years when the operational equipment is in the field in quantity. Developed under contract to the *Rome Air Development Center,* (RADC), the display uses a technique initially investigated by GE, to replace gear trains, synchros and other mechanical devices with a Digital Differential Analyzer as a simplified method of indicating beam direction. The equipment could be used as a one-for-one replacement for the currently operational AN/UPA-35 Indicator Group for Radar Sets and incorporates the latest microminiaturization packaging techniques.

CALL FOR PAPERS — SJCC

The 1968 Spring Joint Computer Conference will be held in Convention Hall, Atlantic City, N.J. April 30-May 2. Original papers reporting on any aspect of the computer or information processing field in breadth or depth, from hardware to software and theory to practice, are invited. Five copies of complete, but not necessarily final, drafts must be submitted by October 30, 1967. These must be typewritten double-spaced on one side only, should not exceed 6,000 words, and must include copies of all figures properly numbered. Each page should contain the name of the senior author and be sequentially numbered. All copies should be sent to: Prof. T. R. Bashkow, Technical Program Committee Chairman, 1968 SJCC, Dept. of Electrical Engineering, 1312 S.W. Mudd, Columbia University, N.Y., N.Y. 10027.

BETTER COMPUTER DATA TRANSMISSION

By applying mathematical formulas, an *IBM Corp.* engineer can determine how to detect errors and their effects on efficiency in transmitting computer data over telephone lines.

Cesar R. Velasco of IBM's Kingston, N.Y., laboratory found that by applying the formulas, it is possible to determine the type of error-detection system that should be implemented — matching the system to the computer users' needs, and presented his findings at the IEEE International Conference on Communications. Using mathematical formulas in his study, he correlated error-detection schemes and transmission methods to calculate efficiency rates.

Also studied were two transmitting methods — synchronous and start/stop. The synchronous method works on a precise, clock-like basis and is more direct and faster than the start/stop technique in which a signal to stop takes longer than other information signals to transmit. Detector check bits can take up valuable information space, lowering efficiency. Sometimes the ratio is so lopsided that there are more check bits than information bits being transmitted.

SPERRY STUDIES "GAS TUBE" APPROACH

Experimental "gas tube" flight display that eliminates the need for moving parts is studied by technician at *Sperry Rand Corp.* in Phoenix. Each small metallic segment on glass plate forms a separate cathode, which will be individually connected to solid-state circuitry. A second plate with transparent anode coating will later be mounted in front of the cathode plate, with neon gas sealed in space between. When voltage is applied between anode coating and automatically selected cathode segments, glowing gas (viewed through anode plate) forms numerals or letters in the four center patterns. Supplementary data, such as "miles" or "X 10," are illuminated in the rectangular blocks, and segments of the outer pattern represent heading pointers when lit.

The Naval Ordnance Systems Command will lease 15 HONEYWELL computers valued at $7.9 million; primary job of the computers will be to form a naval ordnance management information system that will standardize NOSC data processing as it relates to management, fiscal and technical matters.

A new computer language that will cut time spent in technical information searches from hours or days down to minutes—or even seconds—has been developed by LOCKHEED MISSILES & SPACE CO. Dr. Roger K. Summit is developer of the new information retrieval language known as *DIALOG*. Summit forsees a wide range of applications for Dialog including engineering data, personnel data and real estate information . . . Erwin Tomash, president of DATA PRODUCTS CORP., Culver City, Calif. revealed the terms of the Co.'s agreement to purchase over 85% of the shares of stock in UPTIME CORP., Golden, Col. Uptime Corp. manufactures card readers and punches which are sold as peripheral input and output devices to computer manufacturers and users . . . Dr. R. C. Mercure, Jr., vp of BALL BROS. RESEARCH CORP. announced the acquisition of the business of MIRATEL ELECTRONICS CO. Ball Bros. Research, a diversified electronics and aerospace subsidiary of Ball Bros. Co. Inc., will operate Miratel as a division . . . The award of a $3.5 million contract to EG&G, Inc., for development and production of weather chart transmission and recording equipment was announced by the Air Force Systems Command's Electronic Systems Div., Bedford, Mass. Designated as a weather plotter transmitter and receiver, the device will enable the Air Force to transmit weather maps, wind and cloud charts from weather forecast centers to operating bases five times faster than the present system.

DISCON CORP., Ft. Lauderdale, Fla. has been awarded a contract in excess of $40,000 to design and fabricate a Single Mirror Optical Tracker for the U.S. Naval Ordnance Test Station, Pasadena, Calif. The new optical tracker will be entirely self-contained, including its own power supplies, digital shaft encoders and servo drive systems . . . W. L. Maxson, Jr., president of MAXSON ELECTRONICS CORP., informed stockholders that the TELEMAX computerized travel reservation system is now fully operational. The system provides travellers with a printed confirmation in five seconds . . . VARIAN announces the acquisition of DECISION CONTROL INC., Newport Beach, Calif. Eleven year old DCI is a manufacturer of digital computers and related electronic and mechanical equipment. The firm employs approximately 230 people, and current backlog stands at about $3.5 million . . . A $4,800,000 contract for design, development and initial production of advanced air traffic control equipment was made by the U.S. Air Force (on behalf of the Air Force, Navy and Federal Aviation Agency) to the WHITTAKER CORP. The team, headed by Whittaker, consists of Whittaker, Los Angeles and TASKER INDUSTRIES, Van Nuys, Calif. . . . GENERAL TELEPHONE & ELECTRONICS CORP. announces the acquisition by a GT&E subsidiary, SYLVANIA ELECTRIC PRODUCTS INC., of the assets and business of ULTRONIC SYSTEMS CORP. A total of 364,817 shares of GT&E preferred stock was issued in the transaction.

NORTRONICS DIV., NORTHROP CORP. has been awarded a contract to study preliminary designs of an advanced airborne photo-tracking unit. The Air Force Eastern Test Range, Patrick AFB, Fla., issued the contarct . . . GRAPHIC CONTROLS CORP., Buffalo, N.Y. filed a registration statement with the SEC seeking registration of $3,500,000 of convertible subordinated debentures, due 1987, to be offered for public sale through underwriters headed by DOMINICK & DOMINICK INC. The Co.'s principal product lines are recording charts and continuous data processing forms. Net proceeds of its debenture sale will be applied to the purchase of a GE time-sharing computer system and equipment, machinery and equipment to produce recording charts and continuous data processing forms, to the retirement of short-term bank loans, and for general corporate purposes . . . A technical conference entitled "Advanced Composites — A Structural Design Perspective" will be held in Denver Colo., at the Denver Hilton Hotel, Sept. 19-21, 1967. The primary emphasis of the Sept. conference will be on the structural design and hardware development aspects of the advanced composites developmental program, highlighting the areas of aircraft structures, helicopter rotor blades, re-entry vehicles and aeropropulsion systems . . . U.S. Naval Ship Systems Command, Washington, D.C., has selected GENERAL ATRONICS CORP. to supply a large production run of portable oscilloscopes built to miltiary specifications. ELECTRONIC INSTRUMENT DIV. of General Atronics, designer and builder of the fully militarized oscilloscope, An/USM-117, will handle the production run.

GRANGER ASSOCIATES reported nine months earnings of $5,003,617, up from $3,801,419 for the corresponding period a year ago. Earnings per share were 46 cents and 25 cents respectively, after taxes . . . CALIFORNIA COMPUTER PRODUCTS INC., Anaheim, Calif., has received a $750,000 follow-on production contract from the U.S. Army's Frankford Arsenal, increasing an original order for equipment for field testing of the Army's computerized artillery fire control systems to $1,900,000 . . . VARIAN, Palo Alto, Calif., has acquired DECISION CONTROL INC., which has been renamed VARIAN DATA MACHINES, and will be operated as a wholly-owned subsidiary . . . SANGAMO ELECTRIC CO., Springfield, Ill., and INFOTEC INC., N.Y., have signed an agreement for the joint development, manufacture and marketing of electronic data processing equipment. Sangamo expects to participate to the extent of a 20% interest in Infotec . . . Librascope Group, GENERAL PRECISION INC., Glendale, Calif., and COMPAGNIE GENERALE DE TELEGRAPHIE SANS FIL, Paris, have reached a long-term agreement in the field of airborne, multi-colored "head-up" displays which are designed for use in military and commercial aircraft. These displays are systems which project vital navigation and aircraft-attitude information to infinity through the windshield so the pilot can view this information without having to refocus his eyes from the exterior to the instrument panel.

CONRAC CORP. has opened a district sales office in Palo Alto, Calif. The Corp., listed on both the American and Pacific Coast Stock Exchanges, includes eight operating divisions which provide sensing and control instrumentation for both industry and aerospace . . . PHOTOMECHANISMS has acquired the assets and business of SCANOPTIC, INC., Woodside, N.Y. Photomechanisms will conduct the business formerly conducted by Scanoptic through the Scanoptic Div. of Photomechanisms which will be located at their Huntington Station plant. Both Franz Ehrenhaft, former president of Scanoptic, and Dr. Seymour Rosin, a former director of Scanoptic and its chief optical designer, will continue to be available as consultants to Photomechanisms on optical design . . . The first demonstrations of an infra-red light beam used to transmit information is being shown by IBM CORP. at Expo 67 in Montreal. An infra-red light beam is being used to carry stock quotations from the Montreal Stock Exchange across the St. Lawrence River to the Canadian Government's Expo 67 pavilion — a distance of almost two miles . . . Beverley A. Shaw, an engineer in RAYTHEON CO.'s MICROWAVE & POWER TUBE DIV., has been awarded a patent for an improved cathode heating structure for power tubes and traveling wave tubes. Tube designs based on the invention should provide higher heater efficiencies and longer heater life, thus contributing to higher reliability and lower costs in electronic systems such as radar and communications . . . The SOCIETY OF PHOTO-OPTICAL INSTRUMENTATION ENGINEERS held its 12th Annual Technical Symposium at L.A.'s International Hotel, Aug. 7-11, 1967. Co-sponsored by the U.S. Air Force Systems Command & Office of Aerospace Research, the seminar had as its theme "Photo-optical Instrumentation — Toward a better image of Science & Technology" . . . To help its engineers keep pace with the scientific revolution, LEAR SIEGLER, INC. has established a tele-lecture link between its Instrument Div. in Grand Rapids, Mich., and Michigan State University, sixty miles away. This two-way telephone link enables the engineers to continue studying and work toward advanced degrees.

A Navy contract totaling $575,000 for lead-computing weapons delivery sights has been awarded to CHICAGO AERIAL INDUSTRIES INC., Barrington, Ill. The sights are scheduled for use on Navy/Grumman A-6A Intruder all-weather attack bombers.

SID Activities

The Society for Information Display welcomes the following new members:

ACKERMAN, Robert—*Douglas Aircraft Company;* ADAMS, R. A.—*A. B. Dick Company;* ADAMS, Roy L.—*Philips Electronics;* BANKS, Billy M.—*General Electrodynamics;* BARTH, Hugh—*Emerson Electric Company;* BELLOFIORE, Michael—*TIME Inc.;* BONNER, John—*Texas Instruments;* BUMILLER, Donald—*Norton Company;* CALVERT, Thomas—*LTV Electrosystems;* CAUNTER, Peter—*Orbafilm;* COLLIGAN, Thomas E.—*Sanders Associates;* COLLINS, Charles—*Infotec Inc.;* DAVIS, Robert—*Texas Instruments;* DeLOOF, John—*Hughes Aircraft Company;* DEMKO, John — *Electronic Associates Inc.;* DERSCH, William—*Boeing Missiles;* ELION, Herbert—*Mass.*

ERICKSON, Marvin—*Battelle Memorial Institute;* FERGUSON, Milton—*Hughes Aircraft Company;* FORD, Allan—*Sanders Associates;* FRAGER, Arne—*Adage Inc.;* FREDMAN, Irwin—*Data Systems Analysts, Inc.;* GILBERTSON, Lyle—*Univac Federal Systems Division;* GOODE, George—*Texas Instruments Inc.;* GRANTEER, David—*Tektronix Inc.;* HICKS, Roberts—*The Thorson Co.;* HUNT, Geoffrey—*British Embassy—DRDS;* ISENBERG, Sheldon—*Warnecke Electron Tubes, Inc.;* KOCHMAN, Arthur — *Douglas Aircraft Company;* KOPFF, Andre—*Pantronics, Inc.;* KUYPERS, Ned—*Hewlett-Packard;* LEVI, Bernard—*C.S.F.—France;* LOUCHHEIM, William, Jr.— *Naval Ship Engineering Center;* MARCUS, Jean—*Compagnie DeSignaux Et D'Entreprises Electriques;* MARKKANEN, Carl—*Fairchild Camera & Instrumentation;* MILLER, Robert—*Magnavox;* MITCHELL, Jack—*LTV Electro Systems Inc.;* MIYAJI, Koh-ichi—*Matsushita Research Institute, Tokyo Inc.;* MURRAY, Gordon—*Hughes Aircraft Company.*

McCAUSLAND, Ronald — *Hazeltine Elec. Corporation;* O'BRIEN, Robert—*Bio-Dynamics Inc.;* O'DONNELL, William —*Department of the Navy;* OEHLER, Philip—*Autonetics,* PARKS, William—*Jonker Corporation;* POTTS, Jerry—*Scientific Data Systems;* REX, Robert—*University of California at Riverside;* RODDEN, William—*Texas Instruments Inc.;* ROGOFF, Gerardo—*Sanders Associates;* ROSANES, Albert—*Hazeltine Corporation;* SCHAUSS, Edward—*Optics Technology Inc.;* SIMPSON, Anthony—*Sussex University;* SISK, William—*LTV Computer Center;* SOUSA, Walter—*The Mitre Corporation;* STEGINSKY, Paul—*NRA Inc.;* STETTINER, Richard—*Link Group GPI;* WHITE, Robert—*TNT Communications Inc.;* WOLKE, John—*John C. Wolke Sales Association;* WRIGHT, Theodore—*Westinghouse Electric Corporation.*

New Student Members

LOEHNDORF, Chris—*University of California at Los Angeles (UCLA);* STETSON, Robert—*MIT.*

CHAPTER NEWS

The American Documentation Institute has extended an invitation to the Society to appoint an *SID* member for official representation in their Liaison Committee. Mr. Sol Grossman of Western Periodicals has accepted the position of National Liaison Representative between ADI and *SID.* Mr. Grossman is a member of both the American Documentation Institute and the Society for Information Display.

The *Bay Area Chapter* has been inactive due to the summer vacation period. Upon completion of the 8th National Symposium in San Francisco, the Steering Committee held a final dinner meeting. Chairman Don Cone expressed thanks to all those who helped with the Symposium.

A Forum on Man's Environment: Display Implications & Applications, will be held at the Willard Hotel, Washington, D.C. on November 16, 1967. The *Washington, D.C. Chapter* was authorized by Mr. William Bethke, President of the Society, to organize a forum to identify specific aspects of man's environment in which information display can produce vital benefits immediately and in decades to come. Mr. Hal Darracott is chairing a committee to select speakers for the Forum. Mr. Petro Vlahos has accepted an invitation by the Chapter to be the Moderator and to deliver the Challenge of M.E.D.I.A. to the technology. Actively participating in M.E.D.I.A. plans are J. McGuire, L. Gardner, E. Pickett, M. Gunzebrg, D. Doucette, M. Russell and L. Blair.

A recent meeting was held in Dallas to plan the formation of a *Southwest Chapter* of the Society. In attendance were approximately twelve members from LTV, TI and General Electric Dynamics. A set of chapter bylaws were drawn up, and a petition was written, which is currently being circulated among Southwest Chapter members, to obtain the required number of signatures for chapter ratification. The petition and proposed bylaws cover a chapter territorial area of Arkansas, Louisiana, New Mexico, Oklahoma, and Texas. The following temporary officers were appointed to represent the chapter during its formation period: Acting Chairman, C. R. (Chuck) Stobart, LTV Electrosystems, Acting Vice Chairman, Larry Pipken, Texas Instruments, and Acting Secretary, Ted Falconer, Texas Instruments. It is planned to complete ratification of the local chapter and to hold a general organizational meeting sometime this Fall. Any person interested in becoming a member should contact one of the above individuals for more details of the chapter formation, or contact C. R. (Chuck) Stobart, LTV Electrosystems, P. O. Box 6118, Dallas, Texas 75722.

HONORS AND AWARDS

We all recognize the importance of the widest participation possible of the members of the *Society for Information Display* in selecting members and others for Honors and Awards. The information which follows has been prepared to assist the membership of *SID* in performing this duty and taking advantage of the privilege to do so.

The Bylaws of the *Society for Information Display* charge the Honors and Awards Committee with reviewing candidates for election to Fellow and making such recommendations to the Board of Directors, and with recommending such honors and awards as may become appropriate to *SID.*

A Fellow is described as a member elected by the Honors and Awards Committee from nominations at large made annually of outstanding engineers and scientists in the information display field who have made widely recognized and significant contributions to the advancement of that field.

Policy has dictated that to be a Fellow, the candidate must first be a member of the Society.

Last year, the Board of Directors established The Frances Rice Darne Memorial Award, to be awarded to a Society member for an outstanding technical achievement (as opposed to teaching, publication, or service) in, or contribution to, the display field. The first such award has yet to be made.

However, a Special Citation was awarded for service to *SID.*

Other awards may be made in one or more of the following categories:

1. Outstanding technical accomplishment in the field of information display or allied sciences.
2. Outstanding contribution to the literature of information displays or allied fields.
3. Outstanding service to the Society.

While awards and honors are made only to members in good standing, prizes may be given to anyone. Specific definitions of these terms are:

Honor — a rank or position of prestige being a symbol of distinction.

Award — symbolic evidence for recognition of meritorious accomplishment.

Prize — cash or equivalent (such as merchandise, scholarships, savings bonds, etc.) earned for outstanding performance.

In order for the Committee to perform its duties effectively and efficiently, suggestions and nominations for Honors Awards and Prizes must be in its hands prior to January 1, 1968. Any member of the *Society for Information Display* may make such suggestions. The award of Fellow requires that the nomination be attested to by at least five (5) members in good standing. Suggestions and nominations must be accompanied by substantiating material setting forth qualifying evidence.

The Honors and Awards Committee urges your earliest consideration of the matter of Honors and Awards. By wide participation of the membership *SID* will honor members and others justly, equitably, and in a timely manner.

The Committee may be addressed via the National Office, local chapters, or at 502 Kentucky Avenue, Alexandria, Virginia 22305.

SAMPLE FELLOW NOMINATION FORMAT
(Length as Required)

Nomination to the grade of Fellow is submitted by:______
______________________________ chapter or region.

______________________________, a member in good standing of the *Society for Information Display* is hereby submitted for election to the grade of Fellow of the Society. This nomination is officially sponsored by the following five members in good standing, whose signatures attest to the fact:

(1) ______________________
(2) ______________________
(3) ______________________
(4) ______________________
(5) ______________________

The recognized and significant contributions to advancement of the Information Display field and the puropses of the *Society for Information Display* for which this candidate is proposed include:

Below is a brief biographical sketch of the Nominee:

Attested and forwarded to the Honors and Awards Committee this ______ day of ______________, 196____, by:

____
Chapter Chairman or Regional Director

New display system talks back

Profile of SST is shown on CRT display of Tasker Industries' new Series 9000 Modular Display System. Line drawing on scope shows effect of secondary shock waves on SST at Mach .01-03. Typewriter allows non-technical personnel to "talk" to any of the thousands of computers currently in use.

A new computer information display system aimed at aiding industry and government in identifying problems caused by the world's population explosion has been produced by Tasker Industries, Van Nuys, Calif., eleven year old electronics contractor. The real-time Series 9000 Modular Display System is the culmination of three years of intense company sponsored development.

The new system allows business managers and other non-technical employees to "talk" to computers using a large CRT display with a typewriter keyboard. Advantage of the system, according to marketing manager M. E. Forgey, is the rapid display of graphic information. An operator can produce line drawings and words on the screen, thus conversing with the computer on his design concepts, and receive appropriate verifications.

Data inputs can be analog, digital, or a combination, and dynamic data can be presented against static backgrounds. An operator can edit, update, delete and retrieve stored information. He can also monitor and control programs via the display. A series of the 9000 Displays can be time shared with one computer center and carry out separate and unrelated functions. These include gear train computations, stress analysis, electronic circuit design, program progress charting and various management functions.

Logic and circuit networks in the Series 9000 are divided into functional modules, each of which performs a distinct operation. The interface unit is the key element which permits the system to accommodate any type of computer with distinct interface characteristics and command structures. The interface unit not only accomplishes physical connection of signals between a computer and a display, but acts as a command format translator. This characteristic of the interface unit causes computer commands to be translated into a command language suitable for control of the individual functional modules and, conversely, it translates data, which is generated at the display, into a command language compatible with the associated computer.

Basic modules of the display system, which provide the positional and intensifying signals for driving the electron beam of the CRT, are composed of the video and deflection module. Composition of the video and deflection module is in many ways dependent upon the particular CRT and the desired performance characteristics. Several of the parameters are inter-related although, generally speaking, CRT tubes with less than 92° deflection angles can achieve significantly higher writing speeds and beam movement velocities than the 92° deflection angle CRT for any given amplifier size. Function of the video and deflection module is to receive horizontal (X) and vertical (Y) deflection voltages plus video gating (Z) signals from other functional modules and transform these into signals which will deflect the electron beam to a position on the CRT face as prescribed by the X, Y input voltage analogs.

Function of the position module is to accept digital position commands from the interface unit or a refresh memory and convert this digital position into an equivalent pair (X and Y) of analog position voltages. Depending upon the selected CRT size, and desired positional resolution, the position module can accommodate up to 4096 grid divisions in each of the two axes.

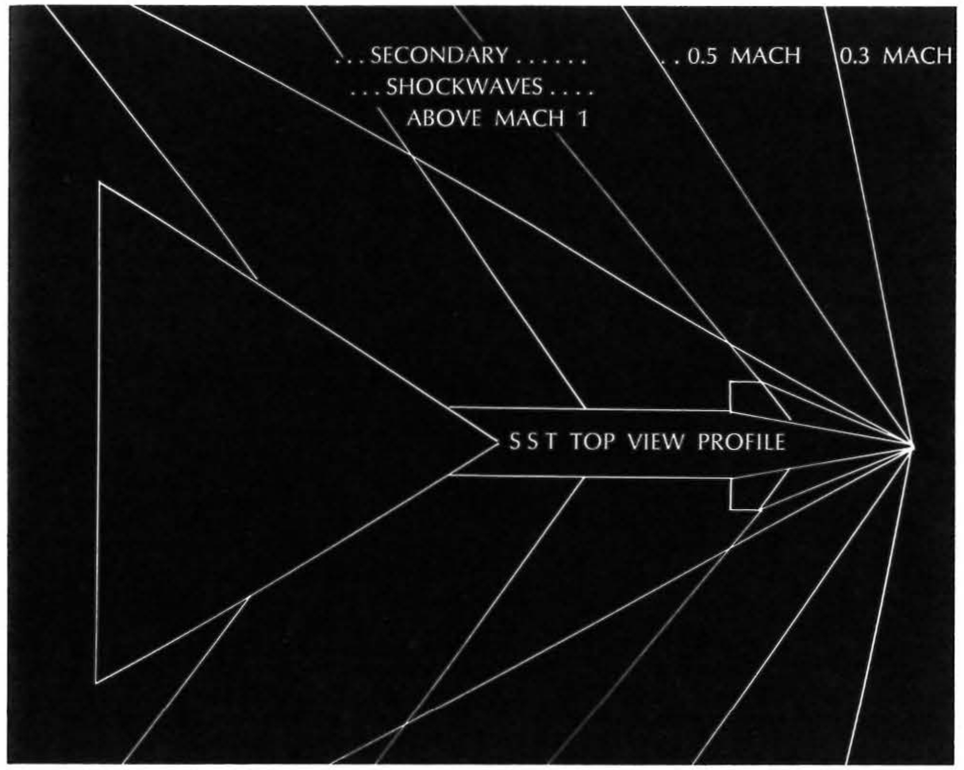
The control unit in itself does not perform any single function for a given display operation, but rather, it functions as a sequencer for the control of all other functional modules and the routing of data between the interface unit and the functional module.

The modules which have been described above form the basic elements which are necessary for the positioning and intensification of the CRT electron beam.

Addition of a vector line generator module provides the capability to interpret digital commands into equivalent voltage excursions which will cause the "painting" of intensified lines on the face of the CRT. These vector lines afford the display a graphics capability for the presentation of line segments in any direction with lengths of essentially 0 (one grid division) to a full screen diameter. The video gating networks associated with the vector generator permits any desired line to blink at a predetermined rate or to appear as dashed or dotted segments.

For the display of alphanumeric characters and/or special symbols, a character generator module is added, the function of which is to accept digital commands and translate these into equivalent small signal excursions in the X and Y axes which describe the selected symbol. The character generator module has a wide flexibility in both symbol style and repertoire. In most cases, when characters are to be displayed, they will occur in formatted positions, as in the case of text. In order to accomplish this positional arangement of characters to form text, a format generator module is included which serves to modulate the main position coordinates for the spacing of characters and the spacing of lines of characters.

The remaining functional modules perform ancillary functions to enhance optional features of the display system. The refresh memory is an optional unit, which is included in display systems whenever there is a desire to lessen the storage and input-output transfer rate requirement on the computer. Where a refresh memory is not included as a part of the display system, refreshing of the display must be accomplished by repetitive transfer of display frames from the computer at some rate between 30 - 60 times per second. The selection of a refresh rate for either computer refresh or local refresh is dependent upon the quantity of data to be displayed and the light output requirements for flicker-free presentations. Although delay line memories and drum mem-



Effect of shock waves on SST stand out in top view.

ories are offered and can accommodate many of the refresh requirements, it has been our experience that the Tasker 9000 Series high-performance characteristics are best satisfied by means of a magnetic core memory. A typical memory's size which satisfies a majority of the Series 9000 applications is 4096 words with 16 bits per word, having a full-cycle time of 2 microseconds.

The keyboard module, offered as an option, is utilized for the entry of alphanumeric and/or special symbolic data into the refresh memory or the computer for purposes of the display composition, editing or instructions pertinent to a data base. In most applications the number and type of symbols provided on a keyboard are a duplicate of the symbol repertoire available from the character generator module. In these cases where the associated computer is accomplishing the refresh operations and software control of display generation, editing, and the like, it is often more advantageous to accomplish an interface directly from the keyboard to the computer I/O bus as opposed to transferring keyboard data via the interface unit and direct memory access channel of the associated computer.

Programmable function keys, usually a group of 16 - 32, are individual push-type switches which are used to initiate discreet operations, either within the display system or via software routines in the associated computer. In effect, it is an aid which allows the operator to manually control a set of display commands. Some typical function key labels include: line erase, page roll-up, store message, light pen plot, etc.

The bowling-ball module, also known as a track-ball, is likewise an operator aid which provides a facile means of positioning a cursor to any given point on the CRT face in a very accurate manner, without precise manual manipulations. Some of its uses are in establishing the end points of vectors to be displayed on the CRT or for "hooking" any desired display element on the CRT screen.

The light pen module, offered as an option, provides the capability for the operator to communicate with elements of the display (vectors, characters and points) in a manner comparable to the use of a wand or pointer. This capability enables the operator to hook any displayed element and through servoing, via the computer software program, he may, in effect, draw graphic presentations on the display. The light pen itself merely detects the presence of light within a matter of a few microseconds after the electron beam has caused phosphor illumination within the aperture of the light pen. Modification of the displayed data for generation of new display data by this technique is accomplished primarily by the software routines which utilize these time-dependent signals.

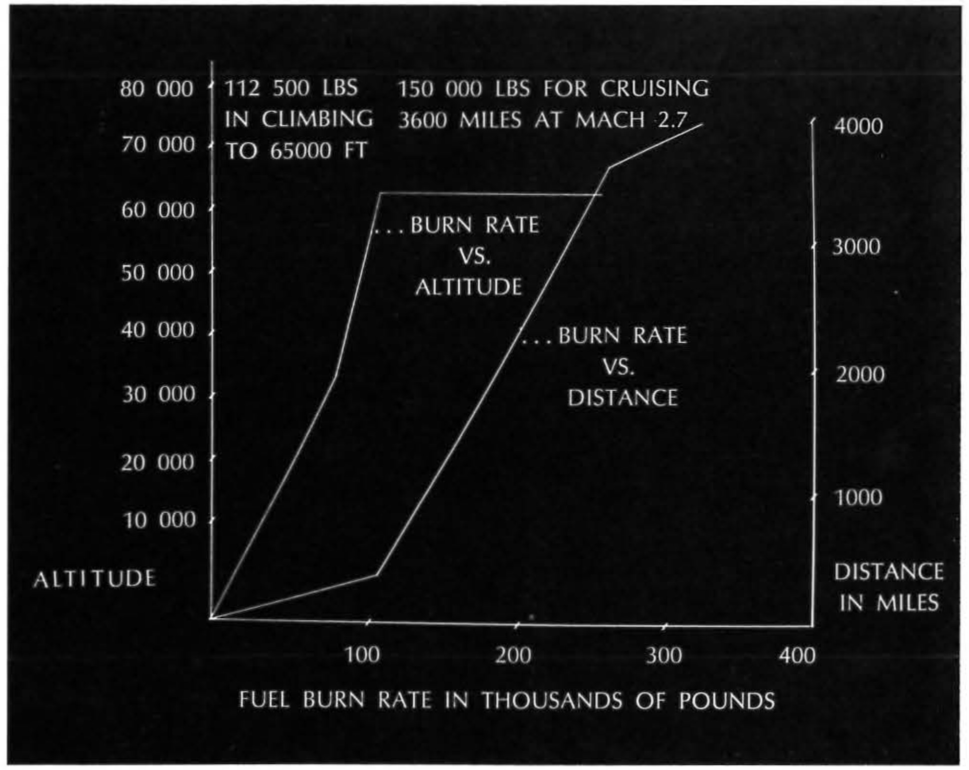
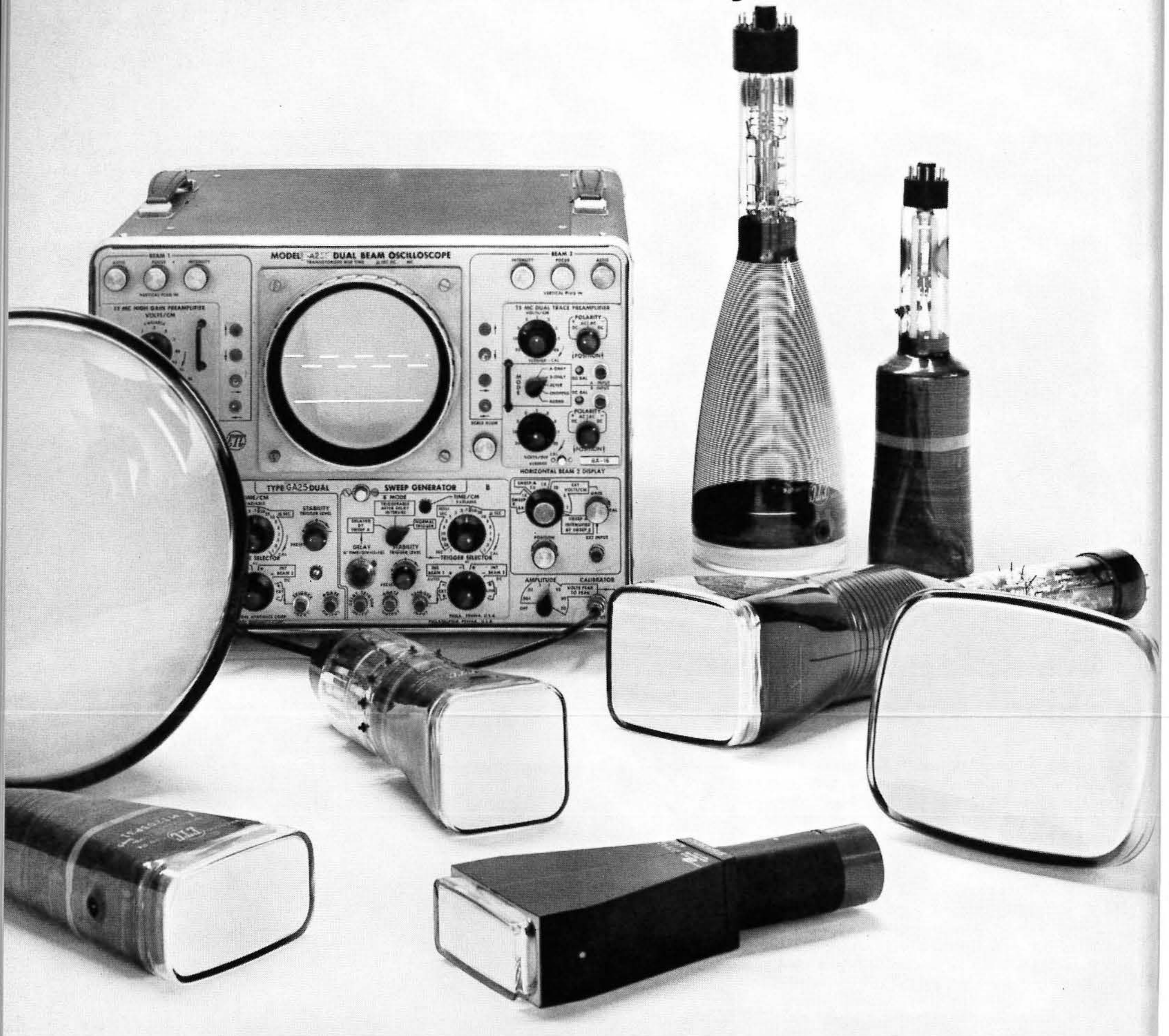


Chart shows typical SST fuel burn rate vs. altitude and time on CRT of Tasker new Series 9000 Modular Display System.



ID Products

Non-Snap Pushbutton Switches

New non-snap, low-bounce versions of an industrial, snap-action pushbutton switch are now being offered by Control Switch Div., Controls Company of America, Folcroft, Pa. The switches feature less than 1 microsecond contact bounce after transfer, and are designed specifically for fast computer circuits. Designated B5200 and BW5200 Series, the switch units complement the company's snap-action, moistureproof, W100 Series pushbutton switches. BW5200 Series switches are moistureproof; B5200 Series switches are not. The switches are part of the family of uniform-panel-appearance switches from Control Switch. Within this family, many different ratings, circuits, and operating characteristics can be selected while still maintaining a uniform appearance across the switch panel. B5200 and BW5200 Series switches are rated for loads of 3 amperes resistive, 1 ampere inductive, and 1 ampere lamp at 28 volts dc or 120 volts 60 and 400 Hz ac. They include 3 circuit arrangements, 18 mounting styles, and choice of red or black pushbuttons appropriate to momentary, non-snap action. The switches are also available as B5250 and BW5250 Series in 1/2 and 3/4-in. sq. and 9/16-in. diameter keyboard plunger caps.

Circle Reader Service Card No. 31

Graphic Input System

A new type of graphic input system which allows an operator to trace or sketch material from hard copy or projected images directly into a computer has been announced by its developer, Data Equipment Division of Bolt Beranek & Newman Inc., Santa Ana, Calif. Designated the GI/360, the device interfaces BBN/DE's 1010A to the IBM System 360 line of computers and may be physically mounted in the console of an IBM 2250 display CRT. Graphic input is independent of any display or tracking on the 2250, the firm claims. The new device has a maximum resolution of 100 points per inch. Interface logic in the GI/360 is said to allow the programmer to specify the rate at which the central processor is interrupted to input graphic data. Programs can specify both an elapsed-time criterion and a change-in-stylus position criterion which must be satisfied before the next graphic data point is delivered to the processor. This eliminates the possibility of encumbering the computer with the processing of redundant data.

Circle Reader Service Card No. 32

Readout Tube

National Electronics, Inc., a Varian Subsidiary, Geneva, Ill., has announced a new numerical readout tube, with an inverted base, NL-874. It is mounted vertically with the base at the top to permit optimum use of panel spacing. ND-874 is a side view, long life, display tube with .310" characters, 0 to 9. NL1874 requires a minimum dc supply of 170 volts at maximum cathode current of 3.0mA average, minimum — 1.5mA average. Prebias limits — 50V to 120V dc. Dynamic operating life — 200,000 hours. Other versions available are: NL-875 with left hand decimal point; NL-876 with right hand decimal point; NL-877 with left and right hand decimal points; NL-884 with + and — only.

Circle Reader Service Card No. 33

Nixie Tube Features Highest Packaging Density

Production of a new nixie tube, type B-5560, has been announced by Burroughs Corp. Electronic Components Div., Plainfield, N.J., manufacturers of nixie tubes, driver modules, memory components and memory systems. This new tube features the largest possible character height (0.52") in the tube bulb diameter (0.6"). This feature permits the equipment manufacturer to produce a physically smaller display while maintaining high readability. Compared to the most popular nixie tube (standard rectangular), the B-5560 only has a 15% smaller character height, but a 24% smaller tube width. Compared to the smallest tube (miniature rectangular), the new B-5560 has a 68% larger character height in only a 28% wider bulb.

Circle Reader Service Card No. 34

AC/DC Converter

A new AC/DC converter with 70 db dynamic range, frequency response from 5 Hz to 5 MHz and 300 microvolt sensitivity has been announced by Pacific Measurement Inc., Palo Alto, Calif. The converter, Model 1008, is suited for swept frequency measurements and for use with digital voltmeters. Circuitry employed includes a MOS FET rectifying detector circuit.

Circle Reader Service Card No. 35

Decimal Translator

Shelly Assoc., El Segundo, Calif., has developed the TR-100, a solid-state PC board which translates decimal code. The TR-100 can be used with all seven-bar segmented displays now available, the co. claims. Measuring 1⅞ in. x 2⅜ in. (not including the connector solder tabs), the translator offers a solid-state module comprised of silicon planar semiconductors, wave soldered to a printed circuit board. Operating temperature range is —20° to +100°C.

Circle Reader Service Card No. 36

Profile Monitor Oscilloscope

A profile monitor oscilloscope which has 10-millivolt full-scale deflection and displays up to 100 channels of information has been announced by the Industrial Products Div., International Telephone and Telegraph Corp. The instrument, designated PM 703, is designed for real time transducer output displays of temperature, pressure, or other physical phenomena. In the process control field the PM 703 reportedly eliminates the need for daily calibration of process control inputs. The 17-in. aluminized screen tube of the instrument gives flicker-free display, the co. claims. The PM 703 has optimum transducer compatibility, interlocking capacity and individual channel gain control. The oscilloscope is of solid-state design and has an automatic warning system and automatic shutdown.

Circle Reader Service Card No. 39

Plotter

The 1140 Variplotter, designed to satisfy the recording requirements of analog computers, is available from Instrument Div., Electronic Assoc. Inc., North Long Branch, N.J. The 11 in. by 17 in. Variplotter features static and dynamic accuracy of ±.075%. Slewing speed is 30 in./sec. on each axis, and repeatability is 0.05%. The 1140's reference capabilities include internal zener reference supplies for each axis and switch selectable external computer reference. The external reference includes dual provisions for ±10 and ±100 volts. Fixed scale factors are selected by push buttons while fixed and variable modes are switch-selected for each axis. The variable scale factor controls provide up to 100% attenuation on all fixed ranges. Input impedance is 50K ohms/volt full scale through 1 volt/in. All other ranges are 1 megohm constant. Input impedance for all fixed scale factors is maintained when in the variable mode. Paper is held down by a reportedly maintenance-free vacuum system with distributed air flow for 8½ x 11 in. or 11 x 17 in. paper. The recording area measures 10 x 15 in.

Circle Reader Service Card No. 40

Tactical Video

Reeves Instrument Div., Dynamics Corp. of America, Garden City, N.Y., announces a tactical video mapper that generates, controls and transmits video mapping data for use with radar displays. The mapper is designed for use by weapons controllers in battle area radar air control posts. It is an all solid-state device used for transmitting and superimposing an image on a radar plan position indicator (PPI). A transparent plastic material map is illuminated and the light coming through is detected by a vidicon whose sweep is synchronized with the PPI. The output of the vidicon is sent through a video amplifier to the PPI. The synchronized image, superimposed on the PPI, is in range and azimuth scale with the radar return. Relative range and azimuth to tactical notations made on the map can be determined on the PPI. An operational positional error of less than 2% of map radius is maintained. This video mapper is designed for use in conjunction with ground based radars. Other mappers are available for surveillance and airport aircraft operations.

Circle Reader Service Card No. 41

Readout Tube

The ZM1000 readout tube, designed for high-volume production readout panels, has been developed by Amperex Electronic Corp., Slatersville, R.I. The high temperature design of the tube base permits the PC board to be dip-soldered with the tube inserted. This method reduces the need for sockets. However, should individual design requirements necessitate sockets, the ZM1000 can be adapted for this purpose. The co. claims that other features of the tube include a built-in decimal-point indicator, accurate readability up to 35 ft., compact construction for the installation of an 8-digit readout in 6 in. of panel space and a life expectancy of 200,000 hr. Driver circuit designs are available with related data, parts, and instructions for all driver types: silicon-controlled-switch (SCS) memories or ring counters, diode/transistor decoders and for special applications

Circle Reader Service Card No. 42

50-MHz Oscilloscope

A lab-quality 50-MHz Oscilloscope in a 30-lb package, fully ruggedized to meet military requirements with respect to shock, vibration, temperature, and humidity, has been introduced by Hewlett-Packard, Palo Alto, Calif. Model AN/USM-281 is a versatile, dual-channel, 50MHz Oscilloscope that meets all its electrical specifications at temperatures from —28°C to +60°C and in 95% humidity up to 65°C. It is drip-proof, complying with MIL-S-108, and it meets the RFI specifications of MIL-16910C, Class I. It withstands shock tests of 1, 3, and 5 ft 400-lb hammer blows in three axes, in accordance with MIL-S-901. Mean time before failure of the all solid-state instrument is 5000 hours under the terms of MIL-HDBK-217.

Circle Reader Service Card No. 43

New X-Y Recorder From TI

A new X-Y recorder, offering convenience features coupled with a high resolution in recording, is announced by Texas Instruments Inc., Houston. Designated the "function/riter" recorder, the new instrument uses human-engineering techniques to create a multi-purpose instrument suitable for many different installations. Plug-in "function modules" permit the recorder to be quickly converted for use in a variety of applications. By utilizing proven solid-state servo systems already in production by TI, and through the use of enclosed infinite-resolution slidewires instead of helical-wound resistance elements, high precision is insured, while deadband problems are eliminated, according to the firm.

Either vertical or horizontal mounting of the recorder is possible, without special fittings or accessories. In addition, when the instrument is used as a tabletop unit, the recording surface may be angled to 45 or 90° from the horizontal to allow visibility of the recording even when the operator is seated. Both 8½ x 11 in. and 11 x 17 in. charts can be used. Either X or Y axes may be geared to time function, while the interchangeable "function modules" permit quick modification for the job at hand. Three modules are presently available: a single range signal-input module, a time-sweep/signal attenuator module and a multi-range attenuator module.

Circle Reader Service Card No. 44

Visible Array

The MVA 300A 5 x 7 Array offered by Monsanto, St. Louis, is a solid state read-out made with thirty-five MVE-101A gallium arsenide phosphide diodes mounted in a metal heat sink. The anode is common to the heat sink, and the cathodes are addressed individually from the rear of the display. The array can be used to display all numbers, letters and a variety of special characters. Each element is lit when forward biased 10 to 100 ma at about 1.65 volts. The display is used for visual read-out and film annotation applications which require solid-state reliability, high brightness, small size and low power consumption

Circle Reader Service Card No. 45

Xenon Arc Lamp

PEK Inc., Sunnyvale, Calif., introduces a line of AC operated xenon long arc discharge lamps for use in continuous operation applications such as materials testing, reproduction devices in graphic arts and photography, and repeating-type printers. The lamps employ quartz wall construction and may be water cooled with PEK's quartz water cooling jackets. Model XEL-2500 requires a power input of 2500 volt amp for a luminous flux of 77,000 lumens at 3300 cd/cm² brightness. Model XEL-6000 requires a power input of 6000 volt amp. for a luminous flux of 215,000 lumens at 3000 cd/cm² brightness. Average life of both units is approximately 600 hr., the firm states.

Circle Reader Service Card No. 46

For Space Applications

Ruggedized CRTs for space applications, designed by Thomas Electronics, Inc., Wayne, N.J., for use aboard the Gemini 8 and 11 spacecraft, are now available for general use. In the Gemini spacecraft, the 2E13P11M CRT was used as a high resolution photorecording device, and another Thomas CRT, the 5M33P4M, was used as a display. Ruggedized CRTS are used in space missions to withstand the shock and vibration encountered in lift-off, separation, and re-entry.

Circle Reader Service Card No. 47

Transistorized Indicating Lights

Transistorized indicating lights are offered by General Electric Co., Schenectady, N.Y. The CR108 Type G indicating lights reportedly meet the application requirements for computers, data processing equipment and communications and control systems using printed or integrated circuits. Input signals required to actuate the lights are: Neon — ON, 0 to 2 volts d-c; OFF, 3.6 to 6 volts d-c. Incandescent — ON, 0 volts d-c at 1.4 ma; OFF, 6 volts d-c. The lights may be mounted from the rear of the panel with a single knurled nut and backwasher. The co. claims that lights mount in a 3/8 in. dia. hole on centers as close as 19/32 in. and on panel thicknesses as close as 1/16 to 3/16 in. Both incandescent and neon forms will operate in temperatures ranging from —40°C to 65°C at 95% humidity. Removable color lamp cartridges are available for the incandescent form in amber, red, blue, green, clear and white translucent or white transparent.

Circle Reader Service Card No. 48

Packaged Generators

Kamag 14 packaged brushless generators have been developed by Kato Engineering Co., Mankato, Minn. The generators are available in single bearing to be connected directly to industrial engines, and in two bearing for engine connection through coupling or for coupling or belt connection to an electric motor or other type prime mover. The Kamag 14 generators come in either single or three phase and with either 50 or 60 cycles with ratings from 10 through 60 KW. They have a direct connected rotating exciter and a terminal box mounted voltage regulator with manual voltage adjustment and built-in series boost. Ball bearings are the double shielded cartridge type. The feet are cast within the endbells and the exciter and the rotating rectifiers are part of the shaft.

Circle Reader Service Card No. 51

Low-Cost CRT Ramp Generator

An inexpensive auxiliary time-base generator for any large-screen application has been announced by a div. of International Telephone and Telegraph Corp. The KS 2760 Ramp Generator provides all waveforms necessary to produce a triggered time base for the CRT display. For other precision timing applications, the instrument is said to offer accuracy, stability, and ±0.1-percent linearity. Sensitivity is 250 millivolts to 5 volts. The instrument has full lockout for completely stable triggering. The controls can adjust parameters for almost any requirement.

Circle Reader Service Card No. 52

Visual Communication Terminal

The Uniscope 300, a visual communication terminal designed for instantaneous viewing of computer-stored information, has been developed by the Univac Div., Sperry Rand Corp., Pa. The equipment consists of a keyboard with 61 keys, a CRT display screen and an associated control unit. Uniscope 300 can be used as a self-contained unit or in a multi-station version providing up to 48 keyboard displays directed by one control unit. The unit's screen has a 10 x 5 in. viewing area, and 16 lines of information with up to 64 characters in each line can be presented at one time. Added overlay keys can have 122 different combinations which give 4880 possible special functions. The computer may also send unsolicited messages, indicated by an audio and visual alarm signal.

Circle Reader Service Card No. 53

Video Amplifier

Beta Instrument Corp., Newton Upper Falls, Mass., has announced availability of Model VA1367 Gamma-Corrected Video Amplifier, a DC coupled 10 mhz, all-silicon, solid state plug-in amplifier which features a gamma-corrected transfer function to produce a linear relationship between CRT light output and input video drive. The model is said to employ feedback and temperature-compensation to provide optimum gain stability and temperature independence, and may be direct-coupled to the CRT grid or AC-coupled to a DC restoring level. It is fully compatible with all other modular display system components manufactured by the firm.

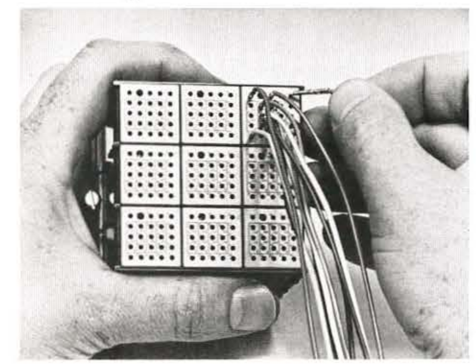
Circle Reader Service Card No. 54

Electronic Tester

The Spectra Optoliner is a high resolution electronic tester for all types of television cameras. Used in place of the "light box" type of testers, it has none of the variables usually associated with these testers, such as uneven lighting, optical misalignment, poor linearity, etc. Also, the Optoliner is small and portable, (weight: approximately 4½ lbs; length: less than 14 inches). In use the Optoliner threads directly into the lens mount of the TV camera. Standard test pattern slides are inserted into the Optoliner and are illuminated by a built-in lighting system. An external meter monitors the footcandles and color temperature of the illumination at the test pattern image plane. The Spectra Optoliner was developed by the Photo Research Corp., Hollywood, Calif.

Circle Reader Service Card No. 55

Plug-In Switch Modules



According to Master Specialties Co., Costa Mesa, Calif., their MSC 800 Square Tellite Plug-in switch is the first lighted pushbutton switch to introduce the use of crimp-type wiring terminals to connect switches. Rear mounted pin-type terminals are plugged into the terminal block held captive on the rear of the mounting rack assembly, allowing easy installation or removal without turning power off or disconnecting other parts. Matrix type mounting racks, that will accommodate up to 144 switch modules in configurations of 5 x 20 or 12 x 12 max., are shipped completely assembled and ready for installation. The switch mounts on 0.800 in. centers, requiring 36% less panel space than conventional designs.

Circle Reader Service Card No. 56

Tungsten Halogen Projector

Development of a tungsten halogen projector lamp with an internal reflector has been announced by Sylvania Electric Products Inc. The new lamp, designated BCK, uses a Tru-Focus base and socket and is interchangeable with existing CZA incandescent projector lamps. Sylvania developed the Tru-Focus base and socket in 1956.

The 500-watt BCK lamp has an average rated life of 50 hours, twice the life of the CZA lamp. Sylvania developed the new lamp under an arrangement with the Airequipt Manufacturing Co. which will use it in a line of new slide projectors. The lamp has an all-tungsten internal structure including the reflector. The support structure required for the C13D filament and internal reflector also are made of tungsten.

Circle Reader Service Card No. 57

Fan Delivers 575 CPM of Air

Rotron Manufacturing Co. Inc., Woodstock, N.Y., announces the Caravel fan that delivers 575 cu. ft. of cooling air per min. at free delivery. The design of the Caravel, which measures 10 in. in dia. and 3½ in. in depth, incorporates a die cast aluminum venturi and polycarbonate propeller. The sound level measures 45 db SIL. The fan weighs 5 lb. and revolves at 1700 RPM. The Caravel is available in two models, 115 VAC — 50/60 cycles single phase and 230 VAC — 50/60 cycles single phase, and has been designed to meet UL specifications.

Circle Reader Service Card No. 58

Interfacing Family of 5 MHz, I/C Logic

The introduction of a new family of I/C logic, with an overall thruput rate of 5 MHz, is provided by Logic Systems Inc., San Diego. Employment of both DTL and TTL logic classes, and certain discrete circuit elements throughout the broad, 70-3000 Series, give the design engineer greater flexibility in obtaining compatible intercommunication with various types and speeds of logic, generally required in complex system or test objectives. Basic operation is NAND logic. Card size is 5.800 x 2.500 in., (usable) and mating is provided by 47 pin Elco connector(s) accommodating most wiring techniques. A single +5 V regulated supply is required for most cards. All boards have discrete keying positions, to preclude accidental mis-location, and test points. Standard logic drawers, holding 60 cards with power supply or 90 without, and occupying 5¼ in. of rack space are available.

Circle Reader Service Card No. 59

Lighted Pushbutton Line

Designated the "Unimax LPB Series 9", the new line of Unimax Switch, Div., Maxson Electronics Corp., Wallingford, Conn., consists of four-lamp lighted panel controls designed to meet the requirements of MIL-S-22885. Features include single screw mounting, two-step relamping and factory-installed internal lamp bussing. The Unimax LPB's are offered with customized messages in a wide range of display styles and color coding. They are available with two, three or four pole momentary or alternate action switching. For maximum flexibility in the selection of components, the switches are of modular design. An added feature of the new line is an ordering system which permits the switches to be chosen by component groups, whether for a complete assembly or for a separate sub-assembly.

Circle Reader Service Card No. 60

Serial Memories

Anderson Laboratories Inc., Bloomfield Conn., has introduced the type 3641 magnetostrictive serial memories for application in computer printer sections to serve as temporary storage buffer memories. The serial memories, which use aluminum die casting, are available with or without electronics. The type 3641 memories are non-return-to-zero, in-and-out, unity gain packages in which the bipolar element is clocked and the NRZ section is not.

Circle Reader Service Card No. 61

 Circle Reader Service Card No. 63

New Advances

The Alpha-Lite, recently developed microminiature, modular, multi-filament, alpha-numeric readout display by Pinlites Inc., Fairfield, N.J. has added features for greater versatility.

In addition to the initially developed units with pigtail leads, the Alpha-Lite is now being produced with a microminiature plug-in termination allowing for mixed use with modular Midgi-Lites. Separate plug-in decimal point units are available in all Midgi-Lite sizes. The Model 43 Alpha-Lite is now compatible with the Model 04-30 Midgi-Lite. Both units have character heights of only 1/4". Overall depth of these units is only 5/16" and the overall height is 3/8". The width of the Model 43 Alpha-Lite is .335", while the Model 04-30 Midgi-Lite is only .275". Midgi-Mate drivers and encoders are now available for both units. Each Alpha-Lite contains a complete alphabet, complete digit, and numerous symbols. Each Midgi-Lite similarly contains a complete digit. Both the "43" and the "04-30" operate on 8 milliamps/segment at 3 volts.

Circle Reader Service Card No. 64

Video Transmission And Terminal Equipment

A new line of long haul video transmission, receiving, and distribution equipment has been announced by the RAM Television Products Div. of Canoga Electronics Corp. Designated Series VT-5000, the new equipment features balanced or unbalanced cable compensation in multiple runs in excess of 40,000 ft. and single runs up to 10,000 ft. Additional features include low cost (almost one-half compared to competitive equipment), all solid state circuitry and the equipment exceeds specification GEEIA-X-2049C. Standard enclosure is only 3½" high and has been designed for a 19" rack or wall mounting. A modular packaging design permits any standard receiving or transmitting enclosure to be customized to the users particular application without the inherent costs associated with customized equipment. The standard plug-in modules offer the user flexibility for either standard or hybrid configurations. Single or multiple runs for balanced (124 ohms) or unbalanced (75 ohms) cable compensation can be easily accommodated through proper selection of modules within each standard enclosure.

Circle Reader Service Card No. 65

Arc Lamp

A new high-performance 1600-watt xenon arc lamp for applications in solar simulation, scientific instrumentation, color projection and other areas requiring high intensity light sources, has been introduced by PEK Inc., Sunnyvale, Calif. The lamp, Model X-1600A, features ribbon-seal construction to provide security against vibration damage and insure reliability under severe environment conditions. Average brightness of the X-1600A is 75,000 Cdla/cm^2 (rated) with equivalent color temperatures of about 6,000°K. The lamp is DC operated, requiring an ignition voltage of 40 Kv. Operating voltage is 24+3 volts. Rated average life (under recommended operating conditions) is 2,000 hours.

Circle Reader Service Card No. 66

Intervalometer Available

Traid Corp., Glendale, Calif., announces an automatic "tripping device" that activates a 35mm cine pulse camera. This device, the Traid Model 390 Solid State Intervalometer, was originally tested and built to operate with the Neyhart Automax 35mm Cine Pulse Camera, distributed by Traid. The Intervalometer can provide five different pulse rates and converts 110 volt AC to 28 volt DC. It has no gears, motors or moving parts. Output pulse is variable between 10 and 250 milliseconds. Built-in power supply delivers 5 amps at 28V DC to camera motor. Counter keeps track of frames exposed. Input power is 115V AC 60 CPS.

Circle Reader Service Card No. 67

Remote Driver/Decoder Card

Industrial Electronic Engineers, Inc., Van Nuys, Calif., manufacturer of "Display-Mates", (Driver/Decoders and Readouts sold as a complete unit), now announces the availability of a 4½" by 5" remote Driver/Decoder Card. Possessing all the capability of standard IEE decoders, the "Card" has numerous driving applications other than readouts, such as relays, printers and other peripheral devices. Top specifications include 4-line BCD input and 10-12 decimal outputs. The unit features forbidden code rejection and both memory and non-memory options are available.

Circle Reader Service Card No. 68

Instrument Light Source

Instrument and control markings that glow safely without external power in a selection of colors are possible with new Betalights — self-contained light sources manufactured by Conrad Precision Industries, Inc., N.Y. Betalights are said to have a useful life of 20 years or more without external power or the need of replenishment, replacement or attention. They are suited for applications where batteries or conventional electrical wiring are impractical, as in instrument dials and controls, chassis illumination, probes, test equipment, etc. Betalights consist of a phosphor-lined glass tube containing a minute amount of radioactive Tritium gas. Beta particles strike the phosphor coating, causing it to glow like a small electric light.

Circle Reader Service Card No. 69

INFO '68

CALL FOR PAPERS

Ninth National Symposium of the Society For Information Display

Papers are solicited for five Symposium Sessions covering the Explosion of Display Technology now occurring. Emphasis should be on Display Systems and their applications to the problems of modern society. It is desired to have five areas covered.

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This Symposium, which is sponsored by the Los Angeles Chapter of SID, will be held May 22, 23, and 24, 1968 at the Ambassador Hotel. Please send Definitive Abstracts by November 3, 1967 to:

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INFORMATION SYSTEMS SUBDIVISION
Douglas Space Center
5301 Bolsa Avenue
Huntington Beach, California 92646
Telephone: 714 - 897-0311, Ext. 3757

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SYNTRONIC INSTRUMENTS INC.
100 INDUSTRIAL ROAD, ADDISON, ILLINOIS

New Literature

Indicator Lights

Datalites, a system of indication suited for computer, data processing and automation applications, are displayed in Catalog L-160F from Dialight Corp., Brooklyn, N.Y. Among the series features described are: choice of plug-in incandescent or neon lamp cartridges; data caps for use with hot-stamped or engraved legends; data strip or data matrix "packages" for use in program and instrumentation panels; and data twin dual lamp indicator lights. The caltalog provides 12 pages of data, specifications, drawings, lamp charts and ordering information.

Circle Reader Service Card No. 71

Synchros

Illustrated bulletin W757 gives complete dimensional data, electrical, and mechanical specifications for both size 8 and size 11 BUWEPS Synchro lines factory stocked by IMC, Maywood, Calif., Western Division. Both synchro families are comprised of Control Transformer, Control Transmitter, and Control Differential Transmitter (CT, CX and CDX) units, developed and manufactured in accordance with MIL-Q-20708; quality control is maintained under MIL-Q-9858A. Each unit is constructed of stainless steel throughout, with precision stainless steel shielded ball bearings, for efficientl, long-life operation at temperatures from —55 to +125° Centigrade.

Circle Reader Service Card No. 72

Magnetic Shield

To help engineers and procurement people obtain magnetic shields properly fabricated to the desired application, newly published time-saving four-page Data Manual 187 is offered by Magnetic Shield Div., Perfection Mica Co., Chicago. The manual illustrates numerous types and configurations of Netic and Co-Netic non-shock sensitive magnetic shields which are said to have minimal retentivity and do not require periodic annealing. Magnetic and physical environment, shield configuration and performance requirements are among the topics discussed.

Circle Reader Service Card No. 73

Teflon Insulated Terminals

The advantages of using Press-Fit Teflon-insulated terminals for assembly line production are described in an illustrated eight-page booklet available from the Circuit Hardware Div. of Sealectro Corp., Mamaroneck, N.Y. Among the instructive production sequences explained in the booklet are the drilling and punching of chassis holes and the insertion of terminals by hand or press.

Circle Reader Service Card No. 74

Video Tape

Bulletin T-107, describing the features and listing the prices of 142 Series video tape for use with VR-1500 and VR-660 Series closed circuit videotape recorders is available from Ampex Corp., Redwood City, Calif.

Circle Reader Service Card No. 75

Magnetic Tape

"Evaluating Performance of Digital Magnetic Tape" is now available from Memorex Corp., Santa Clara, Calif. The bulletin explains the testing philosophy for wear resistance, describes tests used to evaluate dropout incidence, and details some of the more significant variables which affect accuracy and reliability.

Circle Reader Service Card No. 76

Photoelectric Keyboard's Format

Invac Corp., Waltham, Mass., has published a two page data sheet describing the new Photoelectric Keyboard, Series PK-200. This data sheet lists the various format and function options that make this keyboard particularly applicable to data handling and communication systems requiring unusual or customized keyboard capability. Of added importance are the availability of custom coding (up to 14 bits) and the use of photoelectric techniques to eliminate contact bounce and minimize RFI/EMI. Data Sheet PK-200.

Circle Reader Service Card No. 77

Spectrum Analyzers

New booklet describes the operating principles of Federal Scientific Corp.'s ubiquitous spectrum analyzers, which produce high-resolution spectra for frequency bands as wide as 10,000 Hz in real-time. The technique of digital delay line time compression and thereby frequency dilation is described with operating parameters that apply to the latest versions of the instrument. The booklet published by the New York firm includes a block diagram of the system employed. Applications of Ubiquitous spectrum analyzers to underwater acoustic signal processing, vibration and noise analysis, real-time speech dynamics, and radar data processing are illustrated.

Circle Reader Service Card No. 78

Visual Simulation System

An optical pickup that provides pitch, roll, and yaw motions through the use of integral servo-driven elements to provide a fixed point of perspective and thus lend realism to visual simulators, is described in a paper currently being distributed by Photomechanisms, Inc., Huntington Station, N.Y. The article discusses the use of visual simulation equipment for engineering evaluation and training; identifies key design problems; and describes a practical means of presenting a realistic scene to the trainee in a simulator cockpit.

Circle Reader Service Card No. 79

Pushbutton Switich

Two new data sheets are available from Master Specialties Co., Costa Mesa, Calif. No. 3027 details the company's panel-mounted building-block pushbutton switch featuring removable colored pushbuttons, colored face nuts and snap-on switch modules. Supplement sheet 4030 describes MSC's line of panel plugs which are designed to cover panel cutouts reserved for future installation of pushbutton switch-lites or word indicator-lites.

Circle Reader Service Card No. 80

Neon Pilot Lights

Complete designers line of neon pilot lights, providing both function and beauty are described in the 12-page, illustrated design guide released by Industrial Devices, Inc., Edgewater, N.J. The guide, which includes a review of the Omni-Glow 1000 series, Glo-Dot, Omni-Glow 2600 series and Line-O-Lite product lines also develops how to select the right series and individual unit for specific applications. Two pages are devoted to "Guide to Pilot Light Selection." This section outlines the design considerations which affect ultimate choice of a pilot light.

Circle Reader Service Card No. 81

Indicating Devices

Bulletin MR102 illustrates 16 different models of indicating devices offered by The A. W. Haydon Co., Culver City, Calif. Included are: microminiature "BITE" (Built-In-Test-Equipment) indicators which monitor circuit or system performance to meet DOD systems readiness requirements; military and industrial elapsed time indicators and events counters; sweep scale and digital stop clocks; and a new laboratory stop clock.

Circle Reader Service Card No. 82

Relampable Holders

Eldema R-Lites — a product family of relampable holders and lens caps for the midget flange-based T-1¾ incandescent and T-2 neon bulbs — are described in a new series of data sheets. The family of Eldema R-Lites comprises five product groups — each with lamps and lens caps replaceable from the front of a panel. Features of the five groups described in the data sheets include: RM and RN series: both meet MIL-L-361. RM is for incandescent lamps; the RN series with a built-in resistor is for neon lamps. Available in standard and waterproof types, with high impact plastic lenses, front-panel mounting in 15/32" holes from Eldema, Compton, Calif.

Circle Reader Service Card No. 83

Display System

The elements of a total system capability which interfaces the Sanders 720 Data Display System with the IBM System/360 are described in a six-page brochure available from Sanders Associates, Inc., Nashua, N.H. The new Sanders' 731 Display Communications Buffer, including an IO control, multiplexer, transmission control and synchronous modem adapter are described. The brochure depicts schematics for both remote and local connections for the model 731, a modular buffer unit which functions as a high-speed parallel or serial interface between the IBM System/360 and the Sanders 720 Display.

A complete glossary of simple source language for the company's Autograph file maintenance program is provided. Autograph is a powerful Sanders software package for entry, retrieval, revision and manipulation of data files using Sander's 720 on-line with System/360.

Circle Reader Service Card No. 84

on the move

JOHN P. BREYER recently joined the International Data Corp., Newtonville, Mass., as vp/research. He will work directly with customers in preparing specialized studies in the field of information processing technology. He formerly was with Honeywell EDP.

A new firm, Computer Graphics Inc., has been established in Rockville, Md., to serve engineering, industry, business and science in the acquisition and utilization of automated graphical equipment and techniques. The firm was founded by JOHN S. HELD, a charter member of SID, who serves as president.

DR. A. S. HOAGLAND, IBM Corp., has been named General Chairman of the 1968 SJCC, which will be held in Atlantic City, N.J. April 30 - May 2. Since the first US computer conference in 1951, attendance has grown from 200 people to last year's international audience of 5,000 registrants and more than 10,000 visitors.

Election of EMIL LANDEFELT to the office of VP/Administration and Finance Div. of Informatics Inc., Sherman Oaks, Calif., was recently announced by president WALTER F. BAUER. Before joining Informatics, Landefelt was with Operations Research Inc.

The N.Y. firm of Federal Scientific Corp. recently elected two vice presidents, MARK R. WEISS and RICHARD S. ROTHSCHILD. Weiss currently heads the co.'s work in automatic speech recognition and speech analysis systems, while Rothschild is responsible for the firm's Ubiquitious Spectrum Analyzer product line development and sales.

RICHARD F. MILLER has joined Duncan Electronics Inc., manufacturer of precision potentiometers and other electromechanical devices, as manager/quality assurance. He will be responsible for all quality aspects of design and production.

Appointed to the newly created position of Director/International Marketing for Varian Data Machines, Newport Beach, Calif., is ROBERT K. LOWRY. He will be responsible for overseas marketing and services for the entire line, with particular emphasis on the new line of Data 620-1 16/18 bit systems computers.

EARL J. McCARTNEY, research engineer in Spery Rand's Electro-Optics Group in Great Neck, N.J., received the Institute of Navigation's annual Samuel M. Burka Award for the outstanding technical paper published in the Institute's journal. His paper, "The Ring Laser Inertial Sensor" appeared in the Autumn, 1966 issue of the journal "Navigation."

JOHN MARSHALL is now a Product Group Manager for the Display and Equipment dept. of Litton Industries Electron Tube Div., according to FRANK J. KELLY, dept. mgr. Marshall is responsible for the design, development and production of high resolution CRTs and display devices.

ROBERT F. GEIGER has joined Information Systems Co., as Director of marketing, according to an announcement by M. O. KAPPLER, president of ISC, a Lear Siegler Co. Geiger will be responsible for marketing the firm's services in the area of space and missile systems, range operations and scheduling, telemetry data processing, and military command and control.

ROBERT A. BEAUDETTE has been appointed Documentation Administrator for Stromberg-Carlson's Data Products Div., San Diego. He previously was with Teawell Inc., San Diego, as an advertising account executive.

Bunker-Ramo Corp., Canoga Park, has announced two new appointments. F. J. McKEE is now vp/operations for B-R Data Systems Inc., Silver Spring, Md., a subsidiary of the company. HAROLD L. SHOEMAKER has been elected vp/general manager of B-R. He will continue as director of the US Army's ADSAF program.

GORDON L. PENHARLOW is now manager of data control and information retrieval in the Corporate Information Div. of Electro-Optical Systems, Inc., a subsidiary of Xerox Corp.

HARRY W. WILCOX, JR., manufacturing superintendent of Sylvania's Commercial Electronics Div. at Bedford, Mass., has been elected vp—manufacturing of Granger Associates, Palo Alto, Calif.

New sales engineer for Memorex Corp., Santa Clara, Calif., is STEPHEN WALSH. He will cover the Northern California area out of the company's district office in Belmont.

PETER SIEN-KWEI PAO will assume the position of engineering manager of Communication Electronics Inc., Rockville, Md., and will direct all the firm's engineering activities. Pao, a founder of Astro Communications Laboratory, returns to CEI after a four-year absence.

JAMES A. NOTTINGHAM is now vp and gen. mgr. of Sperry Rand's Sperry Piedmont Div. Nottingham has been division manager since 1961.

New appointments at D. B. Milliken Co., Arcadia, Calif., include: LOUIS F. MEYER as director of marketing; GILBERT J. PENDLEY as field engineer on the West Coast; and DUDLEY A. WARNER as field engineer for the mountain states territory.

DALLAS L. TALLEY is now Sales Manager at Systems Engineering Laboratories Inc., Ft. Lauderdale, Fla. Announcement was made by RICHARD D. FELTY, VP/Marketing. Talley will have initial responsibility for expanding the marketing penetration and customer service coverage.

DALLAS L. TALLEY

CHARLES J. MARSH

CHARLES J. MARSH is now the new vp and director of marketing for Comcor Inc., a wholly-owned subsidiary of Astrodata Inc., Anaheim, Calif.

ROBERT L. HADDOCK has been named director-engineering for the Control and Communications Div. of Radiation Inc., Melbourne, Fla. Haddock will report directly to RALPH JOHNSON, vp and gen. mgr. of the division.

IRWIN C. SHONEMAN is the new manager of Avion Electronics Inc.'s Navigation Display Laboratory in Paramus, N.J. Shoneman will be responsible for all of the design and development of navigational pictorial display equipment.

LT. COL. JOSEPH G. CARLEY, JR. (USAF, Ret.) has joined The Bunker-Ramo Corp. Defense Systems Div. as the director of advanced programs. Carley will be primarily concerned with the company's development of an integrated approach to command and control problems.

RICHARD D. BOUCHER has been appointed Memorex vp—manufacturing, of the company's newly-formed Supplies Div. Boucher until recently was director of manufacturing for the magnetic tape manufacturing organization, Santa Clara. Also joining the new division will be STANLEY W. MEYERS, who has been named vp—technical staff.

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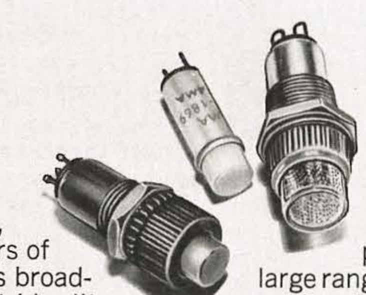

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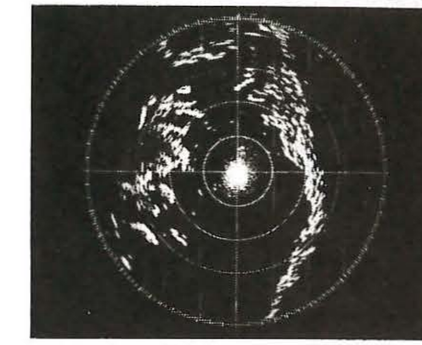
This TV display is a composite of a compass reference superimposed on a stored



ppi display. It is an example of how the Electrostore Model 221 can convert radar data to a high resolution TV picture.

Model 221 Electrostore single-gun storage tube
Input/Output Response 10 MHz or 20 MHz
Input Amplitude Required 0.7 volts to 2.0 volts p-p
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Deflection Response DC to 800 KHz
Programmer Optional

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Write for technical memos and application notes covering the Electrostore.

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