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SID

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Information Display

Journal of the Society for Information Display

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the cover

Cover art, from Northrop Nortronics, Div. of Northrop Corp., depicts the Vigicon IV Display System, which operates in airborne, shipboard, and mobile ground applications as well as fixed-site ground installations.

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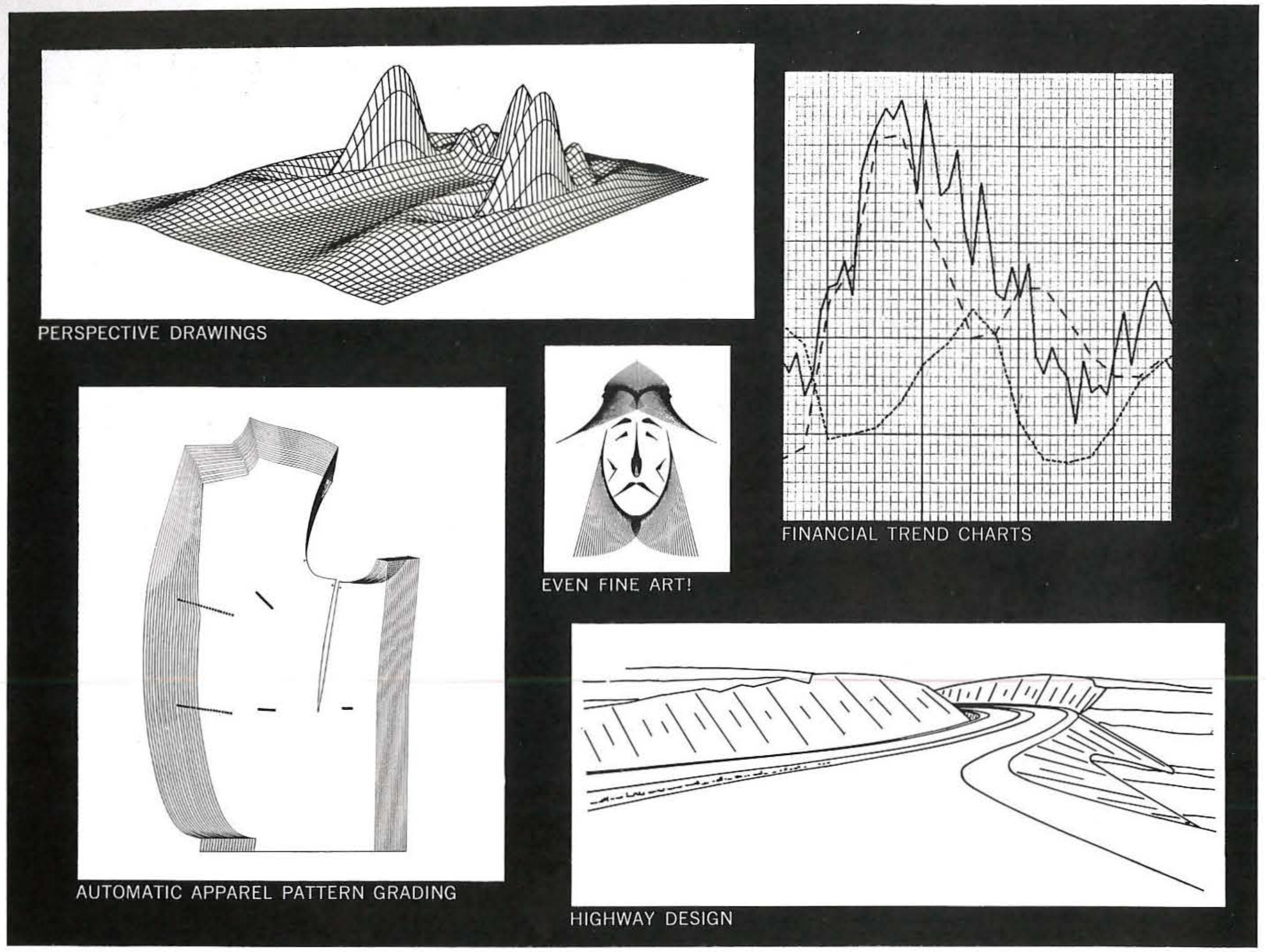

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For more information on the Alphechon and other RCA Display Storage Tubes, see your RCA Representative or your RCA Industrial Tube Distributor. For technical data, write: RCA Electronic Components, Commercial Engineering, SectionE1782 , Harrison, N.J. 07029.

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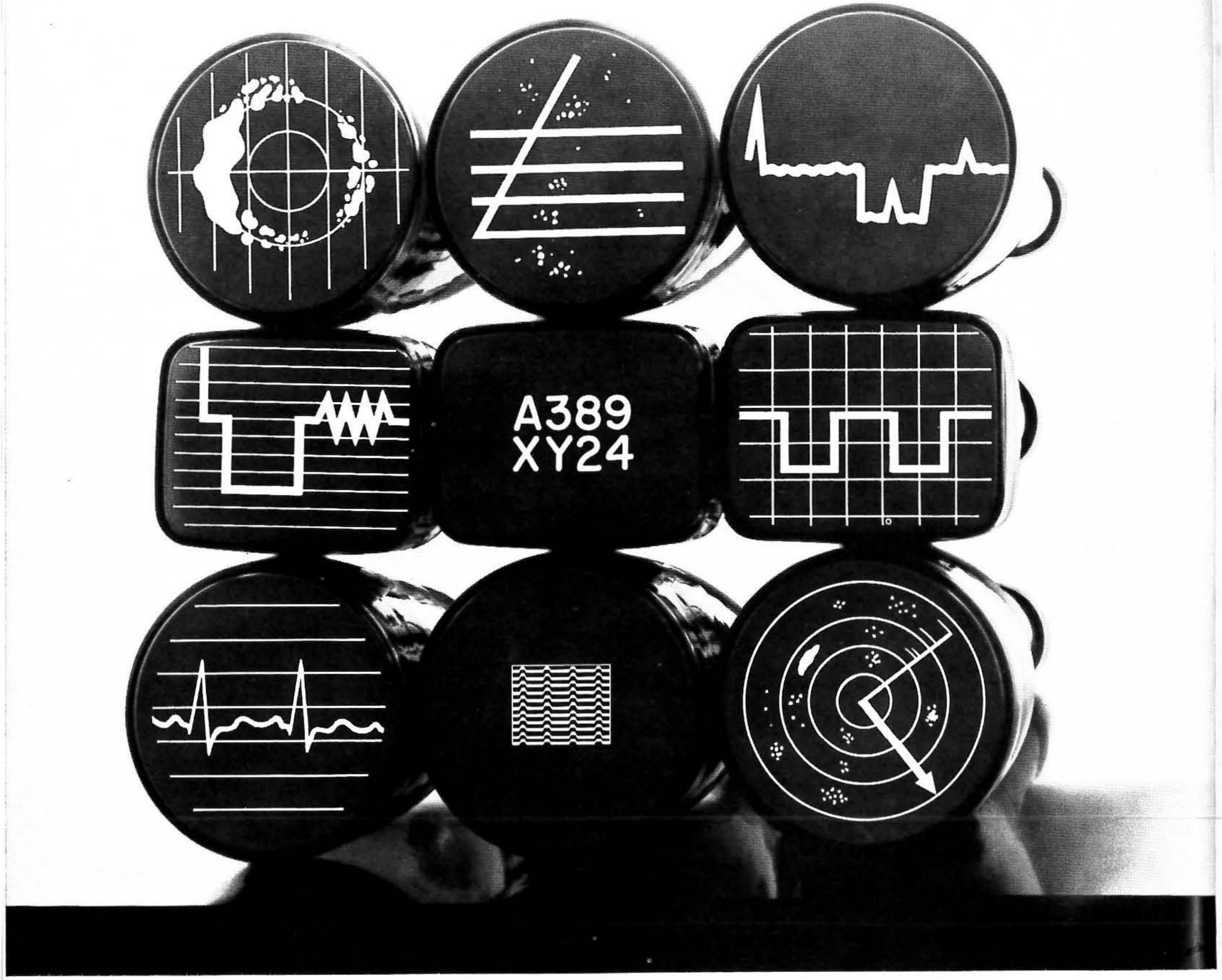

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New information now available on image intensifier faceplates, also New data on UV faceplates.

Bendix Electronics

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EDITORIAL

SID in the year to come

The gratifying success of the 9th National Symposium was a tribute to the imagination and effort of the host Los Angeles chapter. They really gave us something to shoot at for future meetings.

At the same time, the excellent attendance of members and visitors is also indicative of a steadily growing interest in the field of Information Display. This pattern of growth and progress affords challenges and opportunities for all of us in *SID*, particularly to the new officers, the directors and chapter leaders.

The administration of Bill Bethke as president has helped in providing continuing direction to the Society and its activities. It is reassuring to note that Bill and many associates of his team will continue to contribute to the leadership of *SID*. On behalf of your new officers, I would like to express our thanks to the membership for entrusting to us the stewardship of the Society during the coming year.

A development of interest is the apparent intention of several universities to offer courses in Information Display subjects. We have established an Academic Committee to consult and advise colleges on course content. Dr. H. R. Luxenberg will head this group. Two other new committees will help ensure our sound growth. They are: Inter-Society Committee—Bill Bethke, chairman; and the By-Laws Review Committee—Bob Klein, chairman.

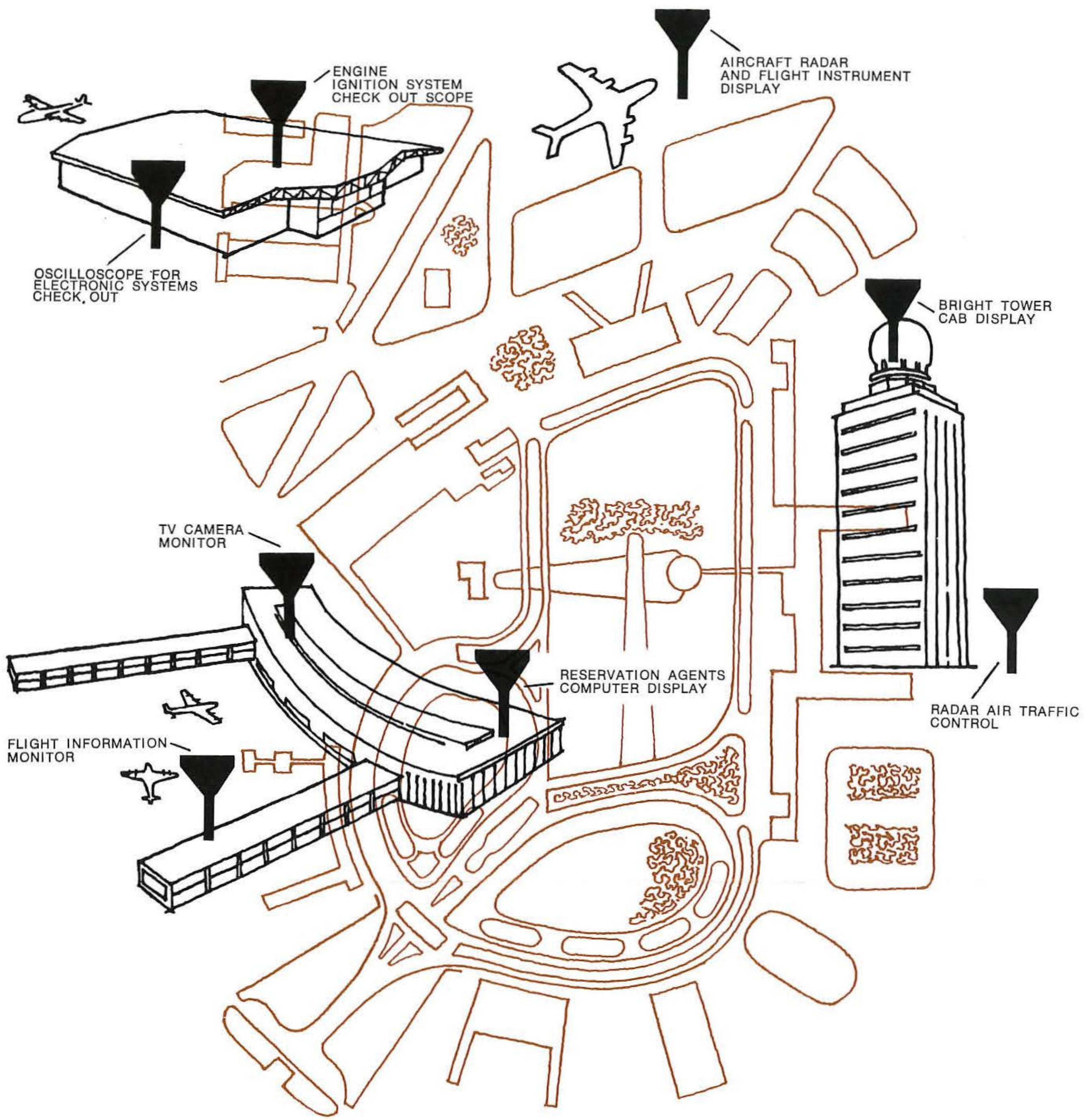
Through these and other measures, we hope to accelerate the Society's growth and to enhance its stature. But the major source of *SID's* strength and growth continues to depend upon vigorous and imaginative activity in the Chapters. The national organization will endeavor to stimulate such activity in any appropriate manner available. One such program is to prepare and circulate summaries of Chapter activities as described in their technical meeting reports.

Exciting developments are coming about in the technology of Information Display and its applications. We can play a vital role in this progress.

C. MACHOVER
President, Society for Information Display

During the past seventeen years, Carl Machover has been concerned with the design and marketing of display devices, servo components, gyroscopes, bombing and navigation systems, and precision test equipment. Mr. Machover was Manager of Sales for Skiatron Electronics Television Corporation before joining Information Displays, Inc. Prior to that, he was Manager of Applications Engineering for the Norden Division of United Aircraft Corporation.

Mr. Machover holds two patents on gyroscope devices, is the author of two books on gyroscopics, and several articles on displays. Mr. Machover is a member of IEEE, Sigma Xi, Tau Beta Pi and Eta Kappa Nu. He holds the B.E.E., Rensselaer Polytechnic Institute, and has done Graduate study, New York University.



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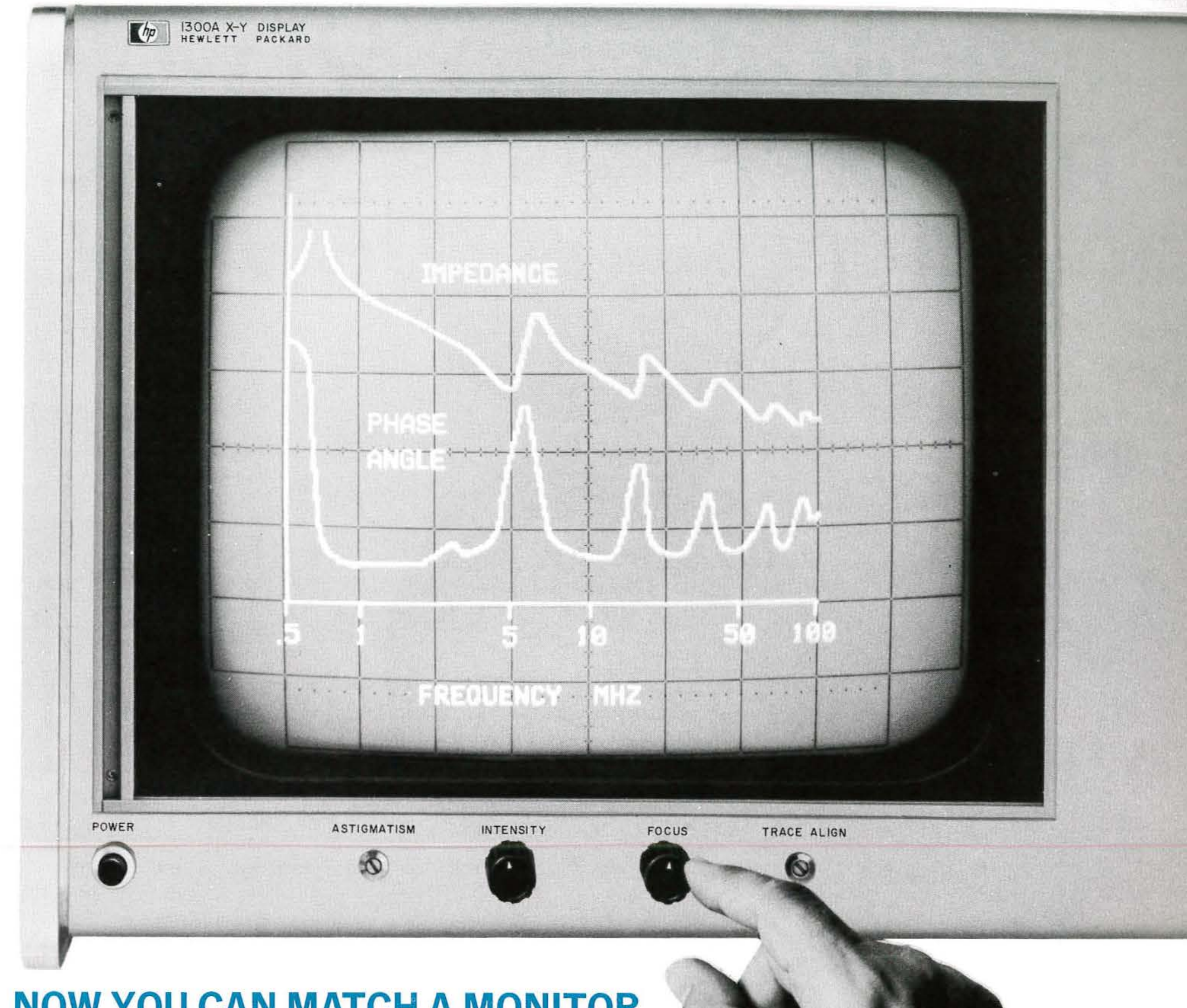

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088/12

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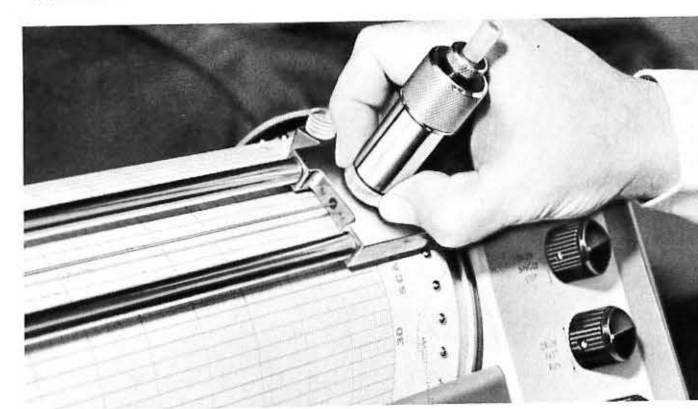

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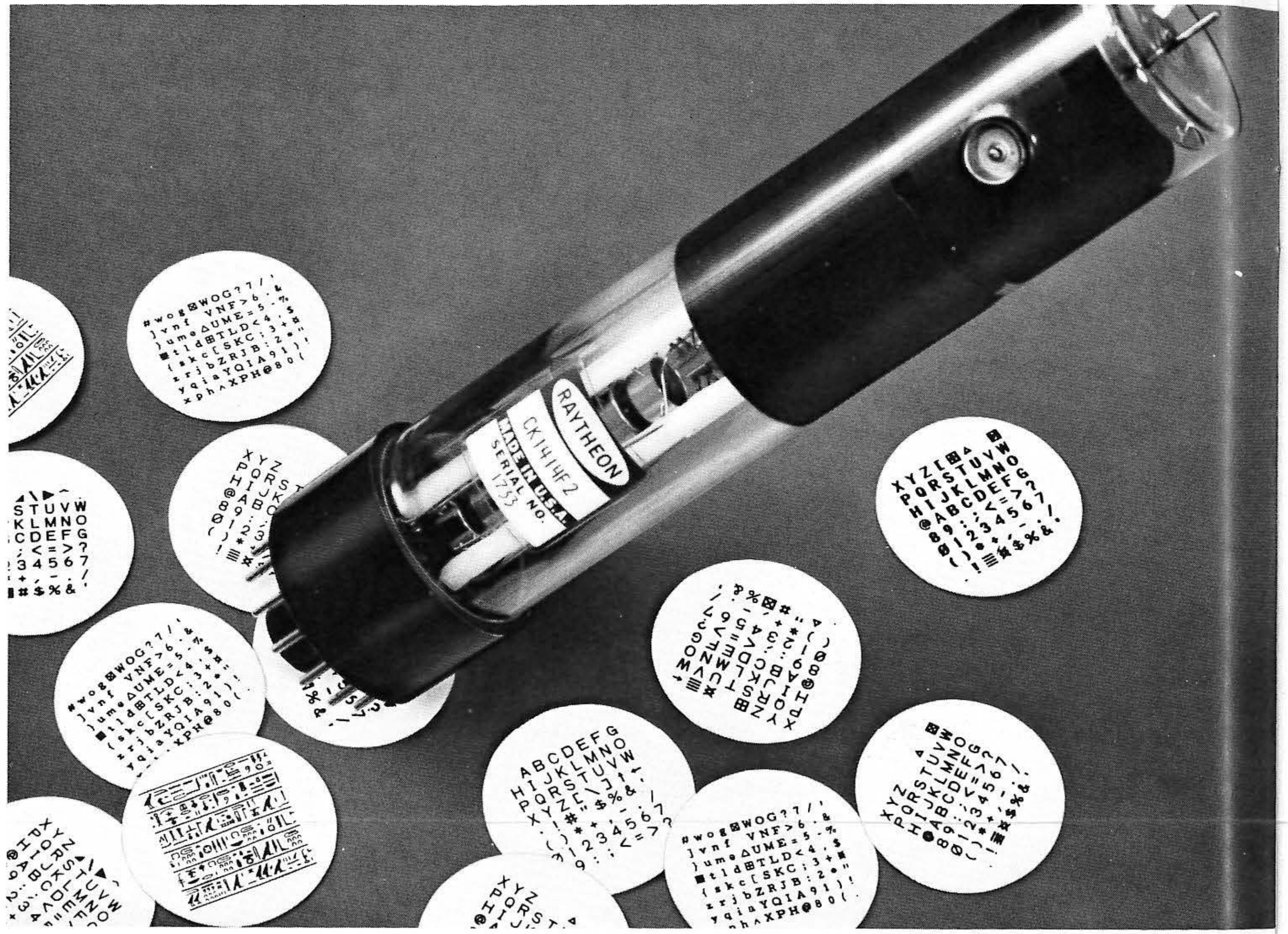
Data Display Devices from Raytheon



A Symbolray* monoscope can generate almost any presentation you can think of. (Hieroglyphics, anyone?)

With a Raytheon Symbolray, you can meet almost any data display requirement for different characters and/or symbols—ranging from standard ASCII† to custom data displays and even hieroglyphics. And we can meet the requirements with only an inexpensive change in the target font design.

An economical method of generating characters. The Symbolray monoscope provides a much more economical method of generating displays than using circuit cards. Only 2″ by 12″, it costs less than $100 in quantities of 1,000.

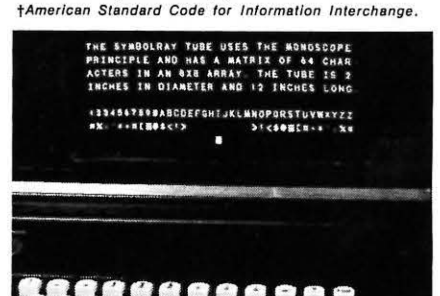
The output of the Symbolray is obtained by electrically deflecting the electron beam to the desired characters on the targets. The characters are scanned sequentially with a small TV raster. The display cathode-ray tube, on which the output is viewed, is scanned in synchronism. The monoscope uses electrostatic deflection and focus.

Full messages can be displayed—as shown at right—when the Symbolray method is used with buffer memory techniques. The monoscope is currently available with 64 and 96 character matrices.

Raytheon Dataray* CRTs include screen sizes from 7″ to 24″. Electrostatic, magnetic and combination deflection types are available for writing alphanumeric characters while raster scanning.

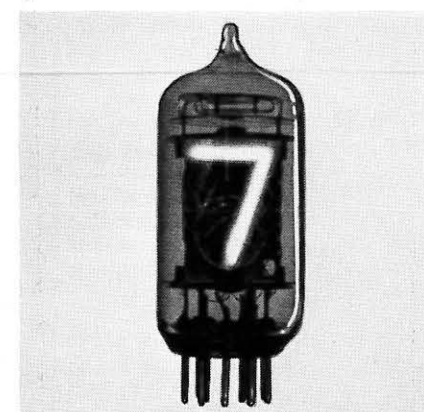
For Symbolray data—or a demonstration—call your Raytheon regional sales office. Or write: ***Raytheon Company, Components Division, Quincy, Mass. 02169.***

†American Standard Code for Information Interchange.

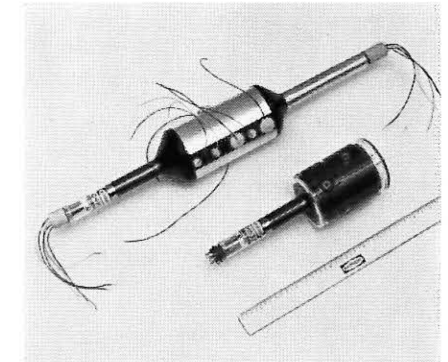


New Raytheon Projectoray* Tube produces more than double the light output of standard projection-type cathode ray tubes. The tube's output results in a light level of 15-foot lamberts on a 3′ x 4′ lenticular screen. Expected minimum operating life is 500 hours, 20 times the life of a standard projection 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.

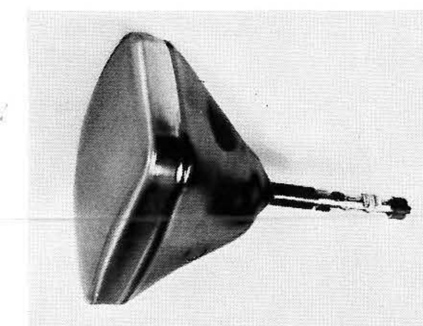


Datavue* Side-View Tubes. New Type CK8650, with numerals close to the front, permits wide-angle viewing. These side-view, in-line visual readout tubes display single numerals 0 through 9 or pre-selected symbols such as + and − signs. Their ⅝″-high characters are easily read from a distance of 30 feet. 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. Many end-view types of Datavue tubes are also available.



Recording Storage Tubes. The two new designs shown utilize miniaturized guns and necks to provide high deflection and focus sensitivity, resulting in savings in coil and power supply weight and size. They provide Kiloline resolution, long storage and fast erase capability. The single-gun version is Type CK1537 and the dual-gun version is Type CK1535.

Raytheon's complete line of electrical-output storage tubes feature high resolution and non-destructive reading. Information can be written and stored by sequential techniques or by random-access writing. Complete, gradual or selective erasure is possible.



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).

For literature, call your Raytheon regional sales office. Or write to *Raytheon Company, Components Division, Quincy, Mass. 02169.*

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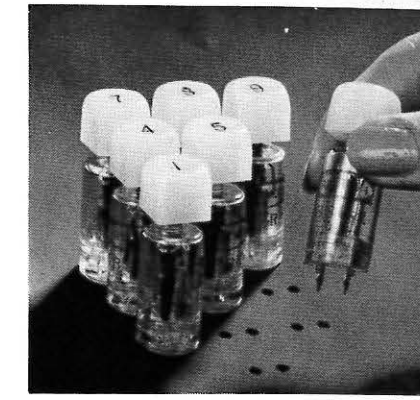
RAYTHEON



New Keyboard Switches. These keyboard switches—an original Raytheon design—are low cost yet extremely reliable. They are ideal for computer input/output devices, learning and business machines, and other advanced information and control equipment.

Just a featherlight (2½-oz.) touch activates the switch, providing momentary contact at a current rating of 0.25A, 32V.dc. Life expectancy of the dry reed type is more than 100 million cycles. Bounce is less than 250 microseconds. Yet, these switches cost less than $1 in production quantities.

The contact pins snap into 0.125″ PC board, locking the switch firmly in place for automatic flow soldering—thereby reducing assembly time and costs.

All switches are made of high-quality materials: polycarbonate plastic, stainless steel, beryllium, copper and noble metals. Bases can be flat or sloped to a 10° angle.

The switches are available with a variety of standard and custom cap shapes, sizes, colors and alphanumerics. Caps are hot die stamped, cured and backed with epoxy coating to provide wear resistance and reduce glare.

Raytheon key switches are available in single- and double-level dry reed types and in single- and double-level wipe-action types.

Complete, custom-made keyboards—using the switches described above—are also available from Raytheon. These keyboards can be designed, built and shipped to you in minimum lead time. All assemblies are supplied with alphanumerics, symbols and coding to your specifications. They are also available with data lines, electronic interlock, connector to external power sources, and with or without case.

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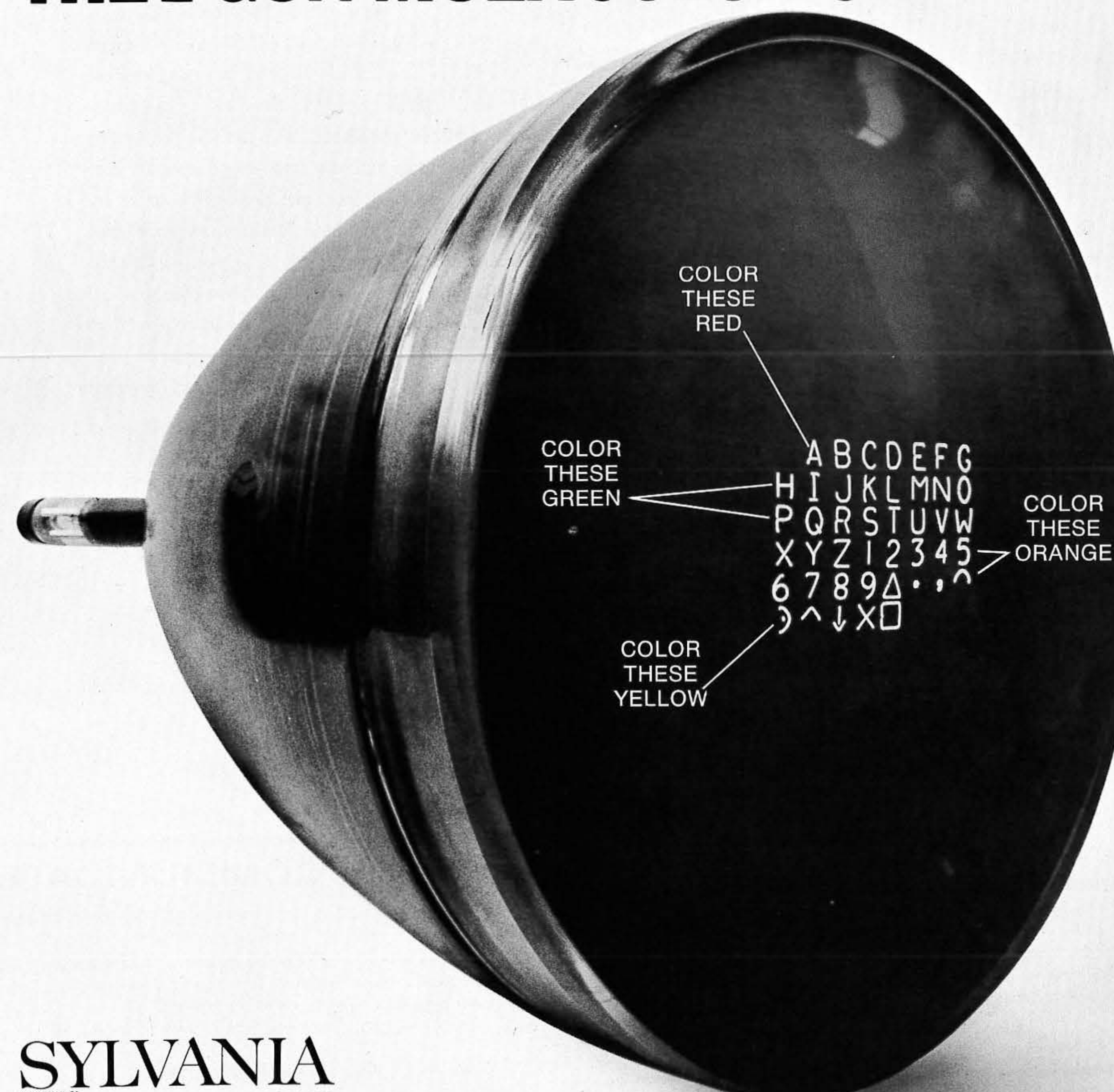
We recommend them for: air traffic control systems; military IFF systems; stock market quotation units; airline and other transportation status boards; teaching machines; electronic test equipment; computer readouts . . . anywhere a multicolor display can facilitate comprehension.

Sylvania Electronic Components, Electronic Tube Division, Seneca Falls, N.Y. 13148



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True stereoscopic movie system without glasses

Artist's drawing depicts a typical scene being photographed by the new capture system. System contains a 100 ft. arc of 1500 pinholes which are uncovered sequentially to expose ten sets of horizontally-moving spherical lenticular filmstrips. Filmstrips' movement and exposure are synchronized by a central control system. Resultant film is specially processed for centralized projection.

825 seat capacity—120 degree field of view

by ROBERT B. COLLENDER

ABSTRACT

Various stereoscopic systems are discussed and the problems inherent with each enumerated. Among them are grand scale holography and lenticular screen-multi-camera and projection systems for a proposed zoneless wide screen viewing criteria within the theatre. Zone system two-picture autostereo techniques with their inherent problems are also mentioned briefly.

The writer's design is presented for an entirely new approach to the age-old problem of stereo pictures which must be projected to a large audience; provide an extended field of view both horizontally and vertically, not restrict the positions of view within the bounds of the auditorium's viewing area; present a unity sizing of original scene to synthetic playback; minimize complexity of theatre projection equipment and completely eliminate the requirements for optical aids at the observer's eyes.

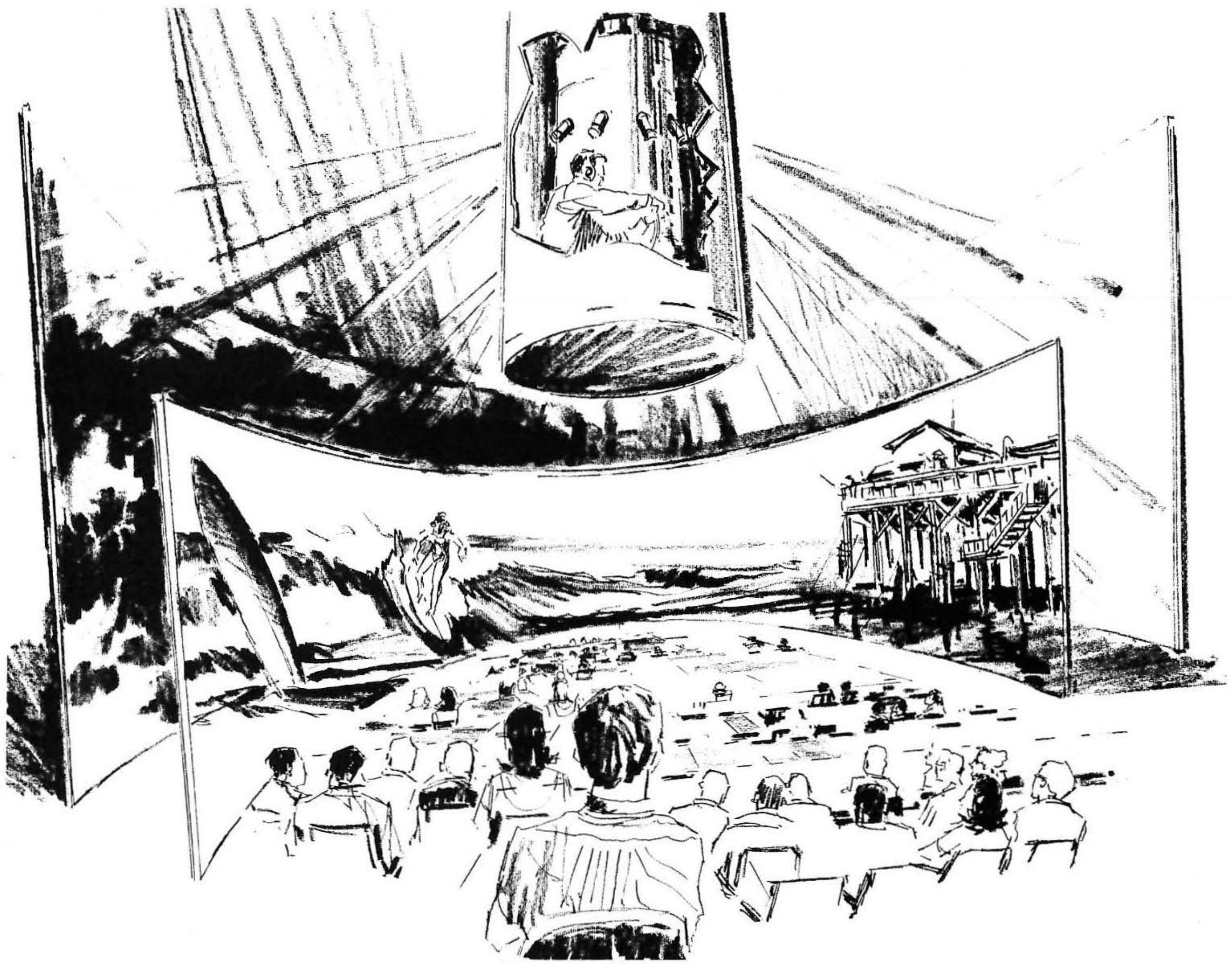
INTRODUCTION

Some people inclined to think asthetically and scientifically have pondered the motion picture enigma for years. Why is it that the real world must be synthetically portrayed without the third dimension on the motion picture screen? Isn't it only natural that the scenes inside the theatre should appear equivalent with nature? In 1953, the third dimension illusion was portrayed while the audience wore glasses—but not everyone wears glasses in the real world! What is the big problem? Why can't the audience just sit in the theatre and look through a 100 ft. wide by 50 ft. high bay window and perceive the same impression as if they were transported to the scene and looked through the window—and do this without any sort of optical aid at the eye?

The author has studied this apparent enigma for about 20 years and concludes that there is more than ample justification for the delay in duplicating the illusion of nature. There is a vast difference in object-space and image-space. Object-space exists— may be verified by the senses and the observer may move in relation to the object—but image-space must be synthetically generated in a volume where only space exists and yet the observer must be free to move into this space (within limits) to examine the images. For example, it is entirely possible to synthetically generate a 3-D moving colored image of a beautiful woman. The observer could be allowed to approach the image until his eyes are touching it and actually pass through to the opposite side of the image—but the sensation of feel would not be present (unless the brain was tapped by other stimuli).

This paper will attempt to acquaint the reader with a few of the basic problems of true stereoscopic illusion allowing the observer free movement with respect to the synthetic images and complete elimination of any sort of optical aid at the observer's eyes. This paper will merely touch on stereo illusion systems which do not give the observer freedom of movement—but still eliminate the need for glasses.

Several stereo systems exist and are still being considered, that provide two-picture stereo (as a common stereoscope view) to a limited number of people (say 100) in which their lateral movement is severely restricted (to about 2 inches). This sort of restriction can be quite tiring over extended periods of viewing and the screen included angle of view is always small. A basic characteristic of the image is that everyone sees the same two pictures to make up an identical stereo pair. Unfortunately, distortion is prevalent similar to 2-D pictures where people view a flat screen from various angles. Both Russia and France have used this system for several years. Ivanov and Savoye[1] are the respective inventors.



Artist's drawing depicts the proposed theatre that will display the new 3-D picture. Centralized projection booth is at the center of curvature of a cylindrical screen and stationary electronically controlled Kerr cell shutter selector. Each person in the theatre sees a "different view" of the scene. Audience will see the scene in nature as through a large bay-window.

A more desirable situation exists where within the seating area of the theatre no viewing dead zones are prevalent, and where observers can be encompassed by the familiar wide screen picture without the need for optical aids at their eyes.

Stereoscopic systems which fall between the 2-picture and the infinite-picture systems will not be considered here as they still suffer from viewing dead zones.

If a goal is to present a system which can be viewed from any position in the audience space and the head of some movie star should fill the screen, a smooth change in perspective from one side of the auditorium to the other would necessitate that the image appear gigantic in depth as well as width and height. In the limited system just discussed, we do not have this problem, because the subtended angle automatically adjusted to each viewer and the actor's image appeared to hover over the head of the person seated just in front of any given viewer, regardless of his position in the theatre.

In the unlimited system, where the viewer has position freedom, the gigantic image is generated by the ratio in size of the "capture window" and the "playback window". This means that the camera equipment would provide a "small" window in viewing the actor and since the "large" theatre screen window is required, the actor appears as a giant. A basic problem in this giantism, which tends to rule it out, is the extreme lack of viewer proximity to the space character. Not only are the x and y dimensions of the image increased by this ratio, but the distance of subject to camera window is also expanded by this factor in playback. Since the observers are remoted now, the depth illusion also subsides and the quest for added realism has been defeated. Therefore, the only way to justify the realism of the added dimension is to provide for a one to one correlation between the scene and the reproduction.

Much talk of late has been given to the hologram, believing that this marvelous innovation will eventually solve the enigma. Since the window width in the capture of the scene has been shown equal to the theatre window size (in order to retain the impression of depth and the same relative proximity of space images to real objects) the hologram frame size would have to be 50 feet high and 100 feet wide (since the theatre screen size for the large audience required has been set at this level).

It is well known in holography that the scene parallax captured depends on the size of the hologram plane and its distance from the scene objects. An active coherent source would not suffice for infinity capture because the inverse square law would under-expose the background and over-expose the foreground. Trying to get sufficiently powerful pulse laser sources (to freeze the motion on the hologram and still provide adequate coherency over these great distances) introduces staggering problems.

Even if 100 foot wide 2000 line/mm resolution film could be made with 50 foot high frames, the required film acceleration at 24 frames/second would pull it apart. Even though the size of the playback could be increased by changing the frequency between capture and playback rendition, the small window capture and the receded projected image during playback defeats the intended purpose.

If the holograph concept is ever to be employed on a grand scale for wide screen theatres, it should use passive light from nature and the 100 ft. by 50 ft. window have a myriad of sensors which link a practical recording media. In reverse (or playback), it should have a 100 ft. by 50 ft. transducer which is controlled by the recorder media. In concluding, applications of holography to the wide screen-large theatre are more remote and impractical than any of the alternate techniques which are known to date.

A much more economical system is described next which wil! give the required illusion with equipment available today. Preceding the description of this equipment, a brief introduction will be given to the unaided viewing system discovered by Lippman in the early part of this century and how these techniques apply to a theoretically ideal method which will then lead into a new approach conceived by the writer.

Gabriel Lippman[2] (1908) discovered that a 3-D picture can be formed by using a photographic plate with a multitude of small pinholes in front of it. In preparation for a discussion of G. Lippman's system, the differences between a lens and a pinhole in recording an object (e.g. a candle) will be shown (Figures 1-a and 1-b).

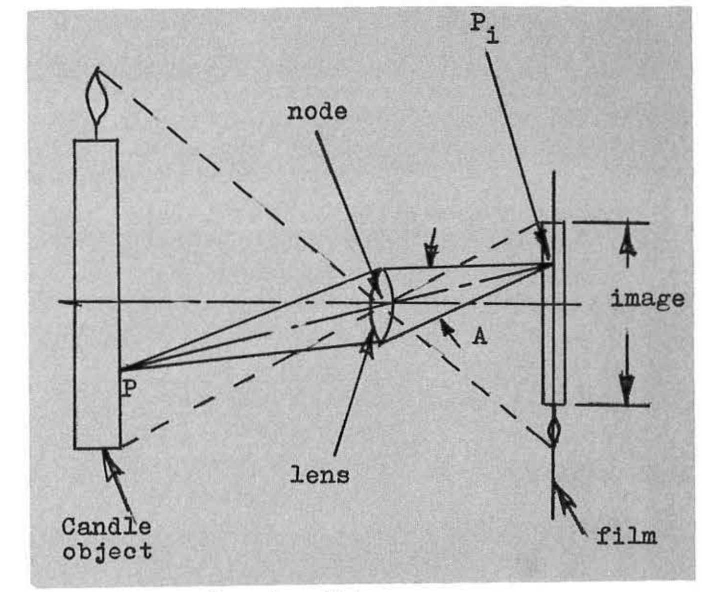


FIGURE 1a: Image formation with lens

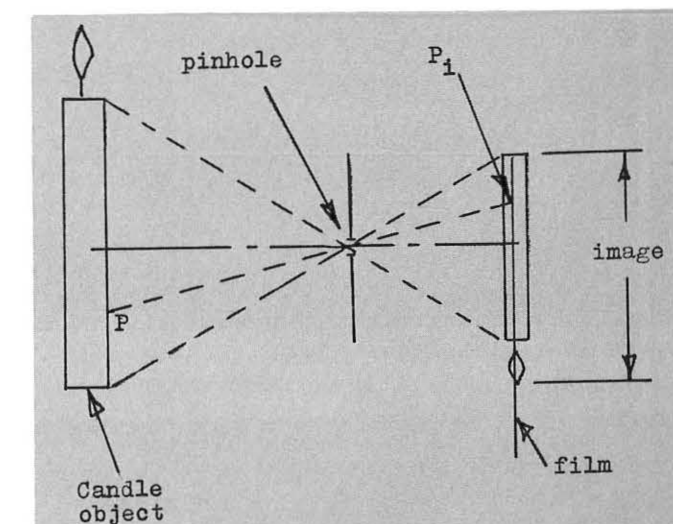


FIGURE 1b: Image formation with pinhole

Figure 1-b is analogous to Figure 1-a except that in 1-a, the image is formed by a lens and the image in 1-b is formed by a pinhole. Note the line drawn through the object's point —P—and the lens node in Figure 1-a; this forms image point P_i on the film which is identical to P_i formed in 1-b except that due to Angle A, more light is gathered in 1-a to form the picture.

Figure 2 shows the basis of Lippman's system. A separate small picture is formed behind each lens on the film. A lens shall be substituted for a pinhole.

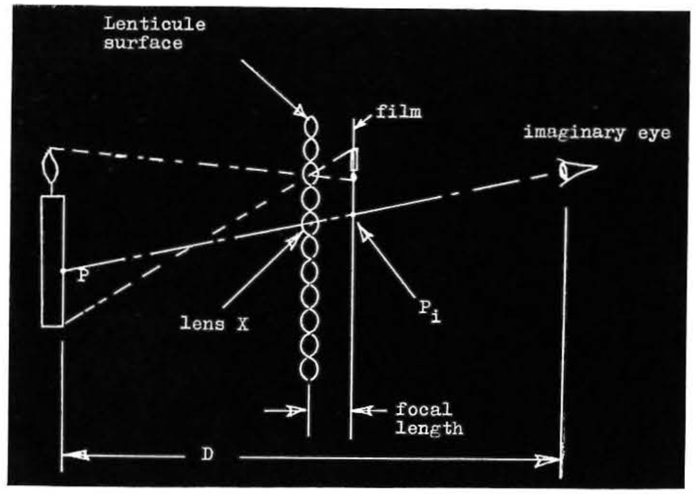


FIGURE 2: Lippman's lenticule capture system

If the imaginary eye is to see Point P of the object, it must look in the direction of the node of lens—X (or along the P to P_i line. If the film was processed into a transparency and viewed as shown, it would not give 3-D because no segregation of the individual pictures can be made unless the observer looks through the lens array.

A conjugate image of the array of pictures must be formed by transferring the pictures back through the identical lens-array onto a new film plane in a one to one correspondence (see Figure 3).

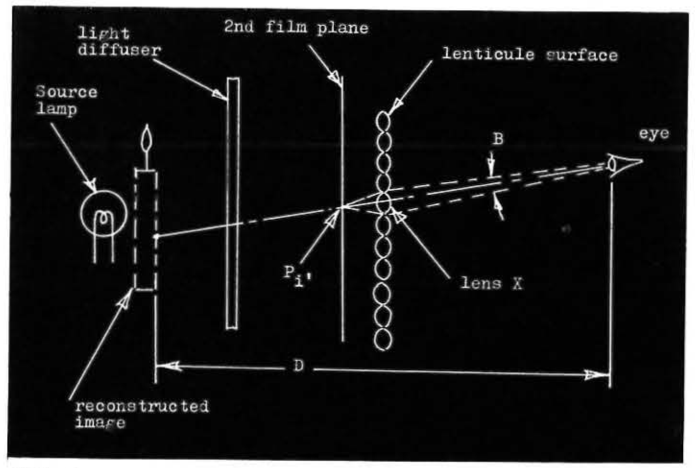


FIGURE 3: Lippman's lenticule playback system

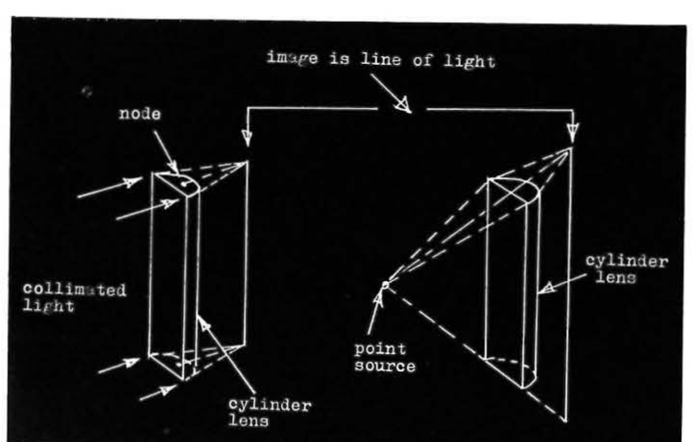


FIGURE 4a and 4b: Geometry of image formation in cylinder lens

If the observer's eye occupies the same position as in Figure 2 and looks toward lens X, he sees point P_i and the image appears at distance D just as the object did in Figure 2. Note that the resolution of the resultant picture is degraded by the diameter of lens-X which subtends angle B at the eye.

A tremendous simplification to this system can be made if it is noted that only lateral information for the two eyes need change—but the vertical information can be the same (most people keep the line joining their two eyes nearly horizontal when viewing a picture). This is not a requirement however, as it has been shown that a plus or minus 45 degree tilt in the interoccular line is acceptable for adequately viewing this form of stereoscopic pictures.

The *spherical* lenticular structure then changes to a *cylindrical* lenticular structure (see Figures 4-a and b).

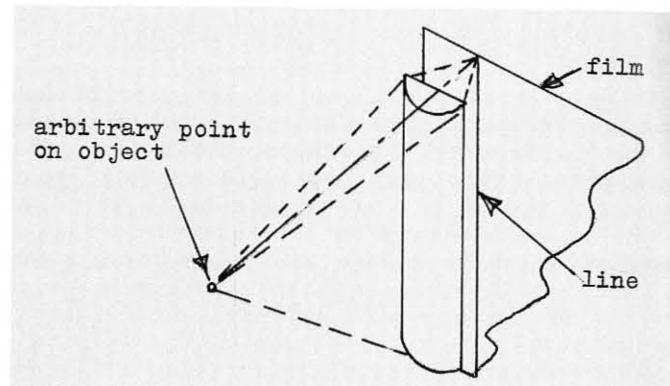


FIGURE 5: Any point in scene forms line on film

The cylindrical lenticule cannot be used directly in the photographing process, as it will not form an image (see Figure 5). Any point on the object will form a line on the film. If viewed through the cylindrical lenticule, the point would then be viewed as a line. To avoid this and still use the simplified approach of cylinders instead of spheres, the stereoscopic photograph is taken through a lens that moves in

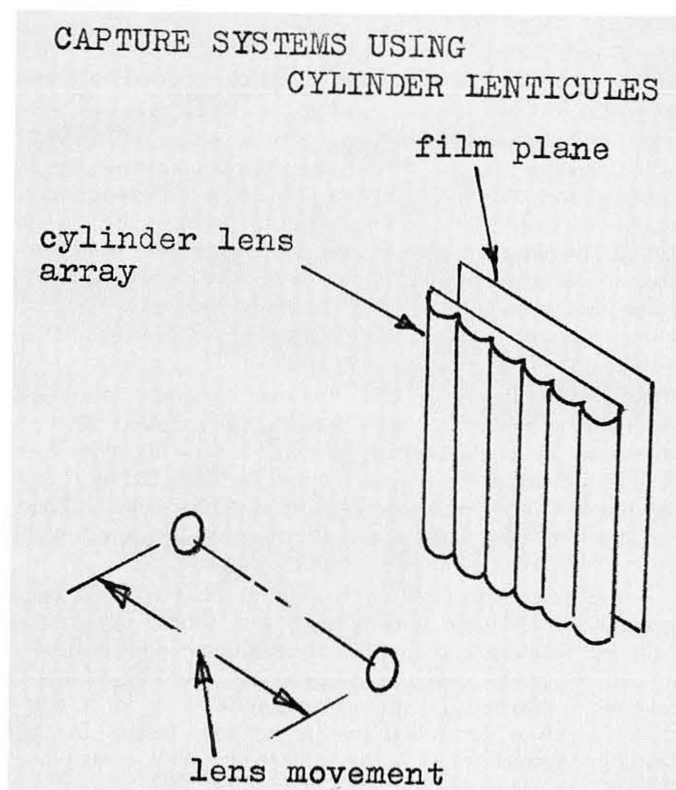


FIGURE 6a

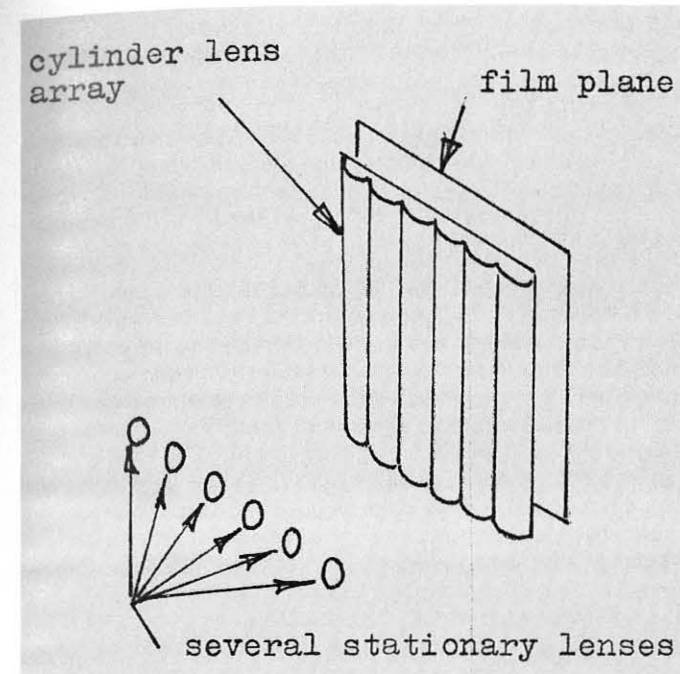


FIGURE 6b

front of the cylinders. An alternate method is to permanently install several lenses in front of the cylinders, as in Figures 6-a and b.

In both these systems, the parallax captured is equal to the excursion distance of the lens or the distance between first and last fixed lenses. Figure 7 shows the basic principle involved in forming proper images on the film plane.

Note that the object point P is formed as a point behind each of the cylinders; the geometry being that the point P line up with both objective lens node and cylinder lens node, (e.g. 3 points align to determine a fourth point along the line).

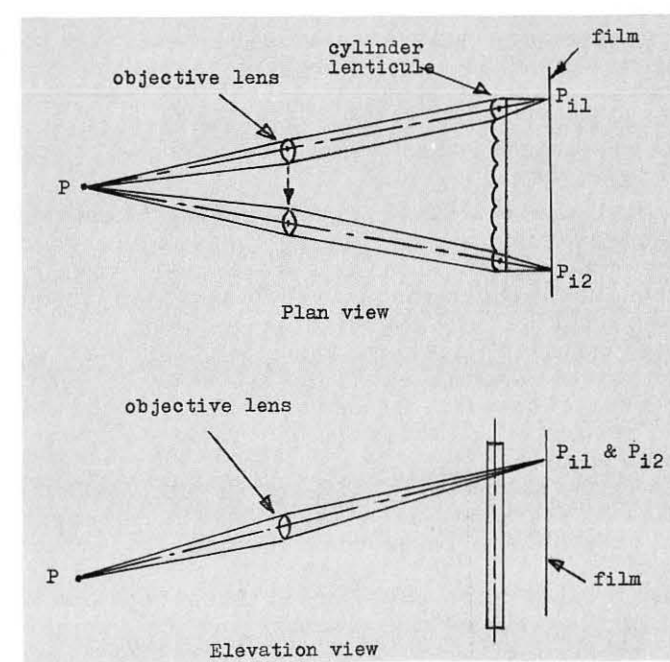


FIGURE 7: Plan and elevation views of image formation in cylinder lens camera

Another way to accomplish the offset of P_i behind cylindrical lenticules is to move the entire camera (lens and plate) relative to the scene, (usually in an arc about the scene's center) and at the same time move the cylindrical lenticule array laterally by the diameter of one lenticule during this excursion. This technique as shown in Figure 6a, is limited to still photography due to the accurate alignment required between the film plane and lenticules and the movement of objective lens. The system in Figure 6-b however, has only the problem of close alignment rather than moving lenses.

The number of lenses required is easily seen in Figure 8 to be governed by an extension of sight-lines from the observer at a maximum distance to the nearest object in the scene. The spacing of the two sight-lines at their intersection with the lens array is equal to the minimum spacing of adjacent lenses (e.g. lens A and lens B in Figure 8).

From the prior discussion it may be evident that the Figure 6-b system could provide movies in 3-D without glasses provided the viewing area is small. Assuming that a one to one correlation in size between scene and re-constructed images is required—and a maximum frame size of four inches square is used, then the viewing screen would also have to be four inches square.

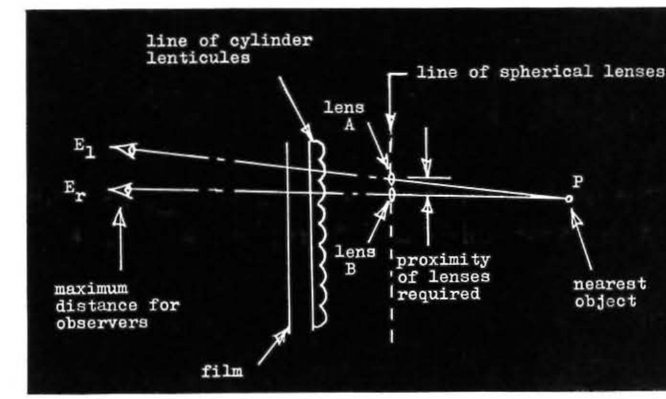


FIGURE 8: Spherical lens proximity shown in composite camera and playblack cylinder lens system

The conjugate images would be viewed through cylindrical lenticules arranged directly over the projector's aperture and at least 16 of the 4 x 4 inch square plates would appear per second. Projector alignment problems are stringent, because the vertical elements on the film plane must not jitter beyond tight limits or the great "light-lever" between the image element and the cylinder lenslet nodal element will cause the image to violently jitter. This jitter results in a spatial change (Z-direction) as well as an X-directional change. Theatre systems, however, require a 100 time enlargement and projection is required. The number of capture lenses in the array line of spherical lenses goes up by 100 times to satisfy the proportionate decrease in observer's interoccular separation, and the picture alignment requirement increases proportionately. Calculations show that movies displayed to an audience of 1000 persons by this technique would require film frame alignment of one-half micro-inch. Space image size would also increase by 100 times and familiar objects would appear giant size (giantism). To avoid giantism and alignment problems, a wide base of cameras are required—each taking its own picture—the number of cameras required is effectively 750 over approximately a 50 ft. arc to satisfy about 800 to 900 persons, if the cameras are arranged concaved to the scene captured. If arranged convexed to the scene captured, a 100 ft. arc or 1500 cameras are required. This corresponds to one camera every 0.83 inch. Figures 9-a and 9-b show a workable system but impractical due to the vast amount of film required and the inherent waste of film. A system similar to this was suggested by H. E. Ives [3] in the early 1930's.

In Figure 9-b, Point Q on the screen is defined by all the light from projector P_4 incident on cylindrical lens element Q. The angle F takes up several information bits that had been recorded on the film in Figure 9-a by C_4. The resolution of this system suffers by this averaging effect of the light in angle F compressed to Q on the screen. Hence all information captured (for example by C_4) aside from Q within the angle

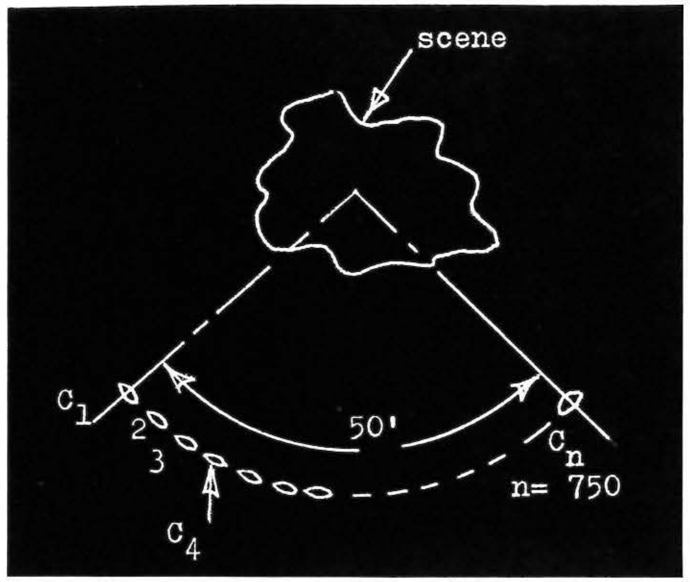


FIGURE 9a: (Camera) extensive lateral array of cameras

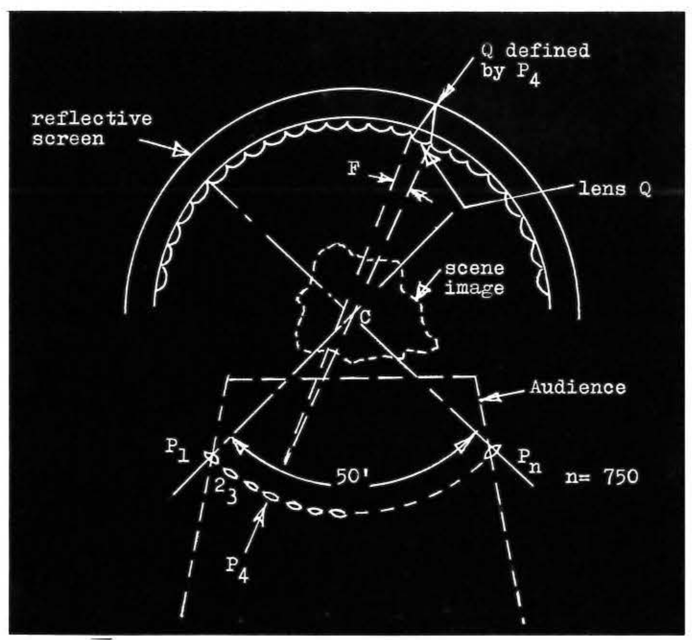


FIGURE 9b: (Projector) extensive lateral array of projectors

F, is wasted. There is no restriction to the width of cylinder lens element, however, and the separation should be such that the closest observer cannot resolve two adjacent cylinder lens-elements.

In Figure 9-b, the scene-image will have exactly the same shape, size and location as the original scene-object and can be projected in full color. The audience can sit as close to the reproduced image as desired provided they do not obstruct the projector-array. The array may be above or below the audience.

Economically, this system is not justified at present, but it is conceivable that as electronic picture systems are improved and subsequently made plentiful and reduced in cost—750 pickup tubes could scan the scene—750 recordings made on some media that can compress and retain resolution (e.g. thermoplastic tape or magnetic tape) and 750 individual electronic pictures projected (e.g. eidophor process) from a scan of the recorded information. This method would eliminate handling of 750 separate film strips but would still suffer from the stringent requirements to project from 750 extended light sources which presents an impossible logistics problem.

To review some of the basic problems discovered to this point: an array of 750 cameras are required (for a concaved arc to scene system) which could be vidicons to avoid film handling; the tremendous expense in accurate lenses and complexed circuitry; extended arc of projectors which equals the length of the camera array and quantity of separate projectors; the vast amount of power required to operate the 750 projectors; the reliability and logistics problems; the vast amount of unused data which is thrown away by the directional element selectivity of individual screen cylindrical lenticules; the complexed theatre circuitry to drive the individual projectors from the recording media, and light and size servos for each of the 750 projectors.

Since the example selected in Fig. 9 was the concaved system to the scene, the quantity of equipment must be doubled for the wide screen techniques implied at the beginning of this paper. That is, about 1500 units are required for a 120 degree system.

As the writer's design philosophy unfolds, the reader will note the following: 1500 capture points will be used over an extended 100 foot convexed arc to the scene but will employ simple pinholes in place of expensive lenses, and special spherical lenticular film in 10 units which can conveniently be transported to the scene. An intermediate processing phase will take about 25 days of continual processing for a 1½ hour show. This processing will prepare the geometry of presentation to allow centralized playback of the information by 3 projector-units revolving about the center axis of a cylinder screen at 2.7 rps. Kerr-cell electronically controlled selector shutters 50 feet in front of the screen will properly regulate and select correct information from the screen to be applied to each eye in the auditorium. The seating capacity will be 825 people and the included angle of view will be 120 degrees.

Every person will see the scene from a different position and the relative spatial position of image to original objects will be the same.

All 3-D systems which are continuous (giving the observer complete freedom) and eliminate the vertical variable, suffer from image expansion or image shrinkage with distance in depth and this phenomenon is strictly a function of capture and playback geometry and affects viewers farther from the screen more than close to the screen. This problem and its compromises will be discussed in details to follow. There will be a total of three films for the projectionist to handle and only one central light source will be required to illuminate the entire screen.

Sufficient experimental evidence over the past 20 years on equipment similar to what will be described here has accredited the process as being sound in theory and practice [4, 5, 6].

Dr. H. E. Ives [3] commented around 1930 that optical scan systems using high speed cameras and projectors seemed a feasible approach. At that time only slow emulsions were available which precluded serious consideration of this approach. It may also be of interest in passing, that Dr. Nikolai A. Valyus, Professor of Physics in Moscow in his recent book "Stereoscopy", (Focal Press, New York 1966,) indicates that the latest stereoscopic research in Russia is also involved with multi-picture hi-speed scanning techniques.

GENERAL PRINCIPLE OF NEW APPROACH USING CENTRAL PROJECTION SCAN TECHNIQUES

In Figures 10 and 11, the basic philosophy is shown for the capture and projection geometry. The arc A_c B_c in Figure 10 has the same radius about "C" that arc A_s B_s in Figure 11 has about P_R. This geometry shows how an arbitrary scene point (P) in Figure 10 is reproduced at at P_i in Figure 11.

In Figure 10, arc A_c to B_c is an array of several capture points (which will be shown equivalent to 1500 pinholes, later). The near scene object point "P" for the farthest imaginary observer with left and right eyes E_{Li} and E_{Ri} shown converging on P, generate sight-lines that intersect the arc at C_x and C_y respectively. The number of capture points equals the number of times the distance between C_x and C_y goes into the arc length A_c to B_c. Each "effective" camera's optical axis intersects at C. The optical axis for C_x and C_y are a_x and a_y respectively. The sight lines from E_{Li} and E_{Ri} to P make angles α and β with a_x and a_y respectively. Hence, P is photographed on the film plane for C_x at P_{ix} and P is photographed on the film plane for C_y at P_{iy}. The pictures are sequentially photographed along arc A_c to B_c so that C_x is shot then C_y, etc.

Figure 11 shows how the same geometry is used to generate the scene image which appears identical to the scene object in Figure 10. Since all of the camera's optical axes intersect in "C", then a single projector with a sweeping optical axis at P_R that has the same angular velocity as the apparent sequential movement of the several camera optical axes, tends to simulate the sweeping action. At the location of the arc, the array of cameras is replaced with vertical slits A_S to B_S that can be triggered electrically to open in sequence. The number of slits equal the number of cameras. At a distance of about twice the slit arc radius, a concentric reflective screen is placed. The angle of projection of the sequential pictures thrown from P_R is made less than the camera. At a distance of about twice the slit arc radius, a concentric reflective screen is placed. The angle of projection of the sequential pictures thrown from P_R is made less than the camera field angle so that the same field angle is subtended by the projected frame on the screen at the corresponding slit.

It can readily be seen from this geometry that the same angles α and β are generated by the projected pictures so that P_{ix} intersects the screen at P_{ix} and P_{iy} intersects the screen at P_{iy}. At this time, P_i can only be seen by eyes located physically at E_L and E_R which are at the same relative position as E_{L_i} and E_{R_i} in Figure 10.

The action of the projection system in Figure 11 is to sweep a successive series of pictures (1500) across the A_s to B_s arc which successively overlap on the screen and simultaneously sequentially trigger open the corresponding slits. This has the net effect of forcing all eyes behind the arc to see a true stereo picture.

In Figure 12, a general system concept block diagram is shown for the capture system, the camera film development central processor station, the projector film development and the playback system. From this diagram the reader can see briefly what elements will be used to form a complete stereoscopic system.

PRINCIPLE OF IMAGE DISSECTION PHOTOGRAPHY

Image dissection photography [7] offers a unique method of reducing the required film strip length compared to recording the same quantity and size pictures on standard motion picture film. A decrease in film length of 2 to 3 orders of magnitude is obtained when this form of photography is compared with standard two-dimensional contiguous frame recording. Because the film speed can be materially decreased and adequate primary frame resolution is retained, this form of photography has been selected for the new true stereoscopic system.

In image dissection photography a high resolution film is placed in close proximity with a matrix of spherical lenticules which have a very small f-number. The number of lenticules in the matrix equals the total number of picture elements desired in the primary picture. The advantage of this arrangement over a conventional camera is that several very accurately registered superimposed full-frame sized images (on the order of 1000) may be placed on a single frame of film. Once the required system resolution has been established from a study of all necessary viewing parameters, the frame size, primary focal length and the quantity of elements can be ascertained.

In Figure 13, the primary lens focal length is chosen small relative to the nearest object in the scene so that all rays emanating from any given point on the object (e.g. distant "arrow") will be approximately parallel. Therefore A, B & C come from the arrow "tip" and D, E and F come from the arrow "tail". If the primary lens is obstructed, the rays pass through the lens as indicated by primed symbols. That is, all the arrow "head" rays converge on n_n and all the arrow "tail" rays converge on n_1. With no obstruction, n_1 and n_n

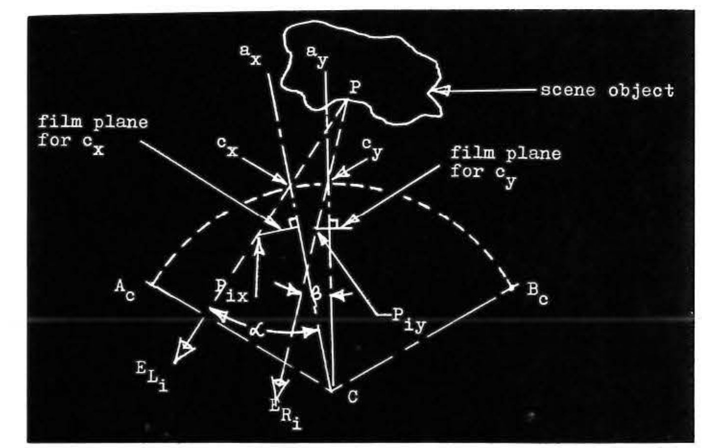


FIGURE 10: Geometry of new capture system

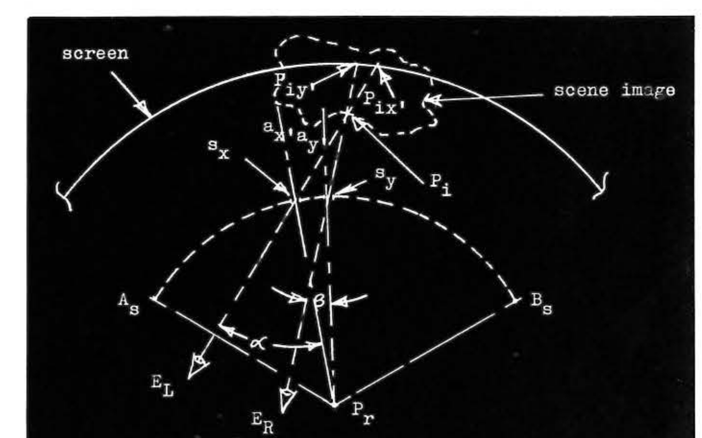


FIGURE 11: Geometry of new playback system

would image smooth discs of light on the film plane. The diameter of the light disc on n_1 would extend from d to f and on n_n from a to c. The disc intensities would be controlled by the intensity of light from the tail and head of the "arrow object", respectively.

The purpose in image dissection is to break up these solid discs into many individual points of light. This is conveniently accomplished by completely blocking the aperture of the primary lens except for a roving aperture indicated in Figure 13 as an "arbitrary aperture". The size of the aperture depends on the primary lens and lenslet focal lengths, and the quantity of dissection points on the light disc.

If the aperture is placed at "M", an image of the arrow tail appears at d and the head appears at a. If the aperture moves to "O", the tail and head shift to e and b, respectively. If the aperture moves to "N," the tail and head shift to f and c, respectively. This same reasoning can be applied to any other points on the object and any other lenslet elements in the matrix. As the roving aperture moves anywhere within the primary lens aperture, a large quantity of dissected images are recorded on the film. High speed motion pictures are possible because it takes only a short time for the aperture to move over its own diameter. It has been found in practice that about 80% of the area behind the lenslets can be devoted to image formation. The remainder is lost in boundary transitions between lenslets.

Figure 14 shows that the camera f/number is not affected by the small aperture stop at the primary lens (focal length = f) since it is located at infinity for the small lenslet. The camera system f/number equals $f/_d$ or the f/number of the lenslet alone. This number can vary and depends on the shape of the lenslet (but generally runs about 2).

The first spherical lenticular matrix film was prepared in 1928[8]. It had a celluloid surface covered with a series of fine spherical lenses in a honeycomb arrangement. There were 15 lenses per millimeter length, and therefore 225 lenses per square millimeter of surface. The corrugations in the film were made by a drum which had been engraved by hand.

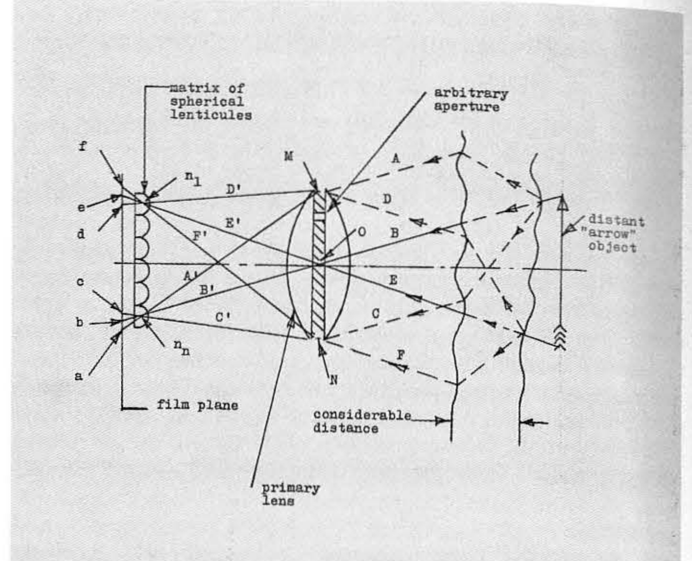


FIGURE 13: Basic image dissecting camera

PROJECTION OF IMAGE DISSECTED PICTURES

Since optical systems tend to be reversible, in order to retrieve the overlapping myriad of images from each of the frames and to do this in the same sequence as they were recorded, the roving aperture is given some sort of regular movement in the capture which is made identical in the playback. One way this is usually done is to use a wheel with holes arranged in a spiral pattern such that when one hole has scanned the primary lens aperture, the next hole

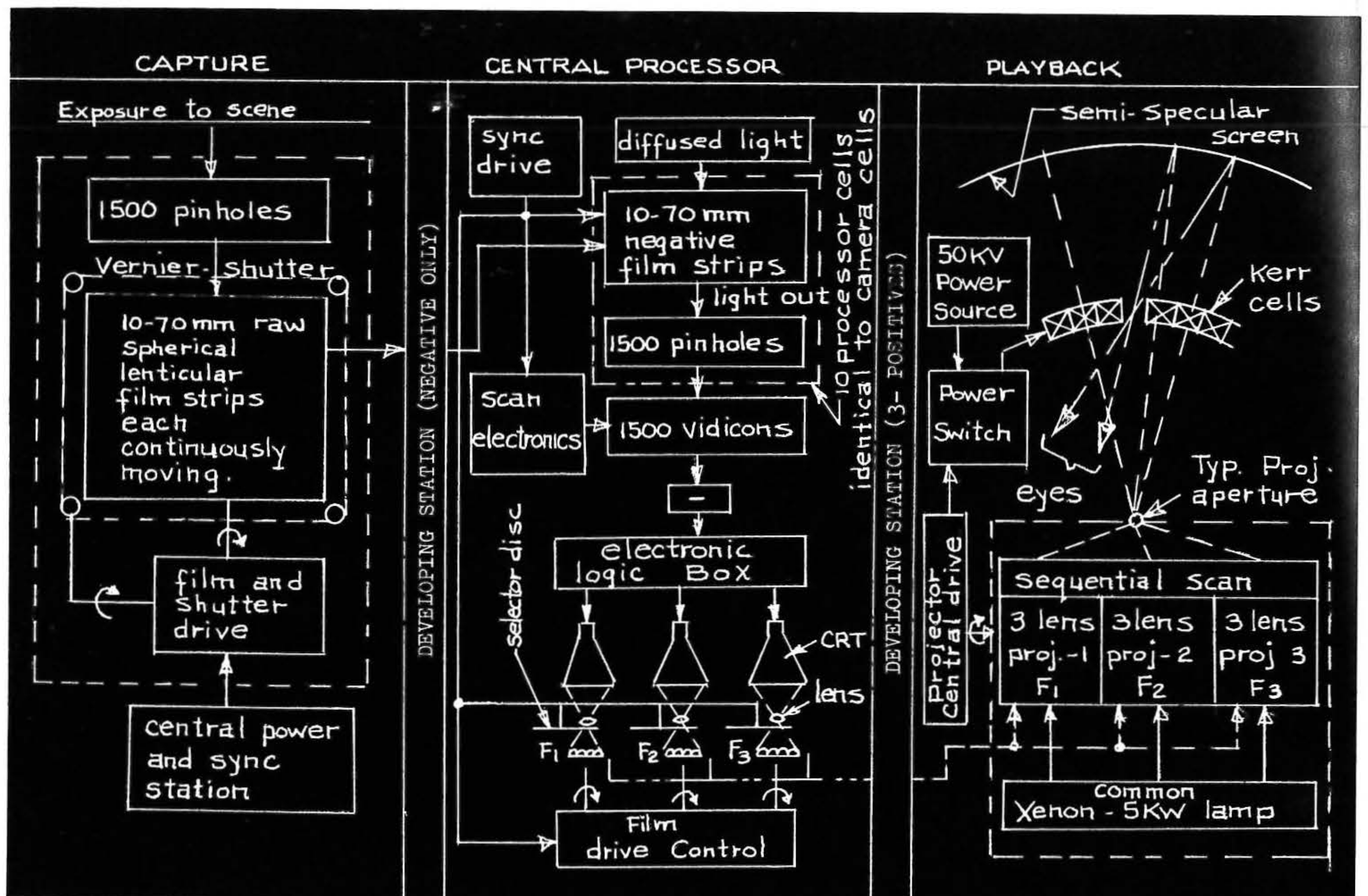


FIGURE 12: Block diagram of proposed system (Sound system not shown)

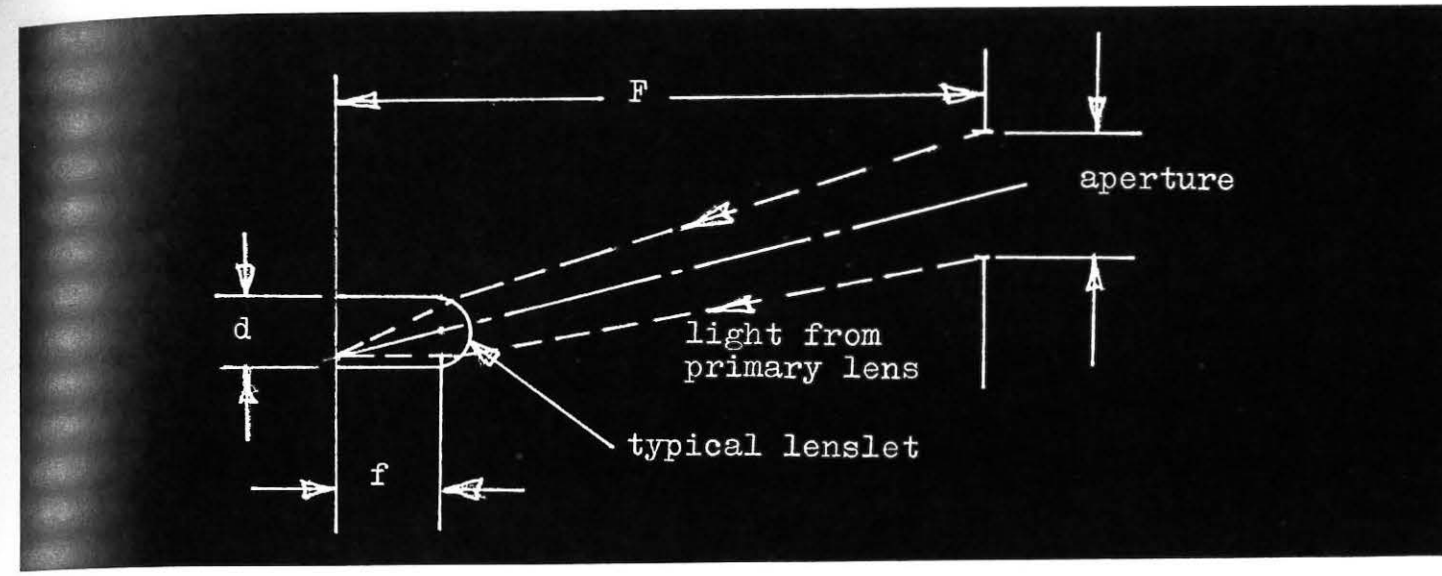


FIGURE 14: Low f-number of camera equals f-number of lenslet, not primary lens

begins its scan at a slightly different elevation (see Fig. 15). The three processor cameras that photograph the CRT images, and the projection system, will use this sort of regular motion.

With this technique of image dissection, projection light-losses tend to exceed capture losses by quite a large margin. This is primarily due to the requirement for a small diameter moving aperture at the primary lens. The projection f-number generally resulting from this restriction is about f/45. However, additional light may be concentrated on each dissected point by providing an identically pitched matrix of spherical lenticules between the film and an extended multi-point source lamp. A further discussion of this will be presented in the projection section.

In order to avoid a lapse in time between frames, the film in the camera, processor and projector, will run at a constant but different rate. This will assure equal time separating adjacent images regardless of their position along the longitudinal axis of the film strip.

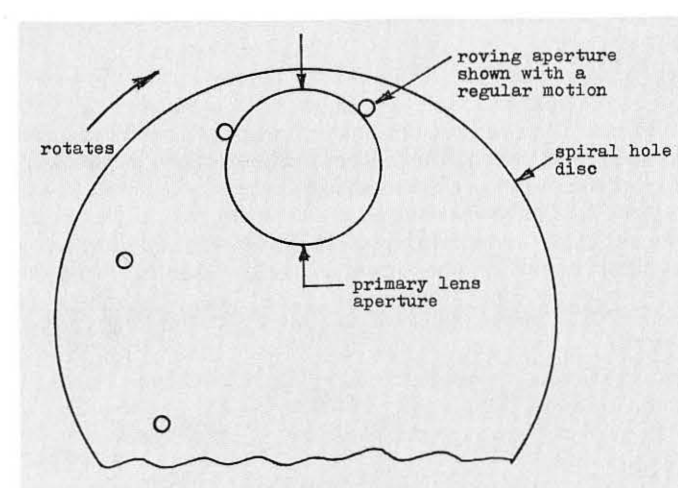


FIGURE 15: Image selector disc

SCENE IMAGE COMPRESSION AND EXPANSION COMPROMISES

As mentioned briefly in the previous introduction, all 3-D systems which are continuous (giving the observer complete freedom) and eliminate the vertical variable, suffer from image expansion and image shrinkage.

An example of this would be that a space character's image as it moves from near to far tends to flatten out to some degree. This, of course, is better than if it should "increase" in height with distance, because that would contradict normal perspective changes with distance in nature. Mathematically this variation of image height with distance can be predicted exactly and allowances made to minimize the effect by adjusting the position of the screen with respect to the slits and controlling the maximum distance from the slits that the audience may extend.

Figure 16 shows a superimposed capture and playback system from which these geometrical relationships are calculated.

Figures 17 and 18 shows parts of Figure 16 separately. In Figure 17, the arbitrary scene object is located between the slit and the screen and in Figure 18, it is placed beyond the screen.

DESCRIPTION OF PARAMETERS IN FIGURES 16, 17 AND 18

d = eye to slit distance
D_n = slit (or camera) to object O_f distance
a_n = apparent height of O_n in theatre
h_n = actual height of O_n
F = slit to screen distance
D_f = slit (or camera) to object O_n distance
a_f = apparent height of O_f in theatre
h_f = actual height of O_f
Let K = the ratio of apparent height that any given scene object appears to an observer located anywhere in theatre to the height that the same object would appear in the original scene to an observer in the same position that he occupies in the theatre.

$$K_n = \frac{a_n}{h_n} \text{ (for an object in front of screen position)}$$

$$K_f = \frac{a_f}{h_f} \text{ (for an object beyond the screen position)}$$

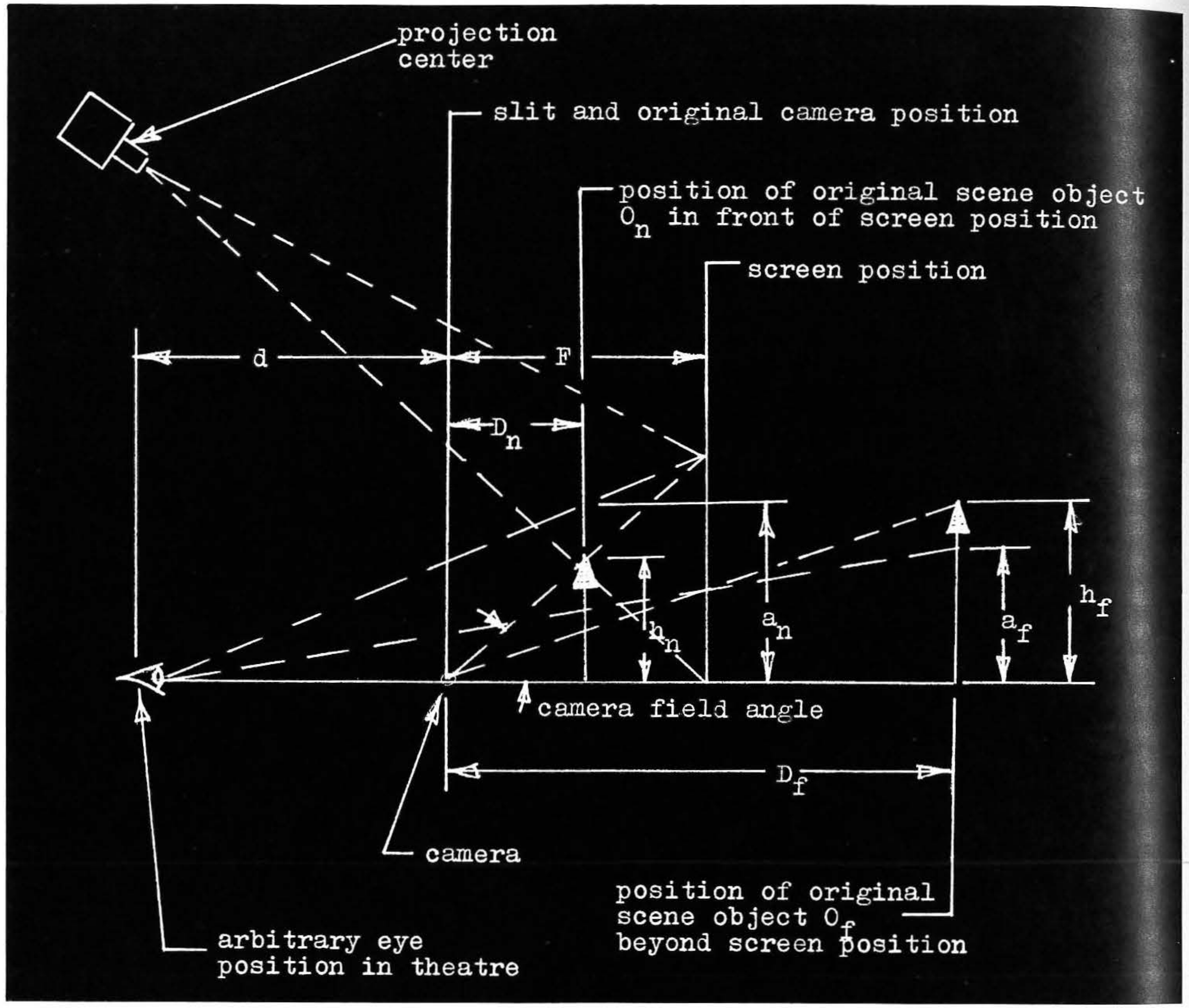


FIGURE 16: Viewing geometry translated from the actual scene to the theatre

By geometric calculations in Figures 17 and 18, it is shown that the general formula for K_n and K_f are the same.

For a fixed observer position, the only variable in the equation is the distance from the camera to any object whether it be D_n (for an object in front of the screen) or D_f (for an object beyond the screen).

A general formula for K then is, $K = \dfrac{d/_D + 1}{d/_F + 1}$ (eq. 1)

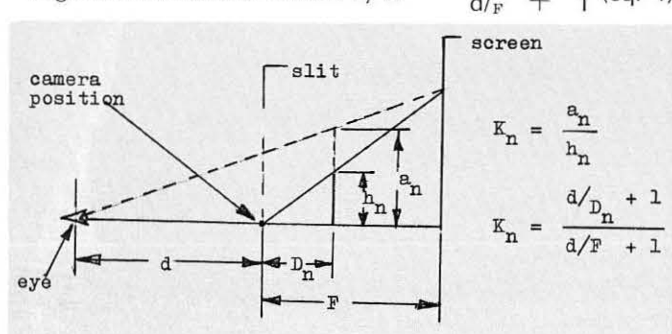


FIGURE 17: Object between slit and screen

Where D is the distance from the camera (in the capture of the scene) or from the slit (in the projection of the scene) to the object or the object's image respectively.

Note as D becomes small, K increases—which means that the apparent size of a fixed height object (e.g. a person) as he approaches the camera would increase. Conversely, the apparent height for a fixed height object (e.g. a person) as he moves away from the camera would appear to decrease to a fixed observer in the theatre. These apparent changes in height of moving objects in the z-dimension (or the depth dimension) are over and above the normal changes due to perspective change caused by the variation in subtended angle at the observer's eye.

From equation 1, if F (the slit to screen distance) is made large relative to d, then K approaches unity for distant objects. If F were equal to D, then K equals unity. This leads to a practical value for F equal to about ½ of the farthest observer's distance from the slits or about 50 ft. for the theatre size intended.

For the desirable geometry in the theatre, the actual magnitude of this variation can be calculated and limits set if it becomes too ridiculous.

The nearest observer will be 12 feet from the slit. The farthest observer will be 100 feet from the slit. F = 50 feet.

A logical range of depth for the location of spatial objects in the scene would be from about 10 feet from the slit to infinity.

Table I shows the apparent changes in the vertical height of near and far objects for three widely separated observer positions in the theatre.

TABLE I

Position of Observer	Observer to Slit Distance (feet)	Apparent size of image viewed compared with an object size of unity	
		Near Object	Infinite Object
Close	12	1.25	0.81
Far	100	0.64	0.33
Mid	56	.88	0.48

THEATRE LAYOUT GEOMETRY

A 120 degree screen was selected because it most nearly fills the observer's horizontal field of view and with the proposed rotating central projection system allows an "off to on" duty cycle of 2 to 1. That is, any given scanning projector sweeps 120 degrees of pictures onto the cylindrical screen and then remains off for 240 degrees before it returns again. Because of this fact there are two segments of film equivalent in length to the 120 degree scan that are blank. These 2 blank sections are utilized to slow the system down and employ 2 more projection lenses to scan these sections of the film. In order to prevent flicker, a 24 cycle repetition rate has been chosen. If the 2 blank sections of the film corresponding to the circular arc from 120 to 240 degrees and from 240 to 360 degrees were not filled in, 3 projectors each spaced 120 degrees and moving 120 degrees in 1/24 second would be required to maintain a flicker-free picture. This would call for an exceptionally high projection rate since 1500 pictures will be projected by any given lens as it sweeps over the 120 degree arc. By adding 2 each projection lenses to each of the 120 degree projectors, each projector is now replaced every 40 degrees and the rotational rate has been decreased by a factor of 3. There are now 9 projectors using 3 pieces of film revolving at 2.7 rev/sec about the central common-light source.

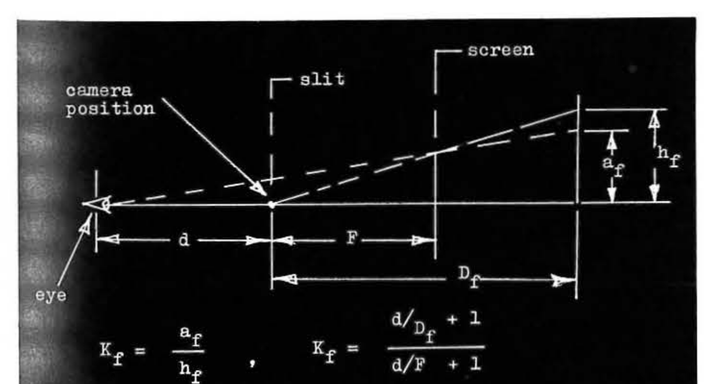


FIGURE 18: Object beyond screen

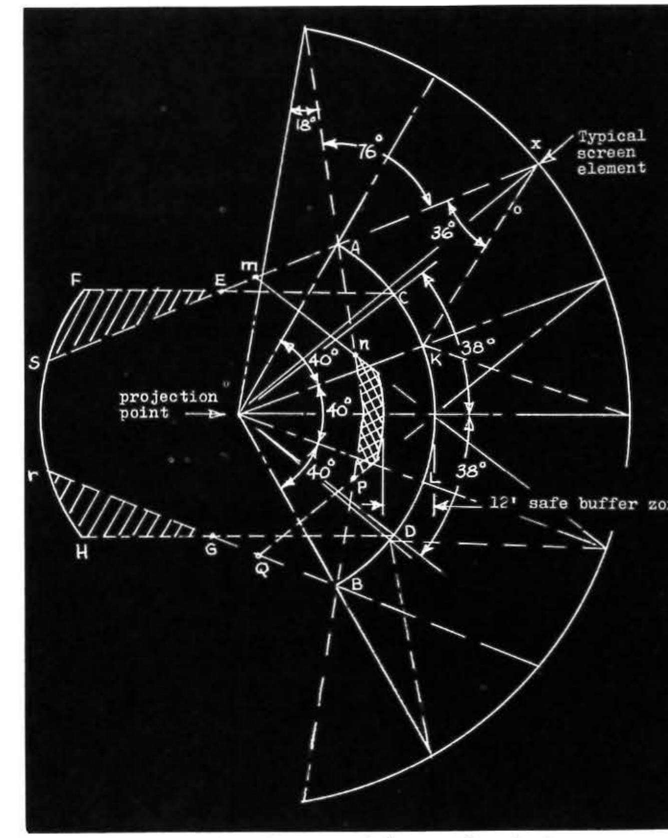


FIGURE 19: Stereoscopic theatre scale layout (plan view)

With the screen placed at a radius of twice the slit level radius, and a 40 degree separation of projected pictures, no overlap on the screen occurs if the angle subtended at the slit by the frame width of any given projected picture is no more than 76 degrees. This value then requires that the pictures be captured from the scene at a 76 degree field angle.

Figure 19 shows the proposed layout plan view of the theatre. Arc AB subtends 120 degrees at the center axis of projection. Anyone within m n o p q r s will see through this entire window arc AB. In the shaded area, the observer sees less than AB. For example, along line EF, he sees arc CB and along line GH he sees arc AD. In other parts of the shaded area he sees more of arc AB until along lines SE or rG he sees all of arc AB. The cross-hatched area represents added seats at the auditorium front which will allow observers to see arc KL or arc DC, depending on where they are located in the cross-hatched area. There is a 12 foot buffer zone between the closest seat and the slit position.

Note that point X (a typical screen element) must radiate light to the successive 500 slits arranged in sequence and extending over arc AK. This total angular sweep amounts to 36 degrees. In the projection section under screen gains, it will be found that very high screen gains can be realized by creating a fan shaped beam which reflects from a screen element (e.g. x) and sweeps successively over the 500 cells (e.g. between A & K) during the 1/24th second scan of any of the nine projectors.

Figure 20 shows the theatre layout from an elevation view showing that the projection station will be located 53' above the ground level and throw a keystone shaped picture (to compensate for the angle of projection to the screen) at an average throw distance of 133 feet. This high projection station is required so that projector rays will miss the slits and still allow the audience to get an approximately normal view of the screen through the slits. The slit height is shown at 48 feet and the screen height at 69 feet. The audience floor will be on a 16 degree incline to the horizontal.

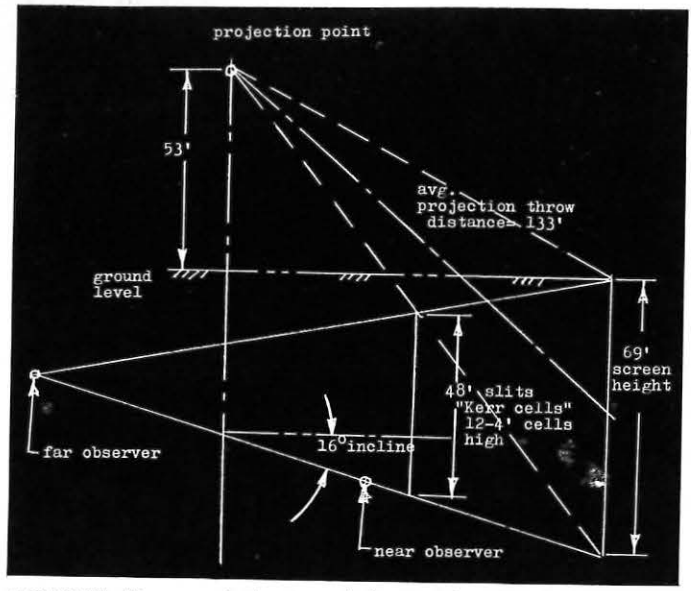


FIGURE 20: Stereoscopic theatre scale layout (elevation view)

Figure 21 shows the seating layout dimensions and the number of seats are calculated from the rules that the front to back seat spacing is 3 feet and the side to side seat spacing is 22 inches. A total of 825 seats fit into the area of acceptable viewing as determined by the theatre layout plan view of Figure 19.

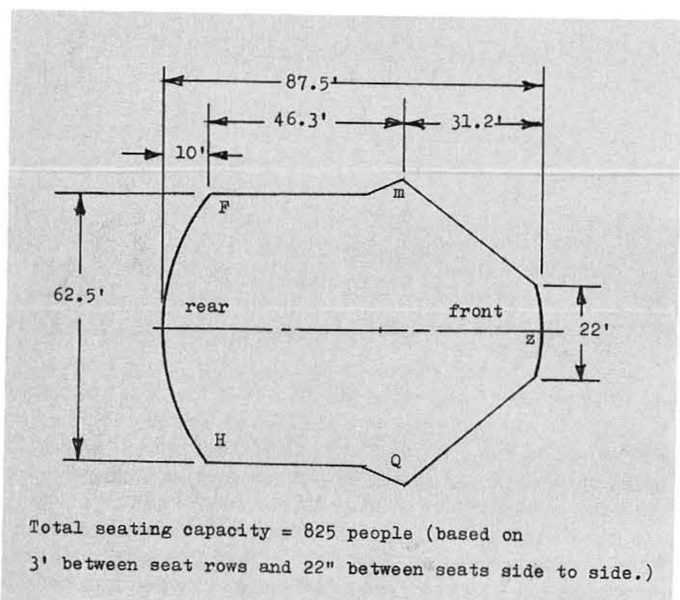


FIGURE 21: Stereoscopic theatre seating layout (best seats are in front)

CALCULATION OF TOTAL CAPTURE POINTS OVER 120° ARC

From the plan view of the theatre, the farthest observer from the slits will be 100 ft. This observer is used as a basis for determining the minimum number of capture points and hence the pitch of the slit-selector cells used in the theatre at a 50 foot radius from the central projection point. The method for determining this quantity is equivalent to that shown in Fig. 8 for the lenticule system and again in Figure 22 for the new system.

Parameters shown in Figure 22 have the following significance:

S = minimum separation of adjacent capture points in the camera system and also the width of a slit-selector cell in the theatre.

$$S = \frac{2.5\ F}{d + F}$$

Where F = slit to screen distance, and

d = distance of the farthest observer from the slit selector with left and right eyes E_L and E_R respectively.

$R = F = 50$ ft, $d = 100$ ft

$S = 0.83$ inches N = total number of capture points or cells/360°.

Therefore,

$$N = \frac{2\pi R}{S} = 4520$$

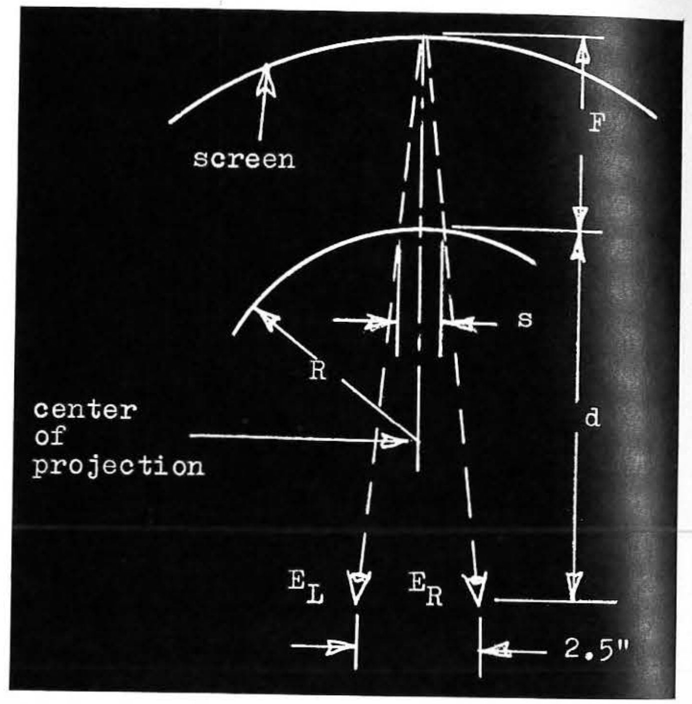


FIGURE 22: Minimum camera separation

CONFIGURATION OF CAMERA SYSTEM

The camera system presents a very complex problem. The camera array must physically occupy the same arc—radius and arc length as arc AB in the theatre plan view. This corresponds to a 50 ft. radius and a 104 ft. arc length. This 104 ft. arc length must contain 1500 equally spaced cameras. Each camera must have a frame rate of 24 frames/second and be sequentially scanned to be compatible with the sequential scan of the projection system.

Figure 23 shows the arc of cameras with their 1500 extended optical axes intersecting at "O".

The array of cameras will be broken up into 10 cells each. Each cell will be approximately 10 feet x 4 in. square with a feed reel at one end and a take-up reel at the other end. Each cell will contain "effectively" 150 cameras.

The sequence of pictures will be such that cameras 40 degrees displaced from each other in the arc AB will always be triggered in parallel as the pictures are sequentially captured across the entire arc AB. This 40 degree separation corresponds to 3.3 cell lengths. Therefore the time to scan through 150 cameras on one cell is 1/3.3 x 1/24 sec = 1/79 sec.

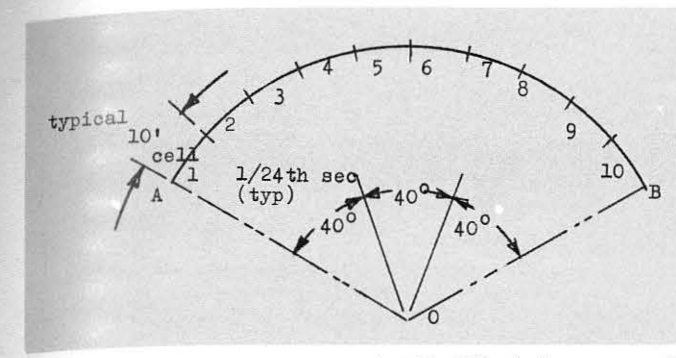


FIGURE 23: 120 degree—104' arc of 1500 "Effective" cameras with common optical axis intersection at "O"

Since each of the 1500 "effective" cameras captures 24 pictures per second, the total number of images captured per second equals 36000.

The 10 ft. cell length is easily handled by a crew of two men during set up at the scene site.

1500 lenses have been replaced with 1500 pinholes and each cell has been divided into sub-cells of 13 pinholes each (e.g. one pinhole on axis and 6 above and 6 below the axis (see Figures 24 and 25). The time to scan a sub-cell is 1/910 seconds.

With reference to the description of image dissection in Fig. 13, it was shown that even though the roving aperture (in this case the fixed pinholes arrayed over plus and minus ½ inch from the optical axis) moved off the optical axis of the system, the primary lens "effectively" brought each of the off-axis aperture locations into the on-axis position. Vertical parallax of 1 inch will not affect the resultant picture since the closest object will be 10 feet from the pinhole array and the vertical variable in the scene has been discarded (as mentioned in the introduction). Note the 10 ft. long plastic cylinder-lens which serves to bring each of the 150 pinholes in the cell, on axis.

As the film moves continuously over the cell length, about 72,000 full-frame pictures are being registered in their matrix islands so that no two pictures at any time have any of their picture elements superimposed on the emulsion.

The film format is a 2.25 inch square and therefore as the film moves from left to right (as in Figure 25) we can examine one elevation level (e.g. 5 pinhole spaces down from the film centerline or pinhole No. 2 in each subcell will be at the same elevation level). If the film moves at least 2.25 inches per 1/24th second (the frame-rate of each individual pinhole) then any one pinhole (e.g. No. 2) does not write any more than one picture in a given frame area.

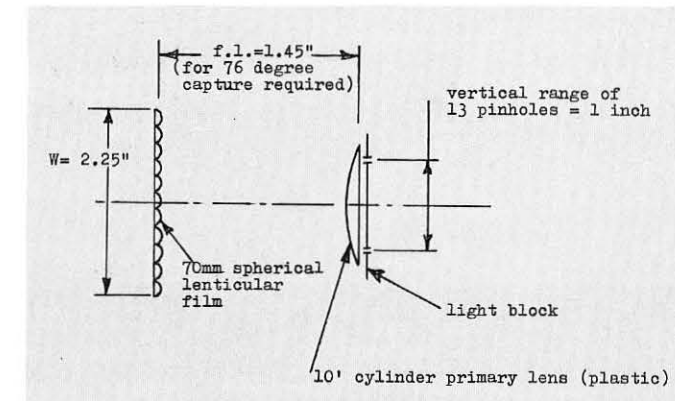


FIGURE 24: Camera elevation—one subcell

From Figure 26, a given frame moves such that in one subcell length its relative position with respect to the next pinhole at the same elevation as the last one, is 1/13th of the frame width at the time this pinhole opens and receives its image. Therefore, from the figure, the film velocity equals the distance the frame leading edge travels divided by the time it takes for 4 openings of the No. 1 sub-cell No. 2 pinhole plus the time differential between two adjacent No. 2 pinhole openings. This velocity equals 10.8 + 0.173 ÷ t', or approx. 5 feet per sec.

From Figure 27, the f-number of the spherical lenticule element determines the maximum capture angle θ allowable. Any angle wider than θ would cause any given lenticule's image to overlap the image of its adjacent lenticule.

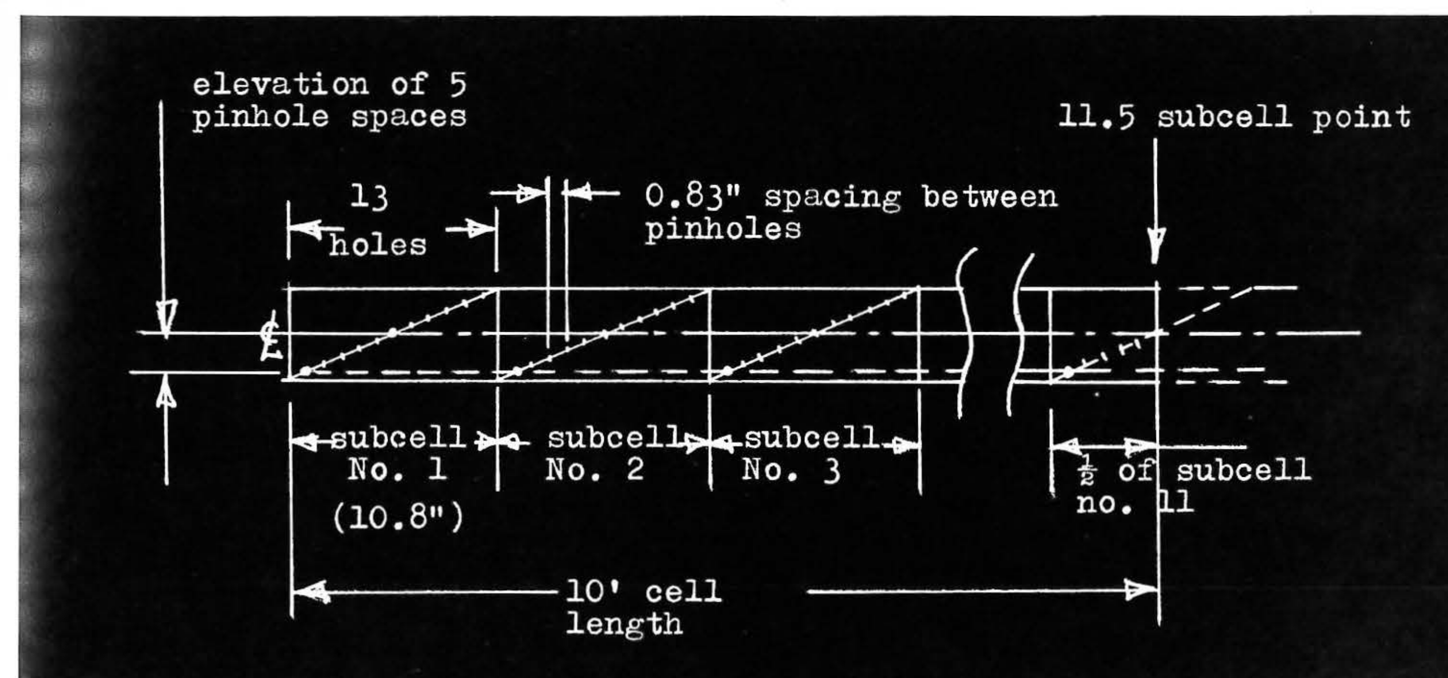


FIGURE 25: Camera cell—front view

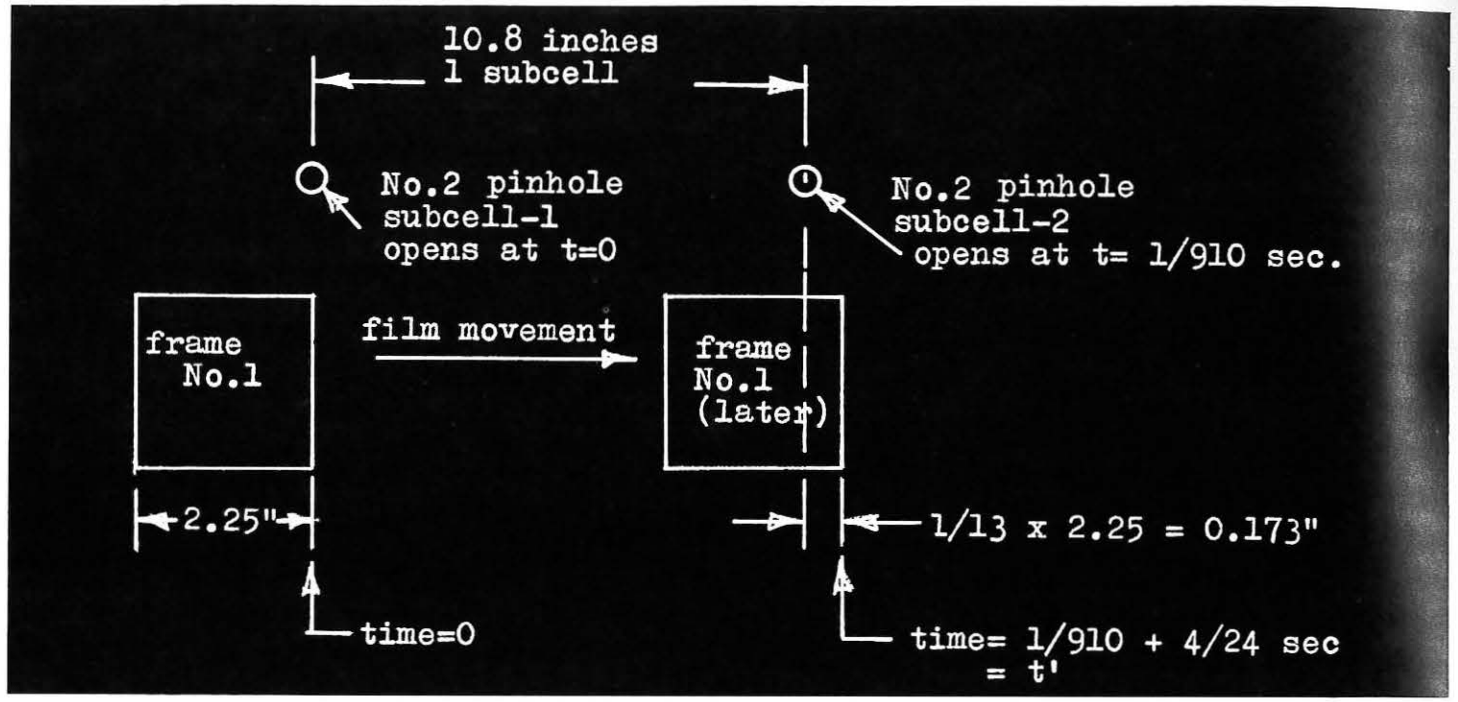


FIGURE 26: Determination of camera film velocity in each cell

The 76° included angle (Table 2) was dictated by the viewing geometry which gives an audience of 825 people. If an f/1 system was used, the audience seating capacity would be reduced to 400 people due to a restricted capture angle of 53 degrees. However, one advantage of this would be a forward movement of the rear seats which tends to give less shrinkage appearance to space characters.

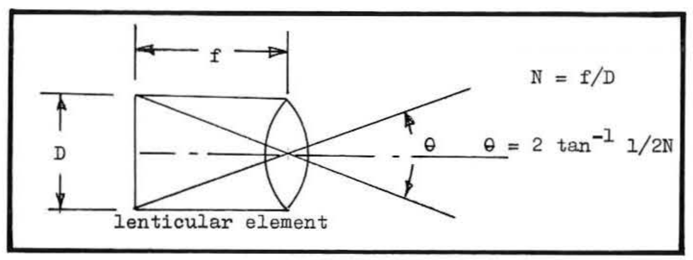


FIGURE 27: Cell f-number

TABLE II
F-Number of Spherical Lenticules (N_r)—
(See Figure 27)

N_r	θ (degrees)
0.5	90
0.64	76
1.0	53.2
1.4	39.3
2.0	28.1

This article continues in the September/October issue

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Mr. Collender is presently with Lockheed Aircraft Corporation's Advanced Development Group in the capacity of Systems Application Engineer related to reconnaissance sensing equipment and ASW display devices.

Legibility requirements for educational television

ALAN S. NEAL

ABSTRACT

To find out how classroom seating affects the student's view of a televised lesson, the quality of a video tape display was evaluated at distances equivalent to that of the last row of seats in a classroom. Displays of alphanumeric symbols allowed quantitative performance measurements that can be generalized to other types of images. The legibility of the televised symbols was measured in terms of the accuracy with which viewers could copy the random character sequences on an input/output typewriter connected to a computer. Four variables were tested: (1) scan lines per character height; (2) bandwidths of 2.5, 3.1, and 4.0 MHz; (3) visual angle formed by the displayed character at the eye; and (4) the off-axis from which the monitor was viewed.

As expected, accuracy improved as the visual angle and number of scan lines increased, and was reduced as the off-axis angle increased. The average number of characters keyed per minute was also measured, with similar, but less consistent, results. Though viewers could often perceive the bandwidth differences, the results showed no significant effect of bandwidth on accuracy or throughput. Tests with a special low-noise video tape also revealed no significant effect on performance.

These results are translated into recommendations for classroom viewing, indicating the maximum distance and angle from the monitor within which students should be seated.

THE NEED FOR EXPERIMENTAL DATA

In more and more American schools, television takes its place beside, or replaces, the blackboard. Books and articles are written to tell the schools how to use TV in the classroom. Experts offer advice on how big a screen to buy and where to place it.[1-7] For a room of standard size, most recommend a monitor with at least a 21-inch screen, and preferably 24. They estimate 15 to 20 students could watch a 21-inch screen, while the 24-inch might serve as many as 20 to 25. Most agree that the monitor should be placed four or five feet off the floor, and students should be at least four to six feet from it. How far away they can sit depends on the size of the screen; 12 to 15 times the screen width is the recommended maximum. Another important factor is the angle

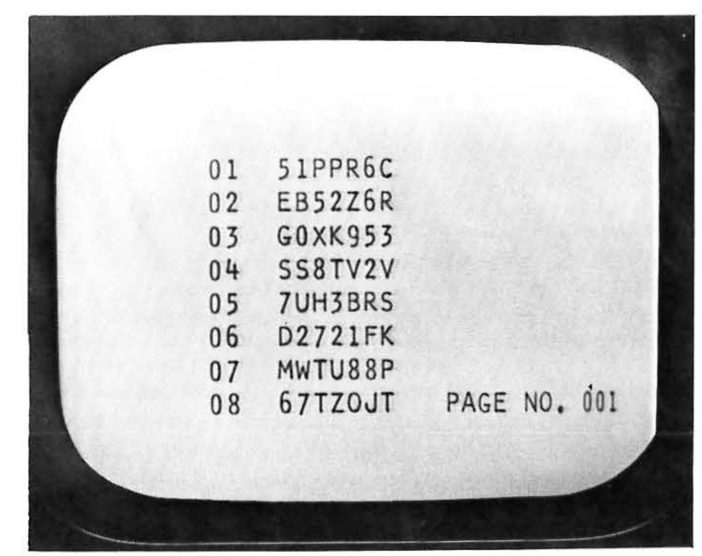

Fig. 1: Sample Display at 4.0 MHz and 30 Lines per Character Height

from which the student views the screen. According to the experts, his line of vision should never be more than 30 to 45 degrees to the left or right of the screen center. Such general guidelines, though apparently sensible, are not founded on experimental evidence. Very little research has been done on the best television system for the classroom. We need to consider not only the size and placement of the TV monitor, but the quality of the TV itself.

The TV quality may become even more important when, as is often the case, the material displayed was originally prepared for some other purpose. If printing or other fine detail appears in a television movie, a teacher might assume that the producer made it big enough to see. In fact, because of basic differences between television and film quality,(8) as well as the discrepancy between the intended and actual image size, some movie frames may be quite unintelligible when seen on TV.

The quality of a TV system can be evaluated by having viewers perform a task requiring the use of the display, and then measuring their performance on the task. Only such empirical studies can give us a real grasp of the relevant variables affecting television displays.(8) Frequently, the task assigned is the identification of standard English letters and numbers. The size and familiarity of the alphanumeric symbols simplify testing and scoring, and the results can be generalized to other picture details of comparable size and resolution.

Shurtleff(9) reviews the technical literature on television quality and discusses the interactions between display variables, particularly resolution and character size. He reports several studies that evaluated the TV quality in terms of human performance measurements. A number of variables have been studied in this way, including properties of the image itself, such as character size, font, and polarity (black on white, or white on black), as well as factors in the display (brightness, contrast, resolution).

Of these studies, perhaps the most relevant for education is the work of Seibert.(10, 11) He attempted to determine how legible displayed characters are at different angles and distances, for a range of character sizes and horizontal and vertical resolutions.

Unfortunately, Seibert does not give full details of the physical characteristics of his TV display, and his measurements do not include conditions in which the displayed characters are large and the viewer is some distance from the screen. Such conditions, which would result in a relatively high vertical resolution but a very small visual angle (the angle that might be drawn from the viewer's eye to the top and bottom of the object viewed), would be typical for students viewing television from the back rows of the classroom.

In many cases, classroom television will rely on material recorded on video tape, in which video noise, dropouts, and sync instability are more likely to occur, with consequent degradation of picture quality. For this reason, empirical measurements of viewer performance with materials recorded on video tape are of concern.

The classroom teacher and the AV director want to know how large detail or characters must be on the screen, how far away from the screen the last row of seats can be, how far to the side of the TV a student can sit, and how good the TV system itself must be. In order to answer these questions, the following study was designed.

AN EXPERIMENTAL STUDY OF TV QUALITY

Experiments were conducted to evaluate the quality of a television display of images recorded on video tape. Display quality was measured in terms of accuracy or legibility, defined as the percentage of randomized alphanumeric characters which viewers could correctly identify. Legibility was chosen as a measure sensitive to small changes in the image. Random character sequences (see Fig. 1) were used to avoid the problems associated with recognition of words of varying familiarity. They served as the equivalent of very unfamiliar words (as many words may be to a young student), requiring recognition of each and every character. (The use of legibility as a performance measure is discussed in reference 12, and the problem of legibility of words in reference 13.)

The following physical characteristics of the television display were investigated:

a. Scan lines per character height—the number of raster scan lines crossing each character, a function of the character size and the vertical resolution of the display. Vertical resolution, in turn, is a function of the size of the monitor and the total number of displayable lines (about 500 lines on standard American TV).

b. The bandwidth of the video display, which partly determines the horizontal resolution. Three bandwidths—2.5, 3.1, and 4.0 MHz—were tested.

c. The visual angle subtended by the displayed character at the eye. This imaginary angle drawn from the cornea of the eye to the top and bottom of the character viewed is a function of the character size and the distance between the viewer and the TV monitor. The visual angle may be thought of as a measure of the effective character size "in the eye of the beholder."

d. The off-axis angle from which the monitor is viewed. The off-axis angle is the angle between a line drawn perpendicular to the face of the TV screen and a line drawn from the TV monitor to the viewer.

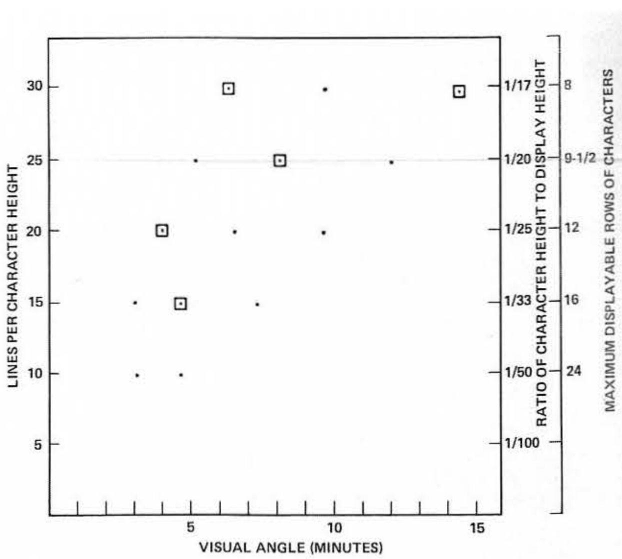

Fig. 2: Viewing Conditions Tested (All experimental points are equivalent to a viewing distance of at least 14 feet from a 21-inch or 24-inch monitor. Box indicates points of additional tests at off-axis viewing angles.)

In addition, one part of the study compared the legibility of characters displayed on two types of video tape—one a standard tape, and the other a higher-priced tape with a low noise level.

Figure 2 is a plot of vertical resolution versus visual angle showing the conditions tested in this study. The points were chosen to represent conditions that were calculated to be equivalent to the view from the last rows in representative classrooms. The combinations of vertical resolution and visual angle, though tested with the 14-inch monitor in this experiment, would be equivalent to a viewing distance ranging from 14 feet to 43 feet from a 21-inch classroom monitor.

The scale at the right of the graph gives the number of rows of characters that can be placed on the screen given the number of scan lines per character height. This caculation was based on assumed standard row spacing of pica or 12-point type, with margins at the top and bottom of the screen each equal to one-tenth of the screen height.

Experimental Design

Twenty different viewers were required to read material presented on the TV monitor and to copy what they read on an input/output typewriter connected to a computer. The computer calculated the average throughput (characters keyed per minute) and legibility (percent of characters correctly identified) for each page of material presented on the display.

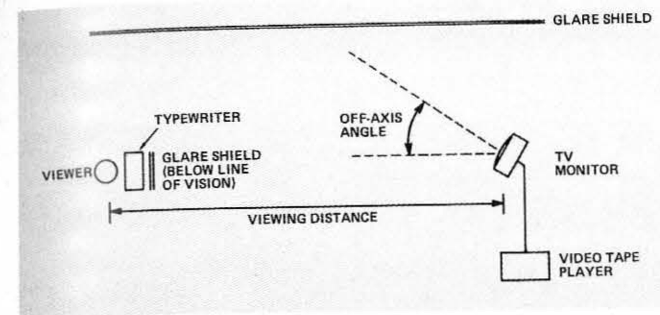

Fig. 3: Diagram of Experimental Setting (Top View)

Each of the 14 basic combinations of vertical resolution and visual angle indicated in Fig. 2 was tested at three bandwidths. The three bandwidths of 2.5, 3.1, and 4.0 MHz produced approximately 250, 350, and 425 lines of horizontal resolution, respectively, on the 14-inch monitor. All of the resulting 42 conditions were tested with the viewer at distances of 10, 15, and 23 feet from the monitor but directly in front of it (0 degrees off axis).

The five conditions indicated by boxes on Fig. 2 were also tested (at 3.1 MHz only) with the monitor placed at an angle to the viewer, so that she viewed the display from 10, 20, 30, and 40 degrees off-axis. The special low-noise tape was used for this portion of the experiment. The tape was also tested at 0 degrees off axis for the five selected conditions, to allow a comparison of the viewers' performance with the two tapes.

The same material was presented to all subjects. The order of presentation was fixed in a counterbalanced design: the viewer first was shown one page at each condition until all conditions had been presented, and then shown a different page at each condition, but with the order of the conditions reversed.

Stimulus Material

All the pages of material presented to the viewer had the same format, consisting of eight rows of seven randomized characters each, plus row numbers and page number identification (see Fig. 1). The character font is a bold stroke sans serif type (Manifold). Half of the characters were capital letters and half numbers; aside from this restriction, the sequences were completely randomized.

Viewers

Twenty female typists, ranging in age from 18 to 39, were hired through a temporary office help agency for this study. Each was given a comprehensive vision test to measure visual acuity and detect any abnormality that would affect the results. All but one had at least 20/20 visual acuity with both eyes for both near and far vision (with glasses if needed). The one exception had 20/20 near vision and 20/30 far vision. No serious abnormalities were found in stereopsis (depth perception), and no serious vertical or lateral phoria (muscle imbalance was detected.

Procedure

Each typist came to the laboratory for one day of individual testing. The total testing period was about five hours, with frequent rest breaks. The experimenter first explained the general purpose and procedure of the test, and then gave her detailed instructions on how to perform the task. Finally, she was given ten pages of practice material on video tape. During the practice session, the experimenter observed her performance, corrected errors in procedure, and answered questions.

In the actual test session, the procedure was the same for each page: The experimenter positioned the monitor, if necessary, at the appropriate distance from the typist and set the off-axis viewing angle of the monitor. He then started the video tape player/recorder, and the image was displayed on the monitor. When the telivision picture became stable, the typist pressed the Ready key on the I/O typewriter. In response to this signal, the computer typed the first line number (01) on the typewriter. The typist then proceeded to copy line 01 on the display, as she perceived it. After typing the seven characters, she pressed the carrier return key. The computer accepted the seven-character entry and typed out the next line number. This procedure continued until the typist had copied all eight lines of material on the page. If she wished to correct a character just keyed, she could press the Attention key and then rekey the entire line of seven characters. (But she had to do this before she pressed the Return key.) If she keyed too few or too many characters in a line, the computer asked her to rekey the entire line by typing "please rekey" on her typewriter.

After the typist finished the last line on the page, she keyed a period, a signal to the computer that this page was completed. The computer then calculated the amount of time (in seconds) between depression of the ready key and keying of the period, i.e., the total amount of time required to read the display and type what was seen. The computer also checked the number of errors the viewer made (and what each error was) and recorded this information, identified by subject number, page number, etc., on punched cards. When those calculations were completed, the computer typed out on the viewer's typewriter the number of the next page of material to be copied. The experimenter then "fast-forwarded" the recorder to the beginning of the next page on the video tape.

Equipment

The parameters of scan lines per character height and bandwidth were set at the time of video tape recording. The recording was made with a 525-line Granger V1000 television camera and control unit, a GEC 8507 high resolution vidicon, and a modified Sony EV200 video recorder/player. The bandwidth of the video signal was altered with Butterworth seven-pole low-pass filters.

Standard Sony V-11-60 one-inch video tape was used to display the 42 basic conditions, and a special Sony low-noise V-11-60 video tape was used for the portion of the study concerned with off-axis angles. The standard tape had a signal-to-noise ratio (peak-to-peak/RMS) of 40.5 db, while the low noise tape had a 42.9 db S/N ratio.

During the test, the tapes were played back on the same recorder/player, and displayed on a Conrac CQE-14/525/1029 fourteen-inch monitor (which had horizontal sync circuits modified to be compatible with the helical scan video recorder). The displayed images had a surface luminance of 20 foot-lamberts on the background and two foot-lamberts on the characters, thus obtaining a Michelson contrast—defined as (Lmax-Lmin)/(Lmax+Lmin)—of 0.82. Considerable from which the student views the screen. According to the experts, his line of vision should never be more than 30 to 45 degrees to the left or right of the screen center. Such general guidelines, though apparently sensible, are not founded on experimental evidence. Very little research has been done on the best television system for the classroom. We need to consider not only the size and placement of the TV monitor, but the quality of the TV itself.

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In many cases, classroom television will rely on material recorded on video tape, in which video noise, dropouts, and sync instability are more likely to occur, with consequent degradation of picture quality. For this reason, empirical measurements of viewer performance with materials recorded on video tape are of concern.

The classroom teacher and the AV director want to know how large detail or characters must be on the screen, how far away from the screen the last row of seats can be, how far to the side of the TV a student can sit, and how good the TV system itself must be. In order to answer these questions, the following study was designed.

AN EXPERIMENTAL STUDY OF TV QUALITY

Experiments were conducted to evaluate the quality of a television display of images recorded on video tape. Display quality was measured in terms of accuracy or legibility, defined as the percentage of randomized alphanumeric characters which viewers could correctly identify. Legibility was chosen as a measure sensitive to small changes in the image. Random character sequences (see Fig. 1) were used to avoid the problems associated with recognition of words of varying familiarity. They served as the equivalent of very unfamiliar words (as many words may be to a young student), requiring recognition of each and every character. (The use of legibility as a performance measure is discussed in reference 12, and the problem of legibility of words in reference 13.)

The following physical characteristics of the television display were investigated:

a. Scan lines per character height—the number of raster scan lines crossing each character, a function of the character size and the vertical resolution of the display. Vertical resotion, in turn, is a function of the size of the monitor and the total number of displayable lines (about 500 lines on standard American TV).

b. The bandwidth of the video display, which partly determines the horizontal resolution. Three bandwidths—2.5, 3.1, and 4.0 MHz—were tested.

c. The visual angle subtended by the displayed character at the eye. This imaginary angle drawn from the cornea of the eye to the top and bottom of the character viewed is a function of the character size and the distance between the viewer and the TV monitor. The visual angle may be thought of as a measure of the effective character size "in the eye of the beholder."

d. The off-axis angle from which the monitor is viewed. The off-axis angle is the angle between a line drawn perpendicular to the face of the TV screen and a line drawn from the TV monitor to the viewer.

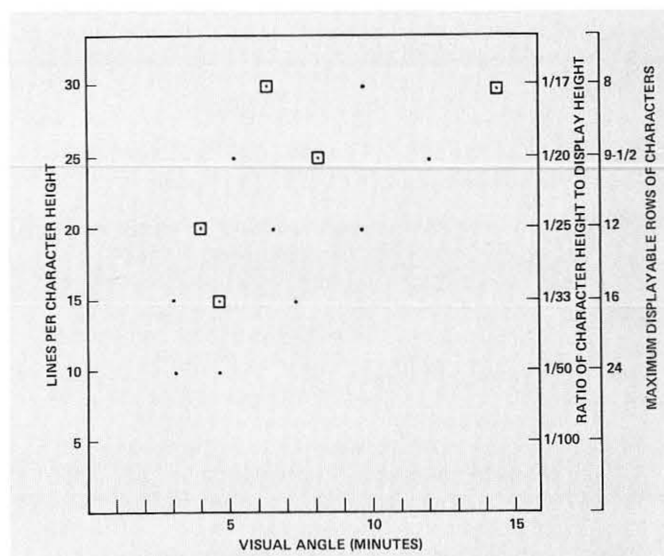

Fig. 2: Viewing Conditions Tested (All experimental points are equivalent to a viewing distance of at least 14 feet from a 21-inch or 24-inch monitor. Box indicates points of additional tests at off-axis viewing angles.)

In addition, one part of the study compared the legibility of characters displayed on two types of video tape—one a standard tape, and the other a higher-priced tape with a low noise level.

Figure 2 is a plot of vertical resolution versus visual angle showing the conditions tested in this study. The points were chosen to represent conditions that were calculated to be equivalent to the view from the last rows in representative classrooms. The combinations of vertical resolution and visual angle, though tested with the 14-inch monitor in this experiment, would be equivalent to a viewing distance ranging from 14 feet to 43 feet from a 21-inch classroom monitor.

The scale at the right of the graph gives the number of rows of characters that can be placed on the screen given the number of scan lines per character height. This caculation was based on assumed standard row spacing of pica or 12-point type, with margins at the top and bottom of the screen each equal to one-tenth of the screen height.

Experimental Design

Twenty different viewers were required to read material presented on the TV monitor and to copy what they read on an input/output typewriter connected to a computer. The computer calculated the average throughput (characters keyed per minute) and legibility (percent of characters correctly identified) for each page of material presented on the display.

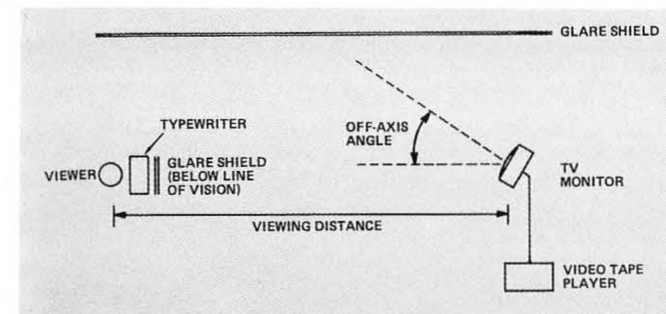

Fig. 3: Diagram of Experimental Setting (Top View)

Each of the 14 basic combinations of vertical resolution and visual angle indicated in Fig. 2 was tested at three bandwidths. The three bandwidths of 2.5, 3.1, and 4.0 MHz produced approximately 250, 350, and 425 lines of horizontal resolution, respectively, on the 14-inch monitor. All of the resulting 42 conditions were tested with the viewer at distances of 10, 15, and 23 feet from the monitor but directly in front of it (0 degrees off axis).

The five conditions indicated by boxes on Fig. 2 were also tested (at 3.1 MHz only) with the monitor placed at an angle to the viewer, so that she viewed the display from 10, 20, 30, and 40 degrees off-axis. The special low-noise tape was used for this portion of the experiment. The tape was also tested at 0 degrees off axis for the five selected conditions, to allow a comparison of the viewers' performance with the two tapes.

The same material was presented to all subjects. The order of presentation was fixed in a counterbalanced design: the viewer first was shown one page at each condition until all conditions had been presented, and then shown a different page at each condition, but with the order of the conditions reversed.

Stimulus Material

All the pages of material presented to the viewer had the same format, consisting of eight rows of seven randomized characters each, plus row numbers and page number identification (see Fig. 1). The character font is a bold stroke sans serif type (Manifold). Half of the characters were capital letters and half numbers; aside from this restriction, the sequences were completely randomized.

Viewers

Twenty female typists, ranging in age from 18 to 39, were hired through a temporary office help agency for this study. Each was given a comprehensive vision test to measure visual acuity and detect any abnormality that would affect the results. All but one had at least 20/20 visual acuity with both eyes for both near and far vision (with glasses if needed). The one exception had 20/20 near vision and 20/30 far vision. No serious abnormalities were found in stereopsis (depth perception), and no serious vertical or lateral phoria (muscle imbalance was detected.

Procedure

Each typist came to the laboratory for one day of individual testing. The total testing period was about five hours, with frequent rest breaks. The experimenter first explained the general purpose and procedure of the test, and then gave her detailed instructions on how to perform the task. Finally, she was given ten pages of practice material on video tape. During the practice session, the experimenter observed her performance, corrected errors in procedure, and answered questions.

In the actual test session, the procedure was the same for each page: The experimenter positioned the monitor, if necessary, at the appropriate distance from the typist and set the off-axis viewing angle of the monitor. He then started the video tape player/recorder, and the image was displayed on the monitor. When the telivision picture became stable, the typist pressed the Ready key on the I/O typewriter. In response to this signal, the computer typed the first line number (01) on the typewriter. The typist then proceeded to copy line 01 on the display, as she perceived it. After typing the seven characters, she pressed the carrier return key. The computer accepted the seven-character entry and typed out the next line number. This procedure continued until the typist had copied all eight lines of material on the page. If she wished to correct a character just keyed, she could press the Attention key and then rekey the entire line of seven characters. (But she had to do this before she pressed the Return key.) If she keyed too few or too many characters in a line, the computer asked her to rekey the entire line by typing "please rekey" on her typewriter.

After the typist finished the last line on the page, she keyed a period, a signal to the computer that this page was completed. The computer then calculated the amount of time (in seconds) between depression of the ready key and keying of the period, i.e., the total amount of time required to read the display and type what was seen. The computer also checked the number of errors the viewer made (and what each error was) and recorded this information, identified by subject number, page number, etc., on punched cards. When those calculations were completed, the computer typed out on the viewer's typewriter the number of the next page of material to be copied. The experimenter then "fast-forwarded" the recorder to the beginning of the next page on the video tape.

Equipment

The parameters of scan lines per character height and bandwidth were set at the time of video tape recording. The recording was made with a 525-line Granger V1000 television camera and control unit, a GEC 8507 high resolution vidicon, and a modified Sony EV200 video recorder/player. The bandwidth of the video signal was altered with Butterworth sevenpole low-pass filters.

Standard Sony V-11-60 one-inch video tape was used to display the 42 basic conditions, and a special Sony low-noise V-11-60 video tape was used for the portion of the study concerned with off-axis angles. The standard tape had a signal-to-noise ratio (peak-to-peak/RMS) of 40.5 db, while the low noise tape had a 42.9 db S/N ratio.

During the test, the tapes were played back on the same recorder/player, and displayed on a Conrac CQE-14/525/1029 fourteen-inch monitor (which had horizontal sync circuits modified to be compatible with the helical scan video recorder). The displayed images had a surface luminance of 20 foot-lamberts on the background and two foot-lamberts on the characters, thus obtaining a Michelson contrast—defined as (Lmax-Lmin)/(Lmax+Lmin)—of 0.82. Considerable

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attention was given to the reduction of reflective glare. A circular polarized screen was placed over the face of the monitor, and nonreflective black paper was placed along the walls of the room at all points where glare was observable. A diagram of the experimental setting is shown in Fig. 3. (The low shield in front of the typewriter kept the typist from being distracted by her own reflection in the monitor screen, without impairing her view of the displayed material.)

RESULTS

Computer programs were written to analyze the data collected. The average values for legibility and throughput obtained with the three different bandwidths for each of the 14 combinations of visual angle and scan lines per character height, with the viewer directly in front of the monitor (i.e., at 0 degrees off-axis), are shown in Figs. 4 and 5.

Under the conditions tested, visual angle appears to be the predominant factor in determining video quality. In Fig. 4, legibility increases systematically from about 10 percent accuracy at a visual angle of 3 minutes, to 95 percent at 8 minutes, and finally to 98 percent accuracy with a visual angle of 14 minutes.

The effect of vertical resolution (number of scan lines per character height) can be seen by looking at those points on Fig. 4 representing data for different numbers of scan lines at the same or nearly the same visual angle. At 9.7 minutes, for example, 20 and 30 lines per character height have the same legibility. At 4.7 minutes we have similar pairs of results. At two intervals on the visual angle scale, from 3.0 to 3.1 and from 6.3 to 6.5 minutes, we can see that a lower vertical resolution was more legible than a higher resolution when it was presented at a slightly larger visual angle. Apparently at these levels, a small difference in visual angle more than compensates for a large difference in number of lines per character height.

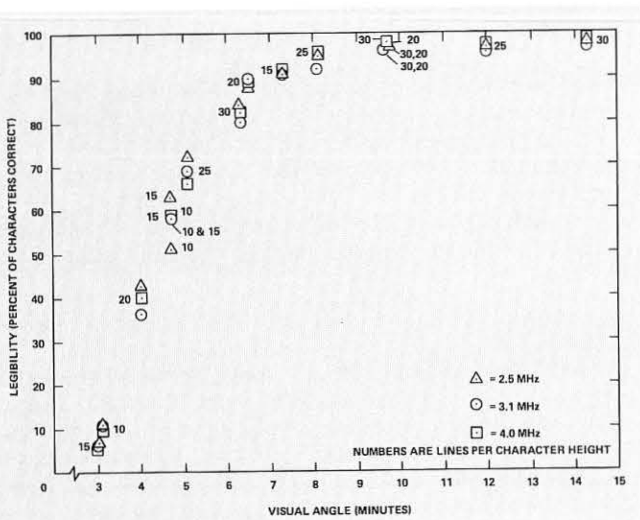

Fig. 4: Average Legibility at Three Bandwidth Settings for Test Conditions of Fig. 2

At most points tested, the different bandwidths produced accuracy rates that overlap or are quite close. This was an unexpected result, since the difference in bandwidths produced perceptible differences in the dispayed image. A statistical analysis of variance of the results for the three bandwidths confirmed the conclusion that there is no significant difference in the effects of bandwidths under these test conditions.

The bandwidth data, insofar as they are comparable with the work of Seibert,[10, 11] appear to be consistent with his results. Seibert found no significant difference in legibility between 4.0 and 2.0 MHz. Legibility did begin to decrease, however, at 1.5 MHz.

Clauer[14] investigated much the same variables, but under conditions appropriate for a single viewer seated immediately in front of a display (so that the visual angle was quite large). When the visual angle was very large, but bandwidth and vertical resolution were allowed to vary, he found a much more systematic effect of these variables on legibility than was revealed in this study.

The results for throughput in Fig. 5 show the same trends as the legibility results, but are much more variable. The throughput shows a consistent increase from 45 characters per minute at a visual angle of 4.0 minutes to 65 characters per minute at an ange of 14 minutes. The variability of the data may indicate that throughput is highly sensitive to motivation and to individual differences. For example, the high throughput rate recorded at a visual angle of 3.0 minutes is a spurious effect that is probably explained by the subjects' lack of effort—the legibility was so bad they just gave up and guessed.

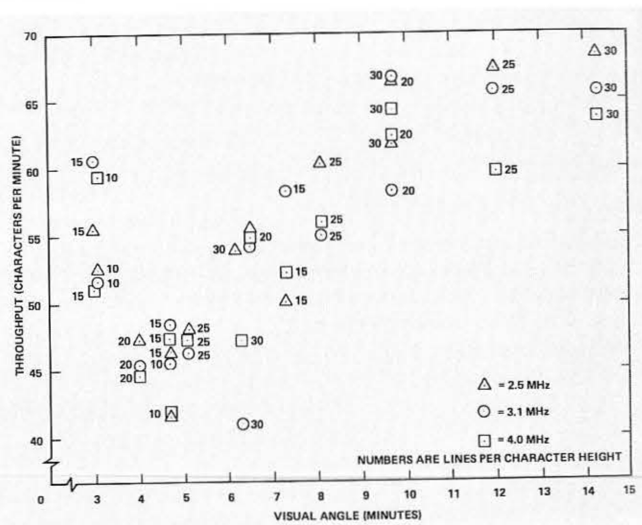

Fig. 5: Average Throughput at Three Bandwidth Settings for Test Conditions of Fig. 2

At points where visual angle varied very little but vertical resolution was increased, the throughput data may be compared with similar results for legibility. Again, it appears at these levels a small difference in visual angle at threshold is more important than a larger difference in lines per character height.

The throughput for different bandwidths confirms the conclusion reached from the legibility data: bandwidth had no significant effect in these experiments. A statistical analysis of variance of the throughput data again verified this conclusion.

Figure 6 confirms the expectation that, if the viewer is placed at an angle to the side of the monitor, some decrements in legibility can be expected. Under conditions where vertical resolution and visual angle give high legibility (better than 90%) at 0 degrees off axis, there is no decrement in legibility until the off-axis angle becomes 40 degrees. Under less favorable conditions, the effect of the off-axis angle is more severe, reducing the legibility even at 20 degrees.

The throughput data for the off-axis angle tests were so variable that no consistent trends were observed and no interpretation is possible.

The tests of performance at off-axis angles were made with the special low-noise tape described above. The tests at zero degrees off axis allowed comparison of these results with the data for these five conditions in the complete series of tests with direct viewing and standard type. The boldface symbols at zero degrees in Fig. 6 give the results for standard type. Neither video tape resulted in consistently superior performanc under either of the two criteria of legibility and throughput.

RECOMMENDATIONS

What do these experimental results mean to a school planning the use of television in the classroom?

First, they help to clarify a principle that is intuitively recognized as sound, and once understood, is easy to apply: When students are to be seated at some distance from the television screen, any printed characters or graphic details displayed must be proportionately larger, to be certain that the text can be read and the details discerned. We can now make this a more precise recommendation by putting numeric value on it: In a classroom television display, we need letters large enough to produce at least 8 minutes of visual angle at the eye of the student in the worst seat in the classroom. According to our results, this should produce 95 percent accuracy of recognition of random characters. (Note that we are unable to specify 100 percent accuracy in experiments like this, in which typographical and experimental errors may contribute to the total errors made.)

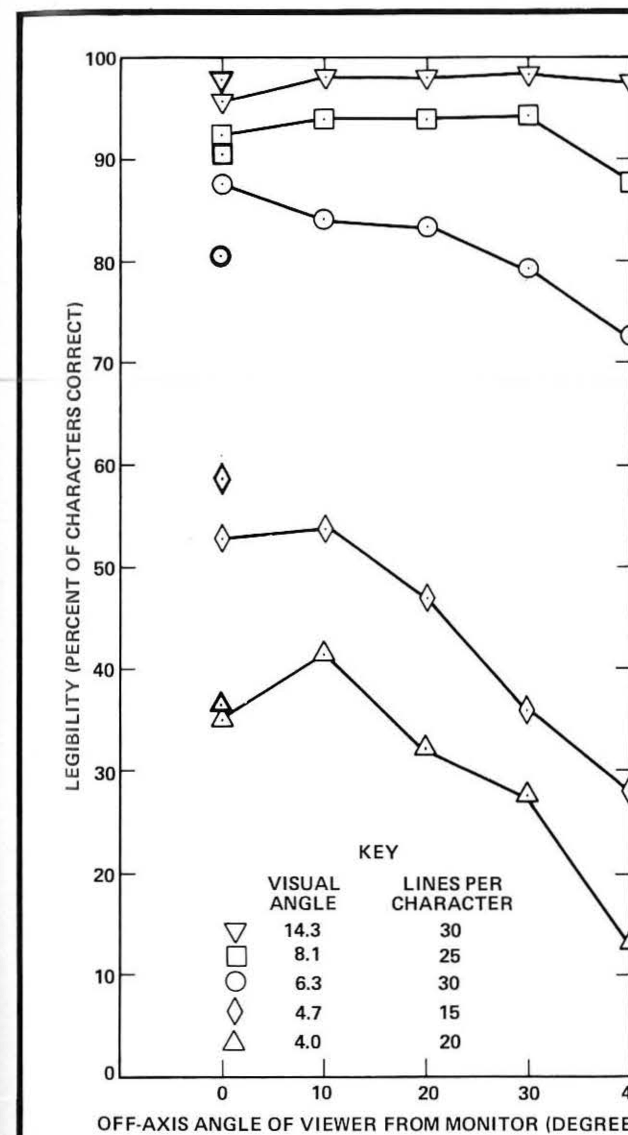

Fig. 6: Average Legibility as a Function of Off-Axis Angle for Five Representative Test Conditions (Boldface symbols indicate data for standard tape; other data taken with special low-noise tape.)

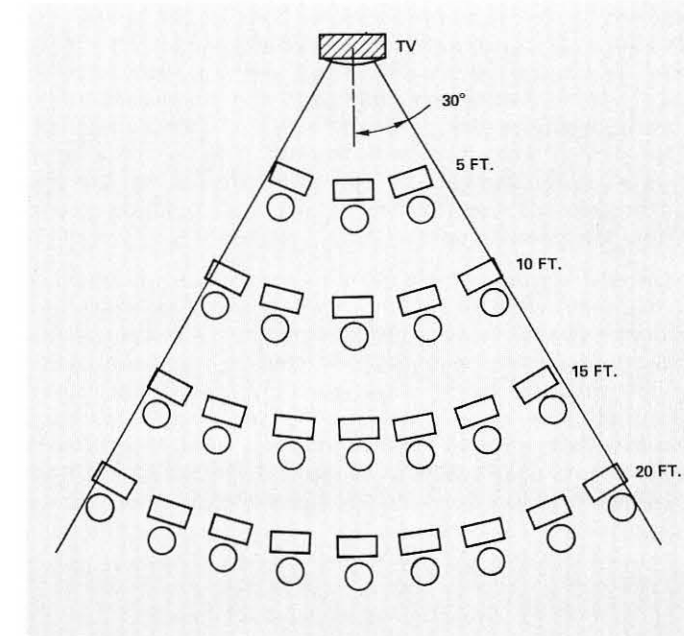

Fig. 7: Recommended "Viewing Cone"

Second, we can specify a recommended minimum vertical resolution of 15 lines per character height when small visual angles are involved. At 15 lines per character, the ratio of the character height to the total display height is 1/33, and 16 rows of characters could be put on the screen (as long as the screen is large enough and the students close enough to keep the visual angle within the minimum of 8 minutes of arc).

In practice, the number of scan lines per character height is often determined not by the required vertical resolution, but the size of characters needed for legibility from the worst seat in the classroom. If some students must be seated at some distance from the monitor, characters must be large, and the vertical resolution may turn out to be much higher than is needed. This inefficiency could be avoided by using a larger monitor. More characters could then be displayed without changing the character size. The monitor size could theoretically be increased until the characters on the screen had a minimum of 15 scan lines of resolution. Another possibility would be to choose a nonstandard television system with fewer than 500 scan lines. This would not be economical, though unless transmission savings were high enough to offset the cost of the special equipment—not a likely possibility.

A third point is that, for group viewing of a large television screen, we can recommend a bandwidth of approximately to 2.5 MHz. From the results of this study and Seibert's work,[10,11] it appears that there is no improvement in performance above this point, but there is a decrement below this point.

Fourth, this experiment confirms the importance of the angle from which students view the monitor screen. If the viewer's line of vision is more than 30 degrees off axis, he may not be able to read the displayed material accurately.

What is the effect of these recommendations in terms of classroom seating arrangements? Figure 7 is a diagram showing the recommended "viewing cone" which would keep all students within 30 degrees of either side of the screen. The number of seats that can fit within the cone depends on the size of the seats, how close together the teacher wants to put them, and the maximum recommended viewing distance. The maximum distance of the last row of seats depends on the size of the monitor and the relative size of the displayed material. Figure 8 shows the maximum viewing distance from various size monitors calculated to maintain the recommended minimal visual angle at the eye (8 minutes). It can be seen that if characters are such that they are scanned by 15 lines (the recommended minimum), the worst seat in the classroom can be almost 18 feet from a 27-inch monitor but only 11 feet from a 17-inch monitor. The use of a larger monitor considerably increases the maximum seating distance and thus the number of students could be placed within the viewing cone.

Another way to increase the maximum distance from which students can view the monitor is to choose larger characters, although this will reduce the total number of characters that can be placed on the display. For instance, Fig. 8 shows that as the character height increases from 1/33 of the screen height (15 scan lines) to 1/17 of the screen height (30 lines) the maximum viewing distance increases from 18 feet to 35 feet from a 27-inch monitor or from 11 feet to 22 feet from a 17-inch monitor. However, the figure also indicates that the

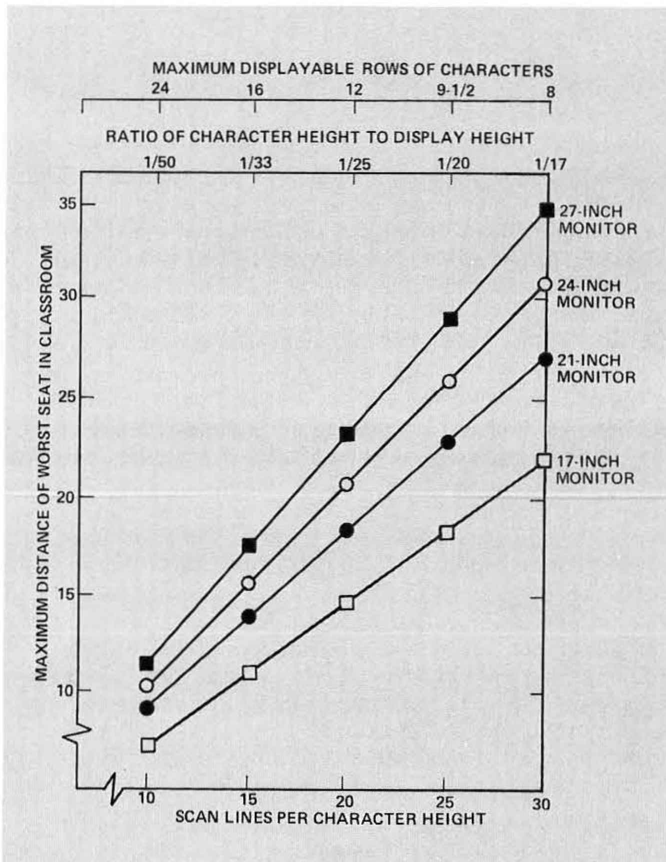

Fig. 8: Maximum Viewing Distance for Worst Seat in Classroom Maintaining a Minimal 8 Minutes Visual Angle at the Eye

maximum number of rows of characters that could be placed on the screen decreases from 16 rows with the smaller characters to 8 rows with the larger.

In many classrooms, there may not be enough space to fit the whole class within the recommended limits for viewing angle and distance. In cases like this, it is probably better to have two monitors than one large set. A class floor plan can be drawn to help to determine where the monitors should be placed to make the best use of the viewing cones for each screen.

Many factors interact to produce an effective TV display, and just one thing wrong—poor contrast, glare, or badly designed characters—can spoil the effect of an otherwise good system. But, assuming that equipment and teaching materials are well designed, the recommendations here should ensure that the image on the classroom television is clear to the student in the last row.

ACKNOWLEDGEMENTS

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General Chairman Lou Seeberger opens Symposium Proceedings

Info 68 Los Angeles

The very successful ninth annual symposium, hosted by the Los Angeles Chapter of *SID,* highlighted the dramatic increase in the effects of the information explosion in government, business, and education.

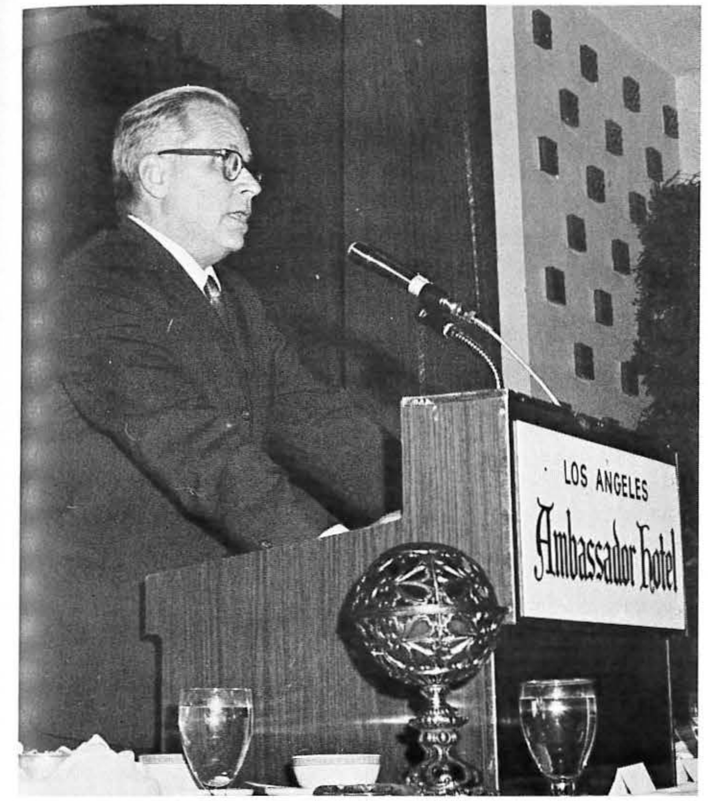
General Symposium Chairman Lou Seeberger, in his welcoming message, said in part . . . "As it is in many human endeavors, diversification is the key to long range stability. The specialist who fails to keep alert to associated or related areas often as not finds himself ill prepared to adapt to an ever-changing environment."

"So it is in display engineering. Born of the demanding military need for information transfer to the most sophisticated computer ever designed, the human being, the science of display is emerging from the era of a 'black art'. The value of real time data transfer is being recognized by more and more system planners. As a result, the display engineer is rapidly learning to quantify his contributions to the new technology."

Dr. Peter Goldmark, President and Director of Research for CBS Laboratories, addressed the Symposium Banquet. Harry I. Davis, Deputy Assistant Secretary Air Force (R&D), delivered the Keynote Address. Excerpts from these follow.


At the Banquet, attendees meet for dinner


General shot of exhibit area

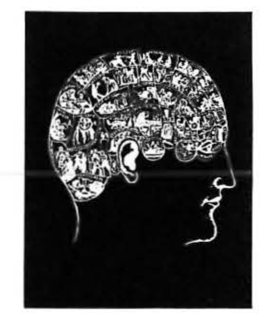


Dr. Peter Goldmark addresses the Banquet


Petro Vlahos presents award to outgoing president William Bethke, as incoming president Carl Machover watches


Demonstration of the visual paging system used for the first time at an *SID* symposium. Message is displayed on bottom half of screen, while top half displays session in progress. Monitors were located at convenient points.


The very erudite Professor Eric Von Hogerstrom (otherwise known as Vince Barnett) Featured Luncheon Speaker, sets *SID* straight on the right way to use the display art. This spoof was successfully carried off, delighting the audience and providing an amusing entre into the technical sessions which followed.




William Bethke congratulates Carl Machover on his new role as president of *SID.*

Forecast for the future

by HARRY I. DAVIS
Deputy Assistant Secretary Air Force (R&D)
Delivered at the Ninth Annual SID Symposium, Info '68, May, 1968

Let us begin by discussing areas in which technological progress is less likely than an even money bet (give or take a factor of five). "True" artificial intelligence, direct input into human memory banks, direct augmentation of human mental capacity by interconnection with a computer, chemical control of character or intelligence, verification of extra-sensory-perception, the technological equivalent of telepathy and direct control of individual thought processes are just not conceivable by the year 2000.

The only input to the brain will be through the human senses, and the eyeball will continue to dominate all other inputs to that marvelous, unmatched computer, the human brain. How to make this more efficient is the challenge the members of this society face. From reading the last few issues of your excellent journal, it appears this problem is in good hands. The article on command control display system for NORAD, as an example, is one close to me, for historical and, if I may be presumptous, nostalgic reasons. Other articles, such as the legibility of printed type, resolution of television displays, moving map displays, stereoscopic photography and holography, man-machine communications and airborne sensor display requirements illustrate the diversity of your interests, the comprehensiveness of your investigations, and help instill the confidence that the challenge of improving the input to the human brain by the old fashioned eyeball will be successfully met by members of this society.

In the technical fields of direct interest to the members of *SID*, the largest number of technical innovations can be and have been forecast. I will briefly list eighteen of them.

The safest predictions are in your technical area, since the new capabilities are represented by items like new techniques for adult education, extensive centralization and interconnections of personal and business information in high speed data processors, techniques (possibly pervasive) for monitoring, surveillance and control of individuals and organizations, use of robots, means for improving human analytical ability, simple and inexpensive home video recording, time sharing of computers with users "on-line" in direct communication with computers, use of computers for intellectual and professional assistance (translation, teaching, literature search, medical diagnosis, traffic control, crime detection, design, analysis, and intellectual collaborator), home computation to run household, home education via video and computerized programmed learning, inexpensive rapid, high quality, color and monochrome reproduction for home and office use, conference TV, rapid language teaching, extensive use of high altitude cameras for mapping, prospecting, census, land use and geological investigation, inexpensive design of "one of a kind" items by computer with automatic fabrication of the item directly from the computer print-out, and three dimensional photography, illustrations, movies and television.

Earlier, I had mentioned some of the interesting articles in the journal of your society, *Information Display*. One of the articles in the September/October 1967 issue described the large wall display in NORAD. The November/December issue contained an excellent article on "Airborne Sensor Display Requirements and Approaches." I would like to add a few comments to these two types of display.

A study of tactical warfare—World War II, Korea, and Southeast Asia, quickly reveals that the largest source of information concerning the enemy's deployment comes from direct observation by humans. The human eyeball, whether on the ground or in aircraft, witnesses much more than is reported, and much more is reported than is recorded. Further, more is recorded than is digested. So here we have a perishable but valuable commodity—the report from the observations of the human eyeball—which is largely untapped as a source of real time information for the commander.

I now challenge you who are interested in military affairs to consider how to use the eyeballs of thousands of observers, how to have them report their observations rapidly and accurately with precise geographic position attached to the reports and how to assemble all these inputs into a large, wall-type display. The object is to have a real time display of enemy and friendly activity available to the commander. Other inputs would of course funnel into the display. We don't need high resolution since we are not interested in the exact shape and size of jeep or truck. We only wish to know how many there are, where they are at what time, and where they appear to be going. This does not require a high bandwidth data link nor a high resolution display. We are starting a development of this device which we call an activity indicator. We hope it will supplement photography, which will be most useful in discovering and locating fixed, as contrasted to moving, targets.

> *"True artificial intelligence; direct input into human memory banks; control of individual thought processes; these are not conceivable by the year 2000."*

A second challenge for your consideration is the problem of displaying the output of sensors in an aircraft, which is frequently a small aircraft with limited area on the cockpit instrument panel in the cockpit. It is not necessary to observe to members of this audience that a sensor, either for day or night use to detect targets, must provide detection ranges over some minimum range, perhaps a mile is a good minimum, and a large field of view to enable the crew to scan the area. Since the sensor must provide a resolution of not less than one foot to identify trucks, with a 60° field of view, we must collect 6000 resolution elements in our sensor. Even if we had a display device with 6000 elements, if we mounted it on the instrument panel, the display would require dimensions measured in feet rather than inches to accommodate the limitations of human acuity, especially under the non-ideal conditions existing in a cockpit.

I was therefore quite pleased to note considerations of display devices other than direct viewing cathode ray tubes in the November article. Of particular interest to me was the helmet-mounted monocular device.

When military R&D is discussed, it is usual to stress research and development leading to major weapon systems. These consume the largest amount of dollars and are most interesting; however, work toward such systems is by no means the only objective of our research and development. There are military problems for which such systems cannot provide acceptable solutions.

The world in which we find ourselves is one in which there are many small and weak but developing countries which need time to achieve political stability and economic progress. But they cannot accomplish this if they are subject to subversion from within and infiltration from without. The technical problems of assisting such countries to defend themselves lie at the other end of the spectrum from the problems of deterring nuclear war which for the past 20 years have been at the core of defense research and development. Yet, in many ways, the research and development problems related to helping these small countries are technically and managerially more difficult than the problems of deterring nuclear war.

Instead of a single multibillion dollar program to develop nuclear weapons, we need to deal with a great many smaller programs to develop bits and pieces of hardware which must work under rather uncertain and unpredictable field conditions in a wide variety of military operations. This is indeed a challenging problem and one in which desirable goals cannot always be related to a schedule for attainment. The Air Force research and development program includes a wide variety of effort directed toward improving our capabilities and those of our allies to deal with the problems of guerilla warfare, infiltration and small scale engagements conducted in close proximity to civilian populations. Techniques and devices for target acquisition at night and in cover, such as jungles, improved highly accurate fire control and weapon delivery, and specialized munitions are among the developments under way.

Our objective must be not only to develop the weapons we have decided we need for the operational inventory, but also to acquire the knowledge and experience we must have to make intelligent and informed decisions about what we need and can have next.

The early stages of research and development do not represent commitments to complete any particular project; rather they are aimed at providing us with the broadest range of options for our own future developments and the broadest possible understanding of the options for weapons developments which science and technology may make available to our potential enemies.

> *"Developing countries cannot accomplish political stability if subject to subversion from within and infiltration from without."*

We clearly cannot develop everything which modern science and technology make possible. Every system has its proponents and they are and should be heard. However, in the end a high degree of selectivity must be applied in choosing systems for full development and operational use. This inevitably results in cries from the disappointed, many of whom will assert, without much provocation, that their favored system is essential to national survival. Nevertheless, were we to pay heed to all of them we would be well on the way to national economic disaster.

The Federal budget for research and development test and evaluation has experienced a steady and phenomenal growth over the past twenty-five years. Even expressed in percent of a growing gross national product, the RDT&E budget has gone from 7/10s percent in 1941 to about 3 percent now. Recently, we have been through a period of highly accelerated growth in which the initiation of a massive space program added to a rising curve of cost for development and acquisition of ballistic missiles resulted in RDT&E growth rates in the neighborhood of 20% per year. Some people have tended to think of this maximum achieved growth rate as now ordained to be the natural order of things and destined to continue indefinitely. This trend, if it were to continue from the level of 1966 for ten years, would result in a Federal RDT&E budget almost as large as the total budget of today by that time. However, the need to control the growth of our research and development activities should not be regarded as a problem. It is a natural result of the healthy scientific and technical posture which the nation has attained.

What in the recent past was primarily a problem of decision on large military and industrial programs is increasingly becoming a problem for research and development generally, even down to the most basic level. Shall we invest more of our resources in further exploration of the planets—manned or unmanned, or shall we build 300 BEV particle accelerators or large radio telescopes and if so, how many and what kinds? We are proceeding now toward a supersonic transport but it is already possible to imagine a hypersonic transport. At what rate should we be proceeding toward this objective? If we are to divert more of our applied research from the defense to the civilian economy, how do we go about it? What should the relative roles of the Federal Government, State Governments, and private institutions?

We, as a Nation, must answer questions such as these, not only on the basis of the best technical judgments but with wisdom and foresight on how our decision will affect the future general welfare, security, and economic well-being of the Country as a whole. Engineers and scientists have much to contribute to this decision—making process but they must recognize the need for consideration of broad perspectives which encompass national objectives and public policy, as well as the technical issues. I am sure that the technical and scientific communities of this Country have not only the capability, but the will to play their necessary roles in assuming the continuation of our world leadership in science and technology not only to assure our national security but in pursuit of the common goals of mankind.

25,000 years of development—

by PETER GOLDMARK,

President and Director of Research
CBS Laboratories

Delivered at the Ninth Annual SID Symposium, Info '68, May, 1968

My associates and I at CBS Laboratories—this is the only commercial there is going to be tonight—are primarily engaged in the field of communication technology and space communication systems.

Recently we were fortunate to take part in a very ambitious space project: the lunar orbitor system, where we developed and finished the thing that scanned out the photographs taken by the Lunar Orbitor. We sent them to the earth by an RCA transmitter, but recorded underground with our system. This was probably the first use of what we may call a triple scan. You are probably familiar with two dimensional scan, but the resolution of these lunar photographs had to be transmitted to the point where film-grain became visible, because every bit of information had to be seen.

I won't bore you with what the principle of this triple scan is, where given enough time or bandwidth or both it is possible to transmit every bit of information there is and remove limitation of resolution within these boundaries. Much has been published about it, and the only reason I mentioned it here is because of the many, many photographs which you probably have seen published. The one we are proudest of, and our lead for today's talk, is a view of the earth as seen from the moon.

Since it was technology that made this view of our planet possible, I would like to share with you some of the thoughts which occurred to me when I imagined looking at ourselves from that large distance and after reversing the telescope also in the time dimension. Perhaps we may be able to gain some meaningful perspective from the past by doing so. And learn where our responsibilities lie for the future, as scientists. There must be two very basic factors that have to be taken into consideration:

> *"The world at the mid-century is like a drum . . . strike it anywhere and it resounds everywhere. Vanishing space and scientific communication have turned our planet into a single small neighborhood."*

First, people have always lived in a changing world. Adlai Stevenson once observed that the expression 'We live in a changing world' was first uttered by Adam when he and Eve were being evicted from the Garden of Eden.

Second, the world at the mid-century is like a drum . . . Strike it anywhere and it will resound everywhere! Vanishing space, global communication, and scientific revolution have turned our planet into a single small neighborhood. We must admit to ourselves that today we live in a world of material wealth and of spiritual poverty. Most of us, as scientists, are largely responsible for this even though, unwittingly, we have obligations towards the present and towards the future. First let's look at where we came from.

About twenty-five thousand years ago, the capacity of the human brain was one and a half liters. Today the capacity of the human brain is one and a half liters! A child born twenty-five thousand years ago and brought up in today's environment would be virtually indistinguishable from any modern child, a child born today. Yet, let's look at the changes of the different world we live in. How did it happen? Let's look at a graph. You can see that the population of the earth around the year 1200, and going back many more thousand years, was fairly constant. There have been no data, we can only extrapolate, but it has grown tremendously, and in the 18th century, it took off very rapidly, primarily due to developments in science, specifically in medicine, hygiene, nutrition and so on. Of the total number of people born since the discovery of America, two-thirds are alive today. I am happy to say, and I am sure you have heard it before, that 90% of all the scientists who ever lived are still alive.

When America was discovered less than five hundred years ago, 1492 I believe, people on earth numbered 250 million. Today, the population is 3 billion and will be doubled by the year 2000. Barring major changes, one hundred years from now it will be 24 billion!

It is quite probable the increase in life expectancy has been a major contributor to this population growth. The next chart will show you how life expectancy grew over the years. You see it remains flat with the average of about 30 years life expectancy, remains flat over the same years where the population remained constant. But it made a tremendous impact on the population just changing from say 30 to 35 years, 30 years before 1700, 35 years after 1800. Today, it is somewhat over 70 . . . I hope to be invited back here to your convention in the year 2000, and I will tell you what the life expectancy is going to be then.

Let's look at some other historical data. The destructive power, developed by man, is shown on this chart. Gunpowder was the only explosive known for many, many centuries, that very flat insignificant line on the bottom. Then came dynamite and TNT. Before dynamite, TNT was fulminate of mercury, which was just a convenient way of exploding a capsule. Suddenly, in 1945, the explosive power jumped several scales in Alamogordo, New Mexico, and then came the H-bomb, and it is anybody's guess how much higher this will go. By the way, the ordinate is plotted in such a way as to accomodate both gun powder and the H-bomb, and so I sort of arbitrarily picked tons of TNT on a logarithm scale.

Let's look for more pieces of statistics. This shows at which rate people were able to move, to travel. In 1600 BC the speed of travel by chariot reached 25 mph. Roughly, 25 hundred years later, traveling became more comfortable but actually slower. I am talking about the English mail coach which moved only 10 mph . . . and so did the Wright Brothers at Kittyhawk in 1903. There were automobiles which traveled much faster at that time. Sixty years later we have rocket planes flying at 4000 mph and manned spacecraft at 18,000 mph. I bet anyone who would have predicted this in Boston and talked about it a few hundred years ago would have been burned alive at the stake. I am not kidding!

We could go on and on showing similar curves, but let's look at just one more, and I think this is the most significant of all. This shows the number of books, I mean titles, not copies, published since the invention of the printing press by Guttenberg in the year 1450. We see that until the 19th century the number of titles increased extremely slowly. But, in the year 1900, 20 million titles were published; these are cumulative, all the titles published since the invention of the printing press. And today there are 50 million books published, in the year 2000, the curve points toward 70 million. We are not talking about necessarily science and art only; these are all types of books.

> *"By the time children finish high school, they probably have seen 3 years of television, or 15,000 hours, compared with 10,000 hours of formal schooling. It's pretty frightening."*

You will recall, when we looked at the previous graphs, that they showed something all in common: namely, a sudden rise within the past 100 years. Keeping this in mind, and looking now at the rate at which books were published, there seems to be a cause and effect relationship. Probably the most important event in the field of communication, the invention of the printing press, is more responsible than anything else for the violent up-turn of those curves we saw before. Let's see why.

Back in the 15th Century, there were very few scientists. They were called alchemists, many of them; they were not regarded too well, and virtually no outside support existed for any kind of scientific work—the DOD and NASA were not yet invented at that time. Without means of communications, experiences and ideas could not be shared with fellow scientists or taught to students. So, many lives were spent rediscovering just what somebody else had already found. In other words, a scientist who tried to investigate something new had to start from scratch. He had no way of knowing what anybody else had done. He had to develop his tools, he had to develop his theories; everything started from the beginning. And with the lifetime of thirty years, average, which today is about the time necessary for a physician to get his training.

> *"Today we have manned spacecraft flying at 18,000 mph. Anyone who predicted this in Boston a few hundred years ago, and talked about it, would have been burned at the stake."*

As printing became more common, even though it went up very slowly, individual experiences and theories were published. This resulted in improved teaching and communication, the sharing of the discoveries led to more scientific work, and a snowball effect in learning and creativity set in. This in turn resulted, again, in more and more publications. Today, the major problem is how to read everything that is being published.

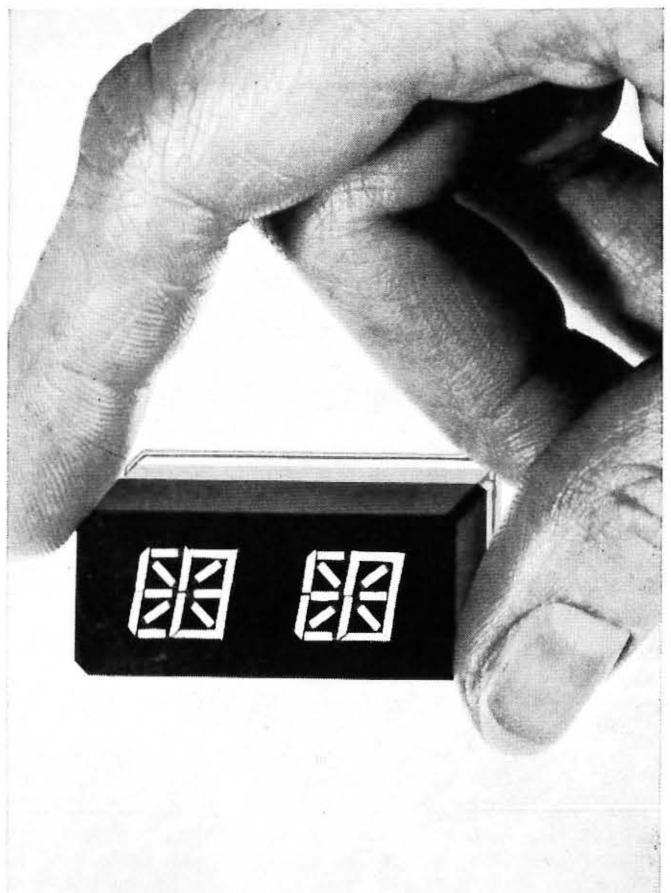
Now, after the general characteristic of these curves, which you have just seen, it is almost certain that this has not been planned. While technology has provided health and comfort and recreation for man, to a large extent it has also been responsible for the major problems of the world today.

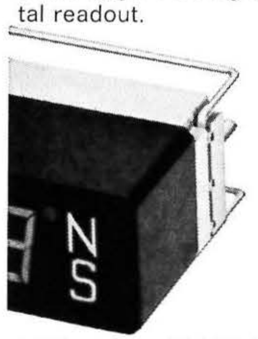
For the first time, science faces a deadline upon which may hinge the survival of billions of people. As scientists, our most urgent mission today is to solve the problem of feeding and educating this rapidly increasing population. I am referring to education in a broader sense, namely, how to teach people in the fastest and most effective way to get along with each other. It is evident that urban, national and international problems will grow as the density of population increases. The advances in science and technology have outstripped the slow changes in our behavior characteristics. What we have to cope with today is infinitely more complex than that baby, when he grew up, had to cope with 25,000 years ago.

What that baby would have learned in his life time would hardly suffice today for a grammar student. The alarming shapes of the curves here we have seen, simply indicate that we must improve and accelerate education both for children and for adults. There is not enough time to say that we are going to improve the education of our children. If we did that, we would merely raise a better generation of teachers, so it would really be our grandchildren who would be better educated, again, in this broader sense. We have to educate today and immediately ourselves, the adults.

The most powerful tool, the most sophisticated tool, developed by scientists is television. You have it in this room, you have it everywhere. I am not sure whether you are aware or not, that, on the average, television is watched in the home 5½ hours a day. Before entering school, children would have spent three or four thousand hours watching television, and by the time they finish high school, they probably have seen some 3 years of television, or 15,000 hours, compared with only 10,000 hours spent in formal schooling. It is pretty frightening.

Speaking on behalf of the technologists of today, of engineers and scientists, I believe we have a commitment. We must put to work our talents, and we must combine forces with the best teachers and the most creative program producers; in order to give the adults and the children of this world a system of education that will result not in the survival of the fittest, but in fitness to survive!





President's annual report 1968

Because of technical error, portions of President Bill Bethke's annual report to the membership, published in the May/June issue of Information Display, were printed in non-sequential order. Following is the original version of these sections:

To promulgate definitions and standards pertaining to the field of information display.

As reported last year, the Standards and Definitions Committee is comprised of one member from each Chapter, who, in turn, is Chairman of his Chapter Standards and Definitions Committee. Assignments which had been made to the Chapters were to formulate and prepare definitions in the areas of (1) Resolution, (2) Colorimetry and (3) Luminance and Luminance Discrimination. The definitions in each of these areas placed emphasis upon those terms which define measurements of significant display parameters.

To date, four Chapters (Washington, Los Angeles, San Diego, Northeastern) have completed their assignments and have provided initial drafts of proposed definitions in the areas of resolution and luminance. Copies of these drafts have been provided to each Chapter committee and they are currently involved in critiquing and reviewing the work of the other Chapters. It is planned that the resultant material will be reviewed at a meeting of the National Committee prior to the preparation of a final recommended draft for submission to the membership.

During the past year, the new Philadelphia-Delaware Chapter has been added, with representation to the National Committee, and is at work with the rest of the Chapters in performing the technical review mentioned above.

It has been extremely difficult to get this program underway. People talk excitingly about it but can't get enough people together at one time in one place to work something out. Perhaps we, being engineers, might be acting too conservatively in not announcing some standards and definitions for fear of criticism. *Perhaps we should set up "straw-men" and let them be picked to pieces and perchance something constructive may come of it.*

To provide forums, by establishment of a journal and regular conferences, for the exchange and dissemination of ideas relating to the field of information display.

One of the major functions of any Society is the exchange and dissemination of ideas relating to its field. In this regard, our symposium in San Francisco provided an excellent forum for such an exchange. Both the facilities and technical program were of the highest caliber. Further, the technical meetings held by the Chapters throughout the country, have also been extremely well chosen and appropriate to our field. Each Chapter has been invited to participate in national activities by suggesting appropriate dates for hosting either the annual symposium or the technical meetings. The schedule to date follows:

	Symposium (Spring)	*Technical Meeting (Fall)*
1968	Los Angeles	New York
1969	Washington	San Francisco
1970	———	Minneapolis
1971	Delaware Valley	———
1972	San Francisco	———

In addition to the normal *SID*-sponsored symposium, the Society structured a session at the Fall Joint Computer Conference of AFIPS which was extremely well attended (standing room only). It appears that we will become a regular part of that program since we expect to participate in the next Fall Joint Computer Conference (December 1968). *The Society is meeting its objectives in this area.*

To maintain a central repository for data relating to information display and its allied fields which shall be accessible to all qualified members of the society for research purposes.

The objective of maintaining a central depository has always been a basic one since the origin of the Society. However, beyond the rather meager beginning last year (establishment of a permuted index), very little work has been done in this area. *The Society is not meeting its objectives in this area and must; therefore, reassess the approach and, if necessary, provide financial assistance to give more impetus to the program.*

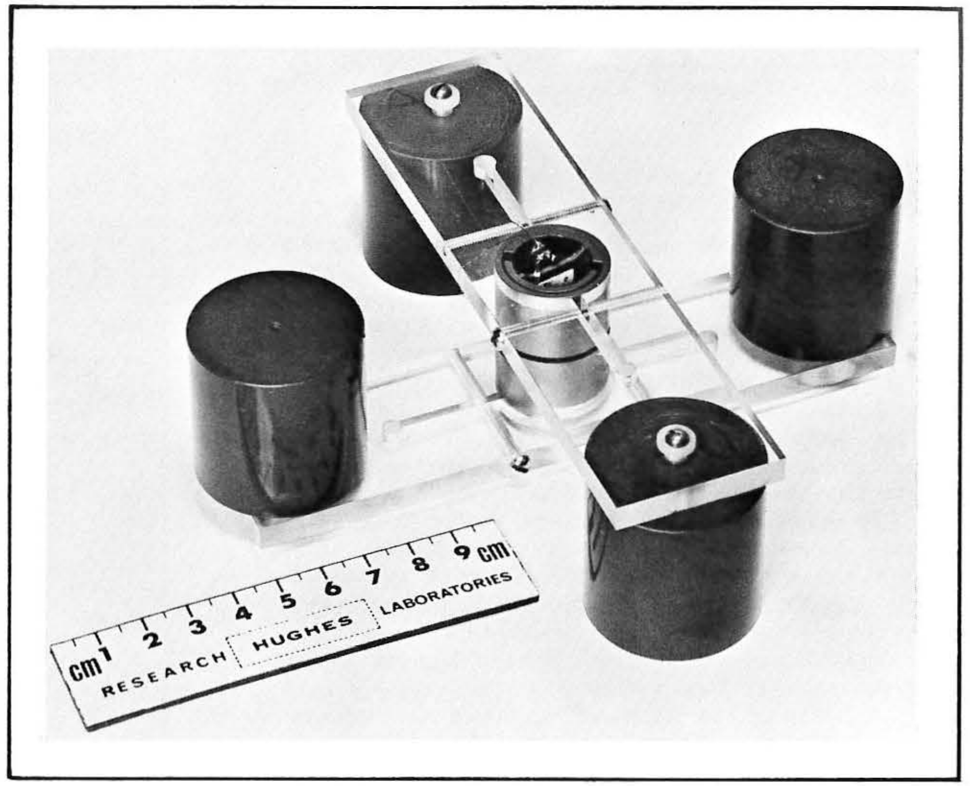
To encourage the scientific, literary and educational advancement of information display and its allied arts and sciences, including, but not limited to, the disciplines of display theory, display devices and systems development, and the psychological and physiological effects of these display systems on the human senses.

The management and advancement of information display and its allied arts and sciences is probably the greatest goal we strive for. Our direction has been, first, to achieve a high level of membership who, as "disciples," could spread the "word." Since the last report our membership has increased by approximately 200, for a present total of 1,500. Memberships denote an international representation. In addition, three new Chapters have been formed in the Society in St. Paul, Minnesota; in the Southwest at Dallas; and in the Delaware Valley at Philadelphia.

Our membership directory has been revised and forwarded to all members. I think you will notice significant improvements in the directory which make it more usable.

The increase in membership and number of Chapters have forced us to reassess our method of operation. It was felt that the Chapters ought to have representation on the Board of Directors. As a result of a petition, followed by intensive study, new by-laws were prepared and voted upon and accepted by the membership. The implementation plans for the change will begin this year. It will allow for each Chapter to have, ultimately, direct representation on the Board of Directors. In addition, it will call for Regional Directors in those areas where there are few or no Chapters.

MASS SENSOR DETECTS MINUTE GRAVITY CHANGES



MASS SENSOR—This cruciform is a new mass sensor that provides a new means of sensing the presence of matter by detecting and measuring minute changes in the nearby gravitational field.

A new means of sensing the presence of matter by detecting and measuring minute changes in the nearby gravitational field has been developed by scientists at Hughes Aircraft Company's Research Laboratories.

Utilizing a technology completely different from previous gravity sensors, Hughes scientists have built a device that is claimed to provide the first practical technique for making detailed gravity surveys from a moving vehicle, such as an aircraft or spacecraft.

The mass sensor, a prototype of which has been built, has demonstrated the sensitivity and resolution required to obtain a map of a geophysical mass distribution. Its first application could be to map the mass distribution of the moon from a satellite orbiting over the lunar surface, scientists said.

Measures Gradient

The basic principle on which the sensor operates is that any mass such as a mountain (or lack of a mass, such as a crater) causes the nearby gravitational field to be slightly different at different points in space. The device measures this differential, or gradient, in the gravitational field, according to Dr. Robert L. Forward, manager of Hughes' exploratory studies department, who led the team developing the sensor.

He explained that in order to measure this gradient, the sensor had to be capable of measuring forces as small as 10^{-11} Gs. It is the first instrument to demonstrate that it can measure these extremely small forces and still be rugged enough to be flown in an aircraft or spacecraft, he added.

In addition to its potential application in measuring mass distribution of the moon and other planets, Dr. Forward said that the sensor also could be used on deep-space probes to measure the mass of such smaller astronomical bodies as asteroids. An airborne version, he added, could make rapid gravitational field surveys of the earth which might detect the presence of mineral deposits, such as oil fields, and it could also be used in an inertial guidance system to compensate for gravitational irregularities.

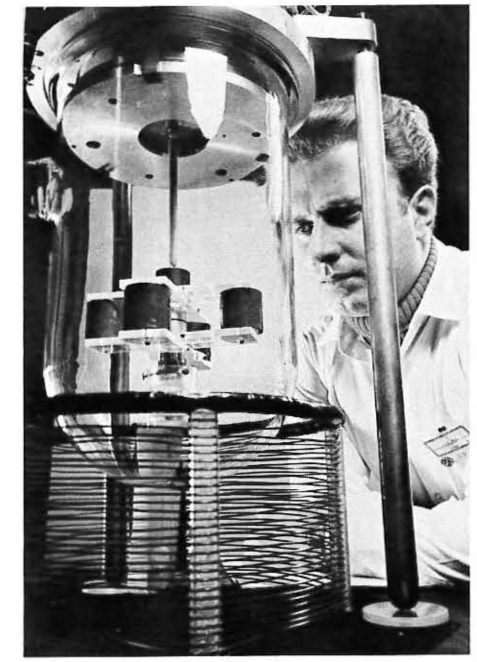
The basic design consideration of any gravity gradient sensor is the need to isolate the very weak gravitational gradient forces from other forces acting on the sensor, he said. This is particularly difficult because the sensor is operating in much larger force fields such as the inertial force caused by its own movement.

Isolates Weak Forces

In addition, external electric and magnetic fields and even pressure from light waves can cause forces larger than those induced by the gravity gradient. The problem, therefore, is to discriminate between the various forces and islolate those caused by the gravity gradient.

This is accomplished in the Hughes sensor by using a rotating four-pole body, in which a major portion of the mass is placed at the ends of two crossed arms. In operation, the gravity gradient forces on the masses cause differential torques on the arms of the rotating body which produce torsional strains at the center of the device.

The torsional forces caused by the gravity gradient oscillate at twice the rotational frequency of the sensor, Dr. Forward explained, while the oscillations from other forces occur at the rotational frequency. In addition, the sensor is designed to minimize the effect of other forces on the torsional mode. These factors, he stated, enable the sensor to separate the gravity gradient forces from the other forces acting on it.



SEES G'S—The tip-weighted cross inside a vacuum jam is a new "mass sensor" that can detect the presence of a mass, such as a mountain or oil field, or even the lack of a mass, such as a crater. Curtis Bell, a member of the Hughes Aircraft Company team of scientists that developed the prototype of the world's first flyable mass sensor, prepares an experiment to prove the device can measure the tug of gravity as low as one-hundred-billionth "G."

The torsional strains are amplified by the mechanical resonance of the sensor, and this amplified force is then sensed by a strain transducer mounted on a flexural member at the center of the device. Information from the transducer is transmitted to instruments which read out the amplitude and direction of the gravity forces.

In Cruciform Shape

In the prototype version of the device, the sensor is rotated at a speed of 16 rps on a frictionless magnetic bearing within a vacuum enclosure to produce near space-like conditions. The sensor is in the shape of a cruciform, using 0.5 lb tungsten-filled plastic masses on two stiff five-inch lucite arms connected at right angles to each other by a torsional member with a piezoelectric strain transducer.

Signal from the transducer is transmitted by a tiny battery-powered FM transmitter to a receiver outside the enclosure, from which it is demodulated and fed to the readout instruments.

Dr. Forward indicated that more sophisticated versions of the detector are now being fabricated and will be tested shortly, and that proposals for the design and fabrication of orbiting and airborne versions of the device have been submitted to NASA and the Air Force. ■

on the move

Named to the position of marketing manager for the Paramus operation of Fairchild Space and Defense Systems div. of Fairchild Camera and Instrument Corp. is AUSTIN F. STUART. Operations manager RICHARD T. PETRUZZELLI said that Stuart will be responsible for marketing of electro-visual, radiation and display systems developed and produced at the firm's facility in Paramus.

RICHARD W. CALFEE has joined the Display Div. of Data Disc Inc., Palo Alto, as manager of their Video Systems Dept. He will develop video systems which use the company's video disc storage units. Calfee was formerly a development engineer and an engineering group manager for IBM in Los Gatos, Calif.

JACK H. VENNER has been elected a vice president of Kollsman Instrument Corp., Syosset, N.Y., according to DAVID B. NICHINSON, president. Venner continues as general manager of Kollsman's Electro-Optics Div., which produces optical subsystems and equipment for aerospace applications.

MATTHEW E. JORDAN JR., has been named director of Computer Time Sales and Services at Management and Computer Services Inc., Philadelphia. President F. A. SCHLEGEL JR. made the announcement. Jordan was previously a manager in the N.Y. corporate headquarters of MAI Equipment Corp., a subsidiary of Management Assistance Inc.

SID member ALLEN T. PUDER is representing the Electro-Optical Div. of Kollmorgen Corp. and the Macbeth Sales Corp. on the West Coast as a Technical Consultant. Since graduating from the California Institute of Technology with a MSME Degree, he has been active in the development of Electro-mechanical, electro-optical, and xenon illumination systems. He is located in Pasadena.

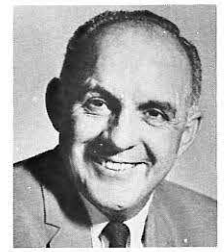
EUGENE M. ZUCKERT, former Secretary of the Air Force, has been elected to the Board of The Te Co., according to CUSTER C. BAUM, president of the optical research and development firm, located in Santa Barbara, Calif The co. is affiliated with Argus Inc., Chicago, manufacturer of amateur photographic equipment and optics devices and systems.

FRANK C. CASILLAS is now director of Corporate Development for the Bunker-Ramo Corp., according to president MILTON E. MOHR. Casillas will function on the corporate staff level, reporting directly to Dr. Mohr. He is responsible for the development of new business opportunities, including merger and acquisition investigations.

HOWARD W. EMERSON has been appointed advertising and sales promotion manager for Master Specialties Co., Costa Mesa, Calif., according to marketing manager JEROLD H. TUFT. Emerson will direct the advertising and sales promotion activities, whose products include lighted pushbutton switches and fault warning systems.

JOHN FITZPATRICK, of Huntington, N.Y., and GORDON H. WADSWORTH, of Roseville Calif., have won the two top 1967 sales awards issued by the Photolamp Div. of Sylvania Electric Products Inc., according to RICHARD B. MARTENSON, vp/marketing of the div. The awards were presented at a national marketing meeting held in Marco Island, Fla.

JOHN MANNIELLO has been named to fill the newly-created post of vice president, Government Operations, for CBS Laboratories, according to PETER C. GOLDMARK, president and director of research. Manniello will coordinate CBS Laboratories Government programs being conducted through a national network of branch offices.



JOHN MANNIELLO

KENNETH SPITZER

Promotion of KENNETH V. SPITZER from manager of the new Electro-Optical Devices Div., to general manager, with full responsibility over all the operations of the div., was announced by JOHN C. MESSERSCHMITT, exec. vp/chief operating officer at Amperex, Hicksville, N.Y. Spitzer's responsibilities include R&D, manufacturing, and marketing. Named vice president/general manager of Amperex's Semiconductor and Microcircuits Div. is NORMAN A. NEUMANN, who was most recently with General Instrument Corp. He will hold full responsibility for all activities of the Div.

JOHN GRANBERY has been named senior sales engineer for digital information display systems at Raytheon Co.'s Equipment Div., Waltham, Mass. He joins the co. from GE, where he served as manager of market development for the past two years for the Medinet Dept.

The Conrac Div. of Conrac Corp., has named JOHN W. CHISLETT sales manager, Data Display Equipment. Prior to joining Conrac, Chislett was assistant to the Director of Marketing at the Solar Div. of International Harvester.

Appointment of ALBERT V. KLIZAS as general marketing manager of Transistor Electronics Corp. was announced by A. R. MASTERS, exec. vice-president. He will be responsible for marketing planning, sales and advertising of the Minneapolis-based firm's products.

THEODORE H. MAIMAN, inventor of the ruby laser and former president of Korad Corp., has formed a new company, Maiman Associates, in Los Angeles. Purpose of the company is to . . . "help bridge the gap between innovators and investors." Maiman founded Korad in 1962; he left the company in 1967, after it was absorbed by Union Carbide Corp.

Two new appointments have been announced by Information Control Corp., El Segundo, Calif. S. V. EDENS is now serving in the newly-created post of vice-president of Program Management. He comes to ICC from his own consulting firm, S. V. Edens Inc., which he had formed to provide engineering and management consulting services to the Reconnaissance and Intelligence Community. RICHARD FRIED is now Western Regional sales manager, also a newly-created post. He was previously with Lear Siegler Inc., Electronic Instrumentation Div., in Anaheim. President G. H. GOLDSTICK made the announcements.

Adage Inc., has named WILLIAM F. WEST, Western Regional sales manager, according to vp/marketing I. R. SCHWARTZ. West moves to Los Angeles from Fullerton, where he has been manager of Adage's West Coast Systems Dept. for the past eight years.

CLINTON CRABTREE has been appointed director of the computer product line at Honeywell's Florida Aerospace Div., St. Petersburg, Fla. Crabtree headed General Business Services, consulting firm in Brandon, Fla., before coming to Honeywell.

RAND W. TUTTLE has been elected vice president for Advanced Technical Development of B-R Data Systems Inc., Silver Spring, Md., subsidiary of the Bunker-Ramo Corp., according to H. L. SHOEMAKER, vp/general manager. In addition to this new position, Tuttle continues as director of Advanced Systems. Elected vice president for Operations is JOSEPH S. REYNAUD, who previously served as director of Management Information Systems and program manager of the contract in which B-R Data Systems is providing services to automate the processes for preparation of the Army's Annual Budget Submission to Congress.

GEORGE R. BATCHELDER, director of marketing of Mosaic Fabrications Div. of the Bendix Corp., recently announced appoinment of JOHN W. MEACHEN as sales manager for Field Sales Activities. His responsibilities in directing external sales personnel and representatives for Mosaic, largest producer and developer of fiber optics in the world, will include customer relations.

Now director of manufacturing at Systems Engineering Labs, Ft. Lauderdale, Fla., is ROBERT G. DISTEFANO, who joined the co. in 1965 as manager of product assurance. Prior to joining SEL, he was manager of quality assurance at Molecular Research Co.

PEK, Inc., Sunnyvale, Calif., has promoted RAY L. BUNCH to the post of manufacturing manager, according to general manager MAX GARBER. Bunch will be responsible for all phases of the production of PEK lamps. He previously was manufacturing engineer.

RAY L. BUNCH

KENNETH MILLER SR.

KENNETH M. MILLER SR. has been named vice president of Computer Industries Inc., and general manager of its Graphic Systems Div., according to co. president ROBERT G. DEE. Los Angeles based Computer Industries is a subsidiary of University Computing Co., Dallas. Miller was formerly a vice president of Motorola Electronics, Daystrom Inc., and Lear Jet Industries.

JAMES E. REMMER has been elected vice president and general manager of the Westwood Div. of Houston Fearless Corp., according to president FRED C. MEHNER. He was previously with Xerox Corp. in a number of executive assignments.

ID Readout

CALL FOR TECHNICAL PAPERS ISSUED FOR 1969 SPRING JOINT CONFERENCE

A call has been issued for original technical papers on all aspects of the computer and information processing field for presentation at the 1969 Spring Joint Computer Conference, to be held in Boston.

T. H. Bonn, chairman of the technical program committee of the 1969 conference, said papers must be submitted by next Oct. 7 to be considered for presentation at the May 14-16, 1969 semi-annual conference in Boston's War Memorial.

"The purpose of the 1969 Conference is to stimulate those engaged in research, advanced development, design and usage of computers and their programs to communicate their ideas and experiences freely through presentation of high quality technical papers," Bonn said. He is assistant to the vice president of product planning and development at Honeywell's Electronic Data Processing Division.

Free and timely communication of technical information has been responsible for the rapid growth of the computer field," he added. "It is our aim to continue and improve that communication in this forthcoming conference."

He said authors should not limit themselves to the general fields of hardware, software, systems and applications but should also consider the technical-social aspects involving the use of computers. He suggested authors submit original ideas and experiences relating to secrecy and privacy, the FCC inquiry into data communications, the design and promulgation of standards in the industry, problems of competition and the direction of the industry's growth.

Five copies of the entire paper should be submitted, Bonn said, including a 100-to-150 word abstract and text of not more than 7,500 words. A full set of rough illustrations, when applicable, should accompany the text and be keyed to it, he added. Final texts will be published in the conference proceedings by the American Federation of Information Processing Societies (AFIPS), sponsor of the Spring and Fall Joint Computer Conferences.

Papers should be submitted to T. H. Bonn, Technical Program Committee Chairman, 1969 Spring Joint Computer Conference, Honeywell EDP, 200 Smith Street, Waltham, Mass. 02154.

ORGANIZATION COMPLETED FOR 1968 FJCC

Committees for the 1968 Fall Joint Computer Conference December 9-11 have been completed.

According to Dr. William H. Davidow, general chairman, who is with the Palo Alto Division of Hewlet-Packard Co., committees have been functioning for the past five months to plan what promises to be the largest computer conference held on the West Coast.

Two vice chairmen are heading the main divisions of responsibility. Thomas R. Dines of NASA's Ames Research Center at Moffett Field is administrative vice chairman. Donn B. Parker of Control Data Corp., Palo Alto, is technical vice chairman and being assisted by Cuthbert C. Hurd of Computer Usage Co., Palo Alto, who will make arrangements for distinguished visitors.

The technical program is headed by Robert H. Glasser of Computer Usage Development Corp., Palo Alto, chairman, and Rex Rice of Fairchild Semiconductor, Palto Alto, vice chairman. Maria Robertson of Computer Usage is administrative assistant.

Serving on the technical program committee are the following: James B. Angell of Stanford University, Robert Bond of Hewlett-Packard Co., Dr. Sidney Fernbach of University of California Lawrence Radiation Laboratories, Marjorie Hill of Control Data Corp., Paul Hodge of Memorex Corp., Warner King of Computer Usage Development Corp. and Marty Silberberg and Roger Simons of IBM Corp.

INTERNATIONAL TECHNICAL COMMUNICATIONS SYMPOSIUM

The Society of Technical Writers and Publishers will hold its first international technical communications symposium in Tel Aviv, Israel, December 9-12, 1968, on the advanced state of the art, theory, and practice of technical communications. Papers should be submitted to: Ken Tong, 55 Point Allerton Rd., Hull, Mass. 02045. Each panel will consist of speakers from 2 or more countries, assuring international coverage for each panel topic.

LENS DESIGN

A two-week short course will be held August 12-23, 1968, at UCLA, presented by the Engineering and Physical Sciences Extension, University of California Extension, Los Angeles. Instructor is Rudolf Kingslake, Director of Optical Design, Eastman Kodak Co., Rochester, N.Y. Description of course includes: various raytracing procedures in common use today; principal axial and oblique aberrations of lenses; usual methods for designing achromatic doublets, aplanats, and simple microscope objectives. Further information may be obtained from: P.O. Box 24902, Engineering and Physical Sciences Extension, University of California Extension, Los Angeles, Calif. 90024, (213) 478-9711, Ext. 7277.

SID Activities

After three years of dedicated and productive service as Publications Chairman for SID, Lou Seeberger has resigned the position, due to other pressing committments. Taking over, by appointment of president Carl Machover, is Rudy Kuehn, who served as the journal's first publications chairman. All society correspondence and technical manuscripts are to be submitted to Mr. Kuehn at P.O. Box 1369, Huntington Beach, California 92648.

SOUTHWEST CHAPTER

The chapter met recently at the Western Hills Inn in Euless, Texas, to hear C. R. Stobart, Manager of Command Display Systems, LTV Electrosystems, Inc., present a paper, "The Scribing Projector Display Technique". The paper was a presentation and discussion of the scribing projector large screen display technique, and was supplemented by an actual projector on display.

DELAWARE VALLEY

Chapter met recently to hear J. Weir Sargent, vice president of Ultronics Corp., and Alan Meyers, Registered Representative, Bache and Co., speak on "Securities Market Information Display." The meeting was preceeded by dinner, and was then held at the offices of Bache and Co., Philadelphia.

BAY AREA

The chapter recently held an outdoor dinner at the Paul Masson Mountain Winery, located in the hills above Saratoga. A steak dinner was catered by a local restaurant, with the wine being provided by the Masson winery. The meeting was well attended by members and their spouses.

LOS ANGELES

The chapter met for no host cocktails in Arcadia, to hear Ken Epple, of Datex Div. of Conrac Corp., discuss the company's electronic computer driven scoreboard. He showed movies and demonstrated the scoreboard, which is to be used at the Coliseum in Oakland, Calif. A tour of the Datex Div. followed the meeting.

DISPLAY TECHNOLOGY

A five day tutorial seminar will be offered August 26-30, 1968 by the Polytechnic Institute of Brooklyn and the Mid-Atlantic Chapter of the Society for Information Display. The seminar will be held at the new Long Island Graduate Center of the Polytechnic Institute of Brooklyn located in Farmingdale, New York. The tutorial program will include four (4) lectured discussion periods in each day's schedule starting at 9:00 a.m. and lasting through 5:00 p.m. Housing facilities will be made available. The fee for each participant will be $225. which will include class notes and a seminar dinner.

Registration before the deadline of August 1 is required. Information on this tutorial seminar is available from Dean William A. Lynch, Office of Special Programs, Polytechnic Institute of Brooklyn, 333 Jay Street, Brooklyn, New York, 11201. (212) 643-2246.

Contributors from the Society for Information Display will include specialists from industry and education as well as faculty members of Polytechnic Institute of Brooklyn and other expert guest lecturers.

The seminar has been planned so that participants will be able to conclude with Labor Day holiday in New York City and on Long Island.

Information Display welcomes the following new members of *SID*.

AARONSON, Gerald, General Telephone & Elec. Labs; ALLEN, Martin C., Ling Group; ALTMAN, Morris, Hazeltine Corp.; ALWINE, Paul R., Jr., Control Data Corp.; AUROUX, Alain F., Grenoble Scientific Center (France); BAAKE, Donald W., Hughes Aircraft Company; BAGLEY, Robert L., Lockheed California Company; BAIN, G. Stuart, Xerox Corporation; BALCHEN, Jens G., Technical University of Norway; BATES, Arthur D., Independent Consultant; BELLOMY, Fred L., University of California at Santa Barbara; BERNSTEIN, George B., Naval Supply Systems Command/R&D; BLANKENSHIP, M. G., Corning Glass Works; BLEAKLY, Charles J., Lockheed/Missile & Space; BOLTA, John T., Tridea Electronics; BORDSEN, Donald T., UNIVAC; BRANCH, James K., Photo Research Corp.; BRENNER, Bernard M., MVR Corporation; BROWN, Jack G., NAA—Space; BROWN, Kenneth A., ITT Gilfillan Inc.; BRUNS, Ronald A., Naval Missile Center.

CARMICHAEL, Don, American Sign & Indicator Corp.; CHABROL, Maurice J., Thomson Informatique et Visualisation—France; CHANDLER, Harvey B., Owens-Illinois; CHESAREK, Donald J., IBM Corporation; CHRISTENSEN, Jay, NASA—Ames Research Center; CLARK, Darrell L., National Cash Register Company; CLERGUE, Jean M., Thomson-Informatique et Visualisation—France; COLLINS, Richard F., Jet Propulsion Laboratory; CORMIER, Robert E., McDonnel-Douglas Corp.; DEGRASSE, Robert M., Quantum Science Corporation; de GUILLEBON, Michel M., French Navy—France; DEWEY, Anthony G., IBM Corporation; DUMAS, Christ, APSO Electronics; DURBECK, Robert C., IBM Corporation; DURBIN, Gerald T., Control Data Corporation; ECKSTROM, William E., Honeywell Inc.; EISENMAN, Trevor W., NASA; ELDRIDGE, Arthur J., Jr., IBM Corporation; ELKINS, David R., Fleet Computer Programming Center, Pacific; EMMONS, Lawrence D., Ampex Corporation; FICKEY, Charles J., American Cyanamid Co.; FIRTH, William G., TWS Systems Group; FLEMING, Gordon Ross, Energy Conversion Devices, Inc.; FRIEDMAN, Harold, Naval Missile Center.

FROESS, Raymond J., IBM Corporation; FRYER, Richard E., Naval Weapons Center; FUJII, Tadakuni, Nippon Electric; GILMOUR, Robert W., Stanford Research Institute; GLAESER, Richard A., General Dynamics; GORDON, Harold B., Harris-Intertype Corporation; GREEN, Melvin, Hazeltine Corporation; GRIFFIN, John R., Tektronic Inc.; GUTTTMANN, Eric S., ITT Gilfillan Inc.; HALE, Keith F., Navy Electronics Lab.; HALLSTROM, John, TUAB, Teleutredningar AB; HARPER, Gordon E., Varian Associates; HART, Edward A., Department of Defense; HAWORTH, Harjorie H., IBM Corporation; HEDBERG, Carl A., Control Image Corporation; HEGLIN, Howard J., Litton Guidance & Control; HELLER, Mahlon D., LTV—Aeospace; HOLLOMAN, Charles, Trans-Lux Corporation; HOLLY, John H., Hughes Aircraft Company; HORGAN, Thomas B., IBM Corporation; HOWARTH, Robert F., SIO Visibility Lab.; IBOSHI, Lawrence K., Hughes Aircraft Company; IVES, Henry D., National Cash Register; JANSKY, Curtis M., Bunker-Ramo Corporation; JANUS, Theodore, Corning Glass Company; JIZBA, A. V., Chevron Oilfield Research Company; JOHNSON, Donald S., Jr., Ball Brothers Research Corporation.

KITAHARA, Eiji, Kyokuto, Boeki, Kaisha, Ltd.; KOCH, William H., Warnecke Electron Tubes; KORNFELD, Henry G., Sperry Gyroscope; LANGNER, Guenther O., IBM Corporation; LAVALLEE, Don F., Redcor Corporation; LEMMER, Robert A., Dow Jones & Co. Inc.; LEPOLD, Joseph H., General Electric AED; LORETZ, Norman F., TRW Systems Group; MARIS, John K., Owens-Illinois Inc.; MARTI, Norman F., Hughes Aircraft Company; MASSEY, Ernst M., Tektronix, Inc.; MERCIER, Daniel, SPERAC—France; MERWIN, Roy L., Control Data Corporation; MICKEY, Daniel D., General Electronics; MUSICANT, Gerald, Naval Underseas Warfare Center; McDOUBREY, Arthur O., Varian Associates; NANCE, Doyce R., Texas Instruments; NELSON, Delbert D., Goodyear Aerospace; NELSON, Hilding Eugene, Concet Inc.; NIDAY, Edward R., ITT Federal Labs.; NILSEN, Marvin H., Symbolic Displays Inc.; NIXON, Nick, RCA; NORTH, Arthur, Leasco Systems & Research Corporation.

O'DENTHAL, Conrad J., Tektronix Inc.; OKAMOTO, Howard K., Philco-Ford Corp.; OLSON, Marlin E., Foxboro Company; O'REILLY, Charles C., Clifford Consultants; OSICK, Walter R., ITT Gilfillan; PEDERSEN, Eva, Danish Atomic Energy Commission; PEIROTES, Yves J. M., French Navy—France; PERSSON, Ake N., AB Projektutueckling—Sweden; PIERCE, Edward W., Owens-Illinois; PONTECORVO, A. B., The Boeing Company; POON, Kam, Sanders Associates; PORTER, Paul E., UC—Visibility Lab.; PUTERBAUGH, W. H., National Cash Register; RAUCH, Conrad J., Texas Instruments; RAY, Charles J., Texas Instruments; RAY, Charles B., Calif. Inst. of Technology; RAYNER, Harry H., UNIVAC; REEVES, Clay, Jr., Digital Data Systems Inc.; REYNOUDS, John, Fredlen Corporation; RITTER, Donald D., Control Data Corporation; ROCK, Henry C., Loral Electronic Systems; RODGERS, Richard L., SDS; SAKOLS, James D., Lockheed; SCANLON, John H., Massachusetts Institute of Technology; SCHOPPMAN, William E., McDonnell-Douglas; SCHOTT, Dan J., Sperry-Rand. SCHREIBER, Donald E., IBM Corporation; SHERBY, Thomas A., National Cash Register; SILVERMAN, Martin, B-Scan Inc.; SLOCUM, Gerald K., Hughes Aircraft Company.

SMITH, Sidney M., Jet Propulsion Lab.; SMITH, Stephen F., University of Calif. at Berkeley; STALLARD, Langdon B., Litcom; STANILOFF, Seldon, A., Fairchild Space & Def. Sys. Div.; STANKOVICH, Donald, Aerojet General; STARTIN, James V., International Computer & Tabulators Ltd.; STILLMAN, I. Leon, Cornell Aeronautical Laboratory; SWEETON, Richard F., Kollsman Instrument Corp.; SWINNEY, Stanley I., Honeywell; TENNYSON, James F., Albion Optical Company, Inc.; TETSUKA, George M., Jet Propulsion Laboratory; THUREIN, Ingo P., Bonneyville Power Administration; TITE, Robert C., UNIVAC; UCHIDA, Prentiss S., Adage, Inc.; ULM, P. D., ITT Federal Labs.; UTTERBACK, Raleigh E., Raytheon Company; VASS, Russell, U.S. Navy Electronic Systems Command; VERDERBER, Robert J., NAA—Rockwell/Space; WALL, Carl E., Philco-Ford; WEIL, Raoul B., Monsanto; WEIRMEIR, Arnold V., Canadian Armed Forces; WERNTZ, Theodore L., Brookhaven Lab.; WILLIAMS, Malsolm E., Scientific Data Systems; WISE, Harry D., UNIVAC; ZIMMER, Karl J., Burroughs Corporation; ZINN, Alfred G., Department of Defense.

NEW STUDENT

LaPLANT, William P., Jr., University of Dayton.

WE WELCOME THE FOLLOWING SUSTANING MEMBERS:

CBS LABORATORIES, Stamford Connecticut
D. Allison, John Maniello, J. K. Moore
THOMAS ELECTRONICS, INC.—Wayne, New Jersey
Michael Beasty, M. L. Chater, H. A. Ketchum, Peter Seats, Ben Sitticase.

National Technical Conference

CALL FOR PAPERS

The objective of this conference, to be held in New York City at the Waldorf-Astoria on November 25th and 26th, 1968, is to provide a valuable and rewarding experience by the stimulation of thinking through:

TECHNICAL PRESENTATIONS
Interesting ideas and concepts are invited in papers that will be of general interest—as short as possible but as long as necessary—that get information across!

TUTORIAL PAPERS
Meaningful presentations are desired which will provide insight and understanding to specialists of other disciplines in the display field.

PANEL DISCUSSIONS
Verbal discourses on important trends or discussions of future needs and requirements would be most welcome—short presentations followed by questions and answers.

DEMONSTRATIONS
Space will be provided for individual or company demonstrations—papers on these interesting devices or systems are encouraged.

Please send a one page typewritten abstract along with your name, address and telephone number by Aug. 5, 1968 for selection to:

William M. Hornish
Western Union
82 McKee Drive
Mahwah, New Jersey 07430

CALL FOR DISPLAYS

In conjunction with the *SID* 1968 National Technical Conference at the Waldorf Astoria, New York City, on November 25, 1968, *SID* issues this call for demonstrations.

SID will provide the space and power, free, to those who wish to demonstrate new ideas to other professionals who are primarily engaged in the display field.

The demonstrations need not be sophisticated or product engineered—"bread board" operating models and "cellar projects" are perfectly acceptable. No advertising will be permitted other than a table top sign with the sponsoring company or individual's name imprinted on it.

We encourage individuals and corporations to take this opportunity to present new product development to those men who are working in the same field and to those who will be specifying display devices in future systems.

For further information and space allotments, phone or write:

Richard DuBois
Wagner Electric Corporation
Tung-Sol Division
200 Bloomfield Avenue
Bloomfield, N.J. 07003
201-748-8700

Call for Papers—

MAN'S ENVIRONMENT.
MEDIA
DISPLAY IMPLICATIONS & APPLICATIONS

Aerial view of Marriott Twin Bridges Motor Hotel, site of MEDIA.

The Washington, D.C., Chapter
Society for Information Display
Invites You To Attend
the
Tenth Annual Symposium
M E D I A
Man's Environment: Display Implications & Applications
May 27, 28, 29, 1969
Marriott Twin Bridges Motor Hotel
Arlington, Virginia

Tutorial and research papers are solicited. Papers should (a) identify specific aspects of man's environment in which Information Display can produce vital benefits and (b) consider man in his environment and the actual and probable improvements which can be engendered through the intelligent and imaginative applications of information display technology. The MEDIA Symposium theme paper is available from *SID*, P.O. Box 187, Kensington, Md. 20795. Five draft copies and five copies of a 100-150 word abstract are due *before* December 15, 1968. Submit to: H. T. Darracott, 3325 Mansfield Road, Falls Church, Va. 22041.

Lewis Blair, left, Media Symposium Chairman, receives welcome from Marriott Hotel Convention Manager William Emery.

ID Products

Counter/Display Multidecade I.C. Decimal

Instrument Displays Inc., Danvers, Mass., manufacturers of digital display units, announces the availability of their Mini-diget DCU, to their counter/displays with memory and Binary Coded Decimal output. The Mini-diget DCU series of decimal counter/displays is claimed to provide a self-contained package built around miniature cold-cathode display tubes. These counters accept series pulse train input and count up to rates in excess of 2 Megahertz. Binary coded decimal output for further system operation is a part of the display. The counter/displays are available in 2 to 9 decade display packages.

Circle Reader Service Card No. 35

Infrared Emitter

Monsanto Electronic Special Products Division, St. Louis, Mo., has introduced the M120-C1 semiconductor infrared emitter designed to match the peak spectral sensitivity of silicon detectors. The emitter is a p-n diode chip made of gallium arsenide mounted on a TO-46 header. A high epoxy lens protects the chip and serves to collimate the radiation. The M120C1 radiates 1.5 milliwatts at a sharply peaked wavelength of .9 microns when the diode is forward based above one volt at a current of 100 milliamperes. The power offers an improved signal to noise ratio and design flexibility when used as a companion light source for a silicon detector where semiconductor rates are required. Typical applications are said to include: card and tape recorders, optical shaft encoders, high voltage isolation switches, photo choppers and collimator.

Circle Reader Service Card No. 36

Deflection Yokes

CELCO, Mahwah, N.J., is now offering certified performance in its FD428 deflection yoke. Designated Deflectron II, this yoke is intended for precision displays with high resolution readouts utilizing Cathode Ray Tubes with spot diameter capabilities to less than .001 inch. According to the company, certified performance is defined as the results of actual measurements of specific parameters such as spot size, spot growth, alignment pattern, astigmatic ratio and spot size figure of merit. A Certificate of Performance including test conditions and test results will be issued with Deflectron II.

Circle Reader Service Card No. 37

Rectangular Shields

Amuneal Manufacturing Corp., Philadelphia, Pa., has introduced Rectangular Shields for cathode ray tubes (Types 3XP, 3SP, 3ASP, 3AHP, 3AYP). Units are claimed to be form-fitting to the contour of the CRT bulb; shields are of three-piece, die-formed construction. They can be supplied in four choices of mounting configurations, either with or without tube support clamps. All Amuneal CRT Shields are hydrogen annealed, after manufacture to restore and insure the optimum magnetic shielding properties of the metal.

Circle Reader Service Card No. 38

X-Y Recorder

Texas Instruments Inc., Stafford, Texas, has announced production of an X-Y recorder. Designated the Contour/Riter II Recorder, the unit is stated to have four-pen versatility for multiple X-Y plots, with repeatable accuracy (0.25%) in TI's null-balancing potentiometric drive. Overlapping pens and reversible chart drive combine to make the recorder a "profiling" device, suited to unattended recording of numerous types of process runs, analog traces of computer results and experimental or production test regimes. Other interesting applications are stated to be: pressure vs. volume, antenna radiation patterns, and analysis of hysteresis loops typically encountered in stress analyses and evaluation of electronic components.

Circle Reader Service Card No. 39

Voltmeter

Ross Engineering Corp., Saratoga, Calif., offers a high voltage Hi-Z portable voltmeter, high impedance, solid state for accurate measurement of AC voltages on cables, cable capacitance taps, and high impedance sources. Range from .001 volt to 25,000 volts for both line to ground and differential phasing. Co. claims it is also useful for voltage presence indication by means of antenna probe or external contact of semiconductor cable shielding and for measurement of voltage differentials from ground or shield currents originating from loads or faults.

Circle Reader Service Card No. 40

Subminiature Indicator Light

A subminiature indicator light that can reduce size of panels and consoles is now available from Marco-Oak Division, Oak Electro/Netics Corp., Crystal Lake, Ill. The 1-in. overall, .340-in. diam indicator uses flange base T-1 lamps. It is offered with domed or flat cylindrical high impact plastic caps and is available in all conventional colors, either transparent or translucent. All operational and environmental requirements of MIL-L-3661 are met by the subminiature units, which also have resistance to vibration and shock, according to the manufacturer.

Circle Reader Service Card No. 41

Desk Top Information Display

Raytheon Company, Lexington, Mass., is now manufacturing the DIDS-400, digital information display systems. New England Mutual Life Insurance Co., Boston, Mass., is now using the systems for desk top information display to provide visible access to policyholder information. The firm claims the DIDS-400 provides direct interface between operator and computer. The data transfer is under operator and computer control, and can be returned for display on a 6" by 9" screen, where it can be analyzed, updated, and returned to the computer for further processing. According to the company, the DIDS-400 terminals are all solid-state and use integrated circuits; and as many as 1040 characters can be displayed at one time on the screen.

Circle Reader Service Card No. 42

Microminiature Lamps

Pinlites Inc., Fairfield, N.J., now offers a modular strip incorporating incandescent lamps. STACK-LITE 75 is a narrow strip of molded plastic (.075" wide) in which microminiature lamps (Pinlites) are spaced .075" apart to form an integral unit. These strips can be supplied in any length (within reason) as an inline display for such applications as meters, gauges, speedometers, etc. (particularly where the ambient lighting is poor). STACK-LITES can be stacked (as building blocks) for matrix applications. Figures, symbols, and letters can be formed by energizing the appropriate lamps, according to the company.

The firm offers the customer a selection of any of its standard lens style or flat top style lamps as a part of the assembly, i.e.—5 ma. to 35 ma. at 1¼ volts. At this rated voltage the life expectancy is 10,000 hours. These units can be wired directly into associated circuitry or can be plugged into a matching connector also supplied by P.I.

Circle Reader Service Card No. 43

New Literature

Versatility of Digital Plotting System

A tweleve-page brochure from Milgo Electronic Corp., Miami, Fla., illustrates a variety of applications for the DPS-6 Digital Plotting System. In its second edition, the brochure shows the use of plotters applied to fields as diversified as civil engineering, finance, marketing, and construction. Included with the system are an X-Y plotter, an input source and supporting software.

Circle Reader Service Card No. 46

Quarterly House Organ Covers Lighted Switches, Indicators and Warning Systems

A quarterly external company publication called the MSC ILLUMINATOR has been introduced by Master Specialties Company, Costa Mesa. According to the company, this new publication will provide detailed material on information display and control devices. Products covered will include lighted pushbutton switches, word-indicator lights, and fault warning systems and annunciators. Information will include new product and accessory announcements, application ideas, and specialized technical data.

The first issue, just released, details a new audio/visual annunciator system called AVA that combines the standard lighted word-indicator with a corresponding pre-recorded voice message into one, compact package.

Circle Reader Service Card No. 47

Digital Displays Booklet

A tweleve page booklet covering some state-of-the-art advancements in illuminated digital displays has been published by the Tung-Sol Division of Wagner Electric Corp., Newark, N.J. Titled "The Second Generation Optimum Contrast Digital Contrast Digital Displays", it discusses three major developments which have improved performance of illuminated bar readout. The booklet also contains a description of the system characteristics of the Tung-Sol readouts.

Circle Reader Service Card No. 48

Easy-To-C Program Computer

Clary Datacomp Systems, San Gabriel, Calif. has published an eight-page brochure describing digital computing equipment. Model DE-600 computer can be used either as a calculator or as a decision-making digital computer. Included in the brochure are solution times for such problems as third-degree polynomial curve fit, solution of simultaneous equations, correlation and T-test, and compound interest. There is also a brief summary of pre-programmed problem-solving packages and computer peripheral equipment available from Clary.

Circle Reader Service Card No. 49

Tube Housings

Pacific Photometric's 16 page catalog discusses the complete line of Photomultiplier Tube Housings. Specifications and dimensions are given for ten separate types of housings which are designed to accommodate all leading photomultiplier tubes. The catalog is illustrated profusely with photos and graphs. Prices are referenced to the photomultiplier tube which is intended for use.

Circle Reader Service Card No. 50

Data Sheet from Raytheon

A data sheet describing the CK1905 Datavue tube is available from Raytheon Co., Lexington, Mass. The CK 1905 is stated to be a gas-filled cold-cathode, numerical indicator tube, using a common anode, ten cathodes in the shape of the numerals "0" through "9" and an integral decimal point. Designed for use as a direct in-line side-view readout device, the tube is stated to be suitable for basic counter and computer circuits.

Circle Reader Service Card No. 51

EECoSwitch Catalog

A fifty-four page catalog from EECo, Santa Ana, Calif., describes the complete EECoSwitch line of Rotary Thumbwheel Switches. Included in the fully illustrated catalog is 16 pages of application information describing how to select and use EECoSwitches. A special section also describes the environmental and "human engineering" factors which should be considered for various applications.

Circle Reader Service Card No. 52

Computer Graphics System Bulletin

Systems Engineering Laboratories Inc., Ft. Lauderdale, Fla., is making available a product bulletin on the SEL 816A Computer Graphics System. The bulletin describes applications, specifications, functional description word formats, and customer sevices.

Circle Reader Service Card No. 53

High-Speed Camera Accessories

A broad range of electronic, mechanical, and optical accessories is listed in the Red Lake Laboratories, Santa Clara, Calif., publication ACC-1167. Primarily oriented toward the operation of Hycam equipment, the 150 referenced items include products having general application as well.

Circle Reader Service Card No. 54

BI/SCAN Brochure

A four page technical specification on the BI/SCAN is now available from S. Himmelstein and Co. The literature includes functional diagrams of the scanning system, description of the scanning technique, detailed input-output characteristics, etc. In addition, the brochure contains the description of the "scanning head" technique which BI/SCAN utilizes to convert transient data into a stable, periodic signal suitable for use with Spectrum Analyzers.

Circle Reader Service Card No. 55

SID Sustaining Members

ADAMS ASSOCIATES
Bedford, Massachusetts

AEROSPACE CORPORATION
San Bernardino, California

CBS LABORATORIES
227 High Ridge Road
Stamford, Connecticut

GRAPHIC SYSTEMS DIVISION
Computer Industries Inc.
14761 Califa Street
Van Nuys, California 91401

BUNKER-RAMO CORPORATION
Canoga Park, California

BURROUGHS CORPORATION
Defense, Space & Special Systems Group,
Paoli, Pennsylvania

CELCO
(Constantine Engineering Labs. Co.)
Mahwah, New Jersey

COMMUNICATIONS & ELECTRONICS DIV.
Philco-Ford Corporation
A Subsidiary of Ford Motor Company
Willow Grove, Pennsylvania

CONRAC DIVISION
Conrac Corporation
600 North Rimsdale Ave.
Covina, California 91722

ELECTRONIC COMPONENTS GROUP
Div., Sylvania Electronic Products Inc.
Seneca Falls, New York 13080

GENERAL ATRONICS CORPORATION
Electronic Tube Division
1200 East Mermaid Lane
Philadelphia, Pennsylvania 19118

HUGHES AIRCRAFT COMPANY
Culver City, California 90230

HUGHES AIRCRAFT COMPANY
Vacuum Tube Products Div.
Oceanside, California

IBM CORPORATION
Armonk, N.Y.

NAC INCORPORATED
7-1 Ginzanishi
Chuo-Ku, Tokyo, Japan

RADIATION INC.
Melbourne, Florida

STROMBERG CARLSON CORP.
Data Products, San Diego, California

SYNTRONIC INSTRUMENTS INC.
100 Industrial Road, Addison, Illinois

THOMAS ELECTRONICS, INC.
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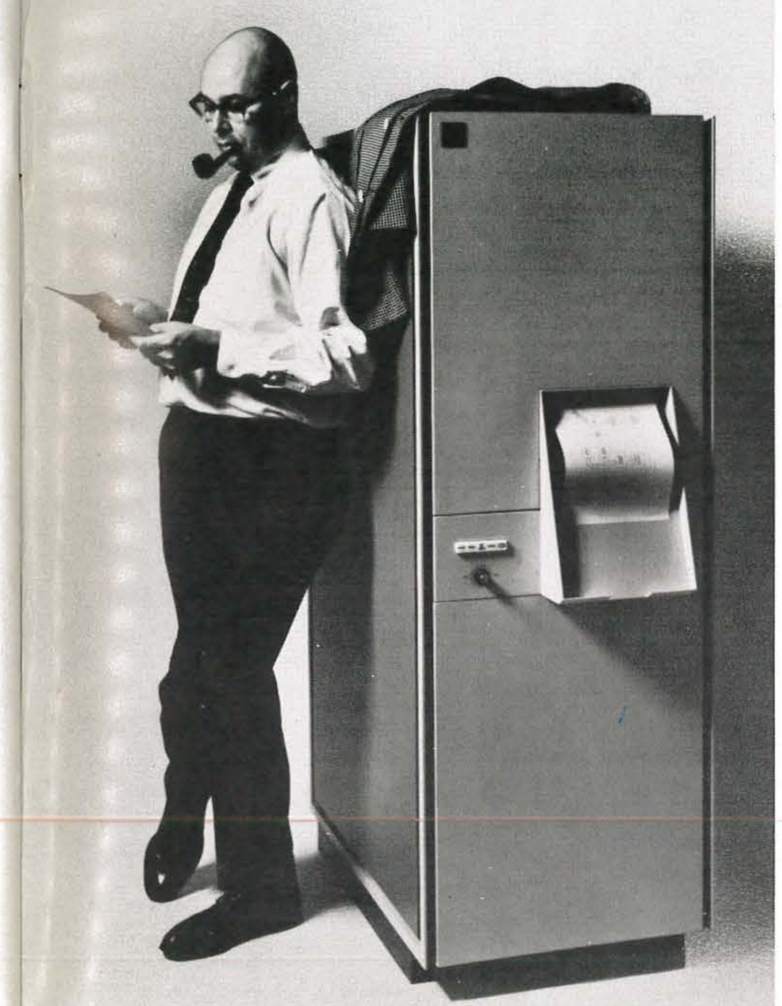
Circle Reader Service Card No. 57

ID Advertisers



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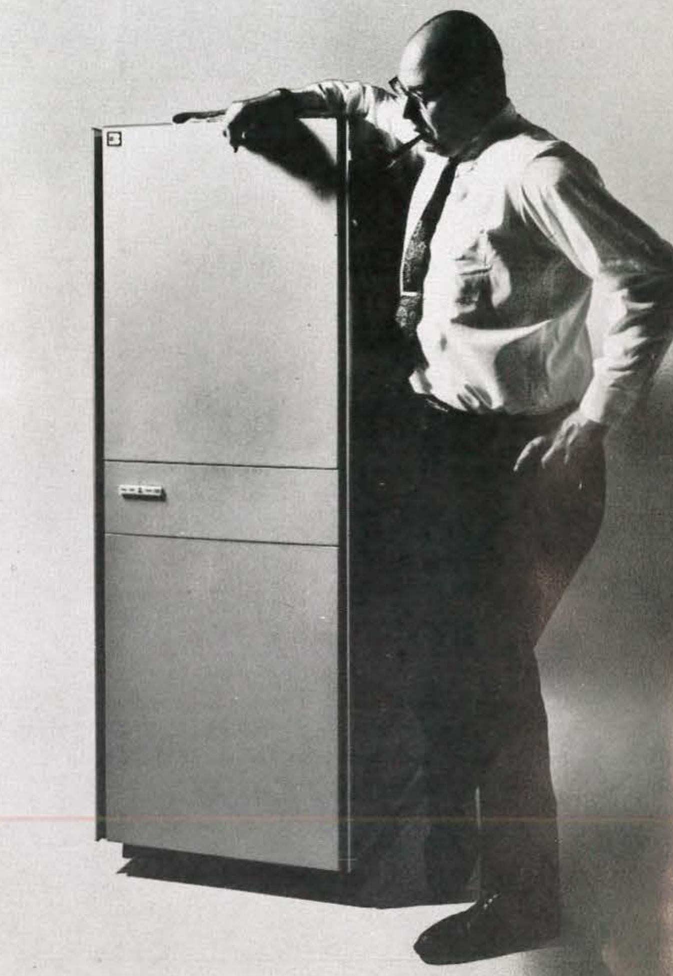

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