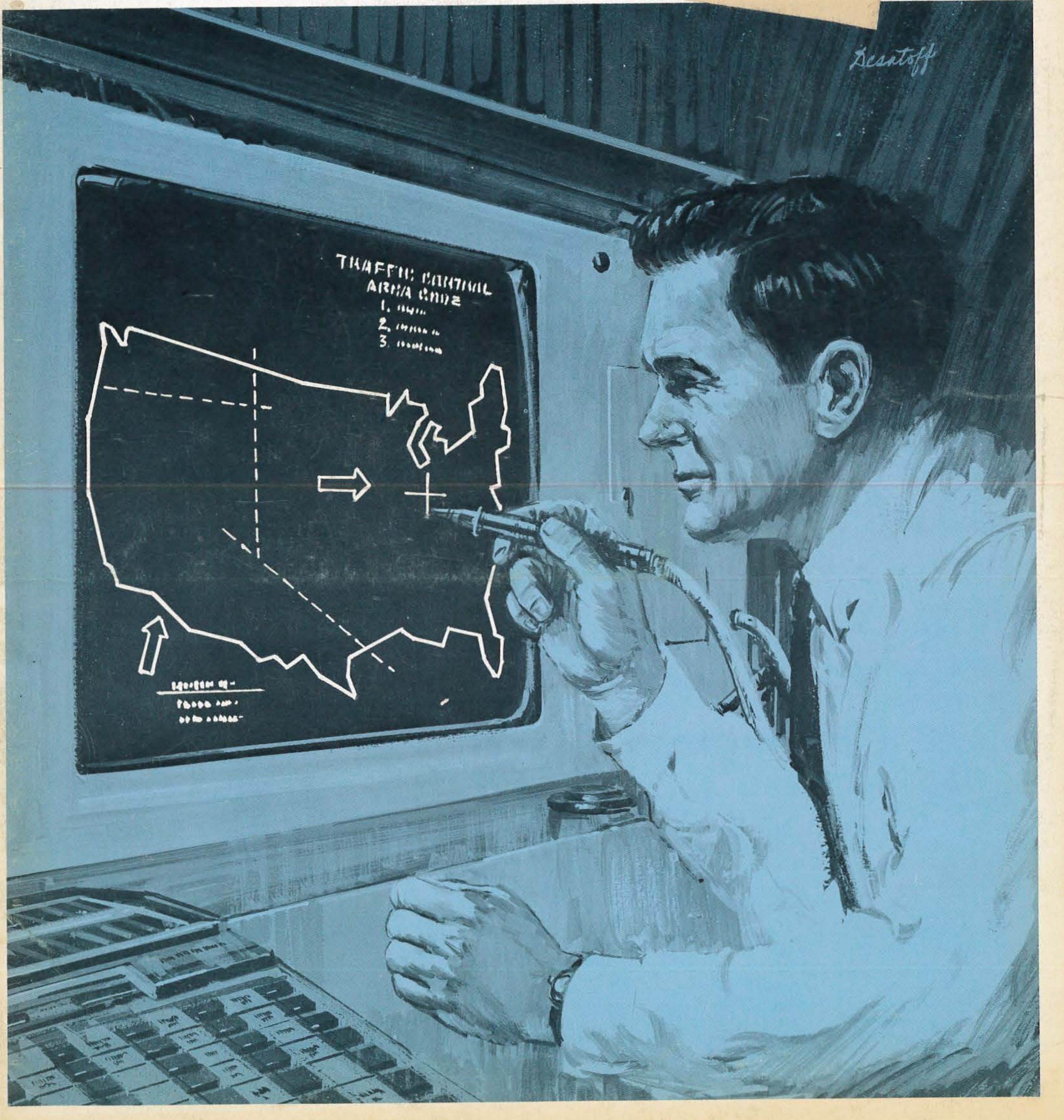
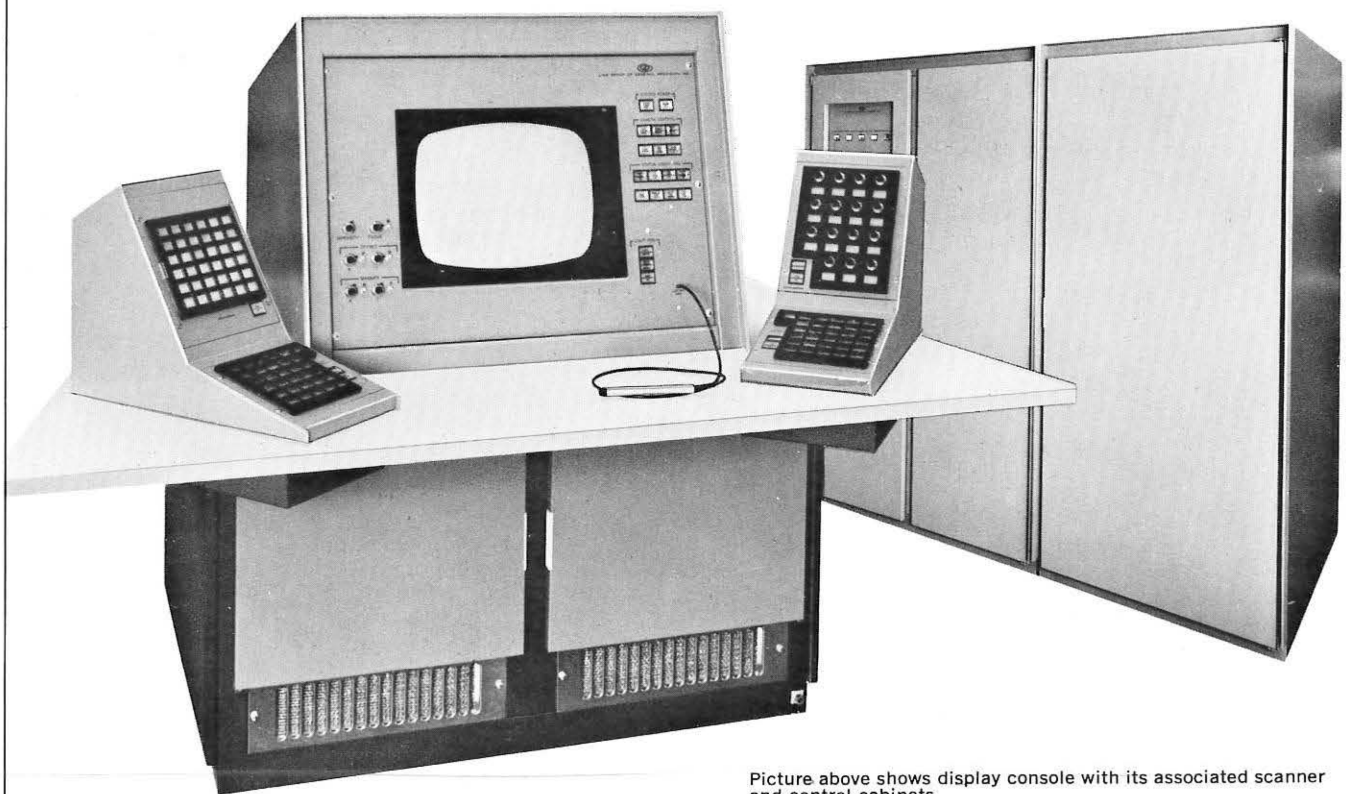
Volume 2 Number 6 November/December, 1965

Informatio… …isplay

Journal of the Society for I…





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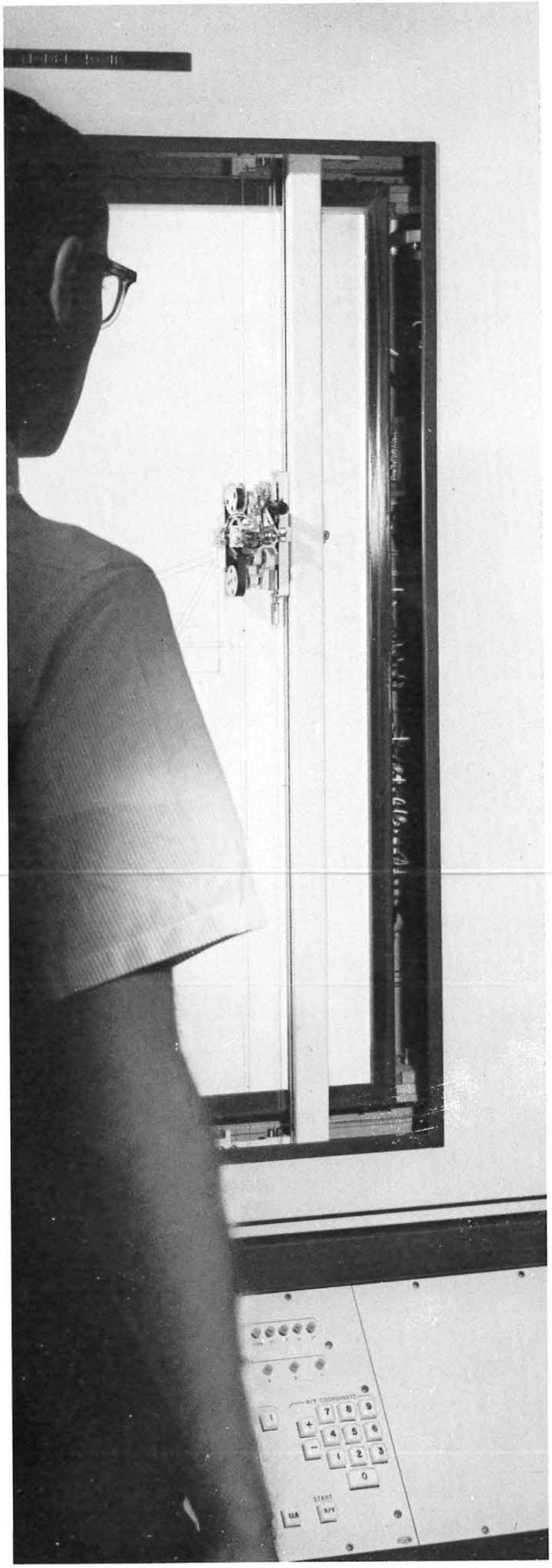

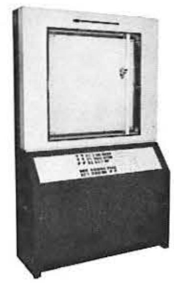

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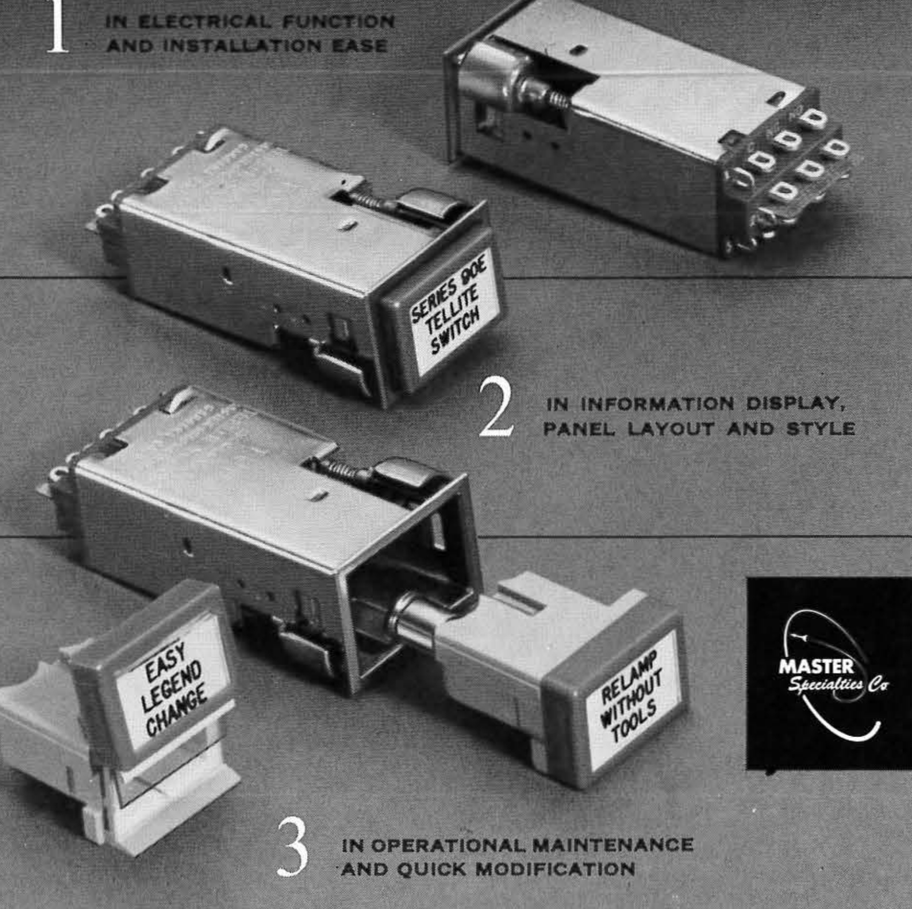

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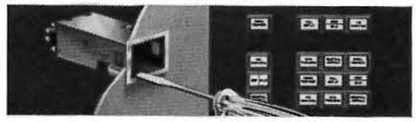

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Volume 2 Number 6 November/December, 1965

Information Display

Journal of the Society for Information Display

ARTICLES

FEATURES

THE COVER

Communication with a computer, long a challenge to optimum man/machine interface, is illustrated by artist John Desatoff of TRW Systems, who portrays an operator using a photo pen to obtain critical computer-generated information.

Celco MAGNETIC LENS
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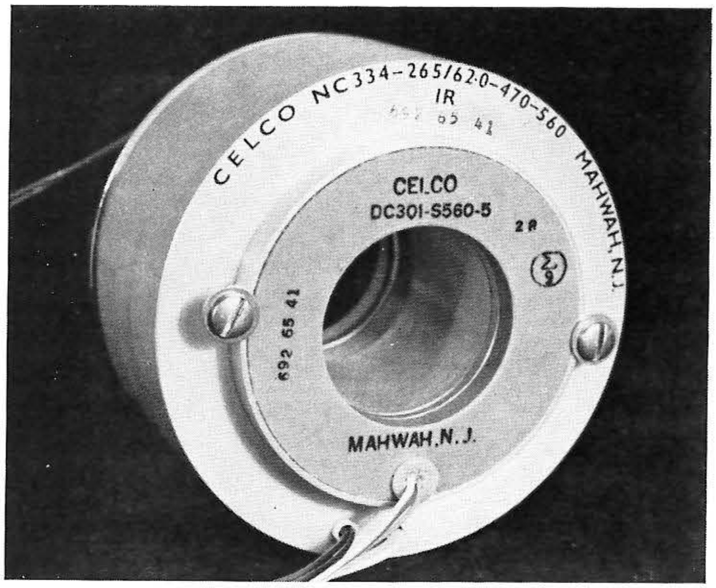
High Resolution CRT's



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EDITORIAL

IS "JUST BELONGING" ENOUGH?

Professional Societies are formed to advance the individual as well as the discipline at large. And the *Society for Information Display* is no exception to this rule. The founding fathers established a framework upon which to build a forum for the exchange of ideas in our special field. But to keep that framework in good repair requires the maintenance attention of those who wish to use it.

The pulse of any organized group should be felt at the local level. It is from this grass roots environment that the leaders of the larger body will evolve. For the *Society* to grow it must be nurtured on the ideas and desires of the individual member. However, that member cannot influence the growth to any degree if he does not participate in the affairs of the local organization.

The Los Angeles Chapter of the *Society for Information Display* is one of the largest in the nation. Yet the response to meeting notices during the past two years has been far from satisfactory. And of those who did respond, even fewer actually attended the meetings. In fact, after subtracting nonmember attendees from the total, Chapter attendance proved painfully discouraging. Is this indicative of the tone of the times, when few people in any walk of life care to become involved?

Certainly we're all busy; time is *always* in short supply these days. And who doesn't like to relax after a hectic day's work? Yet the fast-growing Information Display field requires maximum effort from talented professionals, just to keep abreast of current developments. If we hope to do more – to grow as individuals and to work effectively – the technical programs at every Chapter meeting *demand* our attention and participation.

I like to think of engineers as a breed unto themselves. They are characteristically "different" from the other well-educated people in this world in that they are by nature curious about how and why things function. Most of us are heavily oriented towards the material or physical aspects of science but somewhat less inclined to concern ourselves about the "social" side of working together and the responsibilities we have to each other and to our chosen profession.

From a purely selfish point of view, Chapter participation can reward an individual in many ways. Some of the more tangible benefits are:

1. Broadening of your own technical and business background from the formal discussions and/or field trips.
2. A first-name acquaintance with others of similar interests.
3. "Inside" contacts for employment opportunities.
4. Current knowledge of the affairs of the *Society*.
5. An opportunity to serve on a standing committee or to be nominated for local office.
6. A legitimate opportunity to influence a change in the Chapter character if you are dissatisfied with the "way things are being run."

To the serious minded individual, concerned about his own professional develepment, any one of the benefits enumerated above should be sufficient to encourage some participation.

The *Society for Information Display* is a young organization. It has nevertheless, in its few years of existence made significant contributions to the scientific knowledge of our time. The six volumes of the *Proceedings* of our National Symposia alone represent a basic body of literature on Information Display indispensable to the practicing engineer. The *Society* is still in its infancy and as it matures the need for greater participation and contribution by its members is going to increase. As we look for more involvement to satisfy the demand we will surely find that "just belonging" is really not enough.

LOUIS M. SEEBERGER,
Past Chairman
Los Angeles Chapter

Louis M. Seeberger, past chairman of the Los Angeles Chapter, Society for Information Display, is currently a member of the Executive Council of the Chapter. He is a charter member of the organization and has served as co-chairman for the Fifth National Symposium, and as Chapter Program Chairman. He is presently with Hughes Aircraft Company as a Senior Scientist on the Staff of the Director of the Signal Processing and Display Laboratory, Research and Development Division.

Mr. Seeberger spent two years with Litton Data Systems as a senior advisor on advanced display systems following an extensive tour of 17 years with RCA. His background is broad with concentration in the electrovisual data handling area. He was a Signal Corps radar officer following graduation from the University of California in 1943. His early work involved the development of pictorial storage devices for radar and television use. Prior to leaving RCA he was Manager of the Display Engineering Department with responsibility for major display hardware in the BMEWS, RANGER, and SATURN programs. He is a Senior Member of the IEEE and associated with PTGEM.

The Three-Dimensional Display
Its Cues and Techniques

by Petro Vlahos

Introduction

It has been suggested that the transfer of information from a display to an operator could be improved by utilizing the human's well trained three-dimensional (3-D) visual system. This assumption appears to be quite reasonable in view of the important role 3-D vision plays in our everyday activities. It tells us how far away objects are and allows one to confidently reach out and touch or pick up an object without fear of knocking it over.

There is no question but what 3-D vision greatly increases the information transfer from the real world to the human brain. Since stereoscopic vision is so useful, why not put it to work in displays? Producing a 3-D image has been possible for many years. Our grandparents delighted to view postcard scenes in the stereoscope. Large screen 3-D in color was demonstrated in the early 1950s when about two dozen 3-D movies were made. Engineers and display designers are continually inventing new ways of generating 3-D images. Somehow the customer has been slow to respond with a contract or purchase order.

The customer asks questions like: "Will it help the operator do a better job with less errors?" "Does it improve his capability?" "Who's using it?" "What do the human factors people say?" "Does your system require glasses?" If the answer to this question is yes, the reply is usually, "I don't like 3-D glasses, they hurt my eyes and give me a headache."

These are good questions no matter which end of the display business you are in. The user wants answers and so does the display manufacturer. The fact that information is needed, immediately suggests a literature search and perhaps a series of tests and experiments. Very little is found in the literature that directly concerns human performance involving a 3-D information display.

If this paper answers a question or two, fine! Its real purpose however, is to provide information on the 3-D visual-mental processes as they relate to the 3-D generation techniques and the subject matter. I believe it will become evident that tests are pointless without a firm understanding of these relationships.

Problem Areas

An evaluation of human performance involving a 3-D display requires an awareness that 3-D is a term descriptive of a large class of devices and techniques. The three-dimensional content of any one device or technique can be considered as a point on a value scale, where each point is the summation of a number of positive and negative 3-D information elements, Figure 1. These elements provide or deny depth information and are referred to as 3-D cues or anti-cues. The term "3-D" is specific only in the sense that the term "motor vehicle" is specific. An evaluation, therefore, of the effect of 3-D upon an operator's performance is significant to the extent that the 3-D is defined in terms of the cues and anti-cues both present and absent. Unfortunately, the cues and anti-cues are not absolutes, but vary in quality and intensity, and are modified by other display parameters which tend to influence the effectiveness of the cues. Examples of such parameters are brightness, distance, included angle, contrast, resolution, and scene content.

Another area of difficulty is that of translating hardware terms into meaningful human factors information. The two disciplines may employ a common terminology, but it should not be assumed that these terms have a common meaning.

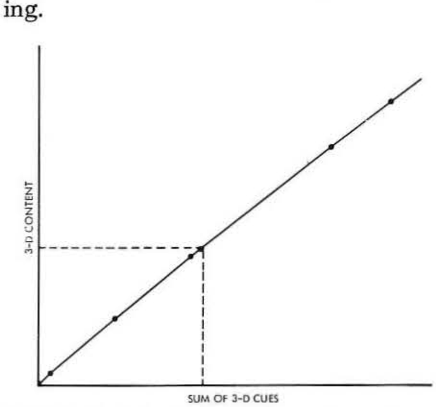


FIGURE 1: 3-D display systems. Summation of 3-D cues determines 3-D content.

The validity of an evaluation of human performance hinges upon the validity of the assumptions that are made. Perhaps the greatest pitfall is that an intended evaluation of human performance to 3-D turns out to be an evaluation of specific hardware whose 3-D content is unknown. An awareness of the presence, quality, and relative contribution of the 3-D cues and anti-cues is the key to this differentiation.

Cues and Anti-Cues

Those visual phenomena which provide depth information are defined as 3-D cues. Thus, a 3-D are any phenomenon that provides information contributing to the observer's perception of object distance or the relative spatial separations between objects. An anti-cue is any phenomenon that denies depth information or provides false information concerning relative distance. Anti-cues cause confusion and disbelief in the cues. A depth cue becomes an anti-cue when it is in disagreement with other cues.

Apparently most seeing creatures are endowed with an ability to perceive depth. This ability is often attributed to the binocular vision provided by two eyes; however, one-eyed individuals also have the ability to perceive depth. Such perception is provided by many different cues contributing to depth. The summation of all the information contained in these cues determines the degree to which depth is perceived.

The artist was perhaps the first to recognize the importance of the depth cues and has gone a long way in achieving an illusion of depth in a two-dimensional plane. The engineer and scientist is too often inclined to consider 3-D a mathematical or geometrical problem of presenting disparate left and right eye images with little regard to equally import monocular cues used by the artist. There are only two binocular cues; all the others are monocular. The binocular cues will be discussesd first.

In a 3-D pictorial presentation, many of the necessary cues to depth are inherent in the photography. While the photographer has provided the two images for stereopsis, he may be completely unaware that the supporting cues in the scene are largely responsible for the excellent results.

The 3-D information display consists of graphical information, such as geographic outlines, tracks, vectors and symbols. Displaying this kind of information in three dimensions is a vastly different problem from that of displaying pictorial material. None of the supporting cues are inherent. All cues must be generated and many anti-cues are difficult to avoid.

Binocular Cues

Binocular cues are those that result from having two eyes and consist of stereopsis and convergence.

Stereopsis (Stereoscopic Vision)

Ordinarily when one thinks of 3-D with reference to either human vision or an apparatus, stereopsis is implied. The interpupillary separation provides each eye a different image seen from a slightly different point of view. The retinal images will not be alike. Objects at different distances will have different relative displacements on each retina. A fusion occurs in the brain so that the two images of an object fuse to a single mental image and the retinal displacement results in a specific placement in depth. Stereopsis is a powerful depth cue at short range.

The precision of depth perception from stereopsis gradually diminishes with increasing distance. The generally accepted limit of useful depth perception is 2,000 feet (2). At this distance one cannot distinguish by the stereopsis cue alone whether objects are at 2,000 feet or at infinity.

The stereopsis cue is the primary source of depth information at distances up to about 30 feet. Within this range the monocular cues play a lesser role in depth perception. A smooth transition occurs from the binocular to the monocular cues as distance increases. As the depth information content of stereopsis diminishes, greater reliance is placed on the depth information provided by the monocular cues. We are generally unaware of this transition. The everyday event of driving a car provides an example. The stereopsis cue is important in parking, but plays a relatively insignificant role in highway driving.

The binocular stereopsis cue is not caused solely by the object of interest but by all other objects in the field of view. A white ping pong ball at a distance of 15 feet in a black room provides very little 3-D information since the monocular cues are very weak and the stereopsis cue at this distance is greatly diminished in intensity. If familiar objects are introduced at intermediate distances of 3, 5, and 10 feet, where the stereopsis cue is stronger, they reinforce the distance cues provided by the ping pong ball.

Convergence

observed by two lines connecting this point to the observer's eyes. A muscular action occurs to converge both eyes upon the viewed object. This angle is, therefore, referred to as the convergence angle. The sensing of this convergence angle provides a rather inexact distance cue.

Convergence angle change, however, provides a rather strong cue that two objects are not at the same distance. Changing the convergence angle causes disparity of the retinal images and thus employs the same cue mechanism used in stereopsis. The convergence agle cue is perhaps most useful in reinforcing other cues. This reinforcement can be readily demonstrated by viewing a tilted picture postcard through a window cut into a piece of cardboard as shown in Figure 2. The picture postcard should be of an outdoor scene with foreground objects at the bottom and more distant objects at the top. The window should not permit the edges of the picture to be seen.

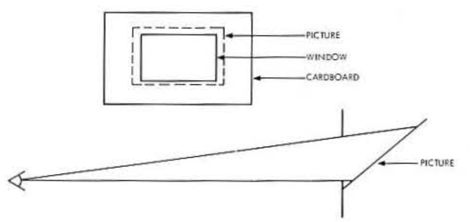


FIGURE 2: A pseudo 3-D image using a picture postcard and cardboard mask.

This simple setup illustrates both cues and anti-cues. The window prevents association of elements in the picture with the edges of the postcard. Such an association would represent an anti-cue. Separation of the picture from the window permits other cues to be accepted. The convergence angle to points at the top of the picture is slightly less than the convergence angle to points at the bottom of the picture because the picture has been tilted back. Even though the convergence angle change is slight, it is sufficient to give a startling sense of depth when reinforced by other cues in the scene. Visible texture in the surface of the photographic paper is an anti-cue and destroys the illusion.

This effect has been reinvented a number of times in various forms. One form is to view the tilted picture in a mirror. Another form is to view the picture postcard in a large concave spherical mirror where the image appears to be suspended in space. In all cases the cues

Monocular Cues

Monocular depth cues are those that can be perceived by one eye. While both eyes may be used to observe the monocular cues, the mechanism of stereopsis is not employed. The monocular cues are listed below:

Focus

An involuntary muscular section occurs on the eye lens to provide an in-focus condition on the retina for the object of interest. Sensing of this action provides a depth cue. The focus cue provides depth information of low accuracy out to about 12 feet. The optical geometry of the relaxed eye and retinal resolution result in sharp focus over a depth field from about 12 feet to infinity. Beyond about 12 feet the depth information of the focus cue becomes simply "not near." At closer distances, the focus and convergence functions are coordinated and act simultaneously.

It is difficult to separate these two coordinated functions at close viewing distances. A stereoscopic 3-D display requires eye focus to be maintained on the display surface while convergence occurs at other distances. The focus cue is, therefore, not available for pseudo or stereoscopic 3-D. To prevent the coordinated focus cue from becoming an anti-cue in stereoscopic 3-D the viewing distance must be several feet, or viewing lenses must be used. The lenses permit the eyes to focus at a distance beyond which convergence and focus are coordinated.

Relative Motion

Relative motion is actually a multiple cue since motion may be relative to a number of reference points. Consider an observer viewing a display of a geographical area containing moving objects. The objects may move with respect to the geography. The observer may move with respect to the display. The geography and its objects are displayed from some theoretical observer position and this position may be moved.

If the objects are in motion, a distance cue is provided by their relative motion rates since distant objects appear to move more slowly than nearer objects. A depth cue is provided by motion of the theoretical observer position employed in creating the display. This motion is normally preprogrammed when on film but could be operator controlled if the display is computer driven. Another motion cue is provided by motion of the observer. A depth cue is provided if the obesrver moves his head a few inches to the side and succeeds in seeing around a foreground object that blocked his view of some background object. When his head motion does not provide a different perspective, it be-

The motion cue has been variously described as motion parallax, relative velocity or movement perspective. Beyond a few feet we rely heavily on this strong cue. The lizard, the bird and many other creatures depend almost exclusively on this cue. The lizard whose head pops up and down is distance ranging. Cinerama, a pseudo 3-D system, utilizes the airplane, the sled, the car, the roller coaster, the runaway train and the speedboat to exploit the relative motion cue. In cinerama, the motion cue is strongly reinforced by other cues in the scene, and the viewing distance is great enough to prevent the occurence of many anti-cues. It is significan to note that when the Cinerama camera is in motion, the motion cues and other cues in the landscape are so powerful that the stereopsis cue is hardly missed. Because of the relatively large viewing distances in a Cinerama theatre, the presence of the stereopsis cue would add little to the 3-D content of the presentation so long as the camera is in motion.

Linear Perspective

The angularity of lines, the convergence of parallel lines and diminution of objects with distance, illustrate linear perspective. Any deviation from the normal angular geometry acts as a strong anti-cue. Proper perspective is inherently present in photography, assuming normal field angles. Perspective is relatively difficult to create in graphical displays generated by a CRT or a scribing projector because line weight, spot size, and character size must be varied as a function of apparent distance in order not to become strong anti-cues.

Relative Size of Familiar Objects

A child and an adult may subtend equal visual angles, but our experience provides the cue that the child is at a lesser distance. The relative size of two identical automobiles is a relative distance cue. Headlights on an automobile are a familiar object. The smaller lights and closer spacing of headlights on a small car can represent a false cue at night when we tend to believe it to be much further away than it actually is.

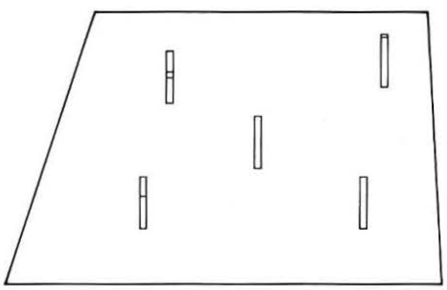


FIGURE 3: Three dimensional objects oriented to provide maximum information.

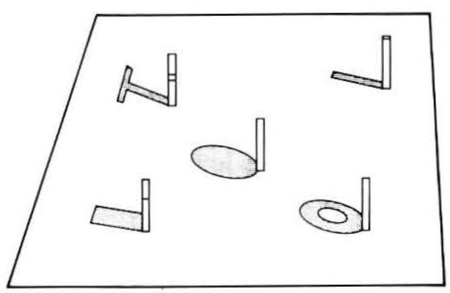


FIGURE 4: Shadows cast by the objects of Figure 3 provide depth information.

After the car passes, there is a subsequent impression that it must have been traveling at high speed to have approached so quickly. This false cue may well contribute to night time accidents involving small cars. Perhaps there is reason to suggest standardization of headlight size and spacing.

Shape Distortion

The apparent shape of familiar objects changes with distance in accordance with the laws of perspective. An object's shape distorts as it is brought nearer. We are not aware of this distortion in normal seeing, but it is quite evident in a reproduction at incorrect viewing distances. A familiar example is the extreme size of a television performer's outstretched hand when he approaches too close to the camera lens. When the observer moves to within a few inches of the face of the TV set, the hand no longer appears to be oversized because now the perspective geometry is correct.

Shadow Patterns

This cue is a special tool of the artist and the cinematographer (4). When skillfully applied, it is rather powerful. An illustration is provided in Figures 3 and 4. The shapes of objects in Figure 3 were deliberately chosen and oriented to provide as little information as possible. A light source from above and to the right in Figure 4 causes shadow patterns to form from the objects. As each object is now viewed, a believable estimate of depth and shape can be made on the basis of the shadow patterns. The addition of shadow patterns provides the equivalent of two simultaneous views from different points of view.

Texture Compression

Texture compression is the gradual change from detail and roughness in the foreground to a velvety smoothness of this same surface as it extends into the distance. Take as an example a concrete landing strip. The visible cracks, joints, tire marks and textural details gradually smooth out and disappear as one looks toward the far end of the runway. Texture compression provides a cue to distance.

Interposition

cue to spatial relationships is provided by the knowledge that closer objects obscure objects further away. While interposition is a strong cue to spatial separation and order, it provides little depth information.

Resolution of Detail

The limiting resolution of the observer's eye has provided each observer a subjectively calibrated distance scale based upon the individual's visual acuity and learned experience. This cue is highly dependent upon the observer's familiarity with the object.

Atmospheric Attenuation Effects

Selective scattering and absorption by the atmosphere provides a crude distance cue. The increasing color shift toward blue-purple as mountain peaks recede into the distance, the loss of color saturation, the loss of brightness and resolution all represent distance cues.

Relative Brightness of Point Sources

A point source of light, or one that appears to be a point source, diminishes in brightness as distance increases. A light source, either large enough or near enough to be visible as an area, does not lose brightness with distance except for atmospheric loss.

Summary

To summarize, the extent to which man's three-dimensional visual system is able to determine and fix spatial relationships in a display is dependent upon the summation of the information contained in the cues and anti-cues. The relative importance of individual cues depends upon the presence or absence of other cues, and on distance. False or anti-cues provide conflicting information resulting in indecision or wrong decisions. A few strong anti-cues can cause complete failure of the brain to establish spatial relationships.

Three-Dimensional Techniques

A number of techniques exist for presenting information in three dimensions. They can be classified as Pseudo 3-D, Stereoscopic 3-D, and Volumetric 3-D. This classification also represents at least three different classes of hardware.

The term Pseudo 3-D, meaning sham or false 3-D, was originated by those who wished to identify their stereoscopic techniques as the real or true 3-D. More recently, both the pseudo and stereoscopic techniques have been designated Illusionary 3-D by those who wish to identify their volumetric techniques as the real 3-D. If 3-D is defined as a display technique which provides depth information, then all three types are real.

Pseudo 3-D

Pseudo 3-D is an illusionary technique that uses only monocular cues. Its effectiveness depends upon the number and quality of the 3-D cues employed and upon the degree to which anti-cues

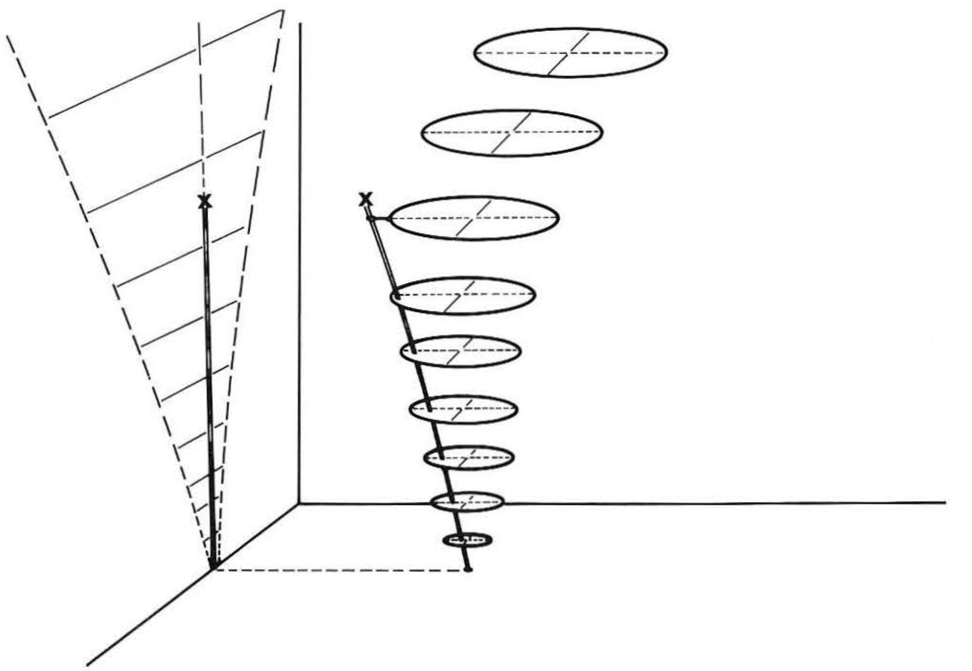


FIGURE 5: Disc or smoke ring pattern displays off-course rocket launch.

are avoided. A perspective display is sometimes considered to be a form of pseudo 3-D. This is perhaps the simplest form of pseudo 3-D since only a single 3-D cue is used. A more effective pseudo 3-D will incorporate a large number of monocular cues in addition to perspective, including diminution of line weight and symbol size, shadow patterns, atmospheric effects, one or more motion cues, texture compression, and brightness loss.

When we look for techniques and applications of pseudo 3-D we find very little in the literature or existing as physical equipment. The earliest examples of using monocular cues as a deliberate technique are in the artist's paintings. Most photographs and motion pictures contain some monocular depth cues. Many cinematographers have shown a special skill in the use of shadow patterns, camera position and camera motion to provide a realistic feeling of depth. The moving camera and peripheral vision techniques of cinerama and Walt Disney's Circlarama employ most of the monocular cues and provide excellent 3-D for pictorial material. The distance from the camera to the nearest objects in these motion picture systems is generally beyond the range of effective stereopsis. Its presence would, therefore, contribute little and its absence does not constitute an anti-cue.

Experimental pseudo 3-D displays have been developed for flight control which display a highway in the sky. An artificial horizon, clouds, perspective grid lines, etc., are displayed. The display is controlled by the aircraft's various flight sensors. Unfortunately, many anti-cues are present.

An experimental pseudo 3-D display at the White Sands Missile Range was reported to incorporate several 3-D cues, including perspective, shadow patterns and color(1). The application was that of providing the range safety officer with real time three-dimensional tracking information to assist in making a destruct decision. Figure 5 illustrates a smoke ring pattern for the same purpose.

An advantage of pseudo 3-D is the rapidity with which an operator may scan the display surface. Binocular depth ranging, by comparison, is a relatively slow process. The lack of the stereopsis cue permits considerable simplification of the hardware and eliminates the precision of image location required of stereoscopic systems. It has been estimated that probably 10% of the population would be eliminated as potential users of stereoscopic displays because of visual problems and because of abnormal visual tasks imposed by the display(2). Pseudo 3-D does not employ stereopsis and is, therefore, tolerant of many visual problems of the user.

When we think of 3-D methods and techniques, there usually comes to mind a special device, material, or equipment. Pseudo 3-D should not be associated with special equipment, but with special ways of displaying data to incorporate the monocular cues. This technique, therefore, emphasizes the conceptual skills of the designer.

To use the monocular cues adequately, it may be necessary to depart from the conventional realism provided by binocular vision, Figure 6. The display of an aircraft's position may be shown as a dot. Its direction and velocity may be indicated by the length and direction of a vector. A non-visible vector assumed capable of casting a shadow allows the shadow length to represent height. The shadow patterns may fall on one or more intersecting planes, i.e., X-Y, X-Z, Y-Z. Calibration grids on the planes permit the shadow patterns to provide quantitative information. There is opportunity for much ingenuity in the use of shadow patterns and other monocular cues.

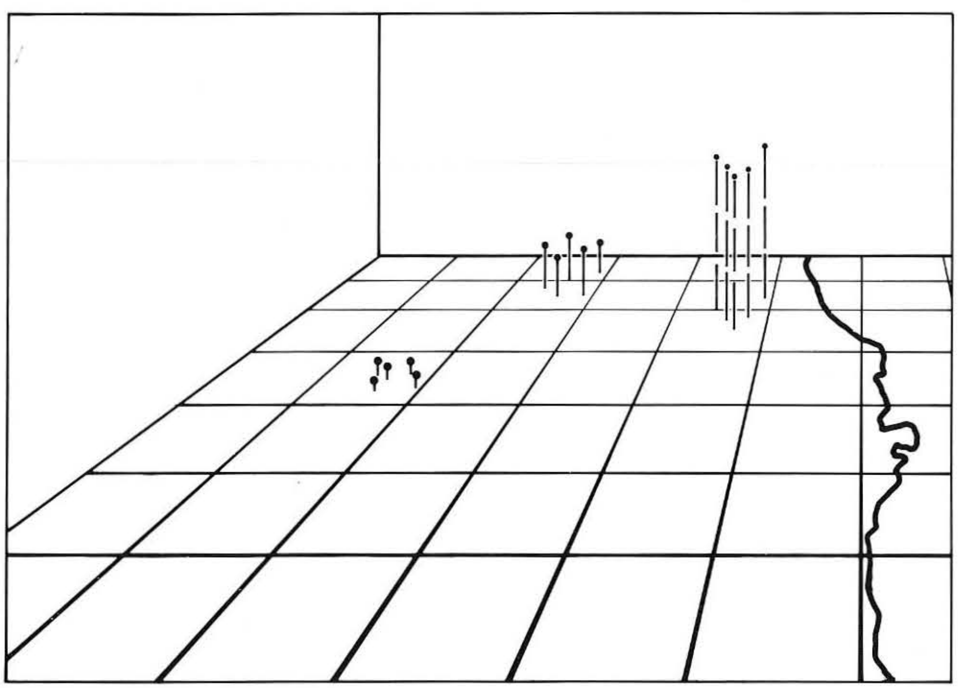


FIGURE 6: A pseudo 3-D display showing aircraft position and relative altitude.

Motion is one of the most useful of the monocular cues. An observer's head motion can be incorporated as a depth cue in a pseudo 3-D display. The technique consists of a positional feedback of the observer's head position to the display control circuits in order to duplicate the parallax shift one would experience in real space. There are several simple methods for incorporating observer position into the display with or without the observer's knowledge or cooperation.

It can be shown that most of the monocular cues can be incorporated into displays. It is also possible to eliminate or minimize the anti-cue effects which result from the absence of the binocular cues.

Pseudo 3-D has received the least attention of all the techniques that have been proposed. Perhaps this is so because it is a technique requiring the combined skills of the human factors scientist, computer programmer, and design engineer.

Stereoscopic 3-D

The illusionary stereoscopic techniques all employ one common principle. Two images are displayed, a left eye image intended for exclusive observation by the left eye, and similarly a right eye image for the right eye. These two images are generated from two points which theoretically represent an observer's pupils. Each image is, therefore, slightly different from the other. The separation of image generation points is the interaxial distance, which may be larger or smaller than the average interpupillary distance. By presenting two views an observer might have seen with his own eyes, it is reasoned that all the human 3-D capability is retained and utilized. It fact, attempts are made to extend man's 3-D capabilities by making the interaxial spacing larger than man's interpupillary spacing.

The various stereoscopic techniques differ primarily in the means used for isolating the two images so that each eye sees only its intended image. Compared to pseudo or volumetric techniques, stereoscopic methods have received the most attention and are best known. Since most of the work has been done with pictorial subject matter, the effort has been largely confined to producing and displaying the image pairs. Monocular cues have been given little consideration because they were mostly present in the subject matter. The few attempts at using stereoscopic images in command and control displays have consisted primarily of providing the disparate images. The introduction of only the stereopsis cue is quite unsatisfactory because of the overpowering effect of the many monocular anti-cues.

Some stereoscopic techniques require the use of viewing goggles, or the equivalent, as part of the system and a serious assumption has been made that a system requiring the wearing of goggles will never be accepted. The goggles are usually considered to be a nuisance and are often cited as the cause of headaches. On the other hand, no one complains about wearing a pair of well fitted high quality sun glasses, nor does one attribute headaches to sun glasses. The discomfort that occurs is not caused by the glasses but by inadequacies in other parts of the system.

The two-image stereoscopic display is a convenient means of generating the stereopsis and convergence cues.

Stereoscopic Techniques

The following discussion reviews the basic principles and the hardware that has been used to produce stereoscopic 3-D.

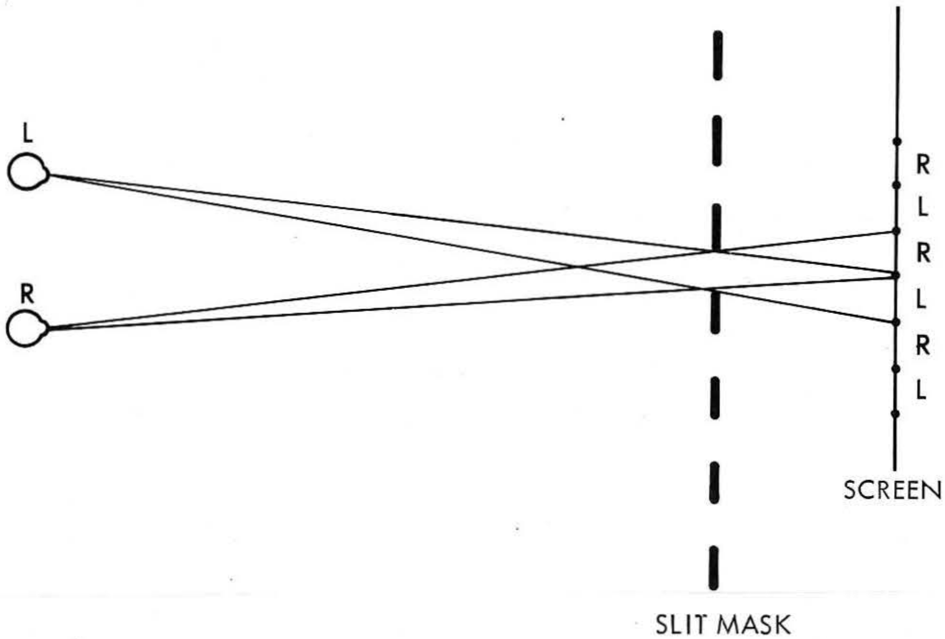


FIGURE 7: Stereoscopic display using slit-mask to provide image separation.

The Stereoscope

One of the earliest 3-D display devices that was developed is the familiar stereoscope, a device used for home entertainment. It consists of a frame on which are mounted two viewing lenses and a picture postcard holder spaced about ten inches from the viewing lenses. The picture postcards contain stereo image pairs made by a camera having two lenses separated about the same as the interpupillary distance. When inserted into the stereoscope and viewed through the viewing lenses, a good stereoscopic effect is achieved. Stereopsis, convergence ranging, perspective, shadow patterns and many other 3-D cues are present. The viewing lenses permit the eyes a relaxed focus toward infinity and prevent the missing focus cue from becoming an anti-cue. Motion cues are absent. Modern stereo viewers are based on the same scheme but are smaller and generally use pairs of color transparencies.

Interference Slit Method

In this method, a series of vertical slits, created by a series of bars arranged like a picket fence, is placed before the picture to be viewed, Figure 7. The picture consists of alternating vertical strips representing the left and right eye pictures. When the dimensions of the slits and their positioning between the observer and picture are properly selected, the left-eye view through the slits is only that of the left image picture elements. Similarly, the right eye sees only the right eye picture elements. The opaque area between slits blocks the view of each eye from the other's image.

While the observer is not required to wear goggles or other viewing devices, his head position must be held relatively fixed. To produce the alternating picture elements with sufficiently good registration has generally required projection through slits onto a front projection screen. The bars are, therefore, painted a dull black to prevent visibility of the intercepted image. In a motion picture application, the bars were kept in motion so as not to interfere with visibility of the scene. This technique has not been very satisfactory. However, most of the 3-D cues, except observer motion can be incorporated.

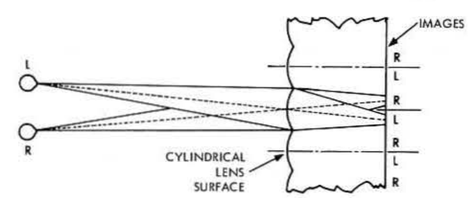
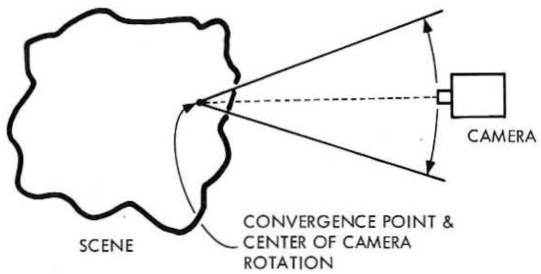
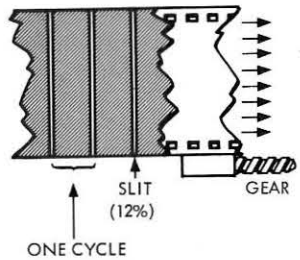


FIGURE 8: Parallax stereogram using simple image pairs and vertical cylindrical lenses for image separation.





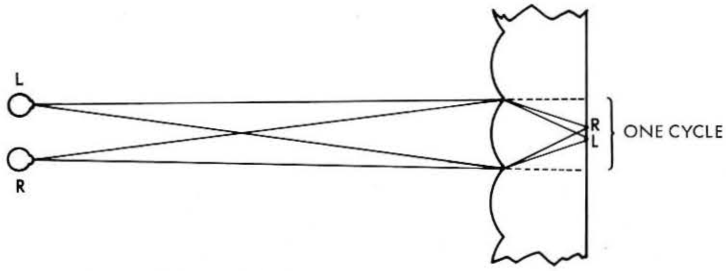


FIGURE 9: Parallax panoramagram. Any two points (L, R) of the continuous image form a stereo pair.

The Two-Image Cylindrical Lens Method (Parallax Stereogram)

This technique uses a series of partial cylindrical lenses molded into a plastic overlay or embossed directly on the film. The cylindrical shapes are given a vertical orientation. The placement of the fil memulsion with respect to the focal length of the cylinders and the camera geometry is adjusted to result in a series of vertical strip images from each of two camera lens position.

The recorded images are viewed through the cylindrical lenses, Figure 8. The magnification of the cylinders provides for each eye the appearance of a continuous image. Goggles are not required. The observer's head must be maintained in a relatively fixed position. There are, however, several positions from which the display may be viewed. The expected motion cue resulting from head motion does not occur and, therefore, becomes an anti-cue. Head motion produces an even stronger anti-cue since image mixing and, finally, image reversal occurs. Except for motion, all 3-D cues can be incorporated.

The Extended Image Vertical Cylinder Method (Parallax Panoramagram)

This method produces rather startling results and is one of the most realistic 3-D displays that have been produced. It incorporates all the 3-D cues including observer motion. When well done, it is difficult to believe one is not looking into real space containing real objects in their natural color. Head motion to either side permits the observer to look behind foreground objects. Goggles or other viewing devices are not required.

This scheme employs vertical cylindrical lens elements placed over the image plane. The image behind an indivi-

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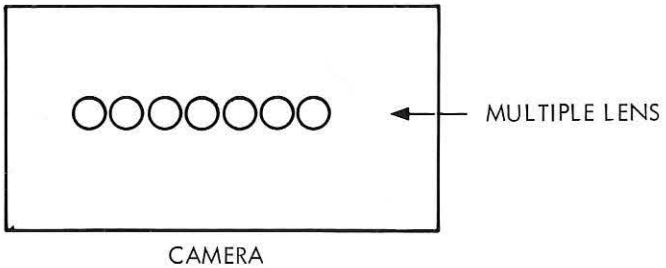

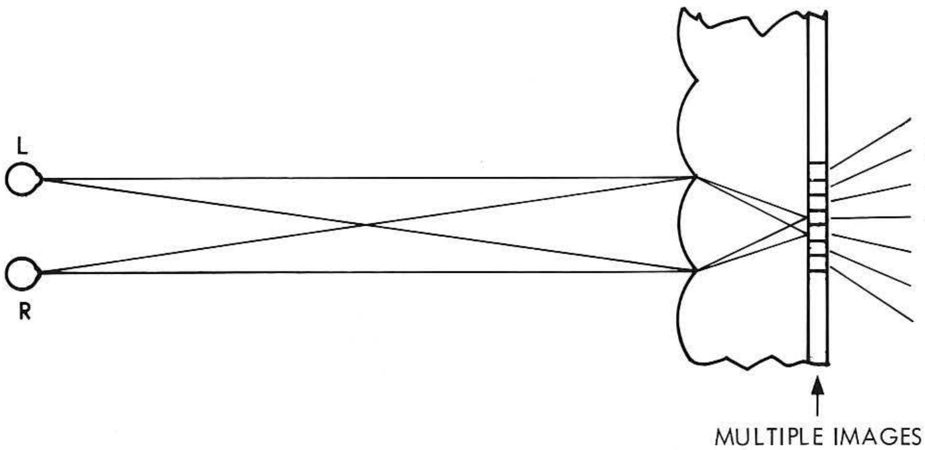

FIGURE 10: Panoramic parallax stereogram. Any image pair within one cycle (cylinder) represents a stereo pair.

dual cylinder lens contains a continuum of information representing a multiplicity of possible viewing positions, Figure 9. When produced photographically, the recorded image is that of a lens in motion from an extreme left to an extreme right viewing position. Thus the two images seen from a given position of the observer's eyes were produced by the moving camera lens having been in those two positions. Two or more observers may view the display simultaneously, each seeing a different perspective. While the observer has wide freedom of head movement, his viewing positions are restricted to the acceptance zone provided in the recording.

It is conceivable that this 3-D technique could be adapted to a CRT; however, registration and resolution problems could be insurmountable.

The Vertical Cylinder Multiple Image Method (Panoramic Parallax Stereogram)

Another method of producing the images behind the cylindrical lens elements uses multiple camera lenses, resulting in a series of adjacent strip images, Figure 10. Any two adjacent images within the image group of one lenticle will have been made by two adjacent lenses in the camera and represent a stereo pair(9).

Head motion to either side results in a smooth transition as in the extended image method.

The Two-Color Method

This method requires the observer to wear goggles containing mutually exclusive band pass color filters. The same band pass filter is used to filter the two projected images.

Typically, the left and right eye images are superimposed on the screen. A red filter is placed over the lens of the right image projector, for example, and a green filter over the left image projector. The goggles, therefore, would contain a red filter for the right eye and a green filter for the left eye. The resulting composite is a 3-D image in black and white.

Ideally the filters should be mutually exclusive, that is, the green filter passes no red light and vice versa. This is a poor scheme since each eye tends to sensitize to the missing colors and viewing becomes uncomfortable for some observers. This technique is readily adaptable to the three gun color CRT used in color television.

The Polarization Method

One of the most satisfactory and easily accomplished image isolation techniques uses polarizing filters for projection and for viewing. Light rays when passed through a polarizing filter and viewed through a second polarizing filter are visible or not visible depending on the orientation of the two filters. When the filters have their polarization axes at right angles to each other, very little light passes the second filter. When the polarization axes are the same, most of the light passing the first filter also passes the second filter.

Typically, polarizing filters are placed over the two projection lenses with their axis at 90° to each other. The observer is furnished polarizing viewers aligned to match the projector filters. Each eye, in this arrangement, sees only its intended image. Images may be in full color if desired. The polarizing filters have a total absorption of about 60%. A special screen is required to provide diffusion without causing depolarization.

This technique can incorporate most of the important 3-D cues.

Factors Affecting Two-Image Stereoscopic Methods

In the two image stereoscopic systems developed to date, there is a general lack of excellence due to the failure to maintain adequate control of registration, synchronization, and the many other factors contributing to system performance. This produces eye strain, pain, headache, fatigue, nausea, and loss of fusion. On the other hand, when these factors are adequately controlled, two-image stereo is as comfortable to view as a two-dimensional display.

Filter Leakage

Systems which employ filters are adversely affected when filter leakage results in poor image isolation. This leakage is visible as ghost images where one or both eyes see faintly the image intended for the other eye. The ghosting effect is a disturbing anti-cue. Visible filter leakage is caused by improper selection, or filters of poor quality. While some leakage is always present, filters are available whose leakage is below the visibility threshold of the eye when adapted to average scene brightness.

Screen Depolarization

The effect of screen depolarization is equivalent to filter leakage and results in ghost images. White and beaded front projection screens depolarize 100% and are entirely unusable. Screens having the least depolarization are the metalized lenticular types. Metalized, nonlenticular screens are generally acceptable, but some of the low grain types produce detectable ghost images.

Few rear projection screens are acceptable. The best types contain no diffusion pigmentation, although a black anti-reflection pigment is acceptable. Those rear projection screens having the least depolarization have relatively high gain and narrow viewing angles.

Vertical Registration

The human visual system does not ordinarily experience any vertical image divergence. Vertical misregistration, where one image is slightly higher than the other, causes discomfort. Divergence equivalent to a degree or two causes physical pain as the eyes attempt to maintain fusion. This same discomfort is experienced when looking through a pair of binoculars having vertical misalignment.

Horizontal Registration

The edges of the stereo picture appear to be a window space. When the vertical edges are in registration on the screen, the window appears to be at the screen plane. By horizontal displacement, the window can be placed behind or in front of the screen plane. While stereopsis will define the window placement in space, the powerful observer head motion cue wants to fix the window at the screen plane. Placement of the window at positions other than the screen plane results in conflicting cues.

Divergence

In normal vision, the eye muscles are capable of and regularly adjust the convergence angle from zero (distant objects) to a rather large angle as when reading a page held close to the face. At no time do normal seeing tasks require the eyes to diverge. Most photographic stereo systems converge the taking optics on a foreground object. Upon projection, background objects may be separated on the screen by as much as a foot or two, depending on screen size and projection distance. Viewing these displaced images requires the eyes to diverge. Divergence up to about two degrees is tolerable. Larger divergence angles cause observer discomfort and finally physical pain. All of the 3-D motion pictures produced during the 1950s contained scenes which exceeded the comfortable divergence limit.

Focus

A stereo 3-D presentation should have all objects in the scene, regardless of distance, in sharp focus. This is not a requirement in 2-D. In normal vision, only the point of eye convergence and fixation is in sharp focus; everything else is out of focus. However, as one's vision ranges to specific points within a volume of space, that point comes into sharp focus. The stereo display provides the facility for depth ranging. When either distant or near objects fail to snap into sharp focus upon eye fixation, the effect is a disturbing anti-cue.

Synchronization

This problem is essentially limited to motion pictures. A time delay of 100 milliseconds is sufficient to disturb fusion and depth fixation of moving objects. Even in alpha-numeric displays, the addition or deletion of tracks or symbology should proceed for both images within a few milliseconds of each other.

Balance

Variations in such parameters as brightness, flicker, focus, noise, color, etc., are less disturbing to the observer of a stereo display when they occur together. An inequality in many of these factors will represent an anti-cue.

Window Entry

The 3-D window is much like a real window. We look through the window at objects in space and our field of view beyond the window is limited by the window's edges. Objects may enter or leave the field of view quite normally so long as they are beyond the window. However, the appearance or disappearance of objects on the observer's side of the window is unexpected and violates normal visual experience. Such illegal entry is confusing and becomes a strong anti-cue.

The violation of normal visual experience also occurs by reason of the reversal of vision cut-off. An object beyond the window leaving the field of view at the window's left edge is visible to the right eye after it is no longer visible to the left eye. The cut-off sequence must agree with normal visual experience. When this cue is reversed, the observer loses confidence in his estimate of object placement in depth.

Scale

The separation (interaxial) distance between the two points of view determines the apparent size of objects. This separation distance also determines the depth ranging accuracy. Aerial photography, for example, may use a lens separation of many feet to provide usable terrain characteristics.

The human observer believes himself to be an unvarying constant. Thus the two points of view from which the 3-D was constructed represent an always constant distance of normal 2½ inch eye separation. A view generated with a five inch separation of the viewing points, for example, causes the observer to believe that everything has shrunk to one-half size. This subjective feeling of size shrinkage or miniaturization is commonly seen in many commercial 3-D displays. Familiar objects, such as people, tend to appear distant as well as smaller than normal. In an investigation by the author, it was found that effective closeups of people require an interaxial distance as small as ½ inch. An interaxial distance less than the normal 2½ inches creates giantism in objects. In stereoscopic photographs of people, however, the mind refuses to accept giantism and substitutes the illusion of nearness. Nearness is a desirable effect in photographic closeups.

The constancy with which the human regards himself can be shown by a stereoscopic reproduction of a model automobile whose length may be 10 inches. With normal (2½ inch) lens spacing, the reproduction, (even when projected on a 60-foot screen) is that of a toy – and it is readily evident that the toy is 10 inches long and not 10 feet long. However, if the camera-lens separation is reduced by the same scale as that used in the toy automobile, the toy will appear to be a full-sixed automobile and it will be difficult to believe otherwise.

The Two Beam Hologram (Lensless Photography)

The light that reaches the lens of a camera continues on to the film where an image is recorded. The lens does not add any information, therefore, it should be possible to make a picture by simply exposing the film directly to the scene to be photographed. The light waves carry the scene information as a modulation in both intensity and phase. All light sensitive materials ignore the phase and record only intensity variations.

The two beam hologram (6) uses a laser light source to illuminte the scene. A portion of the beam is split off to illuminate the film. The light directly from the laser and the light reflected from the scene combine at the film plane. Phase modulation is converted to amplitude modulation due to the coherent nature of the light. The exposed film has no visible image, but appears to consist of random diffraction patterns.

Readout is accomplished by laser coherent light and the diffraction patterns reconstruct the original light wave front that reached the film. In effect, the wave front is frozen at the film plane and is later released to continue on its way.

The borders of the film represent a window. Anything that might be seen through a real window is seen through the hologram. If a real window, the size of the hologram, is masked into many little squares one may look through each one in turn and see the entire scene. If the hologram is cut into many little squares, each one presents the entire scene but the window is now smaller.

If the hologram is wide enough, both eyes may look through it and a full stereoscopic view is presented, including stereopsis, convergence, head motion (both lateral and vertical) and all the monocular cues the scene may have contained.

It is not readily apparent how one might use the hologram in an electronic information display. Holograms of real models could have an application in a vehicle simulator trainer. Conceivably, one could construct a miniature scale model of a given terrain using a sequence of holograms to represent the simulation of a vehicle approching or crossing the terrain model.

Volumetric 3-D

In an attempt to overcome the limitations and problems of pseudo and stereoscopic 3D, development has proceeded on volumetric 3-D displays. The state-of-the-art in volumetric displays has progressed rapidly. At least a half dozen major corporations are engaged in research and development on volumetric 3D display devices. The volumetric 3-D schemes are miniature scale models of a segment of space which is bounded by the walls of the enclosure. A scale is selected so that the given display volume represents the desired geographical volume.

Volumetric displays are represented by a fish bowl or tank shaped volume of fixed dimensions. These are not illusionary displays; consequently they are easy to understand since this type of display physically positions tracks and symbols at desired locations within the enclosed volume. A number of generating and positioning techniques have been developed.

One method uses a tank filled with a clear jell. Fine wires pull an inking pod through the jell leaving a track.

Another method oscillates a screen back and forth through a given distance within a CRT. An electron beam aimed at a selected point on the screen is pulsed at the appropriate time to produce a spot at any location within the volume. A series of spots produce a line in 3-D. One technique rotates a special compound-curved screen through the volume and pulses the electron beam at the appropriate instant. Many of the 3-D cues present in normal vision of real objects are inherently present in volumetric displays.

While a whole class of problems are eliminated in the volumetric display, some new problems occur. The display must be refreshed 30 to 50 times each second to avoid flicker. This is a technological problem of considerable magnitude in the volumetric display.

A single plane TV raster requires a bandwidth of about four megacycles. A rather coarse resolution in the depth axis would require the equivalent of several such raster planes in depth. Therefore, the bandwidth will go up as a function of the number of resolution elements in depth. The time available for illumination is reduced inversely by the number of resolution elements in depth. Maintaining both resoluton and brightness requires wide bandwidth and high beam current. The principle advantage of the volumetric display is in the employment of stereopsis without the air of viewing goggles. Without goggles, the interaxial base is that of the observer's interocular spacing. The intensity of the stereopsis cue as provided by the observer's normal eye spacing rapidly diminishes beyond a few feet. A volumetric display is therefore inherently limited to a few feet in size if effective and relatively accurate depth perception is to be retained.

Applications

Conceivably, 3-D is applicable to any display. It has been used in advertising displays, comic books, motion pictures, still photography, novelties, aerial photography and eye exercise devices. Most 3-D devices have exploited its novelty or gimmick value.

There have been some serious industrial and military applications such as in aerial photography. Industry, science and the military have used 3-D photography and displays as a means of obtaining or providing depth information.

It is not suggested that the applications discussed here would necessarily benefit from a 3-D display. This question requires careful evaluation of each individual case. It has been the intent of this paper to call attention to significant factors that must be considered in an evaluation.

Potential applications can be grouped into three general classes: 1) non-spatial, 2) spatial-static, and 3) spatial-dynamic.

Non-Spatial

The alpha numeric symbols in a data table are non-spatial two-dimensional objects having no visual depth in themselves. In this type of display, 3-D represents a coding dimension in the same manner as color or size. The third dimension can be used to represent classes of data by placing each data class in a different plane. Similarly, the third dimension can represent time, with older data receding into the distance. The third dimension is an effective coding technique in displaying non-spatial data when the technique includes stereopsis. Once the observer has adjusted his eye convergence to a given depth plane, he can rapidly scan all the data in this plane while readily ignoring data in other planes. This facility is provided by the fact that all other planes are out of focus in the brain, although the images may be in sharp focus on the display screen.

Spatial-Static

A spatial-static display represents a given amount of geography where there is no relative motion intended between the observer and the geography. Objects within the displayed geographical volume may be in motion. The dimensional scale is generally so great that object motion is symbolized rather than observed.

In this class of display, the third dimension may be used as a general coding dimension, or it may be used to represent a distance such as altitude. It has been suggested that 3-D be used in radar PPI displays to separate targets from noise and ground clutter.

Spatial-Dynamic

The simulator-trainer best typifies this display class. The operator is physically involved and provides real time feedback. Relative motion between the observer and the displayed geographical space or its objects is inherent. If the mission requires the use of the human's 3-D visual system, then 3-D is warranted in training. However, the binocular cues of stereopsis and convergence are not automatically required, since these cues are related to distance and may play an insignificant role compared to the monocular cues.

The spatial-dynamic 3-D display could conceivably be employed as part of a manual guidance system in submarines, high Mach aircraft, and perhaps certain space reentry vehicles where reaction to the environment is required, but direct vision of the environment is not practical.

Areas for Research

The basic questions concern information transfer at the man-machine interface represented by the display and the human operator. Specifically we are concerned with such factors as:

- Relative rate of information transfer
- Relative complexity and quantity of information
- Error rates

Evaluations are needed to determine these human factors with respect to both static and dynamic information.

A number of research studies have been made to evaluate man's comparative capability with respect to 3-D and 2-D displays. Unfortunately, many of these studies did not give adequate consideration to the cues and anti-cues. It is imperative that the 3-D content in terms of the number and intensity of the cues and anti-cues is known and specified if the study is to yield useful conclusions.

It is a mistake to assume that man's response to stereoscopic photography is transferable to a stereo display of vectors and symbols.

Consider this stereo scene: In the foreground is a close-up of a pretty girl, framed by sun-streaked pines, and set against a blue lake rimmed by the purple-tinted peaks of the High Sierras. The 3-D visual-mental image that results is evidence of nature's handiwork. Man, also part of nature's handiwork, is perfectly matched to this stimulus. The electronic 3-D display is not so assisted and does not ordinarily trigger an equivalent response.

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MISS UNIVERSE, *Aparsa Hongsakula of Thailand, is shown with CalComp equipment which produced the pattern for her swimsuit. Catalina, Inc. has leased the equipment for commercial use at $3,000 per month.*

Another industry has learned that a computer combined with CalComp plotting equipment can speed production and increase operating efficiency.

Catalina, Inc. has demonstrated that a sample size swimsuit pattern can be "size graded" (modified and produced in various sizes) in about 1/6th the time required manually. One man in one day grades a maximum of 2 swimsuit patterns. A computer and CalComp's Curve Follower/Plotter grades a minimum of 12 patterns in a day —automatically and with precise accuracy.

The Curve Follower/Plotter, leased by Catalina, Inc. at $3,000 per month, eventually will be followed by an automatic "marker," now being perfected by CalComp to optimize the placement of pattern parts on material for maximum use of cloth.

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Photochromic Glass — A New Tool For the Display System Designer

by Benjamin Justice and F. B. Leibold Jr.

Author's Note

In January of 1964 Corning Glass Works announced a reversible photochromic glass. Obviously the control of glass for human comfort in eyeglasses, and windows for buildings and vehicles, are natural applications. This glass can also be used in various photographic systems to control and modify light levels. Less obvious, however, are the many applications in visual display systems where information is displayed for real time access or stored for future access.

In the area of display applications, photochromic materials are unique. The silver halide compositions described exhibit high resolution, are light sensitive, durable, predictable, reversible, erasable and above all non-fatiguing. The glass is formable by most conventional glass working or finishing processes.

The flexibility in glass composition and processing techniques permits a wide variety of operating characteristics which can many times be tailored to the specific application requirements.

Best Paper

This paper on Photochromic Glass has been judged the best technical paper presented at the Sixth **SID** Symposium in New York City, according to National **SID** President James Redman.

Competition from numerous excellent papers among the twenty technical presentations at the Symposium delayed a decision so that the announcement could not be made as usually is the case, at the end of the Symposium.

Introduction

Photochromic glass has over the last three years been considered for the control of light for human comfort in eyeglasses and windows for buildings and vehicles. More recently, work has been done to utilize the advantages of photochromic glass in display systems. It is the progress towards this end that we would like to report on today.

Before describing the photochromic glass and its characteristics, we would like to summarize its important properties as related to display devices:

1. *Darkening* – information can be "written" on the glass by using a UV source (3000 - 4000 Å). The maximum obtainable optical density is 2 in a ¼" thickness.
2. *Writing Speeds* – depending on the required optical density and activation source, information can be written using available activation sources in a few milliseconds and under special conditions, with a high energy source, in less than 100 microseconds.
3. *Storage* – in some glasses the recovery rate can be made very slow. Only a slight degradation of contrast is observed after storage for as long as three months.
4. *Contrast* – a ratio of unactivated transmittance to activated transmittance of at least 10 to 1 is obtainable and the apparent contrast can be enhanced by making the background opal.
5. *Resolution* – a resolution of 2000 lines per millimeter has been measured.
6. *Erasing* – in some glasses the information can be erased completely in the order of 5-10 seconds by heating, utilizing an applied transparent electrical conducting layer. Localized erasing can probably be accomplished in much shorter times than these by using a high intensity long wavelength exciter.
7. *Cycling Time* – Initial tests indicate that a data repetition rate (consisting of a 0.2 change in optical density) of 15-30 seconds is feasible.
8. *Non-fatiguing* – to date, the photochromic reaction is completely reversible with no degradation of photochromic properties resulting after 75,000 darkening and bleaching cycles.
9. *Peripheral Characteristics* – the glass is durable and can be streng-

FIGURE 1:

Compositions of Some Typical Photochromic Silver Halide Glasses

Constituent	Glass 1	Glass 2	Glass 3	Glass 4	Glass 5	Glass 6	Glass 7
SiO_2	60.1%	62.8%	59.2%	59.2%	60.1%	52.4%	51.0%
Na_2O	10.0	10.0	10.9	14.9	10.0	1.8	1.7
Al_2O_3	9.5	10.0	9.4	9.4	9.5	6.9	6.8
B_2O_3	20.0	15.9	20.0	16.0	20.0	20.0	19.5
Li_2O	—	—	—	—	—	2.6	2.5
PbO	—	—	—	—	—	4.8	4.7
BaO	—	—	—	—	—	8.2	8.0
ZrO_2	—	—	—	—	—	2.1	4.6
Ag	0.40	0.38	0.50	0.50	0.40	0.31	0.30
Br	0.17	—	—	0.60	0.17	0.23	0.11
Cl	0.10	1.7	0.39	—	0.10	0.66	0.69
F	0.84	2.5	1.45	1.45	0.84	—	—
CuO	—	0.016	0.016	0.015	0.016	0.016	0.016

NOTE: Compositions in weight percent; halogens are given as weight percent additions to that of the base glass.

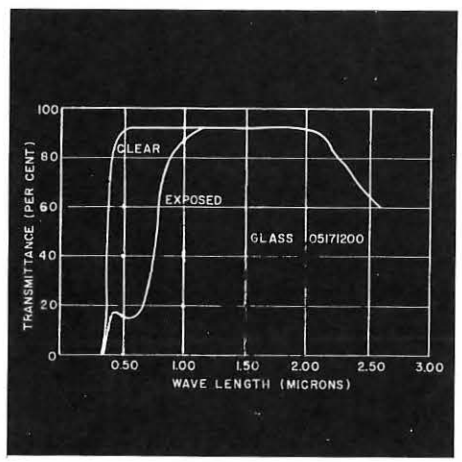

FIGURE 2—Spectral transmittance of a typical glass

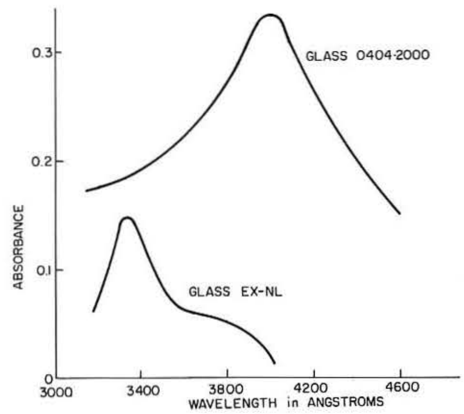

FIGURE 3—Spectral sensitivity for activation

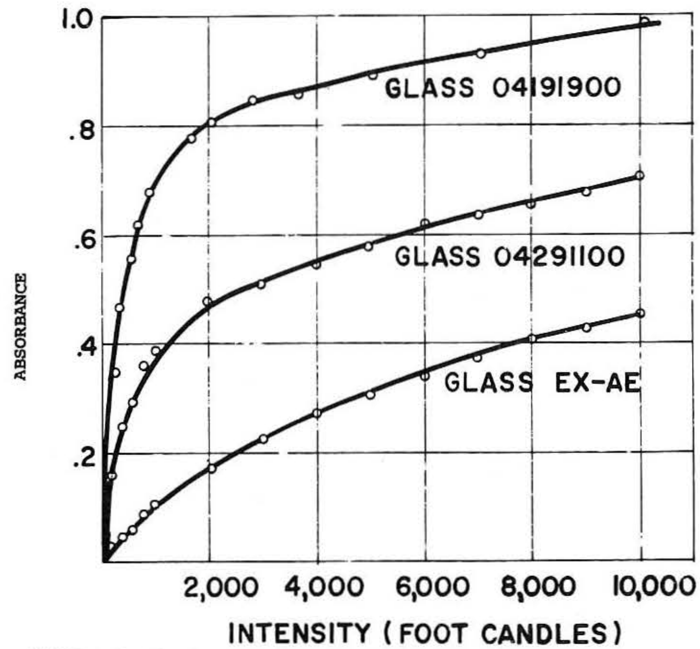

FIGURE 4—Absorbance vs. light intensity at constant temperature

thened by conventional glass strengthening processes. It can be formed by all the conventional manufacturing processes. Composition flexibility provides a range of physical and optical properties.

Photochromic Glasses

The photochromic glasses that we will discuss have been described by Armistead and Stookey[1] and are inorganic materials. These materials are silicate glasses that contain dispersed submicroscopic crystals of silver halide. The colloidal silver halide crystals are formed by precipitation from the homogeneous glassy matrix during initial controlled cooling, or a subsequent heat treatment. Both the composition and the thermal history of the glass determine the photochromic behavior.

Composition and Structure Of Silver Halide Glasses

Some typical compositions for these silver halide photochromic glasses are given in Figure 1 (Table). Most of the glasses so far investigated are transparent in the unexposed state, darkening to a gray or reddish-gray when illuminated (Figure 2). At high concentrations of the suspended colloid, or following heat treatments which produce a large average particle size, the glasses are translucent or opaque. The upper limit for the transparent glasses is usually about 0.7 percent by weight of silver. Other metals, in the form of polyvalent oxides, including arsenic and antimony, tin and lead, and copper, can be added to increase the sensitivity and the photochromic absorbance.

Darkening

The wavelengths that induce darkening for the compositions we are discussing today occur over a fairly narrow area of the spectrum — from the near ultraviolet through the visible spectrum to about 5000 angstroms, depending on the chemical composition. Glasses containing silver chloride are sensitive to wavelengths of, roughly, from 3000 to 4000 angstroms (Figure 3).

Glasses have been made with silver chloride plus silver bromide which are sensitive to wavelengths of from 3000 to 5000 Å.

The maximum obtainable optical density is about 2 in a ¼" thick sample. If the thickness is reduced to ⅛" the maximum density becomes about 1.2.

Figure 4 shows results of three glasses which have a wide range of darkening. The light source for these measurements was a 100 watt low pressure mercury vapor arc; light intensities were measured with a photovoltaic meter. Glass thickness was about 6mm for these samples.

Writing Speeds

Figure 5 shows the transmittance and time relationships for three different activation energy levels.[2] The activation wavelength was 4000 Å.

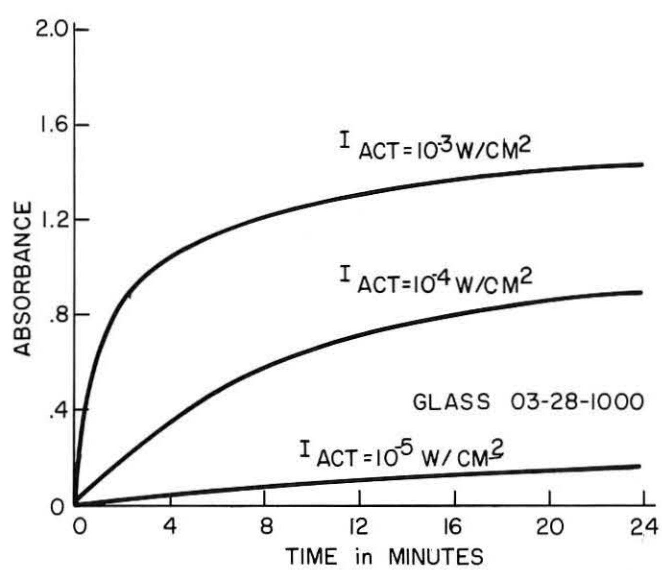

FIGURE 5—Absorbance vs. time for specific low energy levels

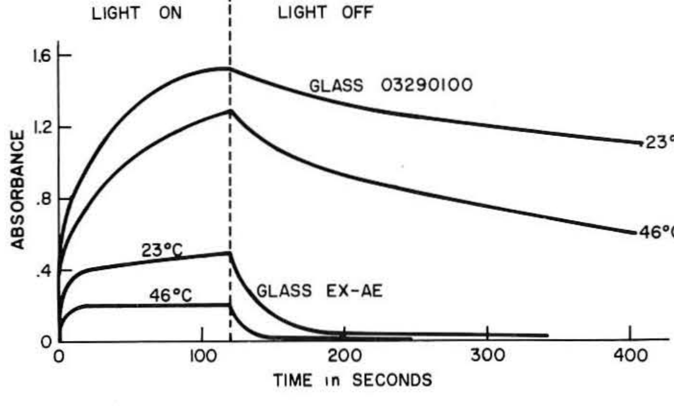

FIGURE 6—Absorbance vs. time at specific temperature levels

The sensitivity is such that the darkening generally approaches its maximum intensity in times of the order of one minute in sunlight. The darkening rate is of course dependent on intensity. A 3-millisecond flash of high-intensity light (1000 joules discharged through an xenon flash lamp) resulted in a decrease in transmittance to 25% of its original value in one measured sample.

The optical characteristics of the glasses can be altered by changing the temperature of the glass. Glasses that are darkened at room temperature and then reduced to cryogenic temperatures will not significantly fade.[4] Conversely glasses that are heated above room temperature will not darken as much as they would at room temperature. The temperature dependence of these glasses is illustrated by Figure 6.

Storage

Once the information has been written in the glass its storage time can vary from seconds to months depending on the glass composition and storage temperature. Figure 7 shows the results of measurements on two samples of photochromic glass which have been activated to different darkening levels and measured over a time of 300 seconds.[2] As can be seen the lower the initial activation level the slower the fading. Figure 8 shows the natural fading chracteristics of a slow fading glass. Figure 9 shows the decay of a glass that has the fastest measured recovery rate and has therefore the shortest information storage time at room temperature.

Contrast

A ration of darkened transmittance to unactivated transmittance of greater than 10 to 1 is obtainable in some glasses. The apparent contrast can be enhanced by making the base glass opal in its natural state.

Resolution

The size of the silver halide crystals, about 100 Å in diameter, is small compared to that in other photographic materials. High speed photographic mater-

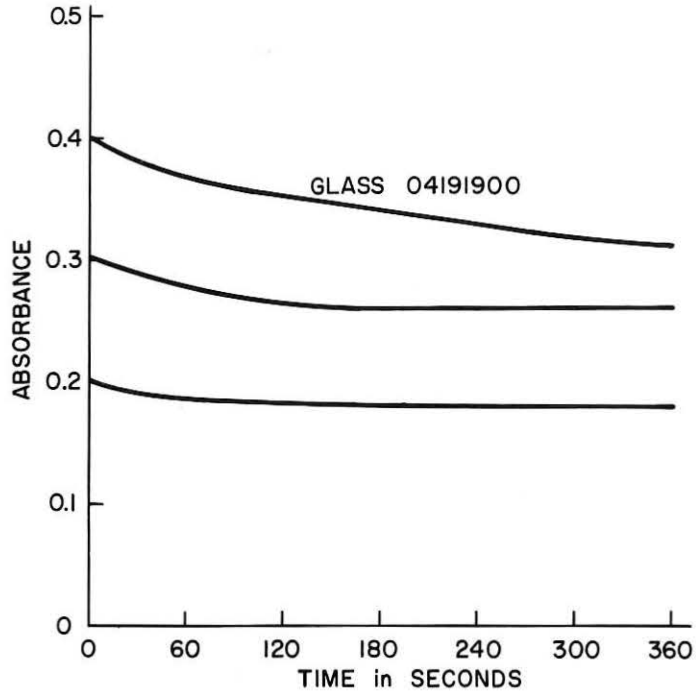

FIGURE 7—Natural thermal fading at room temperature

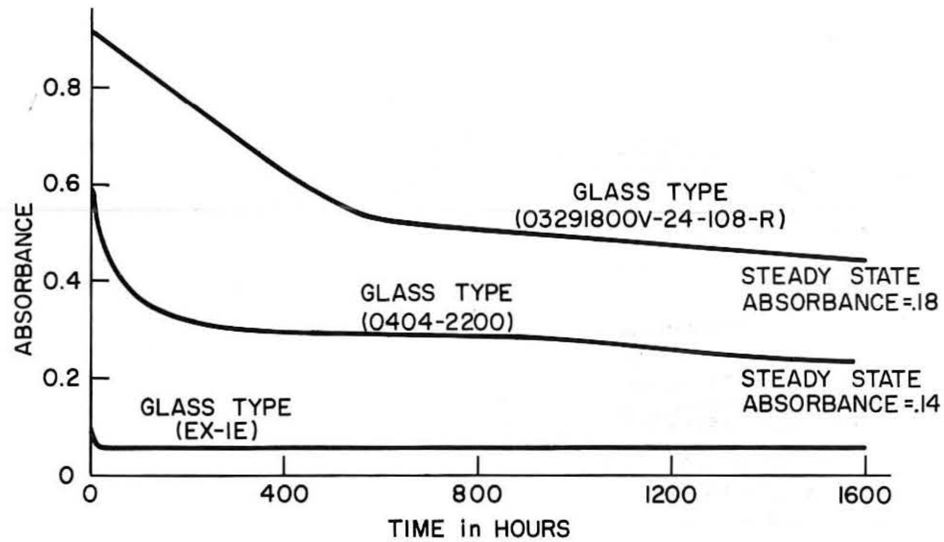

FIGURE 8—Slow natural fading glasses

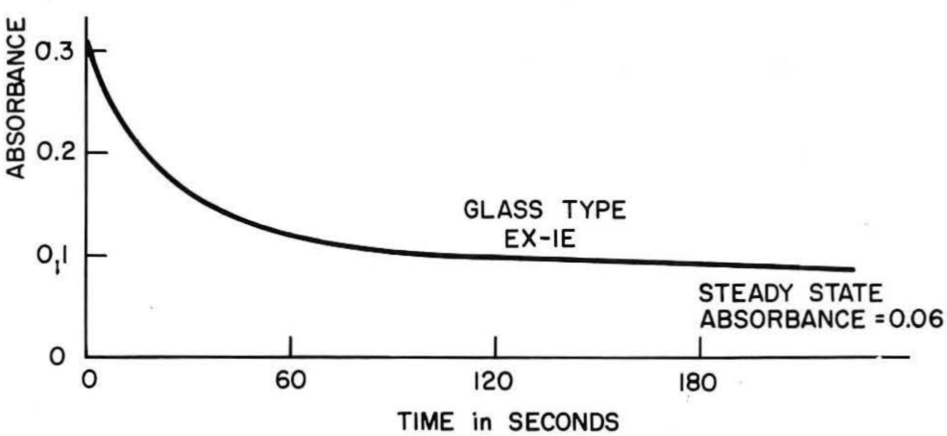

FIGURE 9—Fast natural fading glass

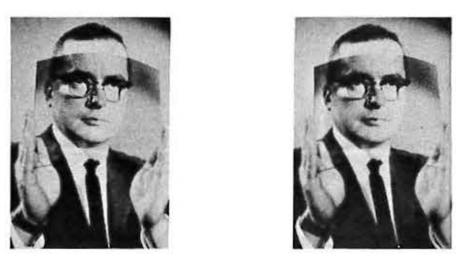

FIGURE 10 & 11—Example of use of photochromic glass as a temporary positive in photography

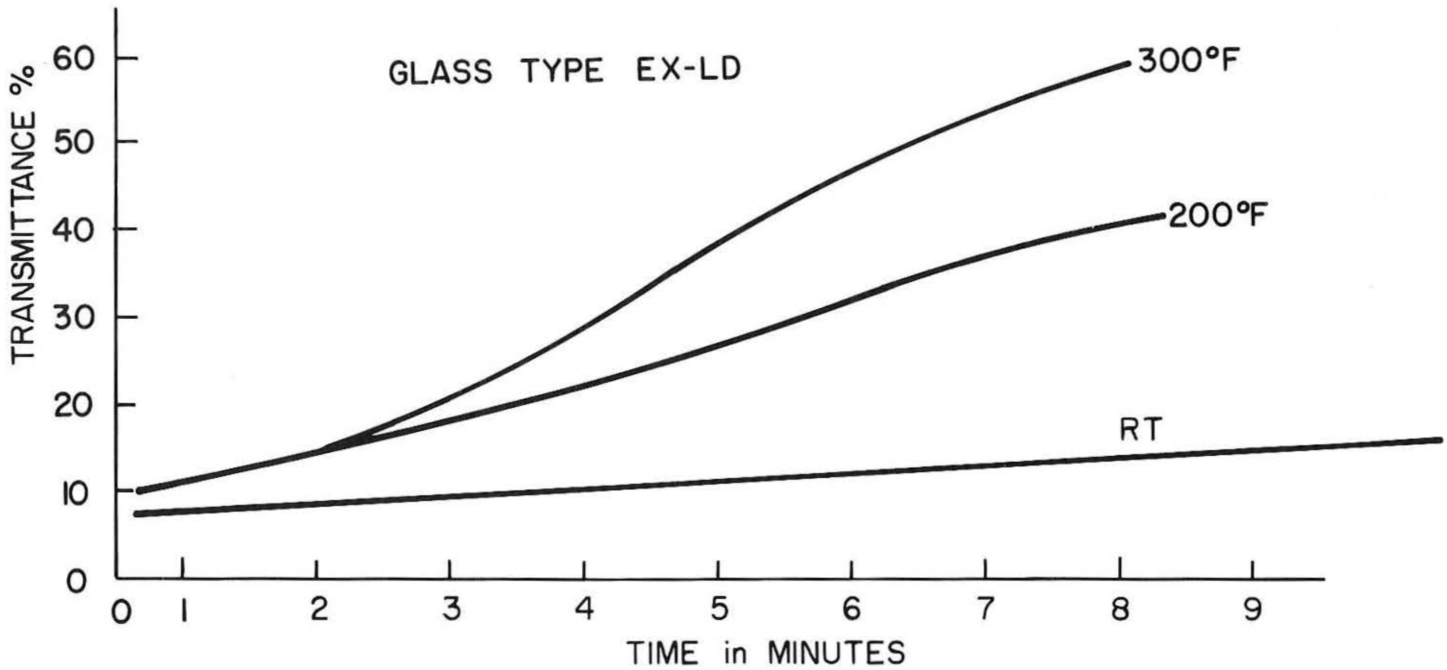

FIGURE 12—Accelerated fading using heated air

ials of low resolution contain crystal sizes of 20,000 Å and low speed materials of high resolution have sizes of approximately 1000 Å. To determine the high frequency resolution properties of photochromic glass at high spatial frequencies the technique of holography was employed. Two laser beams were directed onto a sample and the resulting interference lines were counted. Since the space frequency is given by the reciprocal of λ, with the maximum incident angle fixed at 90°, the maximum obtainable value using visible light is 1/.5 microns or 2000 lines per millimeter. With this method as many as 2000 lines per millimeter were resolved.[2]

Another illustration of resolution is seen in Figures 10 and 11. Figure 10 is a photographic positive, made in the conventional manner from a film-based negative. A piece of photochromic glass 0.15 centimeter thick was exposed to UV light through this negative; the positive made in this way was then photographed, and Figure 11 is the positive print made from the resulting negative. It can also be seen that a gradient in photochromic density under uniform illumination can be produced.[3]

Erasing

In general, glasses that become the darkest are the slowest to clear. One glass that darkened to 7% transmittance returned to 70% transmittance, or approximately to its original transparency, in about ten hours at room temperature. This rather slow recovery rate would appear to make the glass unsuitable for display applications involving normal information rates. However, the rate of clearing can be accelerated by external heating and exposure to wavelengths longer than those used for darkening.

Figure 12 shows the recovery times of a glass sample when exposed to temperatures of 200°F and 300°F. A control sample is shown that was allowed to recover at room temperature. The sample was placed in a beaker where the air

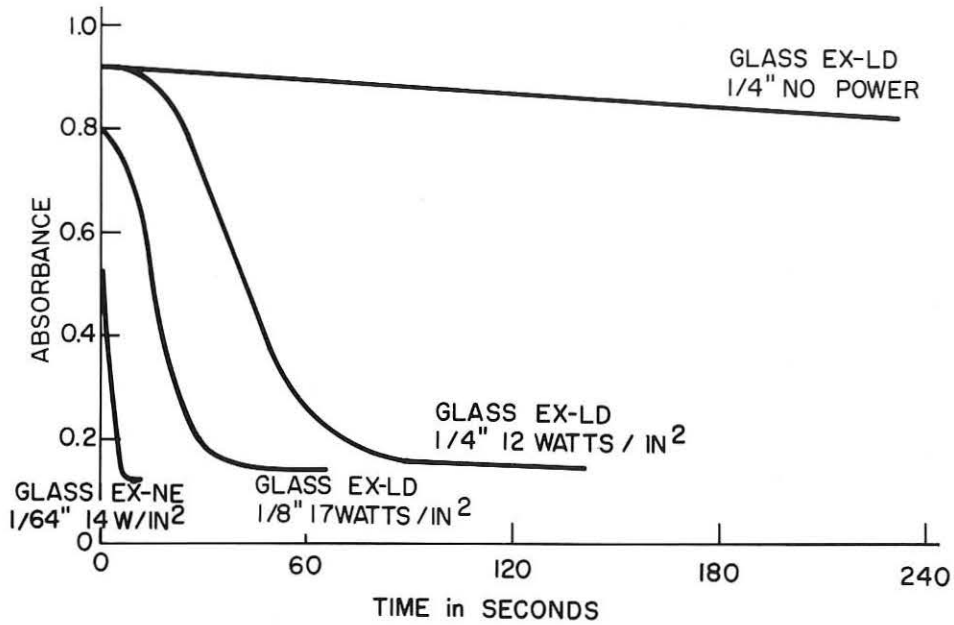

FIGURE 13—Accelerated fading using a conductive coating

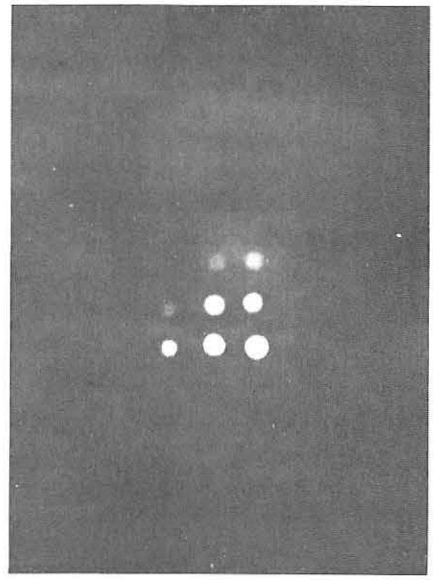

FIGURE 14—Photograph of glass bleached by 632Å laser

was heated by means of a heating filament wound around the beaker. A thermocouple was placed inside the beaker and was used to measure the temperature. The data indicates that heating the sample will substantially increase its fading rate.

A second method of heating involves coating the sample with a transparent, electrically conducting tin oxide coating. The sample was ⅛" thick and 2" square, coated on both sides, and was measured at room temperature without power and at room temperature with 120 volts applied across the square. The electrical power to the sample was about 48 watts. With power applied the glass surface temperature was measured to be 200°C. As can be seen the sample recovered to approximately its original transmittance in about 30 seconds (Figure 13).

Thinner samples of experimental photochromic glass reduced to a 1/64" thickness have recovered completely in less than ten seconds by applying heat through an electrically conducting coating (Figure 13).

The third method for fading the glass is by exposure to long wavelength light.[2] For some materials the peak bleaching radiation was measured around 6000 and 6500 Å, although the bleaching wavelength band is quite broad. The light emitted by the helium-neon continuous laser is especially effective because of its high energy density.

Figure 14 shows the results of an experiment where the sample was darkened with a UV source and then erased or bleached with a two milliwatt CW laser at 6328 Å.

The erasing times increased from five seconds, for the least bleached spot, to five minutes for that showing the greatest change in absorbance.

Figure 15 shows some typical bleaching curves for different activation levels. The bleaching frequency corresponds to 6000 Å, with 10^{-3} watts/cm^2 applied to the sample.[2]

Cycling

In display systems the data display rate can vary. In order to determine a typical data cycling rate an experiment was conducted. A thin sample 1/64" thick was coated with a conductive coating on one side. The sample was darkened with a 9 watt 3660 Mineralight and then erased by applying 14 watts/in^2 to the coating. The Mineralight remained on the sample throughout the cycling. A laboratory blower was used to cool the sample during writing. Figure 16 shows the resulting cycle time. Much faster darkening speeds can be obtained by using a higher energy activation source.

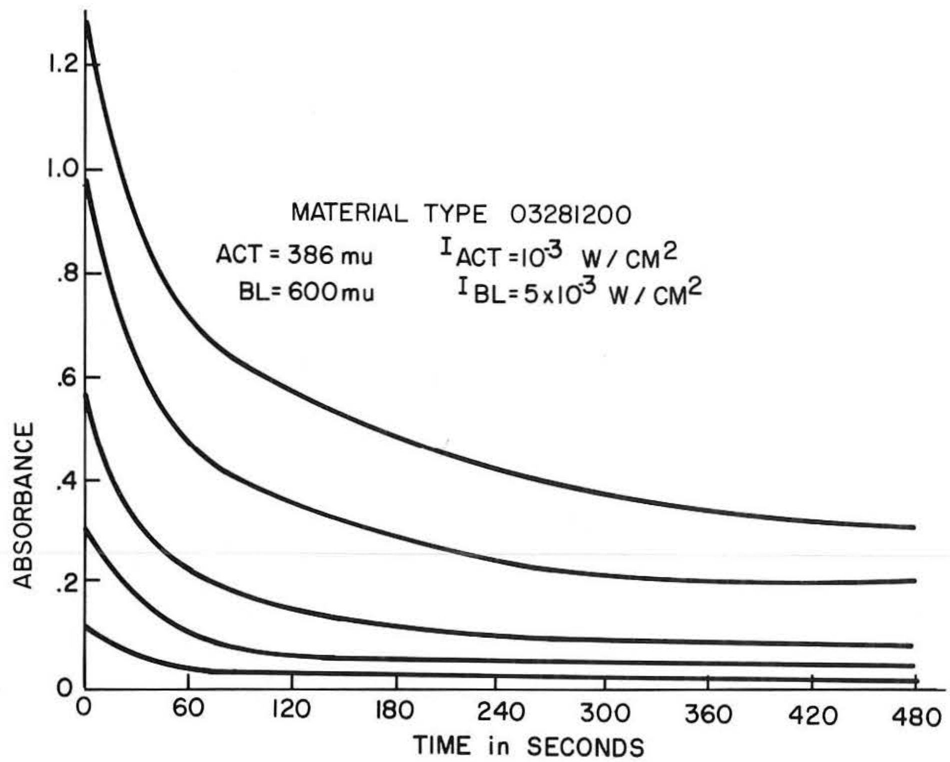

FIGURE 15—Bleaching curves for various activation levels

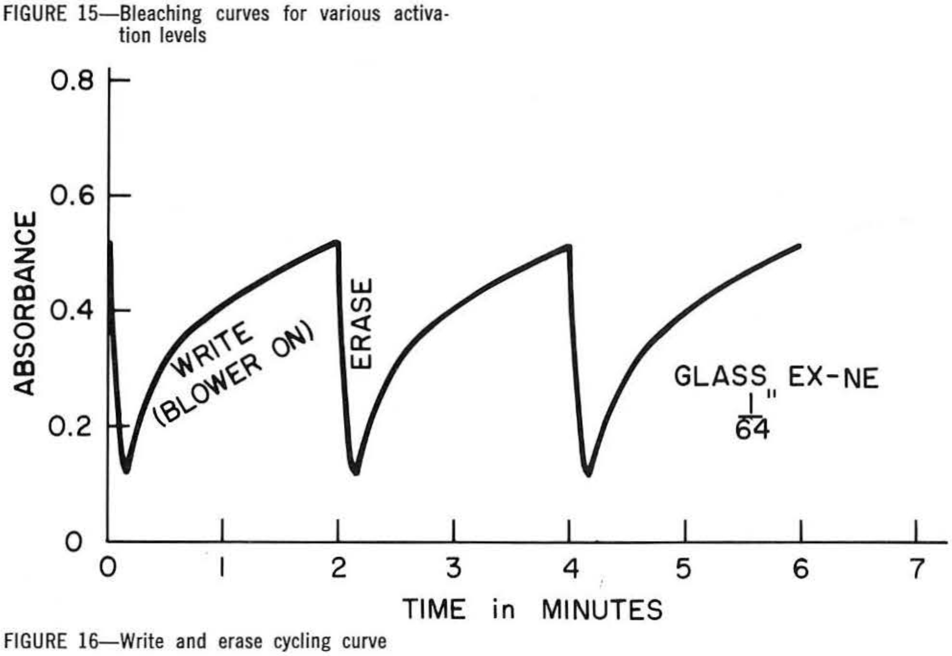

FIGURE 16—Write and erase cycling curve

Reversibility

Photochromic glass appears to be unique among other similar materials because of its non-fatiguing characteristics. No significant changes in photochromic behavior have resulted from cycling samples with an artificial 3600 Å black light source up to 30,000 cycles. There were also no apparent solarization effects causing changes in darkening or fading rates after accelerated UV exposure equivalent to 20,000 hours of noonday sunshine. These tests are continuing in order to generate more conclusive data.

A sample has also been cycled using a constant output source with switching filters to produce writing and erasing wavelengths of 4000 Å and 6000 Å which resulted in 0.3 change in optical density. To date, there is no apparent fatiguing after 75,000 cycles. The bleaching and darkening times were of the order of one minute.[2]

Conclusion

The materials we have just described to you have many interesting properties that might lend themselves to display applications. Information can be "written" on the glass, stored, read and projected. Erasing of the information can be localized or total. The data presented do not represent the performance limits of the glass. Because of wide flexibility in composition and heat treating, the glass properties can be altered for specific applications.

Acknowledgement

We would like to gratefully acknowledge the assistance of Dr. G. K. Megla of Corning Glass Works, in analyzing the optical properties of these glasses and for use of some of his data in advance of publication.

We are indebted to all other contributors who made this paper possible.

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3. Dr. G. P. Smith "Photochromic Silver Halide Glasses" paper given at VII International Congres of Glass at Brussels, Belgium in summer of 1965.
4. R. F. Tucker, CGW.

This paper was presented at the Sixth National Symposium on Information Display held in New York City, October 1965.

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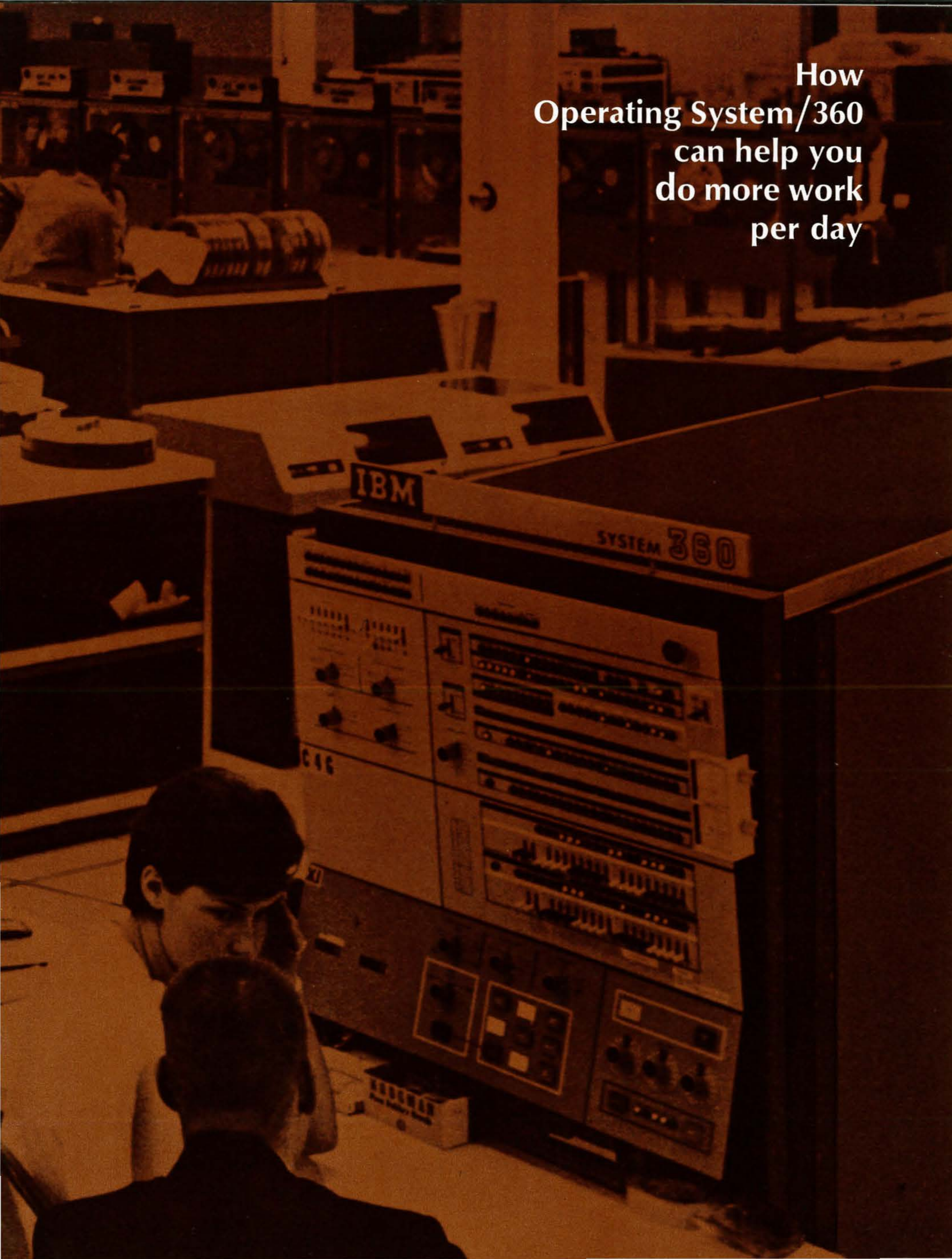

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Information Systems in Information Display

by Daniel Teichroew

Editor's Note

This article provides a comprehensive review of the use of data display and associated devices in business information systems, a rapidly expanding area of considerable growth potential.

Author Teichroew earlier published the article in Bulletin No. 10 of the Center for Technology and Information, The American University, Washington, D.C.

Introduction

Interest in automatic display devices has increased greatly in the last few years. Papers and books[1,2] are being published, conferences[3] are being held. A *Society for Information Display* has been formed.[4] The status and the future of the display equipment industry today are being compared with that of the computer industry 15 years ago. So far the maior market for display equipment has been in the military services and the aerospace industry. However, a number of potential nondefense uses are being actively investigated and some appear promising.

The design engineer in the future, for example, may sketch a design on a special surface with a special pencil and mark a certain (minimum) number of specifications. The design and the specifications would be transmitted automatically to a computer which would compute desired characteristics such as efficiency, weight, strength, power, etc. These values would then be displayed next to the sketch and the engineer could make any changes he wishes. These would again be transmitted to the computer, new values of the characteristics could be displayed, and so on until the engineer was satisfied with his design.

The computer would automatically prepare the necessary data for the production of a prototopye and automatically send it to the manufacturing department. The design engineer would be saved many hours which he would otherwise have to spend either in computing the characteristics of his preliminary designs or in waiting for such computation to be done. Many hours of manual drafting would also be eliminated.

Typesetting Without Human Intervention

The same equipment could also be applied to the editing of manuscripts. A section of a manuscript would be displayed on the special surface; the editor would indicate changes with his special pencil. These would be transmitted to the computer, which would insert or delete material as required. After the editor is satisfied, the manuscript would be automatically be placed in a form that would feed the typesetting machine without human intervention.

These applications are receiving particular attention[5,6] but are only two of many possible applications in which display devices, used in conjunction with computers, could improve the productivity of human beings. One of the areas thought to be a major potential market is the operation and management of organizations, particularly business firms. A substantial part (probably over half) of the computing capability in the country is engaged in this task.

Hence part of the requirement for display devices for business use already exists, since effective means for displaying the important information buried in voluminous reports are not now available and since the data to be displayed is already available to the computers.

There are other reasons why the use of display devices in management systems will receive increasing consideration by business firms themselves. The "computer revolution" has produced a momentum which is causing a basic question – "Is there a better way to do this by using computers?" – to be asked in areas where otherwise there might be no inclination to change. The contractors who have designed display systems and manufactured the equipment for the Defense Department are aggressively seeking new markets. And lastly, the competitive position of the United States in world markets is being eroded.

Other nations are adopting the U.S. mass production system, and in many cases their raw material, labor, and tax costs are lower. Therefore we must reduce our costs somewhere. A general feeling exists that costs of management and administration are too high and hence administrative practices are attractive candidates for cost-cutting investigation.

On the other hand, proposals to use display devices in management systems are likely to meet considerable resistance. It will be harder to introduce proposed changes into the management decision-making procedure than it was to introduce computers into businesses for routine data processing. Management is not likely to agree to changes unless convinced that benefits will eventually appear on the balance sheet. Such benefits of display devices will be difficult to demonstrate. Certainly it will be more difficult than showing clerical savings resulting from computerized routine data processing.

An even more important consideration is the fact that the changes resulting from the use of display devices may well affect the way in which management does its work. It is one thing to approve changes which eliminate, or drastically alter, the jobs of clerks, or to order a completely mechanized management control system for a new military function; it is something elso to alter one's own job voluntarily. Managers will probably be reluctant even to try new methods which may make much of their previous experience obsolete.

Permanent and Temporary Display

Managers and other administrative personnel have available large quantities of data to help them in the performance of their duties in the operation, planning, and control of the organization. The data are most often "displayed" in the form of printed documents or reports. Display terminology distinguishes between permanent display, in which the data are not readily changed, and temporary display, in which the data are changed easily and rapidly.

Under this classification, printed material is an example of a permanent dis-

[1] Howard, J. H. (ed.), *Electronic Information Display Systems*, Spartan Books, Inc., Baltimore, 1963.

[2] *National Symposium on Information Display, Technical Session Proceedings*, March 14, 1963, *Society for Information Display*.

[3] For example: Second Institute on Electronic Information Display Systems, held in Washington, D.C., September 16-20, 1963, under the auspices of the Center for Technology and Administration, The American University.

[4] *Society for Information Display*, 11168 Santa Monica Boulevard, Los Angeles 25, California.

[5] Papers on computer-aided design by S. A. Coons, D. T. Ross, J. E. Rodriguez, R. Stotz, I. E. Sutherland, and T. E Johnson: *AFIPS Conference Proceedings*, Vol 23, Spartan Books, Inc., Baltimore, 1963.

[6] *Time*, "All the News That's Fit to Automate," July 5, 1962, p. 52.

play, while a video screen is an example of temporary display. Temporary displays are used when data change rapidly and when a permanent record is not needed, as, for example, in the status of flights (arrival and departure times, etc.) at an airport terminal, or in the prices of stocks in a stock exchange.

The data in displays, either temporary or permanent, may be changed manually or mechanically or by a combination of both. At an airport, the status of flights may be displayed on a blackboard and may be changed by an attendant using an eraser and chalk. In a more mechanical system an attendant operates a key set which revises the data on a master panel. A television camera then transmits a picture of the master panel to remote video screens.

The increased interest in display does not appear to be caused primarily by the invention of new equipment. Display equipment is based largely on optical and video projection techniques, which have been available in one form or anothter for some time. The only relatively new feature is the ability to transmit data from the display to the computer as well as vice versa; e.g., a "light pencil" can be used to write data on a video screen and simultaneously provide information to a computer. Improvements have been made in both optical and video projection techniques in the use of color, finer discrimination, etc.

Knowledge from a number of disciplines has been synthesized to determine the best values of display parameters: distance to the screen, size of the display, number of symbols used, etc.[7] An important reason for interest in display devices is the availability of the electronic computer, with the capability for storing vast quantities of data and presenting highly "digested" or analyzed data rapidly. (The computer, in other words, can provide the information for a temporary display in which the viewer can, at least theoretically, see any desired data instantly.)

Essentially two different forms of business use of display devices have been proposed. In the first case, a device with the capability of accepting data from the user or operator and displaying answering data from the computer is situated near one or more individuals. The simplest form of a device for this purpose is the "inquiry station," which in the past has usually consisted of a typewriter connected directly to the computer. This is being used in a number of applications, such as airline reservations, stock quotations, and inventory control systems. The way these devices may be used to aid management was recently stated as follows:[8]

> Input devices pick up information at the source of operations and feed it to central computers that process it and serve it up to decision makers. For example, the status and location of any part for any job is continually pinpointed. A plant manager can follow the flow of work from warehouse inventory right up to the shipping gate.
>
> A plant manager, faced with a sudden critical labor shortage in one department, will only have to push a couple of buttons on an inquiry station. Within seconds, the machine will disgorge a complete rundown on all the workers in the plant, so that he can redeploy his workers most effectively.

Comparable to Military Operations

The second use being proposed envisions a complement of display equipment assembled in a single room. From this location managers could control the firm in much the same way as military operations are controlled from a command and control center.[8,9]

> Minutes after top managers sit down in the control room, charts displayed on video screens will update them on all the company's operations. Computers, programmed with company policies, will take up-to-the-minute information, organize it into chart form, run it through a slide-making machine, and flash it to the waiting managers.
>
> Furthermore, if a project is in trouble, the computer can offer and pretest solutions before manpower and materials are committed.

Both the "inquiry" function and the "control room" operation exist in business firms today. An officer of a bank can determine the status of a customer's account by examining a ledger card or a report showing the status of all accounts. Today's form of the control room is the committee meeting – held at all levels from foremen to board of directors – and data are displayed in various forms: printed reports, staff reports, slides, etc.[10] What is being proposed, therefore, is a mechanization of some activities which already occur in the operation and management of enterprises.

The major change would be that display devices would be directly connected to a computer system. The data displayed could therefore be based on the latest data available. A computer can retain in its memory the instructions necessary for preparing a large number of different reports. It could, upon request, display certain data immediately without having to produce all of that particular report every period. In "conventional" reports almost everything that might be printed in a report is frequently included, in the hope that the user will be able to find what he needs. With display devices only those reports or pieces of data relevant to a particular problem at a particular time need actually be prepared and presented.

With display devices the amounts of data that *can* be presented is limited, hence a user must decide in advance exactly what he wants. Furthermore, the user will not be able to study the data leisurely, and therefore the data must be presented in a form that permits him to comprehend its meaning quickly. Graphical and pictorial methods will be used more frequently in display systems than they are now.

The earliest impact of the proposed uses of display devices will be on the formal reports that are now printed in large quantities to aid management. To determine the feasibility of the proposed systems, an analysis of the function of reports is necessary. In the final evaluation, it is important to remember that any manager or administrator making a decision uses data or information from a number of sources in addition to the data he obtains from formal reports.

Interrelationship into Account

Probably the most important source is his own personal experience and training; he recognizes that the present situation resembles one he (or someone else) dealt with in the past, and he proceeds accordingly. The decision maker frequently obtains corroborating or additional information by personal observation, by discussion with associates, by reading staff reports, etc. Therefore any proposed system which affects the formal reports must take into account their interrelationship with the other sources of information in the decision-making process.

The basic question in the feasibility of display systems is the question of whether management can function more effectively when reports are no longer printed and the basic data from which they were derived is available instead. To answer this question, an analysis of the way reports are now used is necessary.

External and Internal Reports

Every organization produces a number of different reports for a number of different purposes. A major classification that is useful here is that of the *external* report versus the *internal* report. An *external* report is one that must be produced for a stated purpose outside the firm itself. An *internal* report is one which is prepared for use inside the organization. The external reports include the reports to stockholders and to regulatory bodies, such as state and local governments. The external reports are

[7] Kuehn, R. L., *The Display System*, Giannini Controls Corp., Duarte, Calif.

[8] *Business Week*, "Millennium for Decision Makers," August 10, 1963, pp. 54-56.

[9] See, for example: Institute for Defense Analysis, *Computers in Command and Control*, November 1961.

[10] *Business Week*, "Chart Room – New Style," November 2, 1963, pp. 150-52.

usually in summary form — e.g., total sales, total assets, etc. The form and content of these reports are usually not under the control of the organization itself.

In the near future, the existence of display equipment will not materially alter the production, form, or content of these reports. However, the very fact that they must be prepared may affect the use of display equipment for internal reports because many external reports are also used internally. Furthermore, the production of the external reports requires the classification and summarization of all transactions. Hence many reports involving the same classification but only partial summarization can, in effect, be obtained at very little additional effort as a by-product in the production of the external reports.

Usually the set of internal reports will consist of some of the external reports plus others prepared solely for use inside the firm. Internal reports can be classified in various ways. One major distinction is between detailed status reports and summary reports. A status report is one which contains the current status, and perhaps some past history, of an individual item. Examples of status reports are lists of inventories of parts, customer balances, outstanding purchase orders, etc. These reports are used primarily in the "operations" functions of the business. Usually there is no question that the firm must, somehow, maintain this status information. In many cases the information is now kept on magnetic tape or in a random access memory.

Two questions associated with such status information are: Which individuals in the firm should have access to the data? In what form should they receive it? In some cases the answers are relatively simple. For example, in an airline reservation system flight seat information must be available *immediately* to every employee who deals directly with passengers. This is clearly a case where status reports printed periodically would not suffice; the status changes too rapidly.

Generally, the requirements for status information can be satisfied by either an inquiry station of the type described earlier by producing periodically a report containing the status of all items. The decision to use one or the other of these media can be based on economic feasibility studies. There may also be some subjective factors, however — e.g., the "value" of a 10 per cent reduction in the time required to obtain a piece of data.

In general, the problem is at least as quantifiable as those in usual computer feasibility studies. The factors that must be taken into account include the possible alternatives and the information characteristics. The alternatives include a display of all available information, either in temporary or permanent form, or in equipment which provides a specific piece of data on request. The important characteristics include the total number of different pieces of data, the rate of requests, the time allowable for an answer, and the frequency of changes in the data.

Possible Elimination of Internal Reports

The internal reports which are not detailed status reports are prepared for management for control and planning purposes. Until recently very little attention has been paid to developing a theory to justify the contents of these reports, or to determining how the information is used by the manager. Textbooks usually imply that these reports are merely summaries of transactions, though in practice they may contain results of more extensive analyses.

An extreme use of display systems would be to eliminate internal reports, as such, completely. All raw data describing transactions would be stored in the computer memory. When the manager wanted a particular piece of information, or a particular analysis, he would ask for it by using an inquiry station or other display device at his desk. The data or up-to-date analysis would then be displayed.

This approach is not likely to become practical for some time, because a computer program would either have to be available for each possible request or be prepared after the request is received. This takes time, even when generalized "display generators" are available. Also, considerable computer time would be required to analyze and display the data. Therefore, the foreseeable future most management reports are likely to be prepared on a regular schedule. (It would, of course, be possible to prepare the report and store it until the manager actually asks for it — no appreciable advantage over the present system.)

Even if a manager had to ask for each display individually, he would certainly ask for some of the reports every period. In particular, he would ask for the control report which shows closely the part of the organization, for which he is responsible, is adhering to a prescribed plan. If the deviation in any category of expenditures is significant, the manager must determine the reason. He usually does this by examining subcategories until he finds a significant deviation, then he examines that subcategory, and so on. Once he isolates the basic cause of the deviation, he may take corrective action.

Mechanical equipment might be used to make this control process more effective by reducing the amount of printed output and the time required to find the source of the deviation from the plan. However, more significant improvements in effectiveness can be made if the manager can state in advance the size of the deviation (at each level of sub-category) that will cause him to investigate further. Once this is known, it can be included in the computer program, and the computer, instead of displaying all the detail at each stage, can trace through to the lowest level responsible for the deviation and display only that pertinent information directly. This would, in effect, create an exception report with an identification of the apparent source of the deviation. The need for rapid display of information is therefore decreased.

Planning Function Offers Potential

The control function by itself does not appear a promising application for display devices. An application with more potential is the planning function, where manager-computer communication using display devices may prove not only feasible but actually necessary.

All organizations must have a plan; the most formal plan in most organizations today is the budget. In organizations controlled by appropriations it sets the allowable expenditures and consequently governs the level of various activities. In other organizations, particularly in business firms, the budget is usually interpreted somewhat more flexibly, but still forms the basis of operating plans.

The preparation of a budget usually begins with a "forecast" stated by the chief executive officer. Each of his immediate subordinates translates this forecast into more detailed forecasts for each of his departments, and so on down the hierarchy. At the lowest responsible level cumulative forecast is translated into projected operating data. The final budget is then compiled by summing the appropriate data at each successive level up the hierarchy. The result is a statement of the level of various activities and the financial consequences if the forecast is correct. The preparation of the budget is therefore essentially a "simulation" of the operation of the firm into the future.

Limitations in Past Budgets

The practical use of budgets in the past has been subject to a number of limitations. The process of preparing the budget is time-consuming and expensive. Consequently a budget will normally be prepared for only one forecast. Preparation of budgets for different forecasts in order to examine the changes resulting from changes in the forecast is usually not feasible.

Another basic difficulty in the use of the budget for control is that assumptions, about how the organization will react to certain changes in the environment, are rarely stated explicitly. Therefore, even if budgets for two forecasts are prepared, the differences in the budgets may be the result of either different forecasts or of differences in the assumptions made somewhere in the organization.

Furthermore, until recently actual results are difficult to compare with the budget in time to take corrective action. The source of significant deviations is frequently hard to identify. Even when the source of the deviation is found to be a change in the external situation from that in the forecast, the budget can usually not be adjusted in time to modify operations quickly enough.

These difficulties can now be alleviated. The data-processing equipment built around an electronic computer can provide the right data at low enough cost and in the right form. Management science has developed techniques for building models of the organization which can be used for the preparation of the budget. It is therefore now possible to consider an integrated system for operation, control, and planning in organizations.

The schematic of such a system is shown in Figure 1. The diagram shows three distinct but interrelated systems. At the top is the *Planning system*. Its major component is a computer model of the organization and its environment. Under the control of the model the computer simulates the operation of the firm into the future and produces a "generalized" budget or operating plan. The word "generalized" means that the plan shows not only the financial condition of the firm but also values of other relevant variables – e.g., the number of employees required, turnover rate, technical specifications, etc.

A simulation starts with the status of the firm at the present time as represented by the data files. The inputs to the simulation are forecast of values of variables representing the firm's environment and any special management directives. Data representing the condition of the firm in the simulation are constantly displayed, and provision is made for management intervention at any time. Ordinarily a number of simulation runs would be made, each predicting the position of the firm for a particular set of assumed conditions. Management would select a plan based on an examination of the results of these runs and on objective and subjective judgements of the likelihood of the assumed conditions.

After management was satisfied with the "operating plan" the computer program would display the decisions that must be made at this time in order to have the company operate in accordance with that plan. An opportunity to override any computed decisions is provided.

Once the operating plan and the commitment decisions are approved, these decisions become one of the inputs to the *Operations system*. This system is an extension of the routine data processing of today. The other inputs are transactions and events which have been initiated elsewhere, such as an order from a customer, or internally, such as a delivery becoming overdue. The outputs of this system are the usual documents and reports.

Another Output which is Input

In addition, there is another output which is the input to the *Control system*. This system is an extension of the present budgeting control system in that it monitors not only the difference between the planned expenditures and actual expenditures, but also periodically examines the validity of the computer model used in the simulation. One set of outputs of this system is "exception reports" indicating significant discrepancies between "planned" and "actual" (variance reports in budgeting terminology), together with analysis to aid the identification of the cause of the differences.

The other set of outputs would indicate areas in which the model is not "predicting" accurately enough. Some analyses could be performed automatically; the output might, for example, list new parameter values. After management reviews, both sets of output are the sources for input to the planning system.

Three Systems Interrelated

The three systems are highly interrelated. All share access to the same set of data files containing current and his-

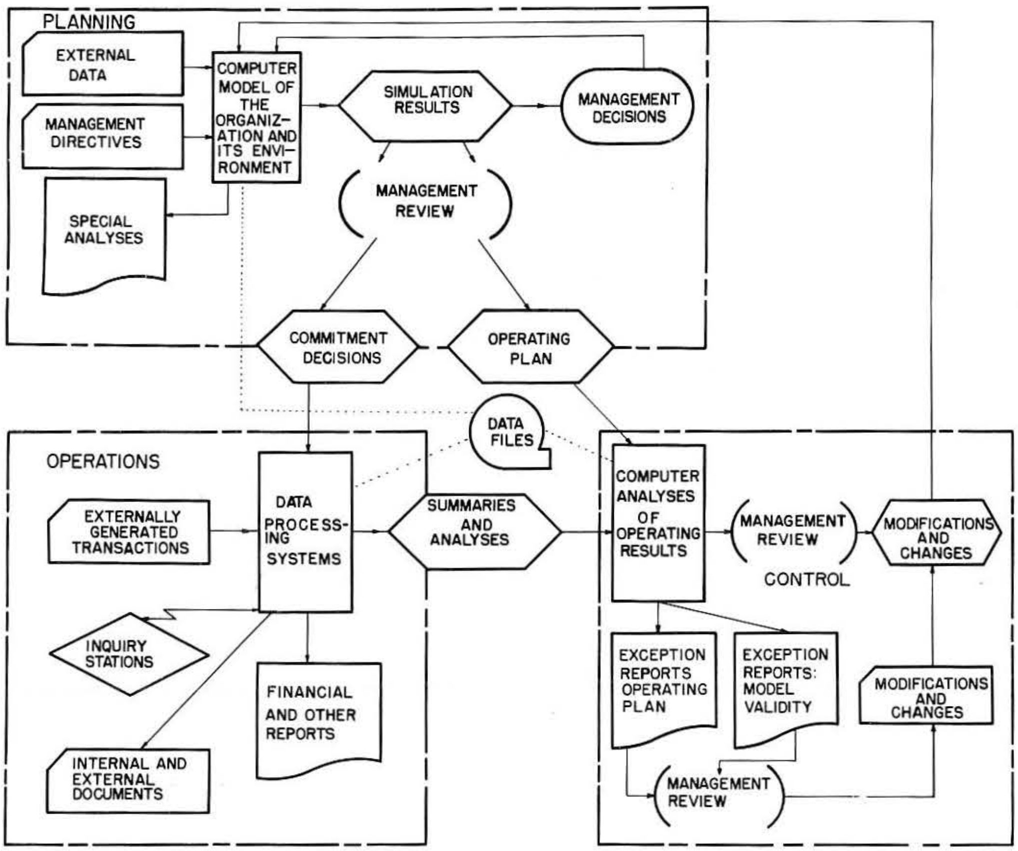

FIGURE 1: An integrated operations, control and planning system.

torical data describing the firm's operations. Each one of the systems receives input data from one of the other systems, and the output of each one provides the input for one of the others. In all probability, all three systems would share one computer; in fact, they would probably be operating simultaneously.

The system as described allows for management review at three points. To make the approach practical, display devices for management intervention in the system will be required. The time that can be allowed for management intervention will be a critical and limiting factor, particularly in the simulation runs. The purpose of the simulator is to predict the outcome of a combination of the firm's decisions. Since the firm operates in an uncertain environment, a number of runs under different external conditions is necessary to determine the value of a given combination of the firm's decisions.

In real life, management will override a previously prepared plan when the situation is extreme enough (either desirable or undesirable). Therefore, if the simulation is to be realistic, management must be able to override a plan in the simulated situation. Since many runs are required, simulation must be at a highly condensed time scale; one minute of computer time may be equivalent to a month or a business quarter of real time.

Not all situations will be completely covered in the model, and management must be ready to make decisions as simulation is progressing. These must be made relatively quickly if simulation is to be realistic and effective. Hence display devices will be necessary to permit quick management intervention and to provide management with the data needed to permit rapid decision.

This system would require a control room for the Planning function and inquiry stations for the Operations function. In the larger organizations the Operations function may be subdivided and each division have its own control room. The Control function would probably continue to use printed reports, though equipment somewhere between an inquiry station and a control room complement in function might prove worthwhile.

Once the equipment and systems development can be justified for these integrated systems, it may also be usable elsewhere in the system so long as only marginal costs would be involved. The technological, methodological, and economic feasibility of display devices in the total integrated systems for all management and administrative functions is examined in the succeeding section.

The equipment required in the integrated system would consist of one or more computers, display devices, and inquiry stations and the necessary communication links. Such equipment is now available, and new equipment with improved specifications is continuously appearing on the market. Equipment is not the limiting factor in the implementation of an integrated system.

The methodological problems can conveniently be divided into two parts, file organization problems and "software" problems.

The feasibility of the integrated system utilizing inquiry and control room display devices depends on the availability of data from the data files. It is therefore necessary to examine the status of business data-processing systems in American industry today to determine whether they could form the data source for display systems.

Initial Use of Computers

The initial use of computers in business was primarily for processing of routine data. This particular area was selected because it was the major bottleneck, because the early computing equipment could be quickly adapted for such processing, and because it appeared that start-up costs could be recovered quickly and over-all clerical costs reduced.

Because of the characteristics of the available equipment, computerized data-processing systems have been particularly successful in applications in which a relatively large number of transactions can be "batch-processed" against a file stored on magnetic tape. As a result, large-scale ledger card files and the clerical help associated with them have practically disappeared. (This result is probably the first major impact of the electronic computer on business operations.)

At present many firms have computer-based processing systems in which files are stored predominantly on magnetic tape. The main output in routine data processing consists of printed documents such as invoices, payments, orders, etc., some of which go outside the firm and some of which (e.g., work orders) are used inside the firm. In addition, a number of reports are printed. A rapidly increasing demand for reports soon gave rise to the output problem. The original output "problem" has been solved by increasing the speed of the printing operation and by taking the printing function from the main computer and giving it to a separate computer.

Data Needed Soon After Events

The integrated system must have the data describing the events as soon as possible after the events occur. This problem of rapidly collecting data produced at relatively low speeds at a large number of geographically and organizationally separated points has proved to be difficult. To minimize errors and decrease delays, a major effort has been made to record data in machine-readable form as close to the original source as possible (point-of-transaction recording).

Unfortunately, the implementation is difficult, and only a beginning has so far been made. The approach commonly used at present is to record data originally in human-readable form and then transcribe it to machine-readable form, usually by punching on cards or paper tape.

Can the routine data-processing systems of today be used to provide the data for automatic displays? The answer, in most cases, is that they could, but that the response would be too slow. The difficulty arises from the fact that the processing today is oriented to the structure of files, and the files are arranged to correspond to the functional organization structure.

In a manufacturing firm, for example, there are likely to be files for the sales department, files for production, and files for accounting. Data needed in reply to a status question or in a display in the control room may occur in any or all these files. Even if these files were indexed so that diverse elements of data pertaining to a question could be identified and located, it would take an unacceptably long time to search all the necessary magnetic tapes.

For rapid analysis of the data and/or a rapid answer to a specific question, it will be necessary to reorganize basic data in a suitable form or to use a memory that permits data to be extracted rapidly. This requires large-scale, economical, random-access memories. One of the applications of remote display devices which received considerable attention a few years ago was that of the random-access inventory control system with inquiry stations. A number of such systems were installed. In general, they appear not to have been too successful. The reason for this, in part, was the inadequacies of the equipment and, in part, a relatively high cost for satisfying a requirement of relatively little value.

Probably as revolutionary as the development of computer equipment has been the development of comprehensive programming systems, or "software." Software was recognized as a limiting factor in the application of computers to business problems only after the central computer itself was perfected and effective ways to get information into and out of it were developed.

The need for software is frequently attributed to the growing complexity of the equipment itself – the "hardware" – but in business, at least, the need for software arises from a recognition of the rate at which changes occur in business. There is no point in taking three months to write a program for a problem that must be solved in two weeks.

Use of display equipment will require considerable amounts of software over and above what is required for the data-processing system itself. Particularly in the control room concept the sophistication of the software will be much greater than any now in practical use or under development.

A number of specialized "languages," such as SIMSCRIPT, DYNAMO, GPSS, etc., make it possible to develop and modify computer models of firms relatively easily. There are also available a large number of optimization techniques which can be applied at either the "global" or "local" level in the planning process – i.e., either to the system as a whole or to parts of the system. In the control system the theory of statistics and numerical analysis techniques can be used to estimate the parameters. Considerably less, however, is known about how to test the validity of models and how to improve the structure of models.

Display Systems are Feasible

In summary, display systems in business are technologically and methodologically feasible. While the data-processing systems of today are not at present in the form most suited for display, they can be modified. The form which is best for display is also the one to which data-processing systems are naturally evolving for other reasons.

Display systems will require considerable amounts of software. The experience gained in developing software for data-processing systems will be of great benefit in producing the software for display devices. The display equipment itself can be produced readily, though most of it is not now in mass production.

Attempts to justify electronic computers for routine data processing were usually based on the basis of a combination of *tangible* and/or *intangible* benefits. The tangible benefits consist of savings in equipment and personnel, usually clerical. Some companies have recovered all the start-up costs and are actually reducing operating costs, though many others have not yet reached this stage.[11] Intangible benefits such as "better, faster management reports," "earlier delivery to customers," etc., were frequently claimed.

Many firms do not allow consideration of intangible benefits to determine the decision to use computers, probably for the good reason that intangible benefits frequently fail to show up on the balance sheet. The same emphasis on evaluation of tangible factors will likely be applied in decision involving acquisition of display equipment.

More Equipment, New Software

The factors in the cost of display systems have been mentioned in the discussion of technological and methodological feasibility.

First, additional equipment for display and communication will be required. Display systems at present are relatively expensive because they are specially designed for each application. General-use, mass-produced equipment with lower unit costs may become available in the future. This has occurred in the case of digital computers, but it is still too early to conclude definitely that display devices will be mass-produced. The cost of display is not likely to be offset or reduced by the elimination of other equipment – the way the cost of computers was offset by the elimination of punched-card equipment.

Secondly, new software will be required to integrate the Operations, Control, and Planning systems and to generate the display. The efficient use of display systems may also require some reorganization of the routine data-processing system and the basic files which might not otherwise be done.

In addition to these one-time costs, the generation of displays will continuously require substantial amounts of computer time. In fact, some evidence indicates that larger computers will be required because the displays will probably have to be generated at the same time that routine work is being processed.

The benefits to offset these increased costs can come essentially from (1) reduction in the present costs of the data-processing operation, (2) reduced personnel costs in clerks or in personnel, or (3) intangible benefits.

Computer Working with Computer

The routine data-processing system gathers input data, maintains files, and produces documents for internal use, documents for external use, and reports. The documents for external use are not likely to be affected by display devices.

(In the future they may be affected by the development of communication techniques from computer to computer. For example, an individual could authorize a bank to pay certain bills monthly, such as utilities, telephone, etc. The utility company's computer could then communicate directly with the computer in the bank. However, even in this situation some printed document going to the customer would ultimately be required. This might well affect the economics of the printing operation.)

In some cases internal documents will not be required if status display systems are available. For example, in a manufacturing company a work order may be prepared for each specific job. The work order shows the sequence of jobs to be done on the accompanying material. The printed work order could be eliminated if each worker, when he finishes a task, could go to the display device, insert a timecard indicating that he has just completed his job, and have the machine then issue or display to him the statement of what job he should work on next and where to route the material after he has finished with it.

In cases such as this, where the direct replacement of one system by another is involved, it should be possible to undertake feasibility studies and economic evaluations that are at least of the same order of precision as that commonly found in computer feasibility studies.

The third possibility is a reduction in the preparation and printing of reports. As indicated above, the external reports will continue to be printed much as they are now. Consequently, the only reduction can occur in the preparation and printing of internal reports. While printing may be reduced somewhat, managers will very likely want permanent copies of relevant reports in any case, and these would have to be obtained by a conventional photocopy process.

Display devices are therefore not likely to reduce printing costs substantially. The use of remote inquiry display devices for status information may reduce data-processing costs by eliminating the need to print status reports. However, the amount of reduction involved will not justify the development of control rooms.

Many managers now operate miniature versions of the control room; a manager uses clerks or secretaries to maintain his own particular charts. While all the data are available in the computer, the cost of using display devices to replace the individual charts is likely to exceed the present cost. Furthermore, most managers would probably keep on maintaining their own charts – at least until they become completely accustomed to the new equipment and procedures. Hence reduction in clerical personnel also does not appear likely.

Economic Justification

The economic justification for the development of control rooms with automatic display devices will therefore have to come from reduction in personnel costs or from better decisions. As pointed out above, management has generally discounted intangible benefits in decisions involving the introduction of computers. Computer feasibility studies have usually been able to show clerical savings. However, operations research or management science studies have usually not. They have had to depend more on intangible benefits for justification of proposed changes.

This accounts to a large degree for their much slower growth compared to the growth in the use of computers. In fact, many management science investigations today are undertaken as the result of a stimulus from the computerized

[11] McKinsey and Company, Inc., *Getting the Most Out of Your Computer*, 1963.

data-processing operation. To a large extent, then, display systems will have to be justified by reduction in personnel. Since there are very few clerks to be replaced, the reduction will have to occur in line or staff management positions.

Management personnel could be reduced if certain functions now performed by administrators could be eliminated, if the way in which the functions are performed is changed so that less time is required; or if a manager is given aids which increase his productivity. All of these situations have occurred in clerical functions. For example, the use of prepunched cards to be returned with telephone bills has eliminated the need for customer identification data to be keypunched when the payment is received. In this case a task has been eliminated.

In the factory an employee may indicate that he has finished a task by inserting his identification card in a transaction recorder and setting a few knobs. The recorder then automatically records this data in machine-readable form. In this case the task of recording the input data has not been eliminated, but the way in which it has been done has been changed so that it takes less total effort, since the job of transcribing it from handwriting to punched holes or magnetic spots has ben eliminated.

One of the tasks that middle management now performs is coordination and liaison. The use of the control room would undoubtedly reduce the need for much of this function. Since the responsible managers with specialized knowledge will be in the same room when problems are identified, solutions in many cases will be obtainable without much of the time-consuming delegation, briefing, and discussion that are now necessary.

Another task that can to some extent be eliminated is that of making the routine decision. In any organization a number of specific decisions must be made: how many units to order, which subcontractor to use, etc. For many of these relatively well-defined decisions, automatic procedures can be devoleped. Once the procedure is accepted and data are available in the computer, these decisions can be programmed and only the exceptions brought to a manager's attention.

In other words, the important task becomes the development of the procedure for making the decision, not the decision itself. The use of display devices will accelerate this trend, because managers will be able to deal with exceptions much more readily.

One of the very unstructured and ill-defined functions of the managers in the management hierarchy is the "consolidation" of data. The top managers cannot be concerned with detail. Someone must abstract, digest, summarize (i.e., consolidate) the detail. If this can be done successfully through the control room, the need for some of the staff positions would disappear.

While these factors could all decrease the number of management personnel, it is not at all clear that they will have this effect. Even if management does become more productive, it will be difficult to determine the credit that can be assigned to the integrated system. Display device systems will be extremely difficult to justify economically without management personnel savings.

More Integrated Files

The use of computers for routine data processing will continue to increase. As the necessary random access memories and associated software systems are improved and the need for status information increases, business files will be organized into a set of integrated files for the firm rather than by separate functions as they now exist in the business. This will facilitate both the routine data processing and the use of the system for answering inquiries, as well as make a control room concept operationally feasible.

Status information, when needed by operating personnel or management, will continue to be supplied both by status reports produced periodically and on demand by remote display devices. There will probably be an increasing use of the latter. Some other internal documents will still be printed, but many will be replaced by remote display units.

Those internal reports that derive directly from external reports will continue to be printed, since they are obtained as a by-product at very low cost. Other reports that require reprocessing of the data will gradually be replaced by the exception reports.

Reports and documents for external use will continue to be printed essentially as they are now, but with a trend to replacement of these documents by computer-to-computer links.

The biggest impetus for the control room, with display devices linked directly to computers, will come from the need in the planning function. The planning function will be expanded to include simulation; the simulation will incorporate models of parts of the firm and allow for management intervention in those areas in which programs are not yet developed, or in unforeseen situations.

The planning system will use the same computer and the same data files as the routine data-processing system. The simulation runs and the model evaluation runs will probably be time-shared – that is, done concurrently with routine data processing – to increase the efficient use of the computers.

While it is fairly safe to predict that these events will happen, it is considerably less safe to predict when they will happen. Much of the display equipment is being, or could be produced now; the software will take some time to develop. The data-processing system must first be improved, and management must acquire the necessary confidence in, and familiarity with, the system to use it as a regular tool.

The greatest uncertainty is due to the lack of adequate economic justification. In direct contrast to the initial computer feasibility studies which almost invariably showed tangible savings, the economic feasibility study of displays does not.

It may be that these systems will develop despite this lack of economic justification. One possibility is that the integrated system may develop without a conscious effort. As the various computer programs increase in scope, the overlapping of programs will increase. The duplication will be eliminated by combining several smaller programs into one large program. The planning system may evolve gradually without any specific overt decision by management. A consequence of the gradual evolutionary, undirected approach is that it takes time; several decades may elapse before the systems envisioned here are in common use if they develop in this way.

It is also possible that systems designers will find a way to charge the costs of the display system to some other project so that it appears as though the system is being obtained as a by-product at low cost. This may well happen in the software development; the simulation model might be obtained as a by-product of programming the routine data processing.

Another possibility is that control rooms will be built, in spite of the economics, for competitive reasons. A reasonably pertinent analogy is the use of jet planes by airlines. The airlines would probably be financially better off without jets. So long as no airline owns jets the competitive situation remains stable; however, as soon as one acquires a jet the others must follow.

In any case, the control room will be a gradual development, despite such statements as "the target date for this management millennium is three years from now. The theory and equipment are ready now."[12] In the early days of computers, business periodicals were filled with descriptions of what the "giant brains" could do for business. The intervening years have demonstrated that, while the potential was there, "theory and equipment" alone were not enough to realize it.

[12] *Business Week*, "Millennium for Decision Makers," August 10, 1963, pp. 54-56.

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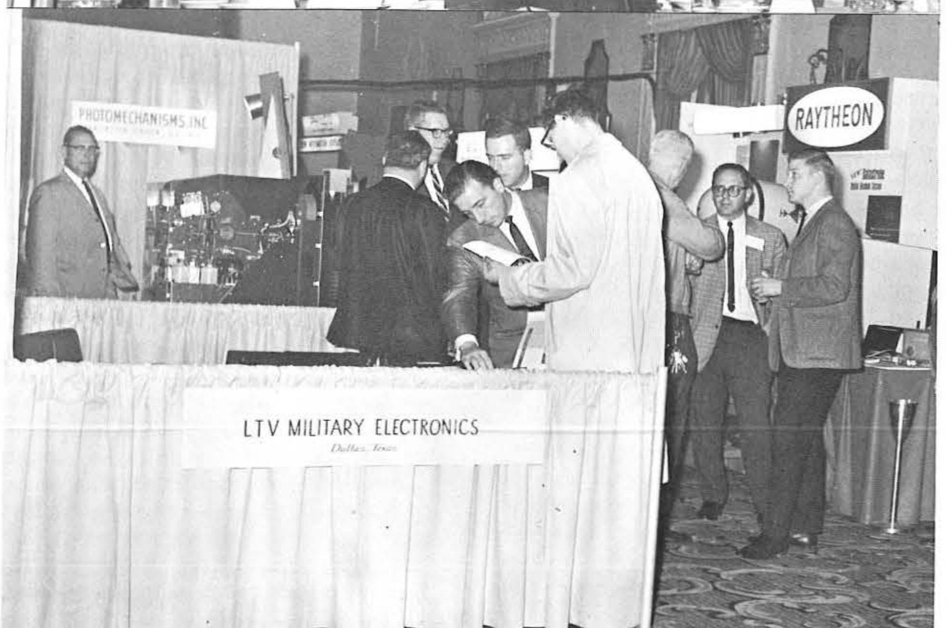
Sixth SID Symposium in New York Reveals Technical Progress, Needs



Scientists attending the Sixth *SID* National Symposium, Sept. 29-30 in New York's Hotel Commodore, heard expert opinions concerning technical progress and basic requirements in the field of Information Display.

Brig. Gen. A. T. Culbertson, USAF, Commander, Rome Air Development Center, in his banquet address emphasized a need for more basic research in the field of ID, in order to keep pace with requirements in the rapidly expanding field.

John Sullivan, Dean of the School of Business Administration, Florida Atlantic University, described applications of ID techniques at his school, as an example of profitable use being made of the new technology. He asserted progress in the field is so rapid it is difficult to keep abreast of developments.

Several hundred attended to view exhibits and hear 20 technical presentations.

Top Left—National President James Redman welcomes Sixth **SID** Symposium attendees, as Robert Klein (l), Kollsman Instruments; E. J. Stockwell, luncheon speaker, NASA; and Brig. Gen. A. T. Culbertson, AFRADC, banquet speaker, listen. **Left**—Portion of Exhibit area shows displays by LTV Mil Electronics, Photomechanism Inc., Philco, Stromberg-Carlson, and Raytheon. **Bottom Left**—Informal group includes (l-r) Henry Oppenheimer, CBS Labs, and wife; Gordon Burroughs, Burroughs Engineering; Mrs. Paul Rogell; Mr. and Mrs. Carl Machover, Information Displays Inc.; Machover was Program Co-Chairman of Symposium. **Bottom Center**—H. G. Davis, Information Systems Div. of North American Aviation; luncheon speaker. **Bottom Right**—Dean John W. Sullivan, Florida Atlantic University, luncheon speaker.

President's Observation

President James Redman, National President, **Society for Information Display,** and associated with Stromberg-Carlson Corp., San Diego, told **Information Display:**

"As President of the **Society for Information Display,** I was gratified at the technical excellence and professional caliber of the Sixth National Symposium. The technical papers given, the state-of-the-art techniques demonstrated at the exhibits, and the evidence of continuingly high technical caliber of attendees proves once again that the **Society** is fulfilling its charter for the encouragement and dissemination of Display Technology."

Top Left—(l-r) Lewis Blair, Army Comm. & Electronics Office; Burton Price, Philco; Eric Kral and Pierce Siglin, Army Electronics Command. **Right, Top**—(l-r) William P. Bethke, RADC, Program Co-Chairman, chats with E. J. Stockwell, NASA, luncheon speaker, and Ford Brown, Photomechanisms, Inc., Symposium General Chairman. **Right, Middle**—Group at banquet table is (l-r) Sol Scherr, Sperry Gyroscope, and wife; Charles Emmert, consultant; Kenneth Moore, CBS Labs; Edmund Kennedy, RADC, Papers Chairman; Mrs. Bethke; Mr. and Mrs. Brown; Mr. Bethke. **Right, Bottom**—One of many crowded technical sessions. **Bottom Left**—Martin Waldman, Publisher, **Information Display,** chats with Al Langer, Kollsman Instruments, at banquet. According to Convention Chairmen, technical sessions and social events were well attended.

ID Readout

Submarine Attack Center Consoles

An electronically controlled simulator built by Honeywell Inc. is providing "battle experience" for the crews of U.S. Navy nuclear submarines. In photo above, control panels call the shots for realistic exercises in Attack Center No. 3 (background) of the attack center trainer at the Naval Submarine School, New London, Conn. The panel in left foreground is called the assistant program operator's console. The one at right is the program operator's console. Display screen is at far right. During a training exercise, curtains are pulled shut so that trainees can't see the consoles.

Multi-Source Direct-View Displays

An unusual direct-view display console, capable of simultaneous but independent presentation of data from two sources, will be manufactured by Stromberg-Carlson Corporation for the Pomona Div. of General Dynamics Corp. Announcement of the $138,000 contract was made by Carl V. Shannon, General Manager of Stromberg-Carlson's Data Products Div. The equipment utilizes a newly developed version of the Charactron® shaped-beam tube. In addition to a special Charactron gun assembly, the CRT contains a second electron gun of more conventional design. Processed data received from a digital converter is displayed as alphanumerically-annotated point and line plots by the Charactron display generator. At the same time, the second gun presents a 729-line, high-resolution TV picture. The composite display obtained in this fashion provides increased efficiency and reduced complexity of control, over previous single-gun time-shared techniques. The equipment will be used by General Dynamics/Pomona in a system devolopment laboratory to facilitate the study of shipboard command and control systems and will provide a major capability in the total function of the laboratory.

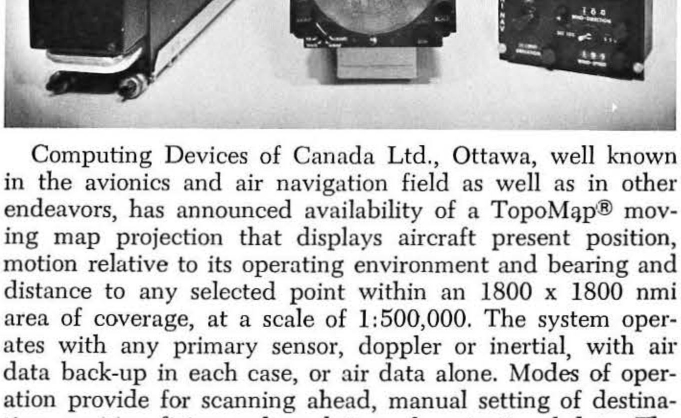
Electronic Surgical Monitoring

An electronic surgical monitoring system which visually alerts physicians to sudden physiological changes in a patient's condition during neurosurgery while storing this information for later computer analysis was described here today for the first time. Dr. John D. Michenfelder, of the Anesthesiology Dept., and Dr. Colin S. MacCarty, head of the Department of Neurosurgery, Mayo Clinic, said the system has been a key factor in helping surgical teams keep patients alive during critical neurosurgery procedures by providing more complete, accurate information than was previously possible. In photograph above, video screen mounted on operating room wall (center, near top of photo) at St. Mary's Hospital, Rochester, Minn., displays continuous flow of information. The photo shows how system would display information during actual surgery. It was developed by Mayo Clinic and International Business Machines Corp., Advanced Systems Development Div., White Plains, N.Y., which handles all medical monitoring development for IBM.

RFI-Shielded Indicator Lamps

The Control Switch Div. of Controls Co. of America has developed a new line of RF-shielded indicator lights to complement its recently-announced RFI-shielded switches. The new lights, like the switches, incorporate internal bonding and grounding to eliminate them as possible points of RFI emission in an otherwise-shielded instrument panel. Both meet requirements for use in radiation-free airborne electronic panels built to MIL-I-26600. RFI emission from lamp filaments is absorbed by an unusual mesh shield inside the panel indicator lens. Electrical continuity between shield and indicator case is provided by a special conductive gasket, and a cadmium-plated brass case furnishes a low-impedance path to ground through the panel. The reported result is effective suppression of RFI in the important 0.15 to 1000 mc range.

Aircraft Moving-Map & Position Display



Computing Devices of Canada Ltd., Ottawa, well known in the avionics and air navigation field as well as in other endeavors, has announced availability of a TopoMap® moving map projection that displays aircraft present position, motion relative to its operating environment and bearing and distance to any selected point within an 1800 x 1800 nmi area of coverage, at a scale of 1:500,000. The system operates with any primary sensor, doppler or inertial, with air data back-up in each case, or air data alone. Modes of operation provide for scanning ahead, manual setting of destination, position fixing and up-dating of navigational data. The display can be track or north oriented – in normal operation present position is indicated in the display center. TopoMap also shows track, course to destination, range and track error.

0.375 Sq. In. 10-Digit Readout

A new 10-message illuminated display readout utilizing miniature incandescent lamps has been announced by Display Devices Inc., Los Angeles. Named Digistrip, it can be horizontally or vertically panel mounted for use with test equipment, system consoles, calculators and related equipment where high information density is a requirement. It requires only 0.375 sq. in. of panel area, and behind panel depth of only 5/8 in., including terminations. Multiple units can be mounted in clusters on ¼ in. centers. It can be soldered directly to printed circuit boards to provide multiple status data. Digistrip contains ten T-1 miniature lamps, with terminations for wire-wrap soldering, p.c. board connections, push-on connectors, etc. In addition, terminations can be provided for insertion in a printed circuit connector. Length of the legend is less than 1½ inches. Letters, symbols, words and colors can be utilized in addition to the standard 0 through 9 digits. Light baffles can be removed to provide fewer than 10 messages, where a single word message is required. All Digistrip lamps can be replaced from the panel side. Delivery 4 weeks ARO.

Dataplotters at MSC Houston

Five Electronic Associates Inc. Dataplotters were used by NASA's Manned Spacecraft Center Mission Control Center, in Houston, as the main monitoring and mapping device for the early phase of the 8-day Gemini-5 flight. Applications included plots of the orbital velocity, apogee, perigee, position over Earth, and other parameters, at 12-second intervals. During the critical launch period, the spacecraft was monitored at ½-second intervals to determine the amount of deviation from the planned path. This information, displayed in graphic form by the Dataplotters, was the basis for the go/no-go decision. The same instruments were also used to monitor the Gemini-4 flight, successfully completed last June. The Dataplotters used were all the EAI Model 99678, which features vertical plotting surfaces for easy observation by a large number of people in a command room. It produces inked records in continuous line or point (interval) form, depending on the monitoring continuity needed. The units were first installed in the NASA Mission Control Center during September 1964.

Magnetic Shield for Video Camera

Magnetic Shield Div. of Perfection Mica Co. has announced the development of a new "Netic Co-Netic" series of magnetic shields for closed-circuit video cameras used in high-density magnetic environments and high ambient temperatures for the remote observation of industrial processing equipment. In one application, the shield was designed for a camera scanning an electric arc smelting furnace. The power for operating the furnace had a different frequency rate than that of the frame repetition rate of the camera. The magnetic field emanating from the 60 kilo amperes current carrying supply busses and electrodes seriously affected the camera sweep system's vertical stability. The Netic Co-Netic shield proved effective with the camera mounted only 25 feet from the electrode system. The shield structure consisted of a series of sequential non-shock-sensitive, low retentivity Netic and Co-Netic enclosures which surrounded the entire camera device. The two inner systems were Co-Netic AA alloy and the outer system Netic S3-5. A compressed air cooling device was used to obtain the operational ambient required by the camera. Other cooling methods are also possible, such as water cooling or refrigeration.

Top ICM Grads to GE Course

The Institute of Computer Management, Chicago, will begin sending its top graduates to a three-week Data Processing Course given by the General Electric Corporation, according to ICM's registrar, Peter Kallem.

Microminiature Rear-Projection Readouts

A series of microminiature rear-projection readouts has been announced by Industrial Electronic Enginers Inc. Each unit displays up to 11 different messages, including numbers, letters, words, symbols and colors – anything that is photographically reproducible can be displayed. They are capable of displaying characters up to ⅝-in. with a viewing distance of as far as 20 ft. Engineering details, mounting dimensions, lamp specifications, a chart of standard displays that are available and a price schedule are presented in a data sheet for the readouts, termed Series 340.

Multicolor Display

Kollsman Instrument Corp., Elmhurst, N.Y., exhibited its new Delphic II data display system at the recent New York Symposium. The Delphic II data display system is an advanced method of projecting communications and data for visual observation on an illuminated screen. Acting as an interface, it will display visual information in real time, motion and color on suitable backgrounds from any input source.

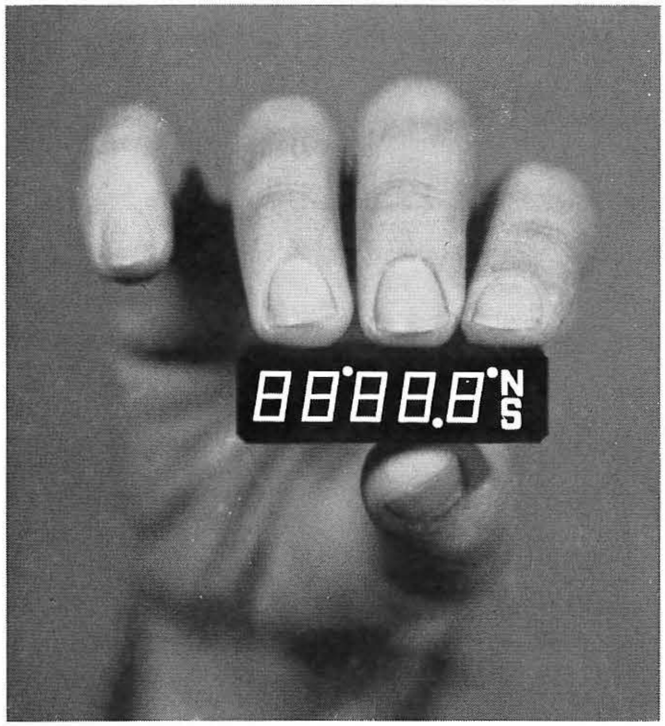
Among its features is the dataKrome, a new method of generating color for the Delphic II. The dataKrome will project any four simultaneous, intense colors, particularly the blue, a color which is normally hard to project with brilliancy. As the dataKrome projects four colors simultaneously, one projector is required instead of four, as in the past. This results in a saving of 75% over other methods of color generation. With the incorporation of Kollsman's improved optical system, clear, sharp characters are projected on the display screen even when projected to 3/10 of 1% of the screen dimensions. For example, with a screen size of 10 ft. the characters will be ⅜ inches square.

Chapter News

Los Angeles Chapter: The annual installation meeting of the Los Angeles Chapter was held on Sept. 23 at the Engineer's Club. The results of the recent election were announced and the floor was handed over to the new chairman, Raymond E. Bernberg of Litton Industries, Guidance and Control Systems Div. The election established the following chapter officers for 1965-66 to serve with Bernberg: Vice Chairman (Chairman-Elect), Erwin Ulbrick, Jr., Genisco Technology Corp.; Treasurer, Wendell Miller, Intertechnical Corp.; Secretary (Secretary-Treasurer) Lynn M. Maldoon, Electro-Optical Systems. In addition, the following members were elected to serve on the Executive Committee for the coming year: L. M. Seeberger, L. E. Haining and R. N. Winner, all of Hughes Aircraft Co. Bernberg reports that three appointments have been made to supplement the chapter activity. These are: Walter E. Deutsch, Program Chairman; James Belcher, Membership Chairman; and Louis M. Seeberger, Publicity Chairman. Following the Business Meeting, an interesting discussion on the role of photography in Information Display was led by John H. Waddell, a Photo Optical Specialist at the Douglas Aircraft Co.

IBM System/360 Display Capabilities Varied

IBM's System/360 displays are used for a variety of operations, including data-supported Gemini flight profiles at MSC Houston, light-pen-assisted data retrieval, and generation of three-dimensional images of complex static force exercises (such as a truss bridge) generated from stored mathematical models. All were demonstrated by IBM's Data Processing Div., White Plains, N.Y., at the recent Business Equipment Manufacturers' Assn. exposition at New York's Coliseum. Three-dimensional diagrams in graphic form – such as the bridge image – can be examined and manipulated through instructions to the computer. Using a keyboard, the operator can display the bridge from different angles and make the image or its parts larger or smaller. This allows the designer or architect to eliminate the time-consuming chore of hand-drawing each view.



fjcc 1965

A number of innovations are planned at this year's Fall Joint Computer Conference, Nov. 30 through Dec. 2, at the Las Vegas Convention Center. Advance reaction to the fine program is excellent, with a sellout of exhibit space 90 days prior to the convention.

Five sessions will be in the experimental "discuss-only" format which forbids reading of papers, dedicating the session to dialogue between author and attendees. Ten sessions will be aimed directly at management personnel whose primary concerns are purchase, installation, management and application of systems. The final day is devoted entirely to presentations by authorities, each exploring the interface between computer technology and a specific area of interest.

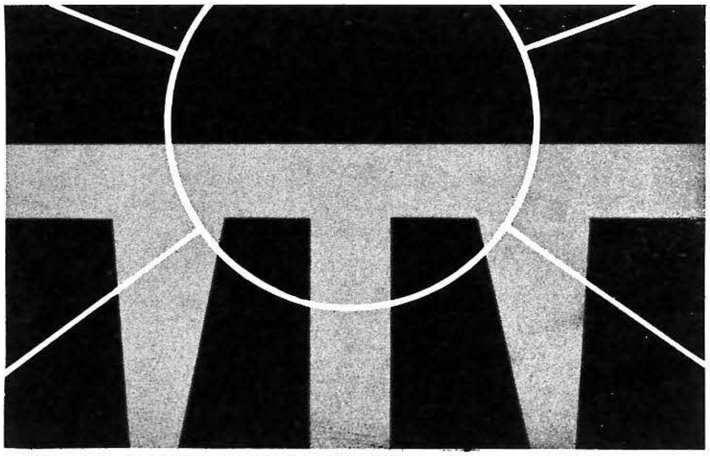
Conference theme is "Toward Qualitative Goals," with 102 papers at 36 sessions.

Of special interest to those engaged in the display field will be Session 25, Wednesday, Dec. 1, 1:30 p.m., Room 15: *Input Output Equipment for Closer Man-Machine Interface,* chaired by J. S. Craver, Hobbs Associates, Corona Del Mar, Calif. Papers and abstracts follow:

MAGIC: A Machine for Automatic Graphics Interface to a Computer, D. E. Rippy, D. E. Humphries, J. A. Cunningham, National Bureau of Standards: The authors describe a machine which has been developed as a research tool for the investigation of man-machine communications techniques. MAGIC consists of two basic units: the processor and the display. The processing unit is a specially designed, programmable digital computer consisting of a control processor and four subordinate list processors. The display unit consists of two large-diameter CRT displays. This paper describes the hardware design and software repertoire of MAGIC with particular attention given to the use of its subordinate list processors. Conclusions are drawn with respect to the adequacy of the system and future plans. Proposed design for the next generation machine is also discussed. •

A Magnetic Device for Computer Graphic Input, M. H. Lewin, RCA, Princeton, N.J.: The device consists of an electronic pen "writing" on a specially-constructed flat surface and operates by periodically detecting the position of the pen and converting it into a machine-readable binary address. The path traced out by the pen is thus stored directly. The pen tip contains a small magnetic head which generates localized magnetic field pulses at high repetition rate. The writing tablet is constructed of a number of superimposed thin winding layers in a laminated structure. Each winding, which may be photo-etched or otherwise deposited on a thin insulator sheet, is designed to detect one of the pen address bits and develops an induced positive or negative voltage pulse as a function of pen position. The output signals from all layers are available in parallel and are of sufficient magnitude to set a register directly. In addition to a detailed description of the winding layer designs, an indecision correction algorithm is described which is simply mechanized and which allows conventional binary address coding to be used. Operating results with an experimental 32 x 32 tablet are presented. •

GRAPHIC I – A Remote Graphical Display Console System, W. H. Ninke, Bell Telephone Laboratories, Murray Hill, N.J.: GRAPHIC 1 is an engineering console system to be used on line with a large scale processing system. It consists of a small control computer, a direct view display, associated memory, and input/output devices including a light pen,



The graphic device for FJCC is an artist's interpretation of the structures at Stonehenge used by ancient Celtic sun-worshippers, as far back as 1500 B.C., to calibrate the seasons. The device suggests the close ties between information and culture, a major theme of FJCC 1965.

keyboards, card reader, pushbuttons, and track ball. This system is used to compose graphic input of data for use with programs on the central computer. It is also used to receive and display graphic outputs from programs on the central computer. The local computing power and display maintenance capability of the console also permit the composition and editing of graphic inputs and manipulation of outputs to be done locally. The console is currently connected to an IBM 7094 which operates in a batch processing mode with console access possible between normal jobs. •

The Beam Pen: A Novel High-Speed Input Output Device for CRT Display Systems, D. R. Daring, MIT: This paper describes the basic theory and practical realization of the beam pen, a new device for increasing the speed of a CRT computed display when high speed man-machine communication is desired. The beam pen replaces the more conventional light pen in reporting the state of the illumination of the CRT screen, by detecting the electron beam that causes the illumination. In this way, the screen phosphor does not limit the speed of operation. The beam pen described in this paper operates with a CRT display having a display rate of one point every 1.5 microseconds, but the pen can operate much faster. The primary speed limitation of a beam pen is the allowable time delay between the occurrence of the electron-beam pulse and the output of the beam pen amplifier. •

A final paper on non-visual readout, by A. B. Urquhart, IBM, Kingston, N.Y., is entitled: *Voice Output from IBM System 360.* •

Fall Joint Computer Conference Program

Explanation of Symbols:
Software ● *Hardware* ■ *Application and Management* ◇

Tuesday, November 30 Where Are We Now? Where Are We Going?

	AUDITORIUM	GOLD ROOM	ROOM 15	ROOM 14	ROOM 3
9:30 to 11:45	● 1 Programming Languages	■ 2 Advances in Computer Organization	◇ 3 Efficiency and Management of Computer Installations	◇ 4 The Computer Industry In the Buyers Market	● 5 Future Hardware Technologies
12 Noon to 1:15	COMPUTER MUSIC CONCERT				
1:30 to 3:30	■● 6 A New Remote Accessed Man-Machine System	◇ 7 Applications of Simulation	● 8 Natural Language Processing	■ 9 Cellular Techniques for Logic, Memory and Systems	■ 10 Time-Sharing In the Real World
3:45 to 5:45	● 12 A Discuss-Only Session On-Line Interactive Software Systems	◇ 11 The Revolution In Written Communication	■ 13 High Speed Computer Logic Circuits	◇ 14 Computers In the Biological and Social Sciences	COURTROOM DRAMA
	6:00 TO 7:00 P.M. CONFERENCE COCKTAIL PARTY, DUNES HOTEL CONVENTION HALL				
8:00 to 10:00		16 ● ◇ ■ Extra-Sensory Perception and Man-Machine Communications	■ 15 Block Oriented Random Access Memory Techniques	■ 17 The Future of Electro-Mechanical Mass Storage	

Wednesday, December 1 Where Are We Now? Where Are We Going?

	BEGINNING AT 10 A.M. IN ROOM 1: SPECIAL EDUCATION SESSIONS				
9:30 to 11:30	● 18 A Discuss-Only Session Time-Shared Computer Systems	■ 19 A Discuss-Only Session Scratchpad Memories	■ 20 Arithmetic Techniques and Systems	◇ 21 The Overseas Computer Market	■ 22 Two-Wire Extended Core Memories & Computer Organizations
	CONFERENCE LUNCHEON, STARDUST HOTEL, 11:50				
1:30 to 3:30	● 23 Simulation of Human Behavior	■ 24 A Discuss-Only Session High-Speed Read Only Memories	■◇ 25 Input/Output Equipment for Closer Man-Machine Interface	◇ 26 Industrial Applications	■◇ 27 Hybrid Computers for Future Systems
3:45 to 5:45	● 28 Computer Dimensions In Learning	■ 29 A Discuss-Only Session Memories for Future Computers	■◇ 30 Computer-Aided Design & Maintenance	■● 31 Promising Avenues for Computer Research	◇ 32 The Impact of Federal Policy on Computer Usage
8:00 to 10:00		33 The Computer As a Factor In Cultural Evolution	■ 34 Computer Memories, Fact and Fiction	35 Implications of Information Storage and Retrieval In the Human Brain	

Thursday, December 2 How Will We Affect the World Around Us?

SESSION 36: HOW WILL WE AFFECT THE WORLD AROUND US? ALL PRESENTATIONS IN THE AUDITORIUM.

Simon Ramo, **The Computer and Our Changing Society**

Ralph W. Gerard, **Computers and the Future of Education**

James V. Maloney, Jr., **On the Future Impact of Computers on Medicine**

C. Robert McBrier, **The Computer and the Consumer**

William I. Merkin, **The Application of Computers to World Trade**

William H. Pickering, **The Role of Computers in Space Exploration**

James A. Ward, **The Impact of Computers on Government**

Paul Baran, **Communications, Computers and People**

Kenneth J. Schlager, **The Impact of Computers on Urban Transportation**

EPILOGUE — 3:30, IN THE AUDITORIUM

ID Authors

Petro Vlahos

Petro Vlahos holds an Electrical Engineering degree from the University of California, and is currently on the Special Studies Staff, System Development Corp., which he joined in 1960. He initially worked with displays at Douglas (1941) and later at Western Electric (1944). He engaged in R&D for the Motion Picture Research Council (1946-1960) where he did extensive work in special photographic techniques and optics, gaining several patents.

Frank B. Leibold Jr.

Frank Leibold graduated from the University of Dayton in 1960 with a BS in Electrical Engineering. He then worked for the General Electric Co. for three years serving as a development engineer and then as a project engineer at their Missile & Armament Dept., Burlington, Vt. In 1964, he received his Masters Degree in Business Administration from the University of Pittsburgh. Since that time he has been employed as a product engineer, Communication Products Sales Dept., Corning Glass Works.

Benjamin Justice

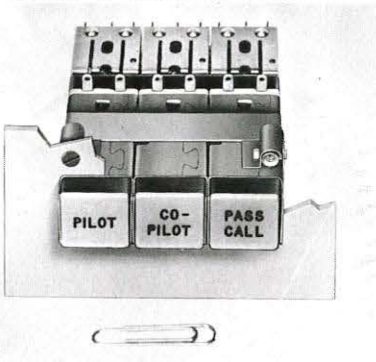
Ben Justice attended Purdue University from 1946-1950 majoring in physics and mathematics. He joined Corning Glass Works in 1950 as a test engineer in Works Control Laboratory for a year. The next seven years he was the Supervisor of Quality Control in Corning's Danville, Kentucky, plant., returning to Corning, New York.

Dr. Daniel Teichroew

Dr. Daniel Teichroew received his BA and MA from the University of Toronto (1948, 1949), and his PhD from the University of North Carolina (1953). He has engaged in research, been consultant with, or lectured at the following: U of North Carolina, National Bureau of Standards, UCLA, USC, National Cash Register Co., and the Stanford Graduate School of Business; he is presently Professor and Head of the Division of Organizational Sciences at Case Institute.

ID Products

Indicators/Lights/Keyboards



A new Series 450 of display indicators, pushbutton switch lights, and interlocked switching keyboards has been announced by Korry Mfg. Co., Seattle, Wash. They feature ¾-in.-square, two T-1¾ lamp pushbutton stations. Maximum light distribution across the entire legend plate is accomplished by internal reflectors; lamps remain stationary. A mechanical holddown-release permits only one pushbutton to be depressed at a time. Switch contacts remain engaged until released by depressing any other pushbutton on the keyboard. Actuations have been tested to guarantee each pushbutton 100,000 operations.

Silicone rubber color filters are removable from each lamp receptacle. Switch modules, alternate and momentary action, and legend plates are also replaceable by hand. The legend area available at each station is 0.64-inch square and can be custom engraved with single or split legends in letter sizes of 3/32 to ⅝ inch.

Circle Reader Service Card No. 18

Tinted Filters/Lenses

Master Dynamics Div., Master Specialties Co., Sunnyvale, Calif., has developed a line of lamp filters and lamp lenses made of tinted silicone rubber. They are designed for use on control panels and lighted indicators which must withstand environmental extremes such as −80° to 420°F temps., water, chemicals, and vibration. The silicone is produced by General Electric.

The lamp filters and lenses are used in various military and aerospace applications. In these situations very specific colors are needed so operator confusion is avoided and maximum response and control discernibility is insured. The silicone rubber indicators are color verified by Master Dynamics using spectrophotometric analysis with the readings later converted to C. I. E. charts. This is reportedly the first time any translucent silicone material has ever been color-matched with such precision.

Circle Reader Service Card No. 19

Microfilm Printer/Plotter

Benson-Lehner Corp., Van Nuys, Calif. is making its first formal presentation of the B-L Microfilm Printer/Plotter, Benson- Lehner's latest addition to its line of data processing equipment, at the Fall Joint Computer Conference, Las Vegas, November 30, according to Andrew Huson, president of the firm. The B-L 120 includes 35-mm microfilm and hard-copy output. Line drawing in both axes, vector-line drawing from point to point, and 64-character printer are included. Various sample tapes will be utilized to display speed, quality, and flexibility of the B-L 120.

Circle Reader Service Card No. 20

Delay Equalizer

Acton Laboratories, Inc., Acton, Mass., is now producing an all solid-state delay equalizer, designated type 475A. It is applicable for use on 600-ohm data or voice transmission lines to equalize the delay and amplitude loss across the selected frequency band. It is also recommended by the manufacturer for laboratory use in adding compensation during the development phases of communications equipment.

Exceptional versatility is claimed for the instrument which contains six delay modules, each of which is capable of providing continuously adjustable delays from 0.25ms to 2.5ms. Cascading of modules can provide up to 15ms of delay at any of the operating frequencies between 1 and 2.8 kc. Other frequency ranges can be supplied.

Circle Reader Service Card No. 21

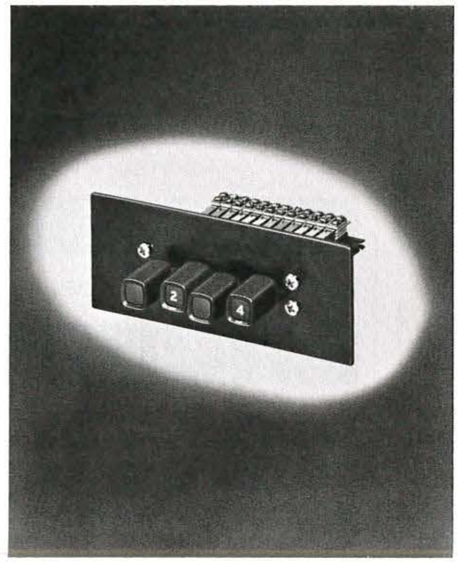
1-In. CRT

Raytheon Co., Lexington, Mass., has announced two unusual new tubes, including a 1-in. CRT providing location or other data for airborne photographic surveying system termed the CK1410P11. It has a high resolution matrix of 21 x 32 lines; reference data on the tube face can be changed in one-seventieth of a second to provide a continuing bench mark for fast-moving aircraft.

The second new tube, termed the CK1414 Symbol Ray Tube, generates a complete font of upper and lower case letters, numerals, punctuation marks, and arithmetic symbols. It is designed to provide alphanumeric inputs for computer readout devices. The tube's 3-in. face can be scanned electronically by a computer to select the letters, numerals and symbols in the proper sequence to form the visible readout on a display tube. Electrostatic deflection is employed in the 12-in.-long tube. Although the standard tube is available with English characters, it can be manufactured with the alphabet of any language or with any special symbols required.

Circle Reader Service Card No. 22

Switchbutton Lighting



Switchcraft Inc., Chicago, has announced a switchbutton which operates like a lighted button but requires neither bulb nor electricity. Called the Glo-Button, it has a translucent front screen upon which a desired legend is marked in an opaque color. The opaque color provides the background for the legend, while the legend itself remains clear. An internal fluorescent illuminator is carried on a pusher which has two legs extending out from the rear.

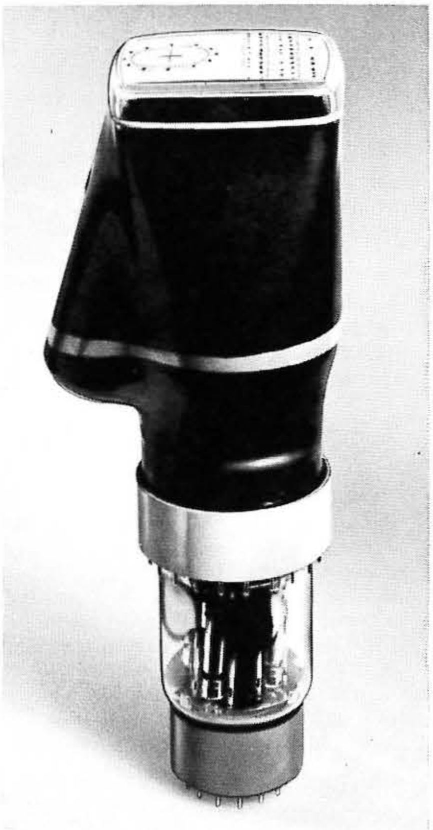
When the station is actuated the rear legs of the pusher bring the orange-red fluorescent illuminator flush with the screen. The legend then lights due to reflected ambient light and projects a clearly visible legend or symbol that signals the switch control status. When the illuminator is recessed, in the unactuated position, ambient light is not reflected and no illuminator color is presented to the legend. Glo-Buttons mount on standard .050 x .187 plungers in either of two mounting planes so that the button shell can be oriented to match horizontal or vertical panel layouts. At present legends are available for numerals 1 through 18, letters A through R, plus ON and OFF.

Circle Reader Service Card No. 23

Rectangular Switch

A new, low cost Tec-Lite Indicator family, offering three different options in one basic module (0.870 in. x 1.000 in. x 1.297 in. deep) is offered by Transistor Electronics Corp., Minneapolis, Minn. Called the Tec-Lite rectangular switch lite, RSL

5-BEAM CRT PROVIDES REAL-TIME DISPLAY WITH SIMULTANEOUS PHOTOGRAPHY OF DATA



Five separate and distinct displays on one tube face-plate together with a rear-view optical window for photographic recording or map projection are two of the features that make the Du Mont type KC 2296 of more than usual interest to design and project engineers. Successfully meeting a number of unusual operating parameters, the KC 2296 is utilized in a military aircraft navigational application, but numerous other uses are possible for this type and other cathode-ray tubes which may be designed around the multi-gun, rear-view window concept.

Time, distance, angular displacement, pressure, acceleration, telemetry... in fact any kind of data that can be translated into voltage format can be displayed and photographed at the same time. With PPI radar, five sets of data can be superimposed on maps projected on the face of the tube through the optical window. The data (e.g., positions of aircraft or other targets) are then viewed in real-time relationships to the map. Any standard or special phosphor, or any graticule configuration, can be supplied.

Actual phosphor used in the KC 2296 is a double layer phosphor with a high efficiency visual component and high energy blue component for maximum results with blue sensitive film.

With KC 2296, information is displayed on the internal graticule, on the inside of the tube face-plate, making both front and rear views free of parallax. A special phosphor deposition technique allows the graticule lines to be essentially free of phosphor and sharply visible from both front and rear. The five electron guns are independently controllable, and each beam is positioned to scan a separate screen area, except for two beams which coincide. The tube can as readily be designed so that each gun sweeps the entire display area, or any selected segment. Each electron gun is electrostatically focused and deflected.

The rear-view optical port includes such design innovations as freedom from distortion, and the internal graticule may be illuminated by a special side-lighting technique for sharp, clear photographic prints.

RECENT DU MONT ADDITIONS TO CATHODE-RAY TUBE TECHNOLOGY

New application requirements in instrumentation, radar, character display, and other display and readout use have seen significant advances by Fairchild's Du Mont Laboratories in essential types and characteristics. Following are several areas which may be of specific interest to systems managers and project engineers concerned with display and readout problems.

Higher Resolution

Newest designs produce tubes with resolutions of 1,000 lines per inch in electrostatic types with electrostatic deflection. Resolution of 2,000 lines per inch is achieved in magnetic deflection tubes. High resolution electrostatic types achieve deflection sensibilities of 15 mv/trace width at writing speeds in excess of 10" trace widths/second.

Deflection Sensitivity

Deflection factors in currently available tubes are 1 volt/cm and 7 volts/cm in the signal and time axis respectively when operating at a screen potential of 15 KV. These types are available with conventional or with fiber optic face-plates.

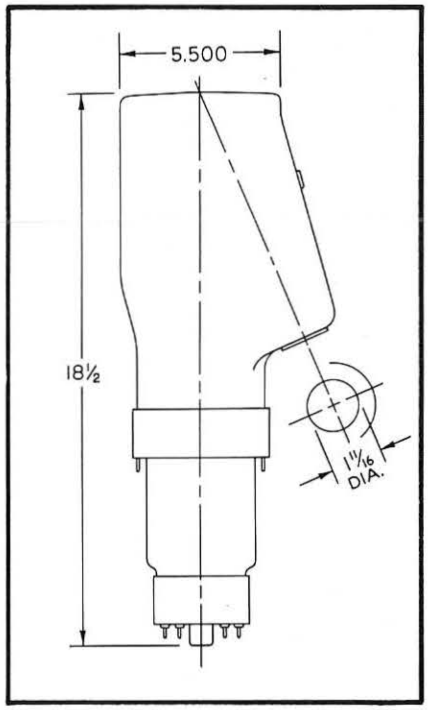
Large Screen Radar Display with High Resolution

Flat face radar display tubes have been produced for high ambient viewing with resolution capabilities of 2,500 lines across the 20-inch useful screen diameter at high display brightness.

Large Diameter All Electrostatic High Writing Speed

For high-speed computer readout, rapid random access and time-sharing radar displays, Du Mont has a complete new line of large diameter electrostatic focus and deflection CRTs with high writing speeds and high deflection sensitivities.

It makes particular sense to look to the leader for cathode-ray tubes — or for **any** other special purpose tube. No other manufacturer is better equipped to design and build special purpose tubes for your specific application demands.



KC 2296 is 18½" overall, has 7" diagonal, 5" square face. Deflection and acceleration electrodes are brought through tube wall to collar base to minimize L and C of leads.

A new tube catalog is yours for a postcard. It describes hundreds of the more than 4,000 types of cathode-ray, storage, photomultiplier and power tubes available. Write for it today. Fairchild DuMont Electron Tube Division, 750 Bloomfield Avenue, Clifton, N.J.

FAIRCHILD

DU MONT ELECTRON TUBES

A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

Series, these modules provide a choice of 14 different lens colors. Lenses can be hot stamped with legends in four different type sizes.

Three available options include: Model 1, SPST normally open switch and indicator; Model 2, two normally open switches, DPST, and no indicator; and Model 3, an indicator only. These three functions can be mounted individually or in horizontal or vertical rows with the shorter sides adjoining. Mounting from the front of an ⅛ in. panel is accomplished merely by pushing the module into the mounting hole until the locking clips snap into place. Available lens colors include both transparent and translucent red, yellow, green, blue and white; black; transparent amber; and translucent orange.

Circle Reader Service Card No. 24

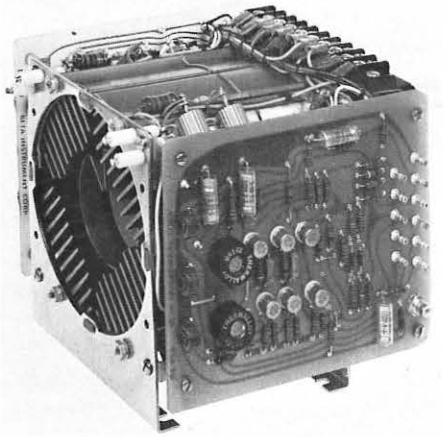
Switch/Display Matrix

Honeywell's Micro Switch Div., Freeport, Ill., has announced a new "KB" Switch/Display Matrix which is color-accented. "KB" is a modular family of devices to encode, transfer power and indicate, a new concept for display keyboards and control panels. It permits up to 256 code combinations from a single encoding switch using a field-variable 8-bit binary output.

Key components of the system are the switch itself, indicators, operating and display pushbuttons. Precision rigid mounting bars, encoding strips, and insulator separators are bench-assembled into the matrix with no tools except a screwdriver. Each mounting bar provides mounting for all different sizes of elements, and locates them separately and accurately, vertically and horizontally. A "KB" unit is ¾ in. square, a ½ unit is ¾ x ⅜ in., a 1½ unit is ¾ x 1⅛ in., and a 2-unit is ¾ x 1½ in.

Circle Reader Service Card No. 25

X-Y Deflection Amplifiers



Beta Instrument Corp., Newton Upper Falls, Mass., has announced four new X-Y deflection amplifiers, offering output current capabilities of 400 ma, 3, 6, and 12 amps, respectively. They are all solid-state modular packages featuring all-silicon semiconductors for max dependability and long life. Beta says they are designed for application in any CRT or storage tube display system employing magnetic deflection, and are compatible with all other CRT display system modules produced by the firm.

Because they are dc coupled throughout, the amplifiers may be utilized in random point plotting or alphanumeric deflection applications as well as for raster or other scan formats. Centering, off-set, geometry correcting and other inputs may be easily introduced at the summing point of the difference amplifier stage. Designations are DA 341 (400 ma), DA 103 (3 amps), DA 104 (6 amps), and DA 105 (12 amps). Delivery is 30 days ARO.

Circle Reader Service Card No. 26

27-In. Video Monitor

A new large screen, 27-in. video monitor for closed-circuit television systems is now available from Packard Bell. The unit features a specially-treated bonded face plate which reduces reflections to a minimum. By cutting down this reflected light, comfortable viewing is possible even in brightly lighted areas. The screen can easily be viewed even in large rooms and from long distances.

The steel cabinet is finished in textured satin black with decorative brushed aluminum trim to fit harmoniously in any decor. The unit has a flat back allowing it to fit tightly against a wall or snugly in a custom-designed housing. A complete set of front controls is concealed behind an attractive flip-down name plate. A pilot light, exclusive with Packard Bell, signals that the monitor is turned on. The monitor's 12-mc band width insures minimum horizontal resolution of 800 lines for display of an excellent, sharp, clear and consistent picture with fine detail. The set features a fully regulated power supply. Immediate delivery.

Circle Reader Service Card No. 27

Circle Reader Service Card No. 29

Circle Reader Service Card No. 28

Digital X-Y Plotter

Discon Corp., Ft. Lauderdale, Fla., has developed a digital x-y plotter requiring no conversion, on Air Force contract. It utilizes 6-digit input numbers and 8-digits/pt. printer input, from manual keyboard, paper tape, or punched card. Plotting area 1.5 meters square offers nominally ± 0.05 mm accuracy with ± 0.025 repeatability at plotting speed of 25 pts./min. All solid state photoelectric sensors are utilized.

Circle Reader Service Card No. 30

Xenon Power Supplies

Christie Electric Corp., Los Angeles, has added 4 new models of d-c power supplies designed specifically for operating Xenon and Mercury-Xenon arc lamps. This most versatile and complete line of its kind includes both regulated and manual units. Covering lamp ratings from 150 through 10,000 watts, they will operate any of two or more different lamp sizes, either Xenon or Mercury-Xenon. They include automatic current regulation as well as extremely low current ripple and other special features for longer lamp life.

Unique "slope control" automatically provides either regulated constant current, constant power, or increasing power. This enlarged line is ideally suited for, and is currently widely used in, such applications as solar simulation, data display systems, scientific instruments, and projection systems, to name a few, according to the manufacturer. It can' be furnished to MIL Specs.

Circle Reader Service Card No. 31

Video Document File

Ampex Corp., Redwood City, Calif., has announced a new Videofile document filing and retrieval system which is completely automated for microfiling. It stores documents as recordings on magnetic video tape and provides fast, automatic access and flexibility in file organization. Files are presented to the user either as pictures on a television screen or as printed copies. The Videofile system makes it possible to file and retrieve documents and update individual files at the touch of a button. It is the first micro-filing system with the flexibility necessary for high speed, automatic handling of documents in large, active files.

The first Videofile system will be delivered to NASA's Marshall Space Flight Center, Huntsville, Ala., by early 1966. That $1 million system will be used as a reference library for technical reports of component tests and reliability data for the use of NASA centers and prime contractors throughout the United States. NASA expects future expansion of the system to provide direct access to the library from key points across the country.

Circle Reader Service Card No. 32

Circle Reader Service Card No. 33

Electroluminescent Panels

High resolution thin-film electroluminescent prototype test panels and large-area XY-matrix panels are described by Sigmatron Inc., Goleta, Calif., for R&D, military and other electronic systems users in a new Products/Capabilities brochure just published by the specialist in this and related advanced high-vacuum technology. Forthcoming Sigmatron developments cited include high contrast/dark field electroluminescent panels; 1000-line and larger panels using mosaic arrays; and transparent panels.

The publication says high operating brightness is a prime feature of Sigmatron activity. Outlined physical characteristics of prototype test panels include: Crossed-grid electrode configuration for XY drive of elements; Resolution, 33 lines per/in.; active lamps/panel, 784; lamp size, .020" x .020". Packaged dimension size is 1-7/8" x 1-7/8" x 5/16". Large-area panels are designed for scan-type presentation of symbolic digital format data. The frame is protected by plexiglass overlay, front and back. Packaged size is 11⅝" x 11⅝" x 1⅝". Custom fabrication takes approximately 60-90 days.

Circle Reader Service Card No. 34

Trace Recording Camera

A new trace recording camera, compactly designed for use with small transistorized oscilloscopes and display instruments, has been developed by the Electronic Instrument Division of General Atronics Corp., Philadelphia, Pa. The camera, Model GA-400, uses the new Polaroid film pack for immediate prints without conventional processing, and offers a 1:1 object-to-image ratio.

The unique "piggy-back" design of the new camera saves aisle and working space and eliminates the imbalance of conventional front hanging bulk when mounted on lightweight display instrumentation. A special tilt-away feature permits direct viewing of the cathode ray tube. Trace viewing while the camera is in place is made possible through a mirror arrangement in a "peep port."

Circle Reader Service Card No. 35

Analog Plot Digitizer

A new analog plot digitizer, Model 302, is being introduced at the FJCC by Calma Co., Santa Clara, Calif. Model 302 converts analog graphical information to coded digital tape for digital computer processing and analysis. Incremental coordinate data is generated without potentiometers or analog-to-digital voltage converters.

As the analog plot is traced with a movable stylus, each 0.01-in. movement of the stylus generates a pulse. Each incremental pulse is automatically (without a manual input instruction for each character) recorded in a single character on IBM-compatible, 7-channel magnetic tape. The task of summing the increments for whole-value coordinates is left to the final processing computer. The Model 302 features a 500 character/sec., 556 bpi output incremental tape recorder and an overall maximum digitizing speed of 125 inches of analog plot per minute. Accuracy is ± 0.012 in.

Circle Reader Service Card No. 36

Rotating Deflection Yoke

CELCO, Mahwah, N.J. announces immediate delivery of its new rotating deflection yoke for high-resolution PPI scans. Features include ball bearings, silver slip-rings, encapsulated coils and high precision gears. A wide range of inductances is offered. Distributed, low-capacitance windings assure fast rise and recovery times. Minimum spot shift is achieved by the use of unusual magnetic materials. Two axis rotating yokes are available on special order.

Circle Reader Service Card No. 37

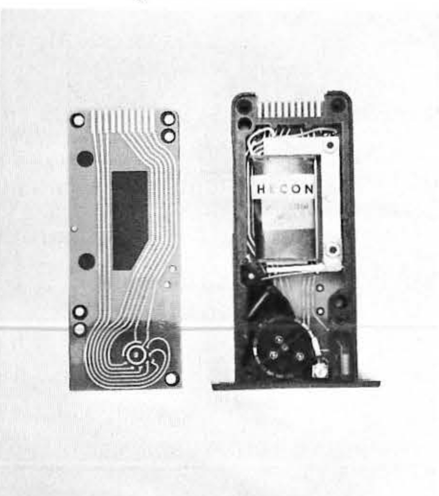
Multi-Station Displays

The Bunker-Ramo Corp., Defense System Div., Canoga Park, Calif., has announced a new 200 Series of display devices for mil and government applications. The display system includes three models of display stations with CRT and numeric, numeric/block-alpha, or alphanumeric keyboards operating into universal control units. The control units may interface into a communications network, a central processor, or a combination of both. Display message lengths range from 32 to 786 characters. The character library includes full alphanumerics, plus data and special function symbols; both input and response messages may be optionally edited, corrected, changed, or deleted.

Used as a primary terminal device, the displays can either replace or supplement other types of input/output terminal equipment such as page printers and paper tape devices. The display system is designed to operate with any general-purpose data processor and practically any number of stations may be used to form an integrated processing/communications network.

Circle Reader Service Card No. 40

Single-Decade Counter



Hengstler Numerics Inc., Palisades Park, N.J., is offering a new FR 967 single-decade counter which incorporates "roller" contacts to provide longer life and higher speeds. Two flush-printed circuit boards provide accurate electric transfer, reset, and straight decimal electric readout. Rhodium-plated circuits used in conjunction with the flush design insure long board life and overall counter life.

The application of hard-gold plated rolling ball contacts, utilizing precision-ground balls that are spring loaded to maintain the proper contact pressure and roll over the circuit board surfaces, provide continuous positive contact even after prolonged use. It is capable of 50 counts/sec. and has a life expectancy in excess of 200 million actuations.

Circle Reader Service Card No. 41

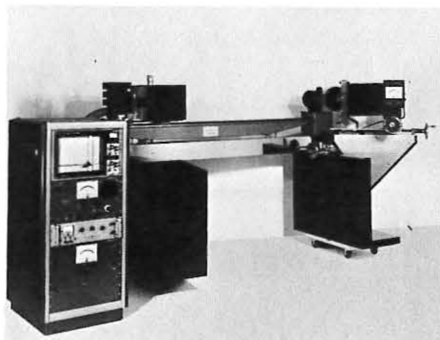
Video Analyser

Colorado Video Inc., Boulder, is producing a Model 301 video analyser which incorporates two unusual features. The equivalent of line selection is provided at field rates, thus allowing a new dimension in picture analysis with a resultant clear, bright, single trace oscilloscope pattern. The unit can actually display video waveforms on the screen of a normally operating TV picture monitor, providing a large, highly visible, trace, and direct correlation between picture content and video waveform.

It includes both vertical and horizontal marking signals for convenience in making point-by-point scene brightness analysis. Other features include remote control, internal calibration, and a reference grating generator. Delivery is 60-90 days ARO.

Circle Reader Service Card No. 42

Lens Test System



The Newtek Lens System measures modulation transfer functions of optich through a carefully selected combination of light source, sign wave pattern generator, collimator, test bench, and recorder. The unit is completely automatic, being internally programmed to produce a continuous sequence of spatial frequencies and to measure and plot the MTF Curve.

The instrument produces lens modulation transfer function accurate to 2% over a range of resolution from 2.5 to 200 lines per millimeter, and from any point in the field of a lens from 0 degrees to 45 degrees. Focal lengths from 0.5 to 20 inches with apertures from F/1 to F/100 may be measured. Manufactured by Newtek Inc., Woodside, N.Y., they are marketed through Traid Corp., Encino, Calif., and Wheaton, Md.

Circle Reader Service Card No. 43

Indicator Lights

Dialight Corp., Brooklyn, N.Y., includes in its products lines of subminiature indicator lights, single terminal, fully insulated, for use on grounded circuits. They meet or exceed environmental and operational requirements of MIL-L-7806 and MIL-L-3661. Available series include those with omnidirectional lenses; non-dimming lights; dimming indicator lights (mechanical or polaroid); lights with flat cylindrical lenses which permit use of hot-stamped or engraved legends; and light shield indicator lights which mount from front of panel in 15/32-in. clearance hole.

Circle Reader Service Card No. 44

½-In. Numeric Readout

A new DiGi series of ½-in.-width numeric readouts styled for industrial applications has been announced by Microphysics, Westbury, N.Y. The new line, Series 16, is an adaptation of the firm's Series 11 Mil Spec design. It utilizes only 7 bar-matrix elements, the unit has a numeral size of 17/32" and a lamp life of 1 million hours at a 4.0 V lamp voltage with 50 ft. lambert brightness. Outstanding use benefits of this new series include 170° visibility without loss of readability, low power input capability and a white, bright presentation. Specifications of the new type are as follows: Current (amps) per lamp, 0.055; current (amps) max. "8", .39 (less dec. pt.), 0.44 (W/ built-in dec. pt.); ave. brightness, 50 ft.-lambert; upper operating temp., +55°C; shock, 50g; vibration, 20g to 2000 cps; Relative humidity, 95%.

Circle Reader Service Card No. 45

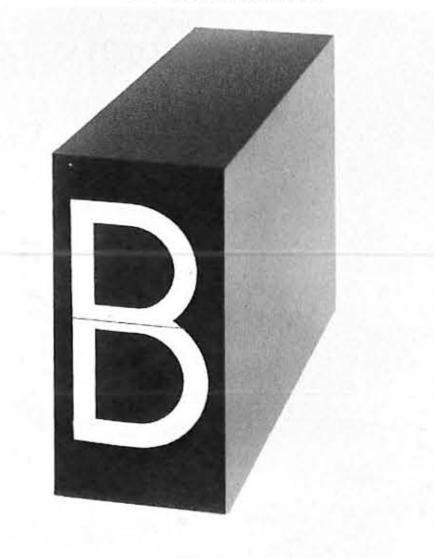
Dot-Bar Generator

Cohu Electronics' Kintel Div., San Diego, has announced a new dot-bar generator that provides test patterns for TV systems having scan rates from 525 to 1029 horizontal lines. Termed Model DBG-2, it is designed to measure the linearity of the television system and its component equipment, as defined by EIA Standard RS-170.

Four test patterns may be selected for modulating the incoming video signal: horizontal bars, vertical bars, crosshatch or grating, and dots. The dot pattern is useful for convergence of color television receivers. A polarity control provides either a white or black pattern on the monitor. The solid-state dot-bar generator operates with either composite video or external sync pulses, and patterns are adjustable for width, number and position. It is 9 x 6 x 5 in. and weighs 3 pounds. Available from stock.

Circle Reader Service Card No. 46

40-Position Readout



Visiontron, New York City, has just announced a new Model 404 alphanumeric readout which utilizes the flap principle to provide 40-position display. Numbers 0-9, letters A-Z all in letters 4 in. high and 2 in. wide, and four blank positions for display of special symbols are incorporated. Readout characters are of high contrast white on non-glare black, with unlimited color combination selection as optional.

Display definition remains constant regardless of ambient light conditions. No bulbs, luminous or projection devices used. The 404 with built-in decoder and memory does not depend on pulse count to reach correct readout position, as readout position is controlled positively through self-seeking 8-channel code directly, eliminating need for reset. Applications include computer readout systems, instrument readout, betting display boards, process control boards, status display boards, etc.

Circle Reader Service Card No. 47

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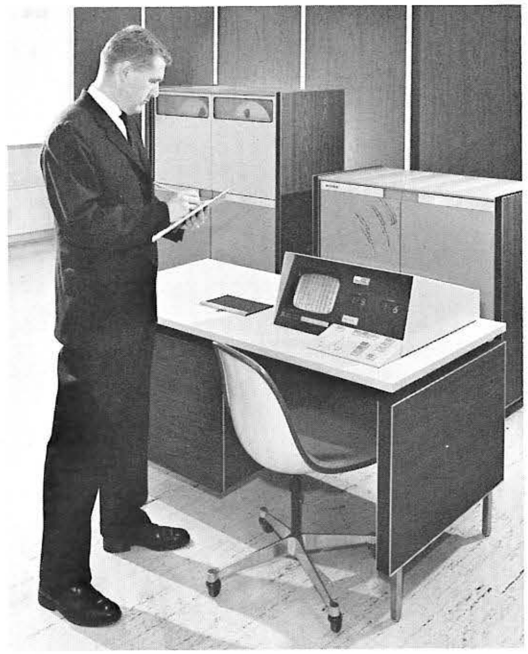
ENGINEERS

MAGNETIC TAPE RECORDERS



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Circle Reader Service Card No. 50

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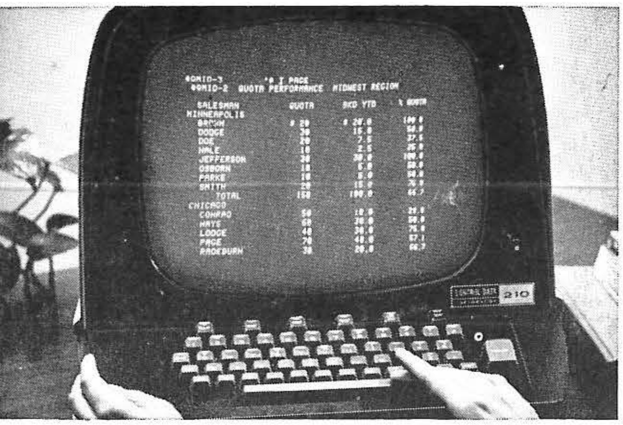

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