Volume 3 Number 6 November/December 1966

Information Display

Journal of the Society for Information Display

YOUR QUICK SELECTION GUIDE to Spectra-Physics' STABILITE* Helium-Neon Gas Lasers

Here is the new generation of CW gas lasers, the *working* generation. These are the lasers being built into today's systems, the lasers that will be doing tomorrow's jobs.

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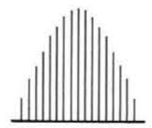
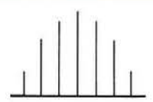
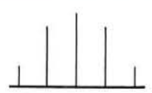
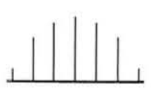
	MODEL	POWER TEMoo 632.8nm milliwatts	LENGTH overall inches	INSTANTANEOUS SPECTRUM axial modes center @ 4.7 x 10¹⁴ Hz 632.8nm	INSTANTANEOUS SPECTRUM axial mode spacing MHz	PRICE with exciter (dollars)	APPLICATION
	* 125	50	75		83	$8500.	General purpose for exacting applications such as holography, Raman Scattering, signal processing. Specially suited for factory installations, original equipment manufacturers and military systems configurations. Most appropriate STABILITE for a particular application is often determined by price/power/size considerations.
	* 124	15	32		214	3850.	
	* 123	7.0	22		341	2900.	
	* 122	3.0	16		517	1950.	
	119	0.1	9		1500	4850.	Single wavelength applications in heterodyne setups; long-path difference interferometry.
	130B	1.0	14		500	950.	General purpose where low cost and utility are primary considerations.
	115	3.0	29		250	3490.	Experimentation where micrometer adjustments, exciter modulation, r-f excitation are advantageous.

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* New STABILITE 6-page color brochure.
** "GAS LASERS," an article by Dr. A. Bloom, reprinted from the joint issue of *Proceedings of the IEEE* and *Applied Optics*, Oct.-'66.

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Volume 3 Number 6 November/December, 1966

Information Display

Journal of the Society for Information Display

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the cover

Artist's conception of the frequency spectrum, a basic tool in Information Display technology, is portrayed in oil painting courtesy of Raytheon Company, Lexington, Mass. Contrast between bright spectrum and flat, pseudo monochrome background emphasizes utility of color in display field.

Editorial

How to start a chapter

At present, the *Society for Information Display* has no chapters in the Central Region, but there are three areas having twenty or more members, where chapters could be organized within the next year or so. These are: Chicago, Dallas-Ft. Worth, and Minneapolis-St. Paul. Within a few years we should see the establishment of chapters in Detroit-Ann Arbor, Huntsville, and Ft. Wayne, since each of these areas has about ten members, at this writing.

In discussing the formation of chapters with *SID* members in this region, the same two questions have arisen repeatedly: (1) What is the procedure for starting a *SID* chapter? and (2) What are the benefits for local members? I have decided to turn Louis Seeberger's invitation to write a guest editorial into an opportunity to discuss these two questions for all *SID* members who live in areas remote from existing chapters.

Regarding the first question, members who are interested in forming a chapter should notify Phillip P. Damon, Membership Chairman, SID, 2202 Alta Vista Drive, Vista, California. He can do the following for you:

(1) Provide a sample set of chapter bylaws.
(2) Advance money to cover organizational costs, if you will advise him of your plans and requirements.
(3) Arrange for *SID* to subsidize much of the expense of the first meeting, if necessary.
(4) Provide a speaker for your first meeting, if needed.
(5) Provide other materials useful in getting started, including membership applications and copies of the journal.

Members who decide to form a chapter need do only the following:

(1) Draw up a set of bylaws consistent with the bylaws of *SID*.
(2) Prepare a petition for chapter formation signed by ten or more *SID* members.
(3) Submit both to Phillip Damon who will forward them to the Executive Committee for review and approval.

So much for the first question.

Regarding the second question, Louis Seeberger, in his guest editorial in the November/December 1965 issue of *Information Display*, lists six benefits of active chapter membership. They are worth repeating:

(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".

Both questions have been answered, but I would like to take a fundamental look at the purpose of chapters, and offer some recommendations for those who are contemplating starting a chapter:

It will be useful to begin by considering the objectives of *SID* as expressed in the bylaws and in Dr. Luxenberg's guest editorial in the January/February 1965 issue of *Information Display*: "To encourage the scientific, literary, and educational advancement of information display and its allied arts and sciences . . ."

At the national level, this is being accomplished by:

(1) Publishing the journal.
(2) Holding technical meetings and seminars.
(3) Maintaining a central repository of data which is available to all members.
(4) Promulgating definitions and standards.

It is difficult for all members to participate in the activities of the Society at the national level. Accordingly, provision is made in the bylaws for the formation of chapters which assist *SID* in achieving its objectives at the local level by way of chapter activities in which most members can participate.

Since *SID* is a young organization, it has not been decided how chapters can best serve members at the local and national levels. Two recent guest editorials in *Information Display* have dealt with this topic: Dr. Bernberg, in the March/April 1966 issue, recommends that an organization committee be established to "take a good look" at the role of chapters. President Bethke, in the May/June 1966 issue discusses the need for better communication between chapters and national officers. I'm going to dodge the question of what should be the relationship between chapters and the national organization, and confine my remarks to how chapters can assist *SID* to meet its objectives at the local level.

As stated earlier I have some recommendations which stem from such considerations as the following: The informal discussions during the dinners before the chapter meetings are frequently more interesting than the formal chapter meetings. It's hard to find good speakers for chapter meetings. It's difficult to get some members to talk during formal meetings. The information explosion in our field makes it impossible for any *SID* member to keep up with the literature without help from colleagues. It's difficult to keep abreast of what other organizations are doing. It's amazing how little communication there is at work between people working in the same fields. There is a need for continuing education. It seems to me the following recommendations, for those who contemplate starting a chapter, flow naturally from the foregoing considerations:

(1) Keep meetings informal and emphasize communication between members rather than formal programs with outside speakers.
(2) Don't hold too many meetings and don't let outside speakers talk too long. One good meeting a year is

better than none at all and better than monthly meetings that are poorly attended. Let the frequency of meetings grow as chapter activity grows.

(3) Don't try to grow fast. Don't worry about size at all. A small chapter of interested members is better than no chapter or a large organization with few workers.

(4) Set up a program for keeping abreast of the literature and for keeping abreast of what the various display research, development, and manufacturing organizations are doing. Encourage members to give short reports on recent trips. Divide the work of reading the literature and reporting on it, among members.

(5) Organize small seminars on special topics whenever a few experts are available. Keep the seminars small and informal.

(6) Encourage each member to talk and publish. Encourage members to publish in *Information Display* and assist inexperienced members to prepare papers for publication.

(7) Make definite plans to sponsor a national technical meeting two or three years after formation of the chapter. This gives the chapter a concrete goal that can be achieved while other projects are taking shape. Allowing two to three years for planning reduces the rate at which committees must work. Don't plan a national meeting without consulting chairmen for previous meetings.

A chapter formed with the foregoing recommendation in mind would assist *SID* in achieving its objectives and would benefit members by keeping them truly informed of what is going on in one of the fastest developing technical areas — information display.

JOSEPH E. HOAGBIN
Central Regional Director
Society for Information Display

Joseph E. Hoagbin was recently elected Central Regional Director of the Society for Information Display for the term 1966-68. He has been a member of SID for three years and is a member of AAAS, IEEE, the National Society of Professional Engineers, and The Institute of Management Sciences. He is editor-in-chief of Management Science, Series C.

He was born in Philadelphia on May 17, 1917, attended Flint Junior College from 1937-39, attended The University of Michigan, on a part-time basis from 1950 until 1957, and received a B.S. in physics in 1955 and an M.S. in physics in 1957.

Mr. Hoagbin is a Research Engineer in the Institute of Science and Technology, The University of Michigan, where he has worked since 1950. Before this, he was an Experimental Physicist at AC Spark Plug Division of General Motors in Flint for eight years. He is currently engaged in research on techniques for interpreting infrared and radar imagery for combat surveillance. He has worked on specialized displays for air defense and combat surveillance, using man-machine simulation as an evaluation tool.

INSTANT DISPLAY

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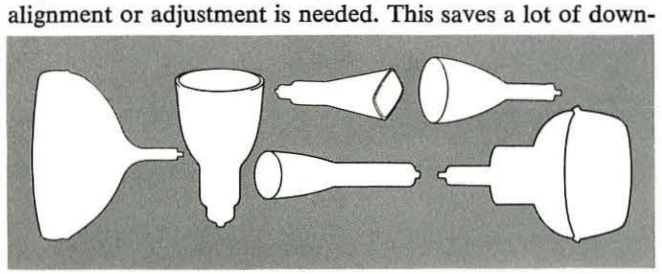

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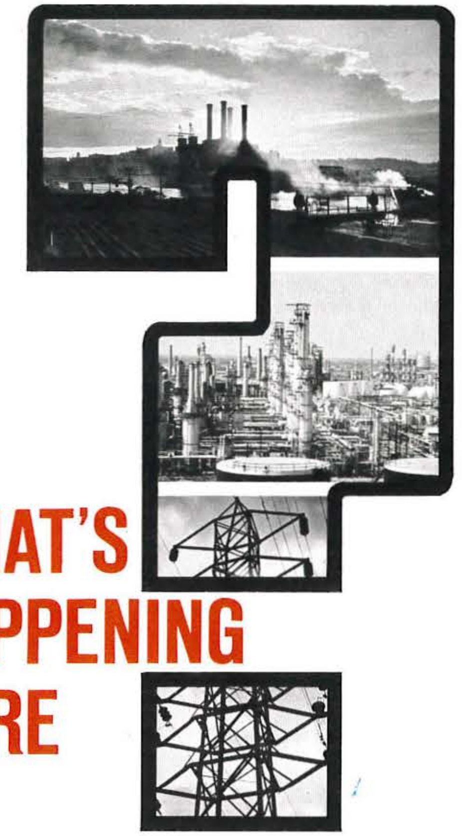

WHAT'S HAPPENING HERE

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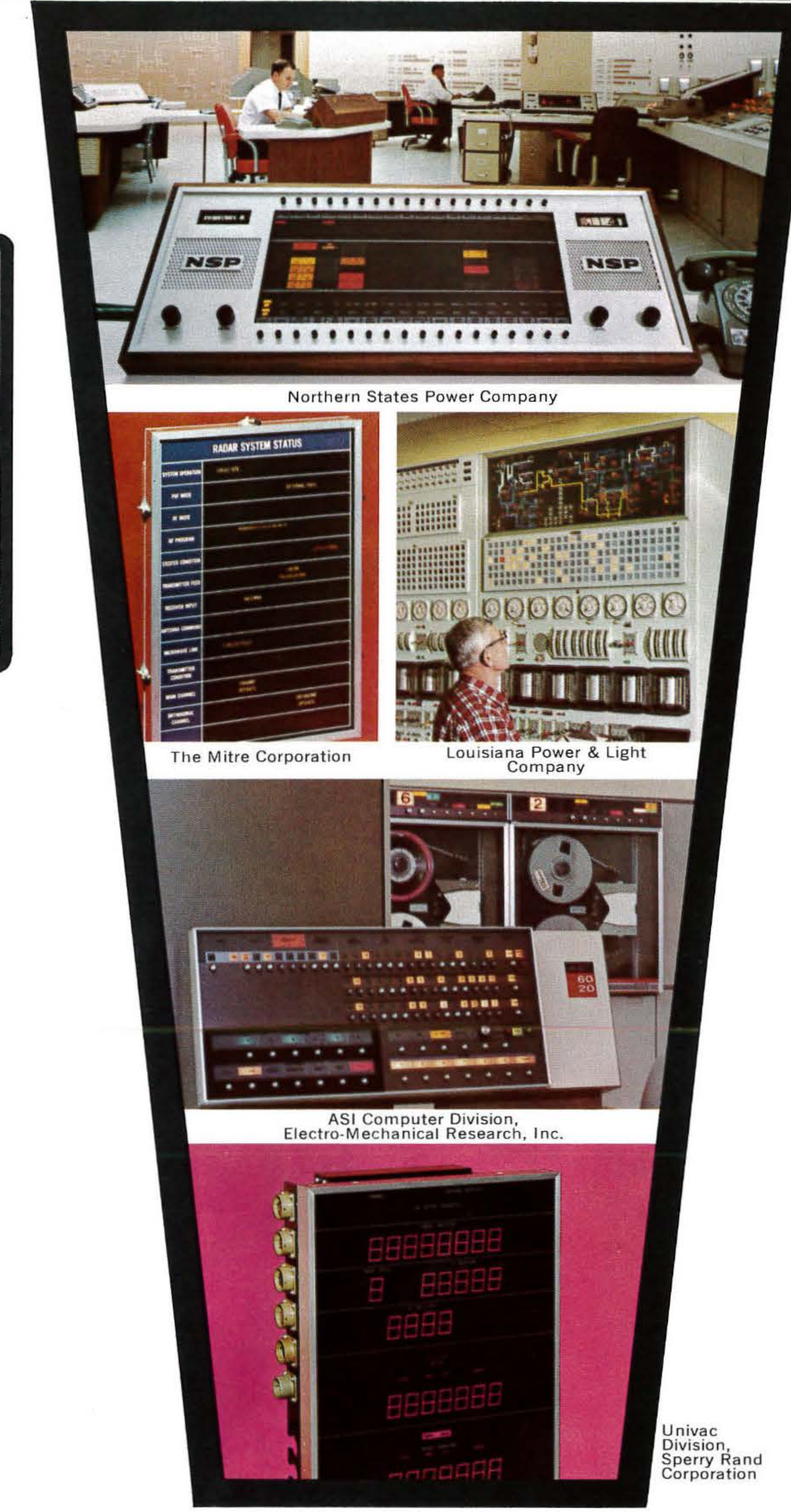
DATA•PANEL

DISPLAY SYSTEMS



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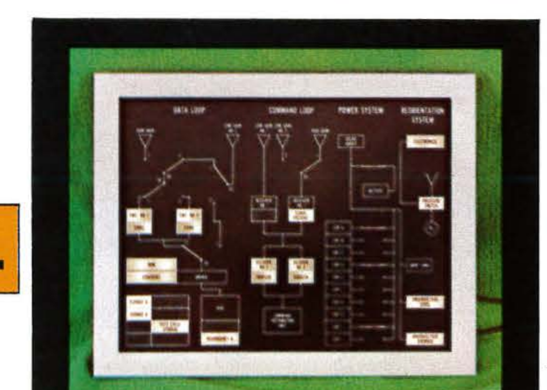
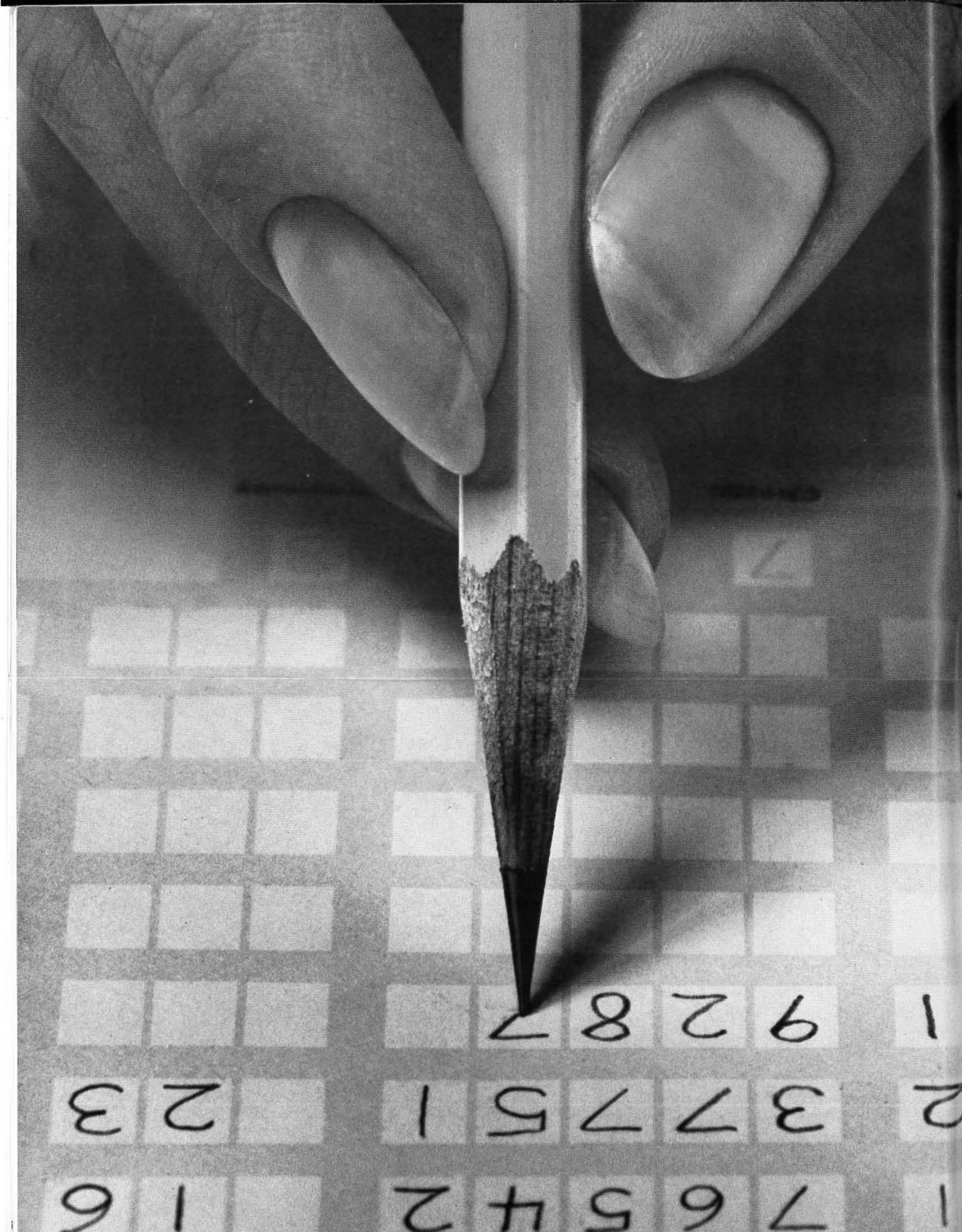


TRW Systems



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Now handwritten numbers are machine-readable. You can forget about conversion steps because the new IBM 1287 Optical Reader speeds handwritten numbers directly into an IBM SYSTEM/360.

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Then people can write numbers by hand for direct computer input. Let their sharp pencils help cut your data processing costs.

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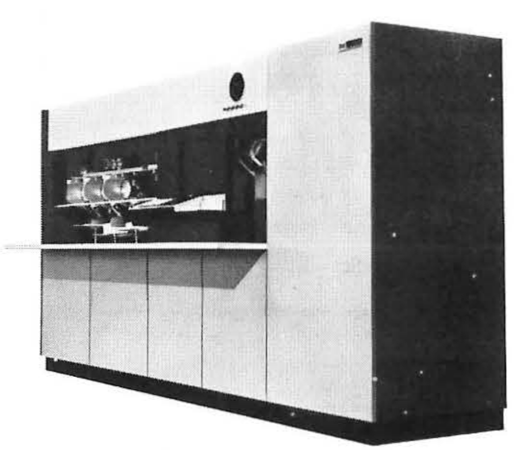

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See literature offer—Bulletin 54-A, 55-C, 63.

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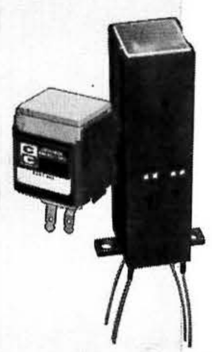
See literature offer—Bulletin 60



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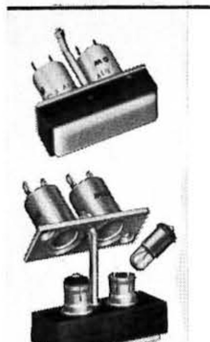
See literature offer—Catalog 120



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See literature offer—Catalog 120

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See literature offer—Bulletin 62

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44	Twinlite Bulletin 55-C
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48	Light and Switch Condensed Catalog 100
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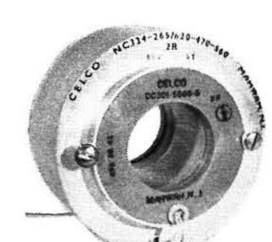

For correction of CRT distortions. Consists of static and dynamic focus and astigmatic coils.

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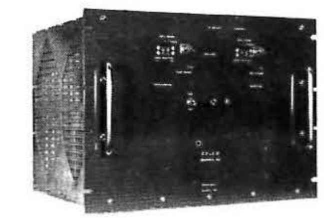

3, 6, 12 amp X-Y amplifiers matched to your yoke and response requirements. Available with regulated power supplies

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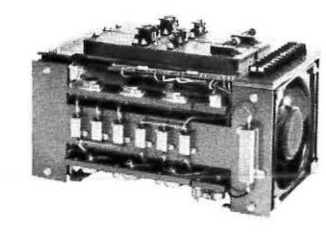

With regulated Quadru-Power Supplies. 12 amp change in less than 9 μsec. 0.02% linearity.

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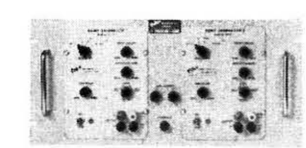

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INSTRUMENTS

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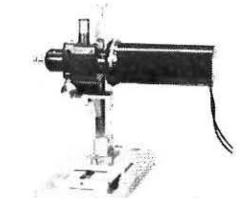

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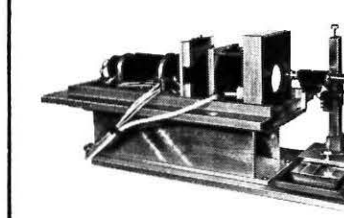

Contains all deflection, focus and corrective coils, micro-positioners for each, your CRT, complete shielding from all stray magnetic fields. Use for automating assembly lines, a reader of bubble-chamber photos.

Celco YOKES

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The Conrac CD Series X-Y CRT display costs less than 1000 dollars, even if you buy only one. You could pay up to three times as much and get less for your money. Just see our specifications, above. And because we built all of the circuitry on modular, plug-in boards we can usually modify it to suit your needs exactly. We use only one rectifier tube in the display. All the semiconductors are silicon. The Z axis amplifier input is an integrated circuit to give you still more performance and reliability. Check our price. See our specs. Then call Al Landsperger at 335-0541 (Area Code 213). Ask him about production quantity prices.

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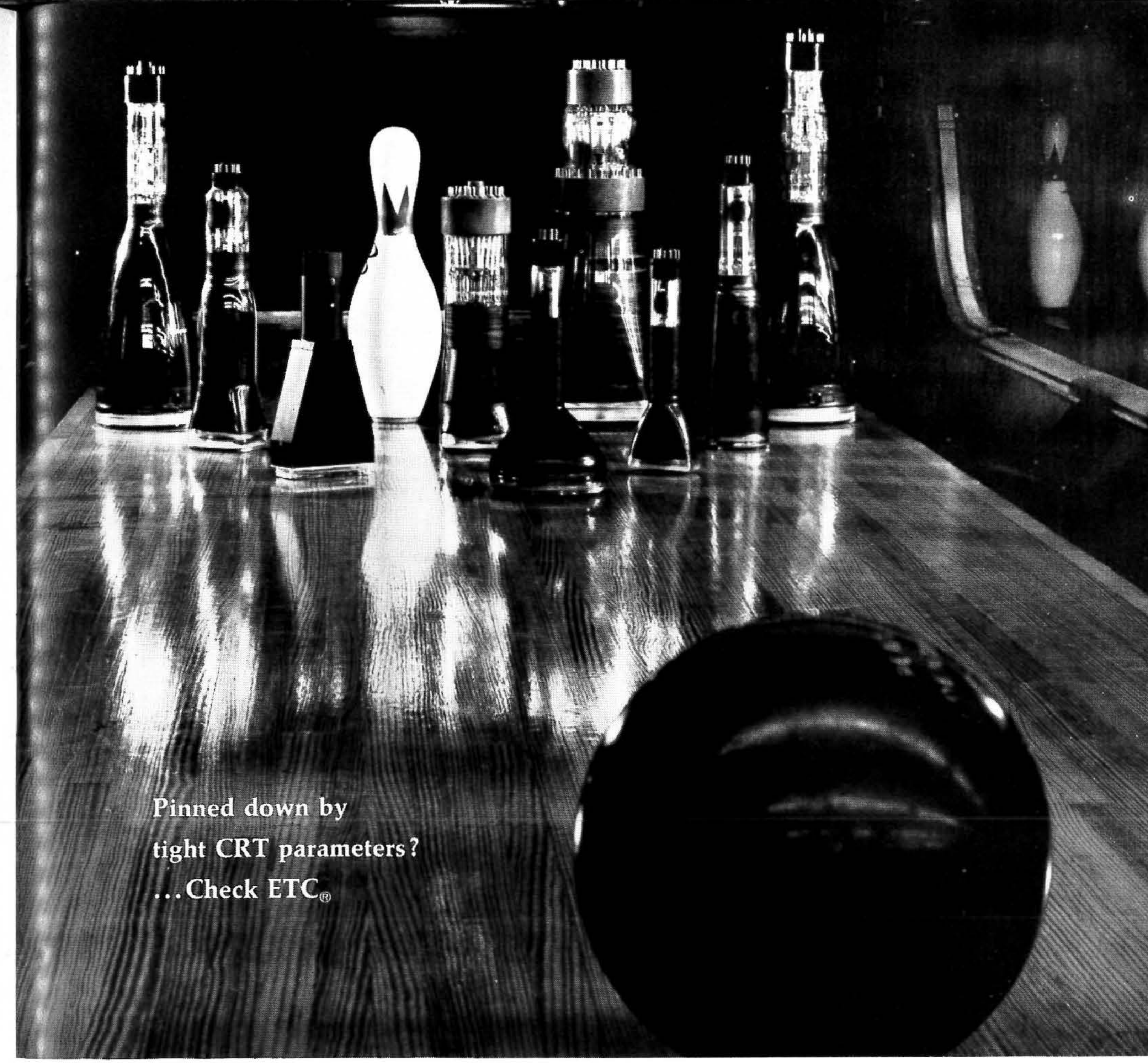

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Capacity and optimum configuration of displays for group viewing

[This paper was a standby paper for the Seventh National SID Symposium in Boston, and is being published by Western Periodicals, North Hollywood, in the Proceedings of that meeting.]

ABSTRACT

Deterioration of legibility with increasing viewing distance and obliquity limits the amount of information a display screen can convey to an immobile audience. The resulting display capacity and the degree of its utilization determine the efficiency of the display, where efficiency relates audience area to screen size for the most favorable screen/audience configuration.

The underlying geometric relationships, derived from legibility experiments, are presented in quantitative form and illustrated by examples. Their application enables a designer to determine optimum display configurations on the basis of geometry rather than intuition.

INTRODUCTION

The amount of information a display screen can convey and the size of the audience it can serve are limited by the resolving power of the human eye, which causes the legibility of small detail to deteriorate with increasing viewing distance and obliquity. While the effect of distance is obvious, the equally important effect of oblique viewing is usually overlooked.

When a display is seen from a fixed position, the viewing direction can considerably differ from the normal to the screen. If the screen is fairly large compared with its distance from the viewer, the viewing angle can also vary from one corner of the screen to the other. Under such conditions, the designer has to consider the combined effect of distance and obliquity on the legibility of the display.

It is the purpose of this paper to derive, from the results of specially designed legibility experiments, the quantitative rules that lead the designer to optimum display configurations.

VISUAL RANGE

Consider the effect of viewing distance, taking as target a black-and-white pattern reproduced at high magnification from photographic film. Close inspection may show an unsharp outline. However, if the transition from the density of the background to that of the pattern is confined to a fringe much narrower than the stroke width, this lack of definition has no practical significance.

When the viewing distance is increased, the definition should be degraded due to the limited resolving power of the human eye. Actually, the image will eventually appear even sharper than at close range. This occurs when the resolving power of the eye becomes the determining limitation, so that the appearance of the projected symbol is no longer different from that of an inherently sharp symbol, such as one cut from black paper. Without other cues or a *priori* knowledge, the viewer will then perceive a symbol with a perfectly sharp outline.

When the viewing distance is further increased, the apparent sharpness is preserved but, at some point, the symbol becomes too small for comfortable reading. While there may still not be any doubt about the identity of the symbol, prolonged reading may cause noticeable eyestrain. A good example is the print of telephone directories, for which even the normal reading distance exceeds what may be called the comfort range.

Finally, the viewing distance may become so long that the symbol can no longer be safely identified. There is obviously no sharp limit, but a practical legibility range can be defined as the longest distance from which an average person recognizes the symbol with a certain tolerable error. While the viewing distance used in a display system may exceed the comfort range, it must obviously stay within the legibility range.

Considerable effort has been made to determine the performance of the human eye under various conditions. In daylight the eye can resolve parallel dark lines separated by intervals equal to the stroke width as long as they are about one minute of arc apart. The so defined "resolving power" is identical with the legibilty range for symbols taking the special form of the standard line pattern of the resolution chart. To obtain the legibility range for symbols of a more general type, it would be necessary to identify the structure of the symbol with an equivalent number of lines per symbol. Other than intuitively, this equivalence can only be established by an experiment comparing the legibility of the symbol with that of line patterns of different pitch. Thus, the legibility range of the particular symbol has to be measured in any case, and the resolving power of the eye (or any other general measure of visual performance) is really quite irrelevant in the context of display optics.

Measuring the legibility range for a given type of symbols is simple. Figure 1 shows a test chart designed for that purpose. Its basic element, a ring filled with alphanumeric symbols in random orientation, is magnified in increments of 2¼ and stacked in a concentric pattern. By placing this test chart or a negative copy of it in front of the subject at a fixed distance long enough to make the innermost ring illegible, one can observe the variation of reading error with size and then interpolate the character size that would give a tolerable error ratio, say 1 percent. For characters of that particular size, the legibility range equals the actual distance from the test chart; for larger characters, as usually employed in group displays, the legibility range increases in proportion to character height. A comparison

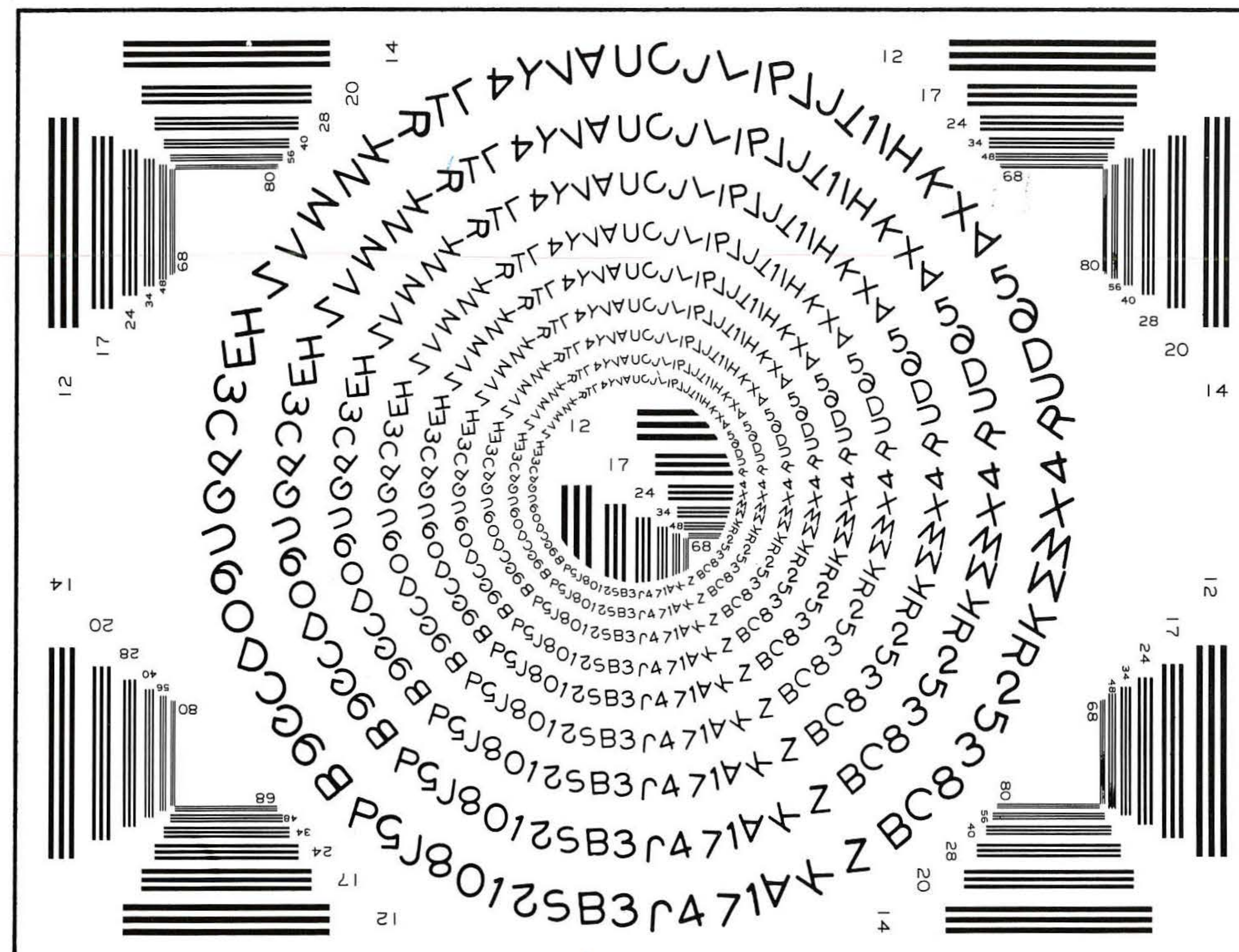

FIGURE 1: Chart for visual range test.

with the elements of a standard high-contrast resolution chart (included in Figure 1) shows that it takes about 5 line pairs per letter height to read the characters of the chart with no more than 1 percent error. As stated before, however, this comparison has only academic interest.

The legibility of individual symbols varies within rather wide limits depending on the intricacy of the pattern, and the legibility range of a given set of symbols is determined by the worst combination. For example, if the letter O can be identified at 28 feet, the distance at which the numeral 8 can be distinguished from the letter B is only 18 feet. On the same scale, the legibility ranges are 20 feet for the pair 5 and S, 21 feet for the pair A and X, 23 feet for the pair M and W, and 25 feet for the letter E.

Tests of this kind, simulating ambient illumination as well as brightness and color contrasts of the display, lead to a realistic estimate of the longest acceptable viewing distance or "visual range" for symbols of given type and size.

EFFECT OF OBLIQUE VIEWING

To visualize the effect of oblique viewing, refer to Figure 2. Consider first a target in the form of a magnified set of standard resolution bars attached to a wall at eye level so that the lines are vertical. If a person marks (with chalk on the floor, for example) the position where he is just able to resolve the lines, he describes a circle tangent to the wall at the symbol. This is not surprising: oblique viewing foreshortens the apparent pitch of the bars, and the viewer must approach the target so that the visual angle subtended by it remains the same. Thus the circle of marginal legibility shown in the upper left corner of Figure 2 represents the locus of constant visual angle in the horizontal viewing plane. If the bars of the target are now turned horizontal, pitch is no longer affected by oblique viewing, and the legibility remains constant on a semi-circle centered at the target, as shown in the lower left corner of Figure 2.

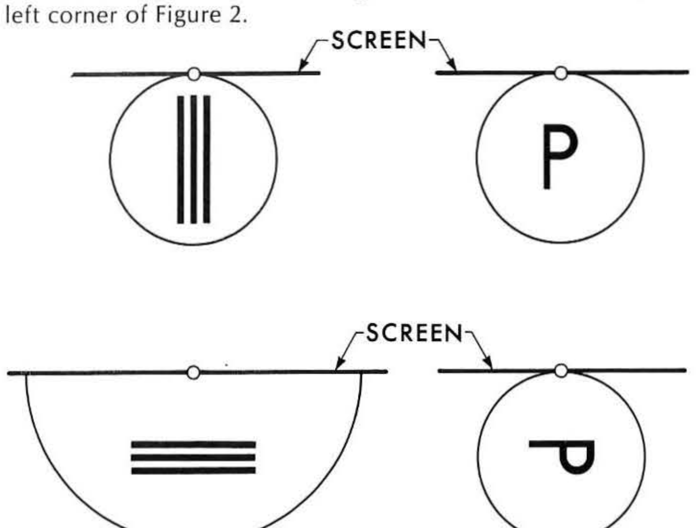

FIGURE 2: Loci of marginal legibility for resolution bars and letter P. The symbols are displayed at eye level on a vertical screen, at left in upright position, at right turned horizontal. The locations of the symbols are indicated by the small circles.

With alphanumeric symbols instead of resolution bars, the situation is materially different. Whether the symbol is in the normal upright position or turned horizontal, the locus of marginal legibility remains a full circle tangent to the wall at the symbol. The right side of Figure 2 illustrates this for the letter P. Carefully conducted experiments at Aeronutronic have verified that even the letter E behaves in the same manner, although it possesses a certain degree of anisotropy similar to that of resolution bars.

Thus oblique viewing of alphanumeric or similarly isotropic symbols reduces the viewing range in proportion to the cosine of the angle of obliquity. Geometrically, the locus of marginal legibility is described by the surface of a sphere tangent to the plane of the display. The diameter of that sphere equals the previously defined visual range of the symbol which, in viewing plane, subtends the same visual angle at any point on the sphere. While the visual range is proportional to the linear dimensions of the symbol, the visual angle that the symbol must subtend depends only on shape.

AUDIENCE SPACE OF AN EXTENDED DISPLAY

To apply these elementary findings to extended displays, consider a symbol of given visual range which is free to move over a rectangular projection screen. Its legibility is again limited by the tangent sphere of diameter equal to the visual range, but this sphere now moves with the symbol. To read the symbol regardless of its position on the screen, the viewer must stay inside all possible spheres, that is, within the volume common to the four spheres which touch the screen at the corners.

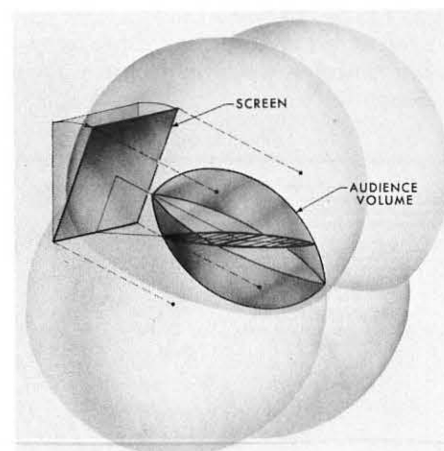

FIGURE 3: Audience volume and maximum audience area.

Figure 3 illustrates the case of a rectangular screen of height/width ratio $1/\sqrt{2}$ with the lower edge at eye level. The assumed visual range is $\sqrt{2}$ times the screen diagonal. The strongly outlined football-shaped volume which is common to the four corner spheres represents the audience volume, and its eye level intersection is the audience area. Because of the symmetry of the audience volume, the largest audience area (crosshatched) is obtained when the screen is tilted so that the center of the audience volume falls at eye level, as shown.

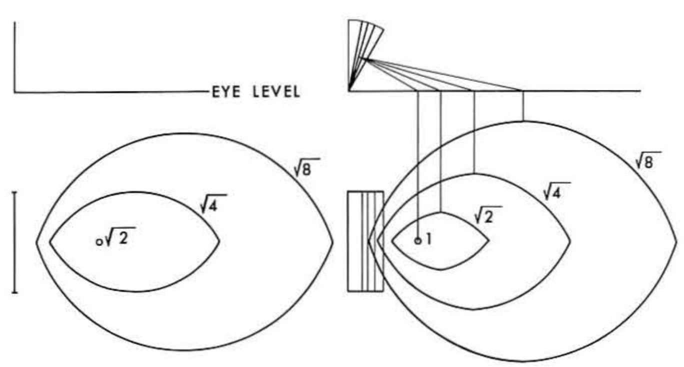

FIGURE 4: Audience areas at different visual ranges for vertical screen (left) and screens with optimum tilt (right). Top of drawing shows side view of screens, assuming height/width ratio of $1/\sqrt{2}$ and lower edge at eye level. Visual ranges are indicated in multiples of screen diagonal.

Figure 4 compares the audience areas of a vertical and a tilted screen for different visual ranges, assuming that the tilt angle is optimized for each range. The small circles indicate those viewing positions where, for the range/diagonal ratio indicated, the audience area degenerates into a point. It can be seen that the advantage of the tilted screen is most pronounced at lower range/diagonal ratios.

After these preliminaries, which lead to the notions of visual range, audience volume, and maximum audience area, we shall now define display utilization, capacity, and efficiency.

DISPLAY CAPACITY AND UTILIZATION

As the tangent spheres at the corners of the display can only intersect if their diameter exceeds the screen diagonal, the symbols must remain large enough to keep the visual range at least equal to the screen diagonal. This condition restricts the capacity of the display. Symbols subtending just the required visual angle δ at the desired visual range V must have the size $(V\delta)^2$. Of such symbols, a screen of area S can hold the number

$$N = \frac{6}{(V\delta)^2} \qquad (1)$$

The number N can be increased at the expense of the visual range until V is reduced to the screen diagonal D. At that limit, the audience area shrinks to a point at the distance D/2 from the center of the screen, and the possible number of symbols reaches its maximum value

$$N_{max} = \frac{S}{(D\delta)^2} \qquad (2)$$

Taking not only the number of symbols into account but also their intrinsic complexity, which is measured by the visual angle, we define the "capacity" as the solid angle $N_{max}\delta^2$. This capacity is independent of the absolute size of the display. It is fully determined by the shape of the screen and assumes its highest value of ½ steradian when the screen is square.

For example, a square display which is filled to capacity with symbols requiring a visual angle of 6 minutes can hold a total of 160,000 symbols, or 400 symbols per line. While this capacity may appear quite high, it is only legible from a single view point.

To provide a finite audience area, the display must be used below capacity. Its "utilization" is conveniently measured by the solid angle $N\delta^2$, which may be interpreted as the effective display field. While utilization relates the screen area to the visual range, it is always smaller than the solid angle subtended by the screen at the periphery of the audience. The reason for this is, those symbols which happen to be viewed from essentially normal directions exceed the minimum visual angle and therefore contribute more to the screen angle than to the effective display field.

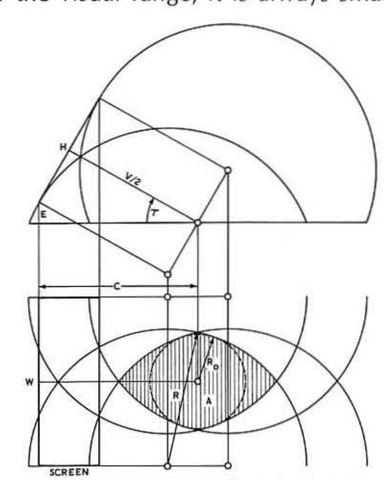

FIGURE 5: Optimum display geometry for single screen.

OPTIMUM SCREEN/AUDIENCE CONFIGURATION

As pointed out previously, the largest audience area is obtained when the screen is so tilted that the center of the audience volume falls at eye level.

This optimum geometry is illustrated in Figure 5 for a screen of height H, width W, diagonal D, and lower edge at a height E above eye level. τ is the tilt angle measured from the vertical and C the horizontal distance to the audience center from the lower edge of the screen. Attached at the corners of the screen are tangent spheres of diameter V equal to the visual range. Their eye level intersections appear in the plan view as circles of radius R which limit the audience of area A (crosshatched). The area enclosed by the inscribed circle (dotted) of radius R_0 will become significant for display systems with several screens.

Figure 5 yields the following geometric relationships:

$$C = \frac{1}{2}\sqrt{V^2 + H^2 - 4E^2} \qquad (3)$$

$$\sin\tau = 2\,\frac{CH + EV}{V^2 + H^2} \qquad (4)$$

$$\cos\tau = 2\,\frac{CV - EH}{V^2 + H^2} \qquad (5)$$

$$R = \frac{1}{2}\sqrt{V^2 - H^2\cos^2\tau} \qquad (6)$$

$$R_0 = R - \frac{1}{2}\sqrt{W^2 + H^2\sin^2\tau} \qquad (7)$$

$$A = 2R^2\left(\arccos\frac{H\sin\tau}{2R} - \arcsin\frac{W}{2R}\right) + HW\sin\tau - \frac{1}{2}\left(W\sqrt{V^2 - W^2} + H\sqrt{V^2 - H^2}\right) \qquad (8)$$

If the screen dimensions H and W and the display utilization $N\delta^2$ are given, Equation (8) can be combined with (1), (3), (4), (5), (6) to yield the audience area A. Dividing the resulting value of A by the screen area S = HW, we obtain the ratio A/S as a function of the shape of the screen (H/W) and the utilization of the display. This ratio can be interpreted as a measure of efficiency.

DISPLAY EFFICIENCY

To define display efficiency in a meaningful manner, we refer it to the ideal case of zero utilization for which we postulate unit efficiency. When the utilization $N\delta^2$ decreases to the point where, according to Equation (1), the linear screen dimensions become very small compared to the visual range, the spheres tangent at the corners of the screen merge, and the audience fills a circle whose area $V^2 \pi/4$ is independent of the shape of the screen. For this asymptotic case, we obtain with Equation (1)

$$\lim_{N\delta^2 \to 0} \frac{A}{S} = \frac{\pi/4}{N\delta^2} \qquad (9)$$

We see that the size of the screen required for a given audience is proportional to the utilization of the display: to display twice as many symbols, one has to double the area of the screen.

This proportionality is lost at higher utilization, where the ratio S/A increases faster than $N\delta^2$. To permit the display of more symbols, not only must the screen be enlarged but the individual symbols as well. This reduces the information per unit screen area and amounts to a loss of "display efficiency," which we now define as

$$\eta = \frac{A}{S}\frac{4}{\pi}N\delta^2 \qquad (10)$$

Figure 6 shows the variation of display efficiency with utilization for screens of different height/width ratios and with the lower edge at eye level. The efficiency decreases

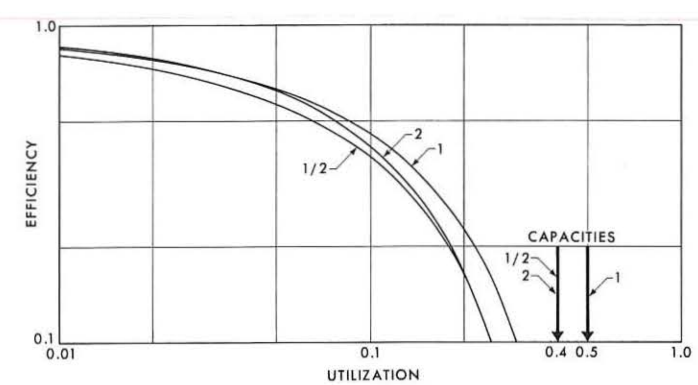

FIGURE 6: Efficiency versus utilization for screens of height/width ratio 2, 1, ½ with lower edge at eye level.

with increasing utilization from unity at vanishing utilization to zero at capacity. Except near capacity, the effect of the height/width ratio is not very pronounced. This does not mean it can be ignored; the aspect ratio of the screen has a strong effect on the shape of the audience area and has to be considered in laying out the seating arrangement.

Because the display efficiency determines the screen area (and with it the illuminating light flux) needed per information element per viewer, its inverse is a direct measure of equipment cost. If too much information is crammed into one display, its cost can become prohibitive. However this is only part of the cost/effectiveness story: if there is more information than the viewer's mind can assimilate, the expense of conveying it to his retina may still be wasted.

EXAMPLES OF SINGLE-SCREEN DISPLAYS

A few examples will illustrate how the concept of efficiency can be applied to the design of optimum displays. As the first example, we consider a screen of height/width ratio 2 with the lower edge at eye level, and display an array of 400 x 200 symbols each requiring a visual angle of $\delta = 0.1$ degree in each dimension. The utilization of this display is $N\delta^2 = 0.24$ ster, which amounts to 60 percent of capacity. For this utilization, Figure 6 shows a display efficiency η of 10 percent. According to the efficiency definition (10), this means that the screen must be 3.05 times larger than the audience. Thus, to serve a $20 m^2$ audience, we need a $61 m^2$ screen.

The configuration of the optimum system is now fully defined. The screen is 11 m high and 5.5 m wide. The symbols measure 2.75 cm x 2.75 cm and have a visual range V of 15.75 m. According to (4) and (5), the screen is tilted at an angle $\tau = 35$ degrees. According to (3), the center of the audience is at a distance C = 9.7 m from the lower edge of the screen. According to (6), the circles which limit the audience area have a radius R = 6.5 m. As shown in Figure 5, their centers are offset with respect to the center of the audience. The lateral displacement is equal to the half-width of the screen. The longitudinal displace-

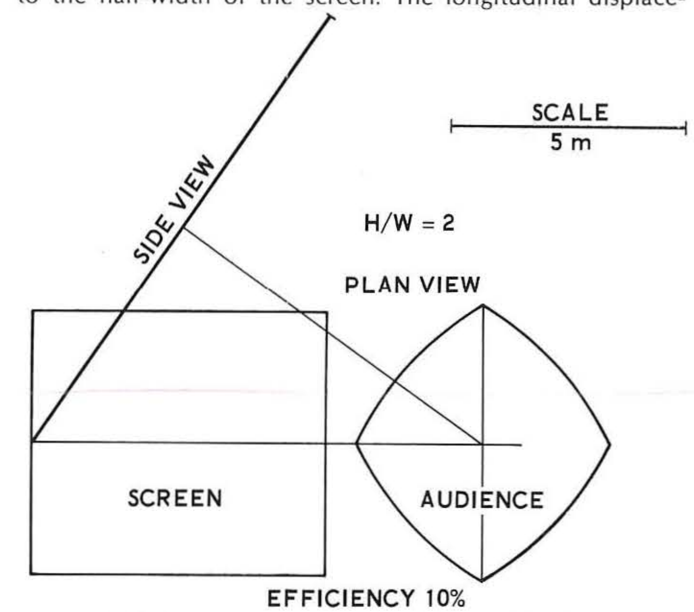

FIGURE 7: Optimum configuration for display utilizing 0.24 ster (60 percent of capacity).

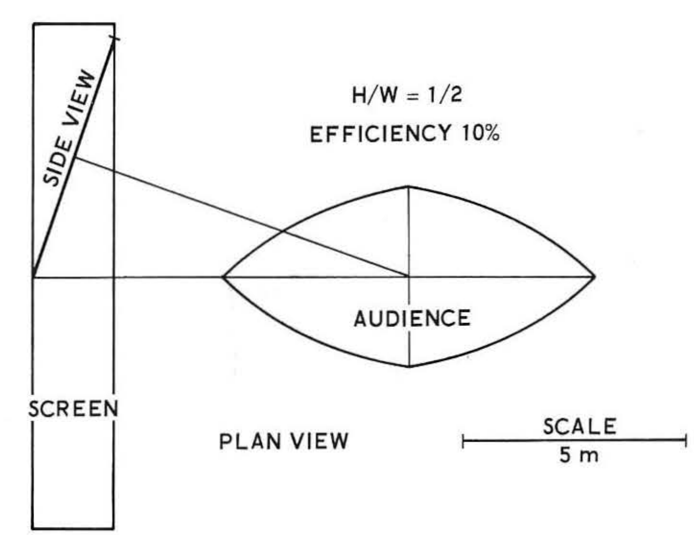

FIGURE 8: Optimum configuration for display utilizing 0.24 ster (60 percent of capacity).

ment is equal to half the horizontal projection of the screen height, or b sin τ = 3.2 m. The resulting screen/audience configuration is shown in Figure 7.

If we now determine in the same manner the optimum dimensions for a screen of height/width ratio ½, leaving all other assumptions unchanged, we arrive at the configuration shown in Figure 8. Comparing Figures 7 and 8, we notice an inverse relationship between the width of the audience and the width of the screen. The size of the audience area, however, is approximately the same in both cases. While both configurations may appear highly undesirable, they do represent optimum designs for the very high display utilization assumed.

At lower utilization, the situation improves drastically.

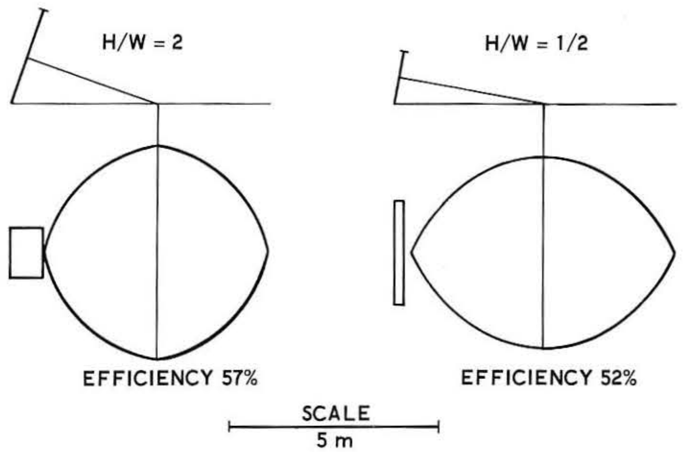

FIGURE 9: Optimum configurations for displays utilizing 0.06 ster (15 percent of capacity).

In Figure 9, drawn to the same scale as Figures 7 and 8, the number of symbols has been reduced to one half in each dimension. If efficiency were independent of utilization, the required screen area would vary in proportion to the utilization, and would decrease to one fourth. Actually the efficiency improves more than five times, from 10 percent to 57 percent for the screen of height/width ratio 2, and from 10 percent to 52 percent for the screen of height/width ratio ½. As a result, the screens of Figure 9 are more than twenty times smaller than the screens of Figure 7 and Figure 8, which were designed for four times higher utilization.

MULTI-SCREEN DISPLAYS

The examples of Figures 7, 8, and 9 suggest that displays requiring effective fields comparable with the capacity of a single screen should be broken up into several displays with a common audience area.

Figure 10 shows as an example a four-screen display, derived from the configuration shown in the left half of Figure 9. The screens, of height/width ratio 2, are linked at the upper corners and so arranged that their nearly circular audience areas are concentric. The resulting common audience area differs very little from the inscribed circle of radius R_0 shown in Figure 5. Disregarding that difference and calculating R_0 from Equation (7) for the dimensions pertaining to the case of H/W = 2 of Figure 9, we find a common audience area of 19 m^2. To match the 20 m^2 audience area of the other examples, the linear dimensions of Figure 10 have been scaled up by the factor $\sqrt{20/19}$.

The four-screen system designed in this manner has 55 percent efficiency. It conveys the same amount of information as the single-screen displays of Figure 7 and Figure 8 with less than one-fifth the total screen area.

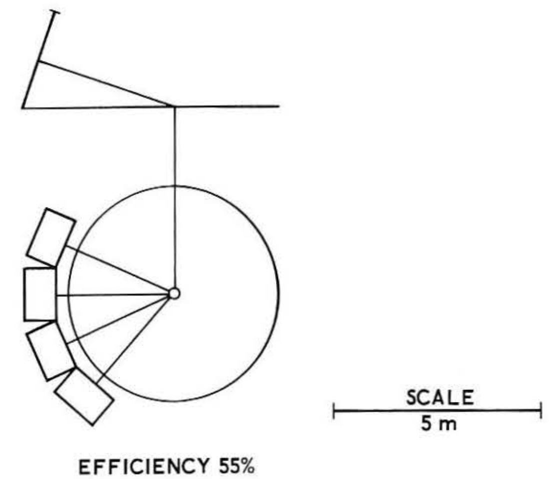

FIGURE 10: Optimum four-screen display utilizing 0.24 ster (15 percent of capacity).

CONCLUSIONS

In displays intended for an immobile audience, the utilized symbols must be at least large enough to be legible from a normal distance equal to the screen diagonal. This condition makes the display capacity independent of the the size of the screen.

If the screen is filled to capacity, the display can only be read from a single point. To accommodate a finite audience, the screen must be utilized substantially below capacity.

With a given screen, the largest possible audience area is obtained by tilting the screen so that its center normal intersects the eye level at a distance equal to half the visual range of the utilized symbols.

With this optimum configuration, the display efficiency, which measures the ratio of audience area to screen area, decreases with increasing screen utilization, which is refined as the number of symbol spaces multiplied by the square of the required visual angle.

If aspect ratio and utilization of the screen are given, the optimum display configuration is fully determined by the required audience area.

If the required utilization is a significant fraction of the capacity of a single screen, it may be advantageous to break the display up into several displays with overlapping audience areas.

THE AUTHOR

DR. HELMUT WEISS is a staff scientist in the Guidance and Technology Department, Air Defense Systems Operation, and is engaged primarily in work on optical systems related to guidance. Prior to this assignment, he directed the development of the display system for the Army Tactical Operations Center. Prior to joining Aeronutronic, he was head of the Homing Guidance Center of the French Army at Vernon, France. With the German Army at Peenemunde, he was in charge of planned high altitude research with the V-2 and with the development of homing guidance for the Wasserfall missile. He attended Stuttgart and Berlin Institutes of Technology and the Universities of Goettingen and Tuebingen, receiving the PhD in Physics from the latter in 1939. He has published numerous technical works and holds several patents.

High resolution multi-color storage tube

by PHILLIP P. DAMON
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ABSTRACT

A color display storage tube having resolution and environmental ruggedness equal to monochromatic display storage tubes has been demonstrated.

The structures utilized in this new tube design are identical to those in standard direct view storage tubes except for a special phosphor. There is no phosphor dot structure to align with the target assembly and only one writing gun is needed.

The stored color is determined by the storage surface potential or halftone level to which that portion of the display has been written. The color in this color storage tube is thus seen to be a function of the grid drive, the sweep speed or, since the storage tube is an integrating device, the number of pulses or hits in a given location. The color is independent of the time at which video is applied to the tube.

The direction of color shift, halftone level at which color shift begins, rate of color shift and color saturation at equilibrium brightness may be optimized by electronic adjustments external to the tube itself. This straightforward associated circuitry is easy to operate and adjust.

The color tube may be fabricated with either the standard direct view storage tube or Multimode storage tube capabilities. In addition to the color-shift display, a monochromatic halftone mode of operation in one of several colors is provided. System applications are suggested.

INTRODUCTION

Interest in higher resolution storage tubes for radar, sonar, computer and other specialized displays dictates a different approach for the color storage tube which has resulted in a new concept. Previous color storage tube designs required delicate target-to-phosphor alignment and had fixed

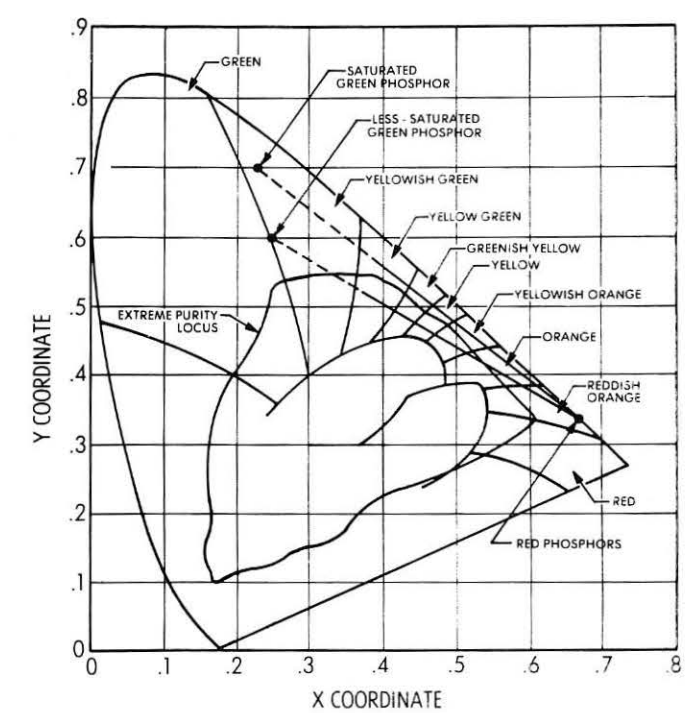

FIGURE 1: Kelley chromaticity diagram and extreme purity locus.

color-shift characteristics.[1, 2, 3] Military applications require a more rugged tube that can be readily set up, not require constant adjustment, and remain virtually unaffected by ambient magnetic fields. A reasonable manufacturing cost is essential. The author has invented and demonstrated a color storage tube satisfying these requirements.

The color display storage tube to be described is capable of simultaneously presenting stored information in one of two colors or in hues intermediate on the I. C. I. Chromaticity Diagram (Figure 1)[6]. An alternate monochromatic mode utilizing either one of the two colors or an intermediate hue may also be presented.

Operating principles allow the use of a continuous phosphor layer and remove any requirement for phosphor alignment with the target assembly or electron guns. In addition to reducing manufacturing costs, this feature permits a rugged design which can withstand severe environmental conditions such as vibration, shock, temperature extremes and magnetic fields. The resolution of the color storage tube is equal to comparable monochromatic display storage tubes because the phosphor layer which is laterally structureless does not degrade display resolution.

OPERATING PRINCIPLES

The operation of the conventional one-color display storage tube will first be explained. The principles upon which the color feature functions will then be more readily understood. This additional color feature is also applicable to multiple writing gun storage tubes, including the versatile Multimode Tonotron.[4] The Multimode Tonotron provides simultaneous high resolution writing, selective erasure and nonstore writing.

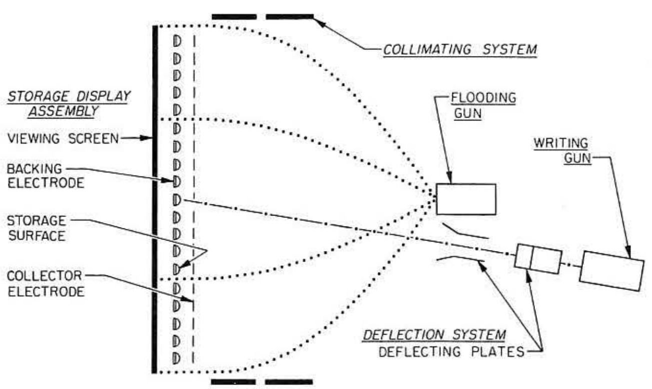

FIGURE 2: Basic storage tube structure.

Conventional Display Storage Tube

Illustrated in Figure 2, Basic Storage Tube Structure, are the five components essential in producing a visible display: (1) the flooding gun, (2) collimating system, (3) writing gun, (4) deflection system, and (5) the storage display assembly.

The storage display assembly includes a viewing screen, a fine mesh backing electrode upon which a thin film dielectric storage surface has been deposited, and a collector electrode.

Operation of the tube is based primarily on the property of the storage surface to charge in a positive or a negative direction, depending upon the energy of the incident electron beam. This property is made possible by the secondary emission characteristic of the storage surface dielectric.

The flooding gun provides a continuous supply of electrons, which are collimated and approach the storage surface orthogonally and uniformly over its entire area.

Whether these electrons pass through each of the many storage elements that comprise the storage surface and accelerate toward the viewing screen depends upon the potential present at each element. Since storage surface potentials in the halftone range are negative with respect to the flooding gun cathode (see Figure 3, Typical Storage Characteristics), each storage element acts as a virtual "control grid" for flood electrons approaching its area. Thus, if a varied charge pattern is present at the storage surface, flood electrons produce a corresponding luminous halftone pattern at the viewing screen.

The writing of stored information occurs when positive-going charges are induced at the storage surface by the incident electron beam. This is accomplished by the writing gun, whose beam energy levels lie within values required to produce storage surface secondary emission ratios greater than unity. When video signals and deflection signals are applied to the writing gun and deflection system, respectively, the intensity modulated writing beam scans the storage surface and establishes the charge pattern to be displayed.

Erasure of stored information takes place when the storage surface charges in a negative direction. This is done with the flooding gun whose relatively low beam energy results in a secondary emission ratio at the storage surface of less than unity.

To erase, a positive pulse of an amplitude equal to the value of storage surface cutoff potential is applied to the backing electrode. Due to capacitive coupling, the abrupt rise in backing electrode potential is accompanied by a similar rise in storage surface potential. Flood electrons, now attracted to the storage surface, charge it down to flood gun cathode potential.

When the pulse is removed, backing electrode potential drops by the same amount that it had been raised, and again the storage surface is carried capacitively with it. By this mechanism, the storage surface is brought to cutoff, erasure is complete, and the tube is ready for subsequent writing. Erasure may be accomplished with a single pulse, as described above or, if persistence is to be controlled, with a train of very short pulses.

High Resolution Color-Shift Feature

The addition of a special phosphor to the conventional display storage tube described above permits its use as a color-shift storage tube. The light output of this special phosphor must be capable of being varied in color as a function of time. A change in electron landing energy or view screen potential of several kilovolts will alter the light output of some phosphors from red to green, for example. In phase with this voltage change (Figure 4B) and resultant color shift, the backing electrode (Figure 4A) is varied over a range of about one volt. This cycle is repeated at a rate above the flicker frequency, sixty cycles per second being adequate. The phosphor current variation for four different halftone level areas is indicated in Figure 4C along with a description of the effective color.

Let us examine in more detail how this accomplishes conversion of halftones to a color-shift. During the first one-half cycle (1/120 second) the backing electrode is at its normal +5 volts and the view screen is at 10 kilovolts, a flood beam landing energy causing red fluorescence. During this "red" time period the relative brightness of the various areas is a function of the storage surface potential as shown in Figure 3 (or the top curve of Figure 5).

During the second half-cycle, the view screen is at 12 kilovolts and the backing electrode is dropped negatively by one volt to a +4 volt potential. All storage surface areas are capacitively coupled negatively by one volt from the initial storage surface potential. A storage element which was at point A along the curve Ebe = +5 volts is now at point A′ on the Ebe = +4 volts curve of Figure 5 and, similarly, B, C, D and E shift to points B′, C′, D′ and E′, respectively. Note, however, that D′ and E′ are at cutoff or beyond when the backing electrode goes to +4 volts.

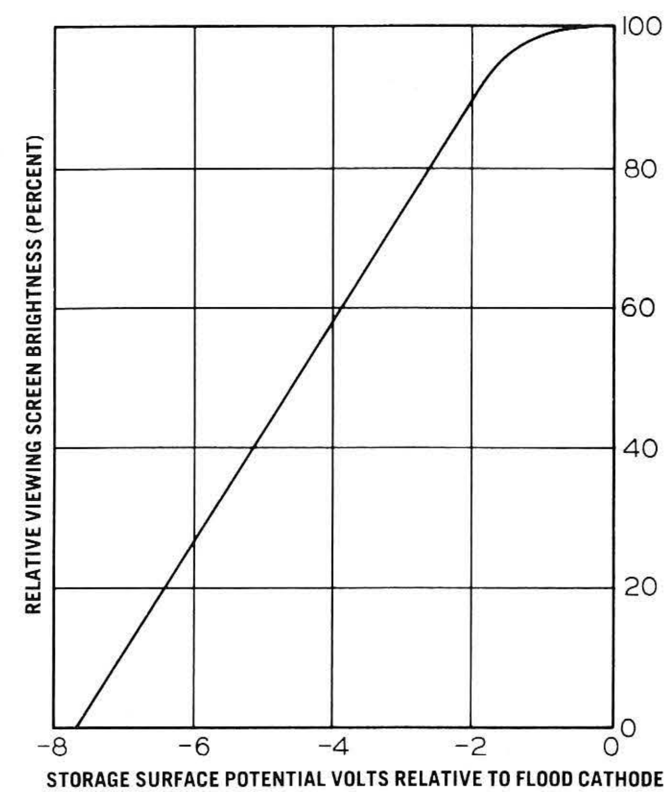

FIGURE 3: Typical storage characteristic.

Areas having initial storage surface potentials designated by D and E appear to the eye as a steady, pure red of varying halftone levels, D being the brightest. Areas which are characterized by points C-C′ are on at full red brilliance during the first half of the cycle and then at a lower green level during the second half of the cycle. The green added to the red produces a resultant orange. When the relative green-to-red ratio increases as at B-B′ and A-A′, the resultant shifts to yellow and then green, respectively.

If the green phosphor brightness were increased by raising the superimposed view screen waveform voltage, a faster color shift would occur. The areas below 25% initial halftone level would still be red, but the range during which orange and yellow occur would be very short. The display would appear as a halftone range in red with a quick shift to green followed by a green halftone range. A longer red halftone range could be effected by using a three-volt backing electrode pulse.

A storage target having a control characteristic similar to that shown in Figure 6 would be best for a red-green halftone display with rapid color shift. With a 3-volt backing electrode, waveform A shifts to A′ and E to E′. Note that this permits optimum red light output since E is at equilibrium brightness during the red portion of the cycle, but cut off during the green time period.

Quantitative Determination of Color Shift

The color-shift may be calculated[6] from the ratio of green-to-red light output. The resultant color lies along a straight line between the two phosphor chromaticities as described in the I. C. I. diagram of Figure 1. This line is shown for two typical sets of phosphors, the solid-line section indicating a typical color-shift range. Kelley[7] color regions are shown as well as the extreme purity locus for the most saturated pigments, inks and dyes available (when viewed under white illumination).[8]

The location of the resultant color is calculated by the center-of-gravity method. The formula for percent distance (d) along the line from red towards green for a given color ratio is derived as follows:

$$(O\text{-}d)\ \frac{Br}{Yr} = (d\text{-}100)\ \frac{Bg}{Yg}$$

Let $\dfrac{Bg/Yg}{Br/Yr} = K,$

then $(O\text{-}d) = (d\text{-}100)K$

and $d = 100\ \dfrac{K}{1+K}$

In the above, Bg and Br are the average luminances of the green and red while Yg and Yr are the Y chromaticity coordinates of the respective phosphors. The light output of the resultant color is the sum of the average luminances of the component colors.

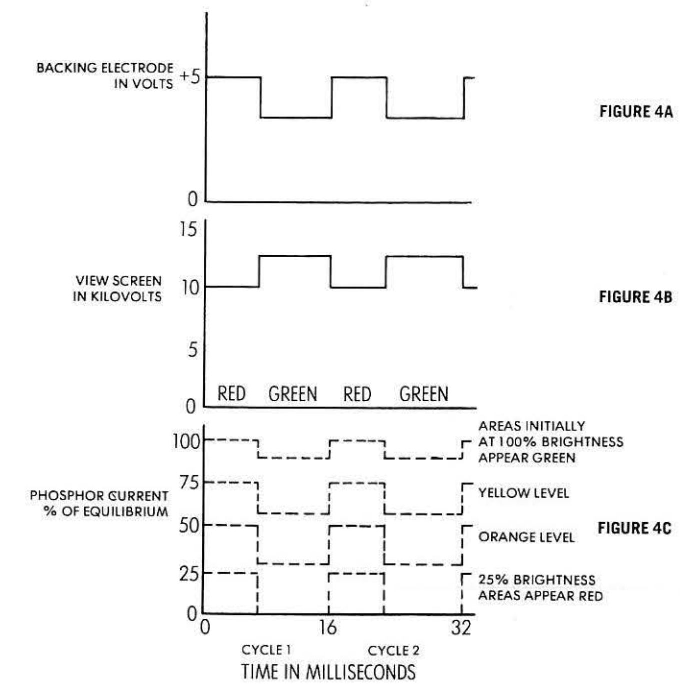

FIGURE 4: High resolution color-shift storage tube typical waveforms & resultant output.

COLOR-SHIFT OPTIMIZATION

Color shift from red to green has been described. It is also possible to shift the phase between input pulses and achieve a color shift from green to red. The tube can be built with another set of phosphor colors or a third color if required.

The halftone level brightness at which the color begins to shift is raised by increasing the amplitude of the backing electrode pulse. The maximum color saturation is determined by the relative average brightness of the red and green components when the storage surface is fully written. This relative average brightness can be electrically modified not only by the proper choice of phosphors, but also by adjusting the amplitude of the view screen voltage waveform. Another effective means is to remain at one of the two voltage levels for a larger percentage of the time. This is especially useful in compensating for the inherent large differences in brightness between many phosphors.

In some applications a halftone range in one color followed by a second halftone range in another color is desired. In this case, intermediate halftones are not wanted. For such a system a step waveform is used along with a somewhat higher average brightness level for the second color.

If, instead of a rapid color shift, one desires a slower color shift to utilize all of the intermediate hues, the backing electrode waveform or the view screen waveform may be shaped to accomplish this.

It is possible with more elaborate waveforms to effect several excursions up and back through the hue range between the several phosphor colors as the halftone level increases towards the equilibrium brightness conditions.

COLOR-SHIFT CIRCUITRY

The simple and reliable circuit to be described functions well and is the only additional circuitry needed to convert from a conventional storage tube to a color storage tube. 0 to 115 volts, 60 hertz power (Figure 7A) is supplied to a silicon controlled rectifier circuit. This provides a variable width output adjustment to set the percentage of time in a given color. The resultant waveform (Figure 7B) is fed into two transformers:

(1) a coupling transformer to feed the backing electrode circuit, and

(2) a high voltage step-up transformer to feed the view screen circuit.

The waveform in the backing electrode circuit is rectified (Figure 7C), clipped (Figure 7D), and the correct amplitude superimposed on the normal backing electrode level. One side of the secondary of the high voltage transformer in the view screen circuit is floated on a supply. The rectified output is clamped to remain at or above the reference level used for the lower voltage color.

With this circuit, synchronization of the backing electrode and view screen waveforms are certain. Note that these are not fast rise time waveforms. They are also of relatively low frequency and do not require synchronization with any video inputs.

Production units will perhaps not require this complexity and range of adjustment. For laboratory evaluation of the color-shift storage tube additional waveform flexibility may be useful.

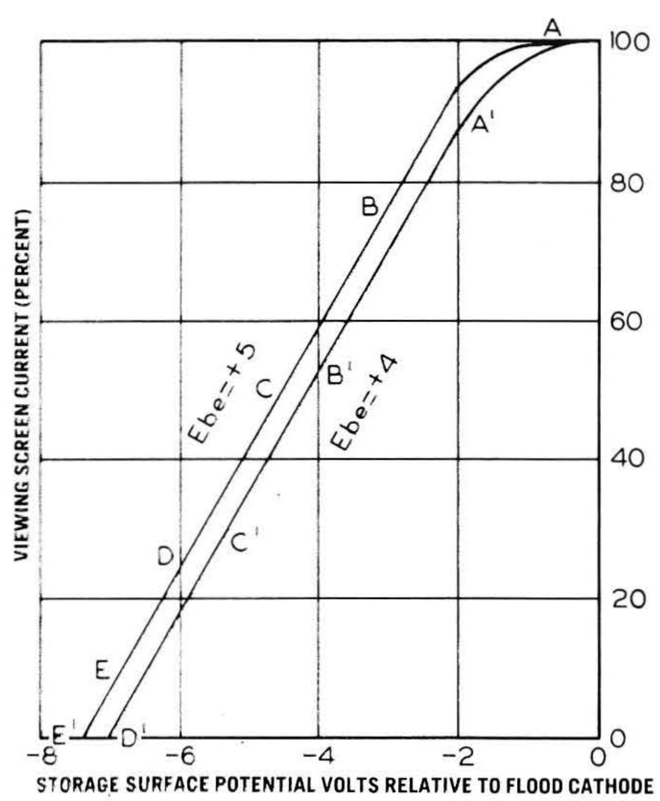

FIGURE 5: Typical storage characteristics as backing electrode is varied.

PERFORMANCE

The color feature is applicable to Tonotrons and Multimode Tonotrons. The features of these tubes are summarized[5a], and their operating principles further described[5b] in available publications.

The functional difference between a conventional display storage tube (Tonotron) (See: OPERATING PRINCIPLES, *Conventional Display Storage Tube*, above) and the Multimode Tonotron needs to be emphasized. The Tonotron provides either single-pulse overall erasure or a gradual overall erasure. The gradual erasure causes areas to fade, after writing, from the higher brightness halftone level through the lower brightness level color to cutoff.

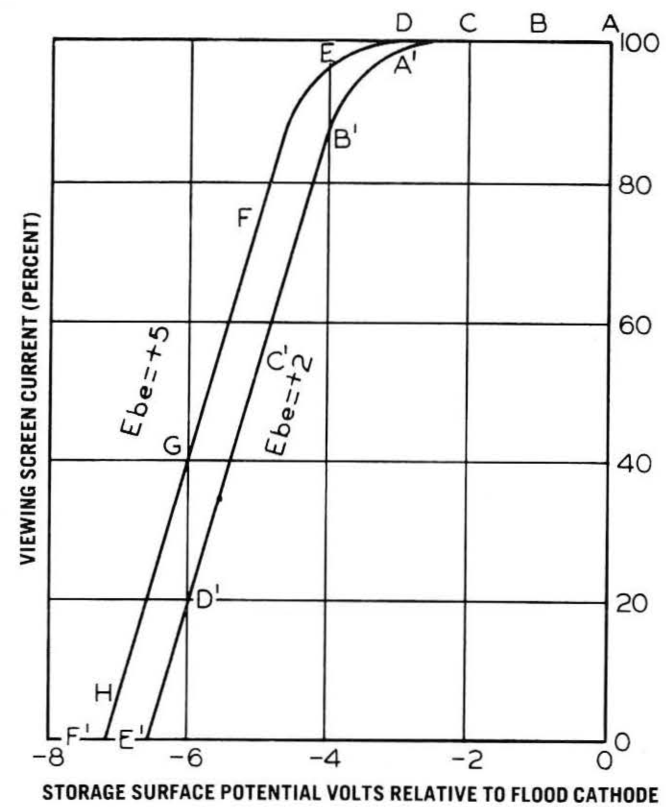

FIGURE 6: Storage characteristics for rapid color-shift display.

The Multimode Tonotron has a different storage target and an extra electron gun. Rather than completely erasing a display or causing it to fade out between scans, the target is primed or restored to an equilibrium condition by the electron beam from the second gun which immediately precedes the video writing beam scan. This method of erasure eliminates the overall background brightness, or need to attenuate it, of the conventional direct view storage tube. The stored display is thus retained with full clarity in the written condition and color until just prior to the presentation of new information.

Some Multimode Tonotrons contain a third gun for presenting non-stored information. Because of the laterally structureless nature of the phosphor, this write-through beam functions well. In previous dot-type color tubes, this beam produced a color moiré as it moved across the display.

Tonotron direct view storage tubes are available which write at one million inches per second and erase in several milliseconds. Resolution exceeding 250 TV lines per inch is available, with some 5-inch diameter tubes being only 8 inches long. Other tube sizes cover the range from 3 to 21 inches in diameter, some being ruggedized to withstand 10G vibration levels. These magnetically and electrostatically deflected storage tubes display up to nine halftones.

Brightness of the color storage tube depends upon size and operating mode. Present brightness is about equal to that of a home television set. Considerable brightness increase is anticipated with further development.

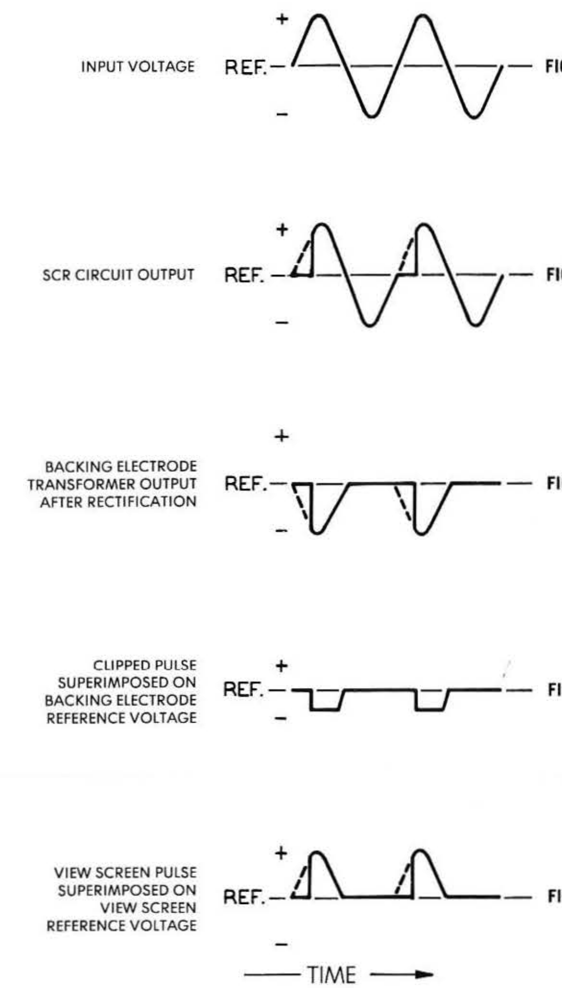

FIGURE 7: Color-shift circuit waveforms.

APPLICATIONS

The stored color observed has been shown to be a function of the level to which the storage target is written. The color is thus determined by the grid drive, the sweep speed, or the number of pulses or hits in a given location.

In air traffic control, color might be used to alert an operator that two aircraft were at the same altitude. Target velocity relative to "own-ship" velocity could be coded for air-to-air applications and, in terrain avoidance displays, radar returns for nearby objects could be red while those at greater distances could be coded green.

The color tube can very effectively present data from a computer. In addition to printing various colors from the computer output, change in computer output can be readily observed. If the old information is partially erased, then when new information is printed it integrates up only if it is superimposed on the previous data. Areas of change are thus spotted as different halftone colors.

The tube may be used as a moving target indicator by limiting a single radar hit to the red with multiple hits on successive scans integrating into the green. If the target moves, it is red and readily distinguishable.

In other applications, raw radar returns might be in one color and returns from other inputs such as infrared, processed radar data, computer, or transponder information presented in a second color. Coincidence of the two sets of data could shift that data to yet a third color level.

In the multi-sensor systems now being used and developed many different display modes are utilized. Some may not require a multi-color presentation. A storage tube capable of presenting monochromatic displays in addition to color displays has not been available before. The monochromatic mode is accomplished by removing the view screen or backing electrode waveforms. A useful feature is the ability of this tube to present these halftones in one of several colors — perhaps red for night and green for day use.

CONCLUSION

The efficacy of color in many display situations is not known. It will require experimental evaluation by human factors engineers and others to determine where use of this color storage tube is warranted. The reasonable manufacturing cost of the tube and associated circuitry will aid in its acceptance. The high resolution, simplicity of input signals, use of only one video gun and rugged design make available for the first time a versatile color storage tube capable of satisfying military and industrial requirements.

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Ultrarapid film systems for data display and computer interlock

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ABSTRACT

Film systems can greatly reduce requirements for computer memory capacity and operations in automatic checkout equipment. They can also carry binary code data for interlock between the test step description on film and the test routine in a computer. The five dry-process film systems outlined can record, process and project individual frames in less than two seconds. Three of the films are erasable. Some features of computer-operated checkout systems are also useful in educational technology. A narrow-band (240-kHz) audio-visual transmission and sound filmstrip record is proposed as an alternative to educational television.

INTRODUCTION

This paper presents some results of a study of recent developments in opto-electronics and unconventional film systems. The incentive for the study was the possible benefit to be derived from ultrarapid processed microfilm recording and projection as an alternative to computer operated cathode-ray tube (CRT) displays.

Also included in the presentation is a proposal for use of ultrarapid processed filmstrips and commercially available transmission channels as an alternative to special television channels for educational presentations in distant classrooms. A major premise of this proposal is that pictorial information does not usually need to include motion in training-teaching-decision making situations; and that thoughtful assimilation by the student of the information presented can well require a 2-sec minimum viewing time on each picture presented.

Automatic checkout equipments such as those used on military and space missions have been studied for representative operating requirements. Display concepts outlined in this paper refer to those equipments as a convenient basis for evaluating the proposed system.

INFORMATION DISPLAYS IN AUTOMATIC CHECKOUT SYSTEMS

As launch and space vehicles and their subsystems become more intricate, and as reliability requirements become more stringent, automatic monitoring and checkout of thousands of test points has become a necessity. A recent issue of *Spaceport News*[1] advised that computers were being used for the first time to automatically perform a number of checkout functions. The entire concept of automated checkout is relatively new and is being used on Saturn 1B launches as a forerunner to Saturn V (Apollo) launches.

Automatic Checkout Equipments employ one or more computers to initiate and periodically recycle individual measurements and discrete operations in an established test program. *All* checkout results are continuously recorded on magnetic tape. Discrete events and critical parameters are also displayed on indicator lights, multipen records, meters, and cathode-ray tubes. Quick call-up of any one of several pages of test measurements is provided on several CRT display consoles. These are automatically updated at 1-sec intervals, with the latest measurement values shown in engineering units. This enables test conductors and group leaders to make critical decisions quickly on the basis of rapid review of selected, correlated, and up-to-date measurements from hundreds of test points.

Near-real time display of test results occurs at the rate of need and response of test personnel. Many test results are extracted from magnetic memory after the measurement is made, since many measurement steps are being automatically recycled at a much faster pace than can be man-read from a real time display.

REPRESENTATIVE DISPLAY PAGE

Figure 1 shows a representative page display which includes 24 test step descriptions and associated numerical test values. In one application, the operator can call up top half-pages and bottom half-pages separately in any desired combination.

Latest test values are automatically inserted in each line of measurement description. The test computer continuously compares these values with predetermined limits. An out-of-tolerance test value blinks repeatedly on the CRT display to notify the operator to take appropriate action.

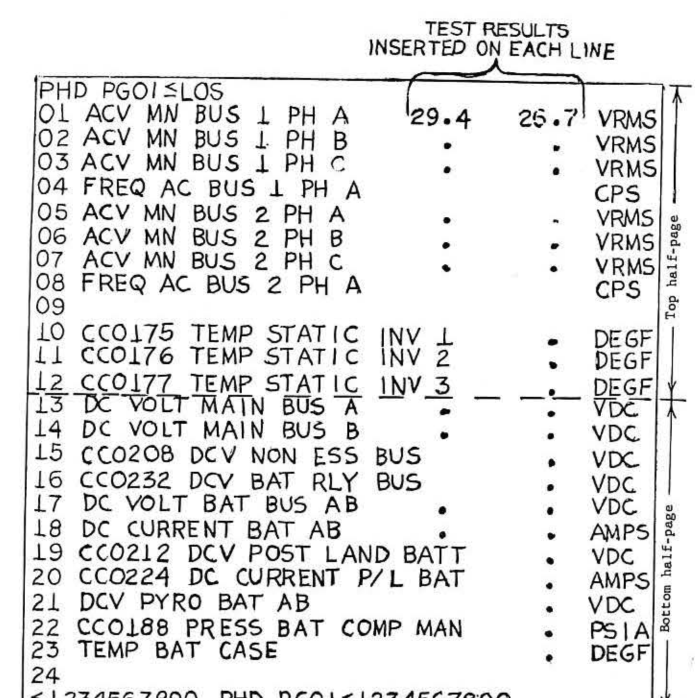


FIGURE 1: Typical page of test steps for CRT display.

Present CRT displays provide fast, flexible coupling to the test program. A display computer stores and formats their alphanumeric displays. This special unit also provides conversion from binary code to engineering units for man-reading, and automatically signals when a measurement result is out of tolerance.

PROPOSED SYSTEM

The Ultra-Rapid Processed Microfilm Projection for Real-Time Display of Acceptance Checkout Data is expected to provide certain benefits, such as: (1) a larger, brighter display (not masked by room lighting); (2) quick expansion of display page library; (3) data separation by colors, if desired; (4) large reduction of computer memory and manipulations; (5) no special display computer (to write-refresh CRTs); and (6) reduced demand on computer programers.

Visual access time requirements are: (1) approved draft to finished slide, <2 hr; (2) changing the page on display, <3 sec; and (3) updating the test values in display, <2 sec.

Design principles include: (1) the use of ultrarapid process films for alphanumeric, analog, and digital data store; (2) the capability to photocompose test programs by rapid, accurate optical reduction to film; (3) the use of perforated film and random access projectors for accurate data positioning; and (4) compatibility between motion picture and microfilm practices and components.

USE OF SLIDES AND FILMSTRIPS

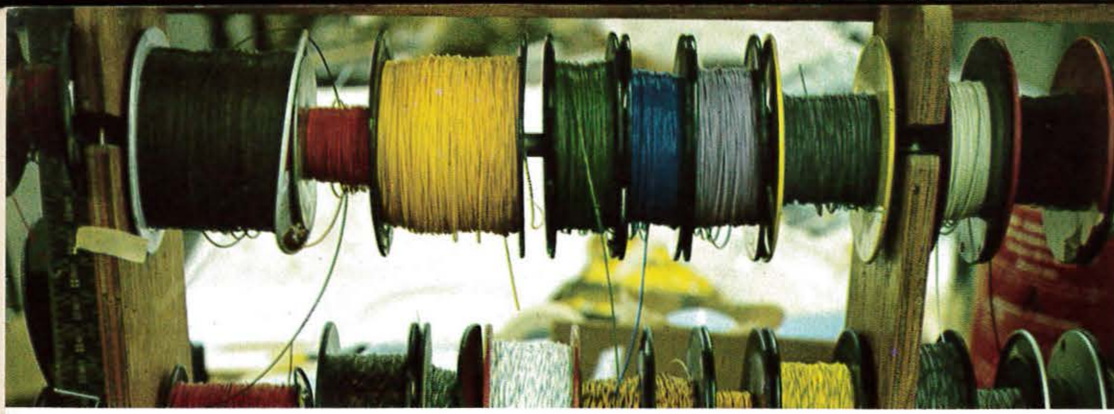
The desired display improvements plus the visual access times given above can be obtained in currently available equipments. These equipments use direct photocomposing on slides or filmstrips of new data formats by computer and/or manual keyboard control. Multiple projectors superimpose images in separate colors and with accurate registration of the viewing screen. For example, the Iconorama System (Ling-Temco-Vought) operates as many as nine separate slide projectors with projected images superimposed with an accuracy of 1:1000. An ordinary 16mm motion-picture projector commonly registers individual frames with an accuracy of 1:500; and this is accomplished on a film print that may be three generations removed from the original camera film.

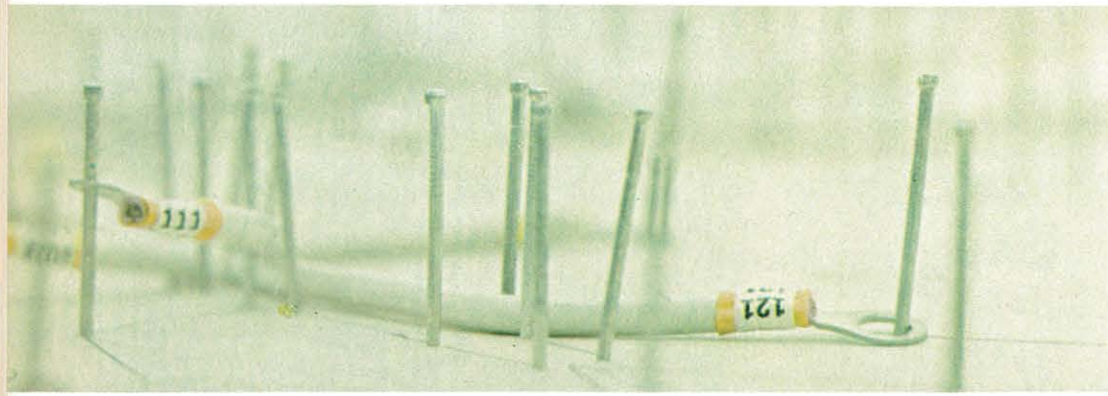
To what extent can a slide or filmstrip system relieve the load on a computer used to run a CRT display system? At least 85% of the page format is determined well in advance of test operations and does not change during test data display (see Fig. 1).

Moving the fixed portion of each page format to a slide or filmstrip system can reduce demand on display computer memory by as much as 100,000 binary bits for page formats used on one display console. This can also release much display computer time and memory capacity for use in updating an expanding list of test values and measurements routines.

The special display computer unit is no longer required to continuously circulate about 6,000 bits of binary code to maintain a CRT display that presents unchanging information most of the time. It can be replaced by a much smaller, lower cost alphanumeric composer available from several sources.

Random access slide and filmstrip projectors provide a





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Direct typing of new page formats, and photocomposing directly to slides can reduce by many hours the time required of computer programers for generating display programs. Commercially available tape / typewriter / headliner combinations can be adapted to do the job.

FILM FRAME/COMPUTER INTERLOCK

Successful use of slides or filmstrips requires direct interlock of the test step descriptions (for man-reading) with the test computer operations required to obtain and insert the latest test values. Figure 2 and the following premises show a possible way to accomplish this:

(1) Record binary coded computer instructions on the same film frame as the corresponding page layout. Record each computer instruction on the same line as its corresponding test step description.

(2) When a test value is inserted into the display, record it in both alphanumerics for man-reading and equivalent binary code (as used by the computer to generate the alphanumeric equivalents).

(3) Do not rewrite a test value unless the new value differs by a significant, preset limit from the binary coded record of the test value displayed.

(4) Project Fixed Format Data from slides or filmstrip prepared in advance and stored in a random access projector.

(5) Project data *subject to change* from a second projector, using a filmstrip system in which fractional frames can be exposed, processed and projected in less than two seconds.

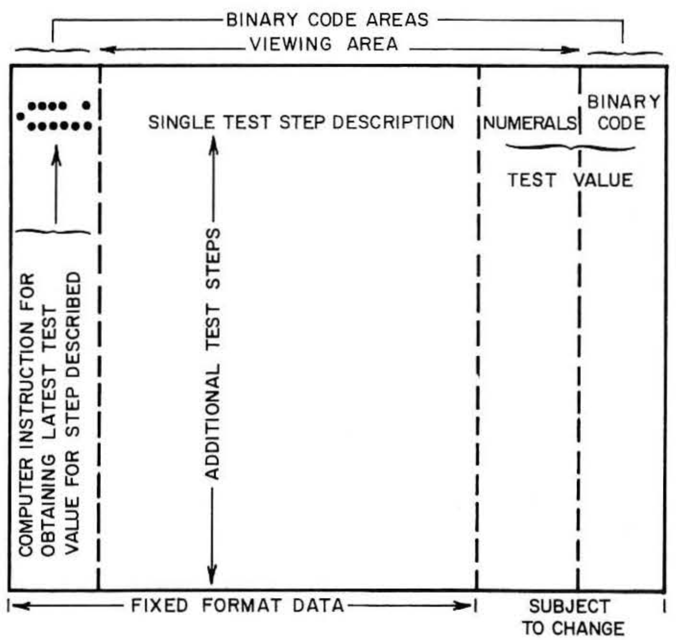

FIGURE 2: Data placement plan for interlock of film frame and computer.

DISPLAY BRIGHTNESS VS. ROOM LIGHTING

What is the effect of room lighting level on CRT display viewing? For example: with overhead lighting at 15 fc (Fig. 3) characters on the CRT are bright and easily read. However, this level of room lighting is too low for easy reading of unlighted meters and for writing notes and log book entries.

The usual recommendations for office and laboratory space lighting levels are at least 100 fc of incident light. This requires full brightness from overhead lights (Fig. 4). At certain viewing angles, lighting reflections can blank out portions of the CRT display. Deeper hoods on the CRT and better directional control of overhead lighting will improve this viewing situation. However, a display at least twice as large and at least four times as bright is needed to compete with increasing room lighting levels.

FIGURE 3: CRT display plus 15 fc of room lighting.

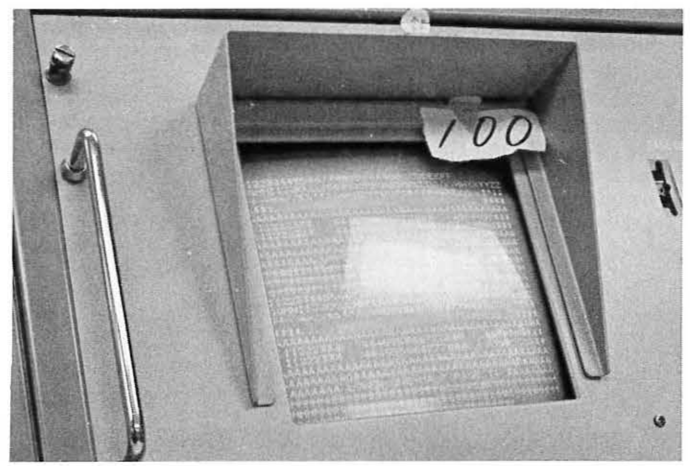

FIGURE 4: CRT display plus 100 fc of room lighting plus reflection from overhead lighting fixture.

BINARY CODE DATA BLOCKS ON FILM

Figure 2 and premises (1), (2) and (3) require that binary code bits be recorded on film and later projected from film to optical sensors. Overall tolerance is less than 1% of the height of the projected film frame if maximum advantage is taken of "buffer storage" of computer instructions and test value limits on associated film frames. This is within the capabilities of established tolerances for low shrink film stock, film perforations and film intermittent movements as used in the motion-picture industry. For example:

(1) Assume a 24mm $\times$ 36mm film frame for display formats (this is the same as used in 35mm film slides from candid cameras).

(2) 1% of 24mm is slightly less than 0.010 in.

(3) The sum of published tolerances on film perforations and registration pin intermittent movements is less than 0.001 in. Established jump and weave tolerances on motion-picture projectors is significantly less than the 0.010 in. required by (2) above.

Commercially available random access filmstrip projectors offer a frame positioning tolerance of about 0.010 in.* It is hoped that a judicious marriage of low-shrink film stock and motion-picture type intermittents can significantly reduce this tolerance. There are random access slide projectors available with slide positioning tolerances of the order of 0.001 in. (Various models as used in the Iconorama and LTV Data Display System (Ling-Temco-Vought) use a scribed slide on a 2- $\times$ 2-in. glass plate.)

*Model RA-132 Random Access Projector, Mast Development Co., Davenport, Iowa, uses 35mm single-frame filmstrip.

TABLE I: Rapid processed films.*

Film	Expose-Process-Project Time	Camera-Processor-Projector
Prehardened, thin silver halide type, available from most film companies	6 s	Kelvin — Hughes, RP3
	7 s	Photomechanisms, Rapidata
	6 s	OPTOmechanisms, Series 380
Bimat — Estman (almost dry chemicals)	10 s	RCA/DEP Bimat Processor
Polaroid-Land	10 s	(Camera-processor only) Polaroid-Land

*All of above films have much more sensitivity to radiant energy (light) than the films in Table II, with possible exception of photoplastic film.

TABLE II: Ultrarapid processed films.

Film Type	Expose-Process-Project Time	Exposure Energy Ws/cm²	Processing Ws/cm²	Image Quality	Image Contrast
Kalvar Co. Type 80	>1 s	Near UV, 0.2	IR-0.2 Heat (115C)	Permanent	Variable
Diazofilm H5-201	2 s	Near UV, 0.4	Ammonia gas 80-lbf/in.² pressure	Permanent (colors in image)	Medium
Photoplastic (Gen. Elec. Co.)	>1 s	Near UV & visible, 0.005	3.9 Heat (65C)	Erasable (colors by projection)	High & Medium
Frost (Xerox Co.)	>1 s	Visible	Heat (65C)	Erasable	Low
Photochromic (American Cyanamid Co.)	>2 s	Near UV, 0.1	None but image fades in 1-2 min.	Erasable (colors)	Low

On the basis of these considerations, a goal has been set of one code bit in each 0.005- $\times$ 0.005-in. area of the film frame set aside for binary code data. This is about the same dimensional requirement as that met by the Fosdic System[2] which photocords 13,000 machine tabulation cards (Hollerith) on one 100-ft roll of unperforated 16mm microfilm. Each hole in a punched card is reduced to a 0.0023- $\times$ 0.0029-in. spot on the film record. These spots are about 0.006 in. apart.

There have been several recent developments in solid-state, semiconductor type photocell arrays,[3] and in photo-optical methods used in microelectronics production. These offer new, useful solutions to the problem of rapid, accurate, optical readout of binary code data blocks.

Recent improvements in the CRT have provided high UV energy output with small spot size and good raster geometry. These tubes plus fibre optics faceplates make possible much faster writing of display data on low sensitivity films as used in the microfilm field (Table II). A specitl tube (Litton, type E2A16B) for CRT writing on Kalvar film was offered commercially some time ago. An improved CRT is now available (Litton, type L4141).

ULTRARAPID PROCESSED PHOTOFILMS

Premises (4) and (5) of the film frame/computer interlock have led to a survey of currently available equipments and films with rapid processing capabilities. Tables I and II cover most promising possibilities.

(1) About five commercially available equipments can expose, process and project single frames of conventional silver halide film in less than 10 s/frame. This is not fast enough for test value updating as a real-time operation. They also use some form of wet processing. However, they might be useful in producing master frames of FIXED FORMAT DATA on short notice.

(2) About five currently available nonconventional film systems can be exposed, processed and projected well within the 2-s time cycle. They all use dry processing of film frames.

(3) Three of the five dry-process films are dual-spectrum — i.e., exposed by one wavelength (near ultraviolet) and projected for viewing by another wavelength (visible). This allows exposure and processing without fogging from moderate values of room light.

(4) Processed images on three of these films can be erased, and new images formed on the same film. Erasable film images suggest the possibility of test value updating without the need of a continuous supply of new film, or more than one film projector.

EDUCATIONAL TECHNICAL USE?

The project to be described below may, in time, be useful in the field of educational technology.

Rapid production of sound filmstrips appears to be needed in this field. It will aid experiments with programed learning by means of filmstrip and sound-tape programs. Short run production of a few program copies will be expedited.

A few crude tests have been made to demonstrate the possibility of making, in real time, an acceptable sound filmstrip record of a classroom lecture or discussion, or of low-cost recording of an educational television broadcast. Results from these tests have shown promise for the idea. On one recent test, made of an educational classroom broadcast on a home television receiver, the average time for each filmstrip frame was about 3 s with variations from 1½ to 8 s between snapping of individual pictures. This sound filmstrip record (or a live pickup by slow-scan TV) can be transmitted over a 240 kHz channel available commercially as Telpak C. This would be a 25:1 reduction over the bandwidth required for commercial or educational television, and would provide a new, high-definition picture every 3 s.

Continuous reception and recording of the transmission as a filmstrip and magnetic tape (for sound and sync signals) is possible by the films and methods shown in this paper.

Bright, large-screen projection of the filmstrip record is possible with not over 5-s delay between sending point and receiving points. After initial use, the low-cost sound filmstrip is available for repeated showings at any time and place, on any one of several portable playback-projection equipments that sell for about $300.

Experimental recording runs have been made using a conventional stereo sound tape recorder and a tone signal generator coupled to a low-cost, compact filmstrip camera made in France. The camera photographs a double frame on 16mm single perforated film. Frame size is so close to that used on microfiche (4- × 6-in. microfilm cards) and 16mm microfilm that it may provide the basis for a compatible arrangement for use of 16mm perforated film (motion-picture film stocks) in microfilm cameras. Proposals 1 and 2, shown in the Appendix, give the details. This also offers one possible way of using modified microfilm cameras to achieve the registration accuracy needed to photographically reduce long-roll chart records to 16mm microfilm. For example, Proposal 2 takes a minimum of film width for the added perforations which provide the basis for a frame-to-frame registration tolerance of less than 0.001 in. This is significantly lower than the current tolerance in the step-and-repeat cameras used for producing microfiche masters.

Perhaps these ideas and proposals will provide some stimulus for added useful interchange between workers in the fields of television, motion pictures, microfilm, and educational technology.

CONCLUSIONS

(1) Photofilm methods of operation are feasible for a frequently updated visual display if time delays of less than 2 s are acceptable. A design goal of less than 1 s appears feasible.

(2) Computer control of the operation is feasible, and can be electro-optically interlocked to individual test steps on a page display of a checkout program, as projected from a filmstrip or slide.

(3) Use of these methods can reduce demand on display computer memory and operations by as much as 80%.

(4) Required increases in display size and brightness are feasible within a reasonably small console.

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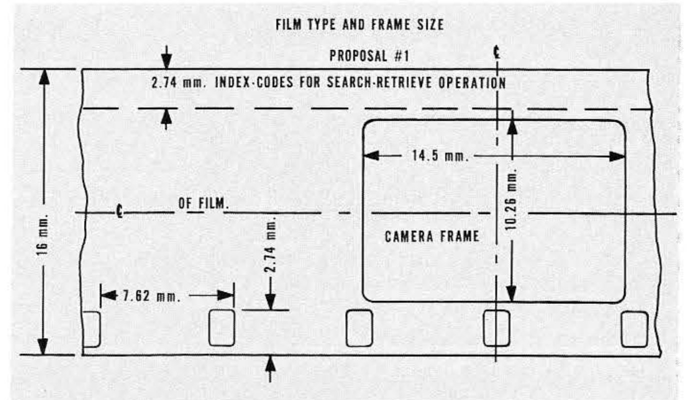
APPENDIX

Features of Proposal 1

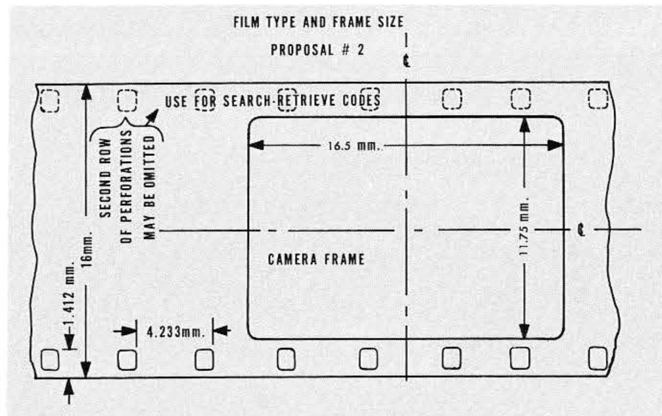
(1) Standard 16mm, single-perforated film stock per ASA Standard PH22.109-1965. Also available in 32mm widths (double 16mm) per ASA Standard PH22.71-1965.

(2) Camera frame area and index-code area are compatible with printing apertures on continuous optical printers for 16mm sound motion printers. This anticipates future need of many low-cost prints of 16mm filmstrips for use by educators.

(3) Camera frame size represents a 20:1 reduction from original letter size (8½ in. × 11 in.) paper. This is within the requirements of National Microfilm Association Standards adopted for reduction of multipage documents to microfiche copies. It also represents a compromise between 2:3 picture aspect ratio on 35mm slides and the 3:4 aspect ratio on motion pictures.



PROPOSAL 1: Film type and frame size.



PROPOSAL 2: Film type and frame size.

Features on Proposal 2

(1) Standard 16mm film stock perforated both edges with the new perforations for "Super 8" mm film. Now available from Eastman Kodak Co. to film printing laboratories.

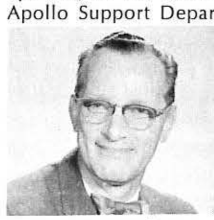
(2) On special order Eastman Kodak Co. will omit the perforations on one of the two edges. This provides a clear channel for index-codes for high-speed search-retrieve operations in a random access filmstrip projector.

(3) More area of film is available for pictorial information. Photographic reduction ratio from 8½ in. × 11 in. sheet is only 18.5:1.

(4) More and closer spacing perforations allows more choices of camera frame sizes and shapes along length of film.

(5) CAMERA FRAME size is identical to individual image areas on microfiche made in accordance with COSATI-Federal Microfiche Standard Specifications.

THE AUTHOR



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Display requirements assessment for command and control systems

by RUDY KUEHN • Vice President's Senior Staff • Information Sciences Subdivision • Missile and Space Systems Division • Douglas Aircraft Co.

[The following paper was prepared for the AGARD-NATO Eleventh Symposium at Munich, West Germany, Nov. 7-10, and delivered there by Mr. Kuehn. It is presented here through the courtesy of Dr. Irving J. Gabelman, Director, Advanced Studies Group, Rome Air Development Center, who was chairman of the meeting in Germany, and with the author's permission. The editors wish to thank E-OS for assistance in preparing this material.]

SUMMARY

The major underlying parameters of a command and control display depend to a great extent upon the basic attributes of the human visual mechanism. The latter are briefly reviewed in order to place the display system requirements in harmony with visual limitations. Resolution, amount of data displayed, display dynamics, coding, and screen size are discussed. Illustrations are given by means of figures and tables of the interrelationship of certain of these criteria. Material is presented demonstrating that display specification and design need not be based upon intuitive judgment, but do have a foundation in sound scientific and engineering principles. The proper parametric designation of the command and control display system can lead to greater effectiveness and overall satisfactory performance

INTRODUCTION

The word "display", despite the dictionary's literal definition, is sometimes used in connection with auditory and tactile presentation of information. Without debating the semantic merits of terminology, the following discussion will be confined to displays which are purely visual. To place the latter in context, the elements of the human visual mechanism will be first reviewed briefly.

BASIC ATTRIBUTES OF THE HUMAN VISUAL SYSTEM

The eye is a highly refined image sensing device, responsive primarily to the electromagnetic spectrum lying between the wavelengths of approximately 400 and 700 nanometers. Although individuals differ, a normalized visual response curve based upon a very large number of measurements has been internationally accepted. This so called standard luminosity function is shown in Figure 1. The ordinate represents the ratio of the visual sensation of brightness to the actual radiant energy at each wavelength. At about 550 nanometers, the peak of the curve, one finds a luminous efficiency of 680 lumens per watt of radiant energy. The latter should not be confused with the efficiency of a practical light source usually given as the ratio of the total luminous flux emitted to the total power consumed.

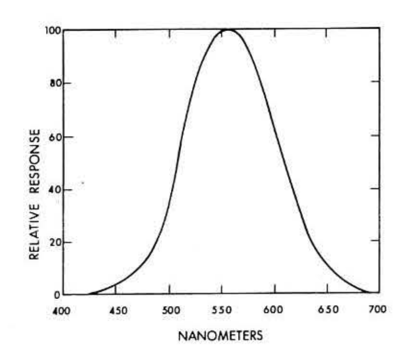

FIGURE 1: Standard luminosity function.

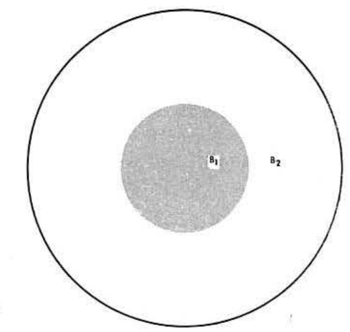

FIGURE 2: Contrast in a luminous visual field.

Before continuing, note the meaning of a few terms which are encountered in the measurement of light and hence are cogent to display systems. The basic unit of *luminous intensity* is the *candela* which is of such a value that a blackbody radiator at the freezing temperature of platinum produces 60 candelas per square centimeter. *Luminous flux* is measured in *lumens* such that one lumen is emitted in a solid angle of one steradian (The unit solid angle subtended at the center of a sphere of unit radius by unit area of the spherical surface. The total solid angle about a point is 4 π steradians.) by a uniform point source having an intensity of one candela. Table 1 lists some commonly used units derived from the preceding definitions.

TABLE 1: Commonly used light measurement terms.

Physical Quantity	Physical Significance	UNITS English	UNITS Metric
Luminance (for extended sources)	candelas/unit area, or lumens/steradian/unit area in a specified direction	candelas/ft²	candelas/meter²
Luminance (for non-luminous surfaces as well as for isotropic self-luminous surface)	lumens/quarter-sphere/unit area in a specified direction	foot-lambert	meter-lambert
Illuminance	lumens/unit area	foot-candle lumens/ft²	meter-candle lumens/meter²

Returning once more to the eye, one encounters the condition of *adaptation* which is a photochemical phenomenon taking place in the retina so as to maintain maximum visual discrimination of luminance. The latter results in the eye *adapting* to average illumination levels over the enormous range of 10^{11} to 1. By comparison, the variable aperture of the eye, known as the *pupil*, can only alter the amount of light reaching the retina by a ratio of less than two orders of magnitude. Table 2 lists some typical luminance values illustrating the visual range.

TABLE 2: Typical values of luminance.

1. Absolute visual threshold	3 microcandelas/meter²
2. Snow under starlight	0.3 millicandela/meter²
3. Just readable average chart	0.15 to 0.25 candela/meter²
4. White page in normal reading light	50 to 100 candelas/meter²
5. Upper limit of visual tolerance	0.3 megacandelas/meter²

Visual discrimination of an object depends upon a large number of intrinsic physical attributes which include but are not limited to:

1. Shape
2. Size
3. Selective reflection, absorption, or transmission of radiation in the luminous spectrum

4. Surface texture

One is instinctively aware that increasing levels of luminance elicit sensations of greater brightness. The term *brightness* should always be reserved for describing the sensation we experience, whereas, *luminance* and its derivatives should be used for the physical quantity of radiant energy (in the 400 to 700 nanometer band).

Consider the visual field to be filled with a luminous surface, the center of which may be varied in intensity as shown in Figure 2. Call the luminance of each area B_1 and B_2, respectively. If $B_1 = B_2$ one is unaware of any discontinuity in the surface. At some minimum absolute value of $|B_2 - B_1|$ the presence of the central disc can be detected. The detectable luminance difference depends upon the adaptation level of the eye. Thus there is a fundamental measure of "seeability" which is called *contrast* and is defined as:

$$C = \frac{|B_2 - B_1|}{B_{av}}$$

where B_{av} is the adapting luminance. In the case of Figure 2, as well as in many practical instances, $B_2 \equiv B_{av}$ where B_2 is the surrounding or screen illumination. Note that in most displays, in contradistinction to printed material or hard copy, the information is brighter than the background, that is, $B_1 > B_2$. The latter is of little consequence since the absolute value of the difefrence of the two quantities appears in the equation for contrast.

One may also define a quantity called *contrast ratio* given by

$$C_R = \frac{B_2}{B_1}$$

where $B_2 > B_1$. Either contrast or contrast ratio may be used, but the former is the preferred quantity. It has the advantage of lying between the limits of 0 and 1.

As the structure or pattern of an image becomes increasingly fine, a condition is ultimately reached at which visual discrimination fails regardless of the contrast. Visual acuity depends upon the contrast, luminance, nature of the image, time of observation, and the criterion used to determine threshold performance. A few examples of familiar high contrast objects are given in Table 3.

Intermittent stimulation of the visual mechanism over a limited range of alternation results in the sensation commonly known as *flicker*. As the frequency of the light and dark (or darker) is increased from zero, there is at first no flicker experience. The initial perception of coarse flicker develops at a rate of a few hertz, progressively becoming finer until the sensation disappears. The lowest frequency at which flicker just ceases to be noticeable is called the *critical fusion frequency* (CFF) or the *critical flicker frequency*.

TABLE 3: Average values for discrimination of some high contrast objects.

Object	Visual Angle (microradians)
1. Separation of two stars	290
2. Two black bars on a white background separated by a distance equal to the bar width	145
3. Vernier	44
4. Spider web on a luminous white background	38

The CFF depends primarily upon the average illuminance and the *light-to-dark ratio* (LDR). Figure 3 shows the functional dependence of the CFF upon luminance. One important fact should be noted: at frequencies in the vicinity of 60 hertz no flicker is perceptible regardless of the viewing conditions. There is a rapid transition in the region between 48 and 60 hertz which is of considerable significance. Traditionally, the 48 hertz motion picture frame rate has required the projected luminance to be limited to less than 20 foot-lamberts. On the other hand, television systems employing 60 fields per second have virtually no such restriction.

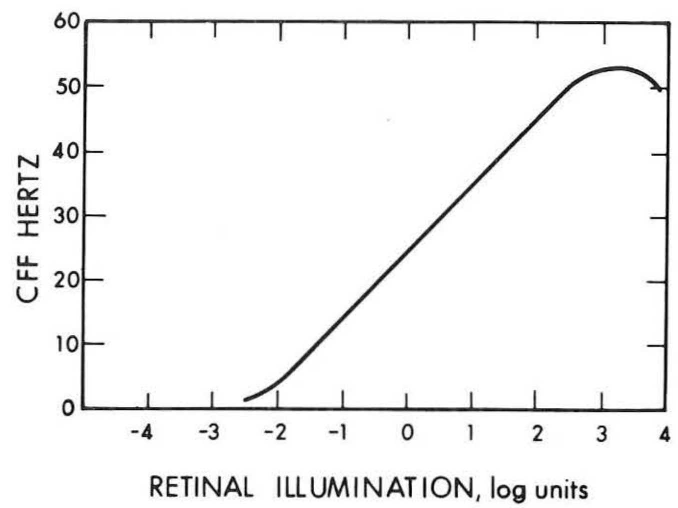

FIGURE 3: Critical flicker frequency as a function of luminance.

Color is defined by three characteristics which are luminance, hue and saturation. Luminance and its relationship to brightness have been discussed. Now consider hue and saturation.

Hue is that sensation primarily elicited by wavelength and to which descriptive names are assigned, such as red, blue, green, and so on. Saturation is evoked by the physical condition of purity and describes the degree of dilution the color appears to have with white light. For example, one may describe blue as being light, or pale, or deep, or dark. Purity is a quantitative physical parameter which can assume values between 0 and 100%. Thus any "color" can be completely described by its luminance, wavelength, and purity which in turn elicit the corresponding sensations of brightness, hue, and saturation.

FUNCTIONAL PARAMETERS OF THE DISPLAY SYSTEM

Now some of the main parameters in command and control displays can be considered. Assume that the mission of the overall system has been determined and that operations studies have established the nature of the data to be displayed. Two basic constraints appear: the capability of the human visual mechanism, and the state of the art of hardware technology. Not unlike the design of other systems, the display is brought into harmony with operations requirements and the necessary other restrictions by a series of iterative design processes.

Resolution and Definition

The smallest symbol or character to be displayed must be rendered so that it is clearly visible from the furthest intended point of observation. The "definition" of displayed data is determined by a number of contributing characteristics. For the purposes herein consider only the most important factor — *resolution*. There are two ways that resolution is ordinarily expressed. Both depend upon how well the system reproduces a series of alternating black and white bars or lines of successively decreasing width. Such a pattern is known as a spatial frequency target. The number of such black and white *line pairs* per linear dimension (such as one millimeter) that is sharply reproduced by the system is called its resolution. Typical photographic films, for example, may have resolutions in the range of 20 to 100 lines per millimeter, although certain films are available with 600 to 1000 lines per millimeter. Note that *lines per millimeter* implies the word "pairs" in photo-optic practice only.

Customary practice in electronically generated images, as in television, counts each line instead of pairing the black and white. For the same actual resolution, therefore, one may find the number quoted to be equivalent to twice that of the photo-optical quantity. Furthermore, it is frequently convenient to state the *total resolution* in a given direction instead of per unit length. Thus, a television system may have 600 lines horizontal resolution which is equivalent to 300 line pairs. For a 300 millimeter horizontal dimension, the latter becomes identical to 1 line per millimeter.

A system should not be required to exhibit greater resolution than necessary to clearly reproduce the smallest picture detail expected, allowing if need be for some degradation in performance over a period of time or under ambient conditions. Taking into account the limits of human vision, one can establish the rule-of-thumb that the smallest detail to be displayed need not be less than 300 microradians included angle at the eye of the furthest observer. Under the same conditions, alphanumeric characters should occupy an angle of at least 3 milliradians. The intercharacter spacing should be about 10 to 12% of character height and interline spacing should be from 50 to 100%. Other symbols are preferably larger, by at least 50% depending upon their complexity.

Amount of Data Displayed

The amount of information is not dependent on the size of the display nor upon the viewing distance, but rather upon the included solid angle. This criterion can be illustrated for alphanumeric characters by means of Figure 4.

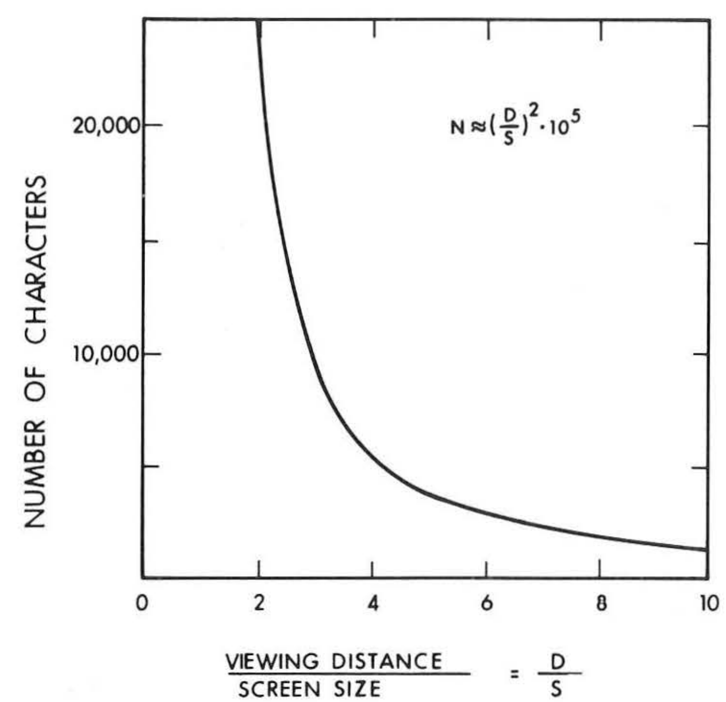

FIGURE 4: Number of alphanumeric characters displayed as a function of distance/screen ratio.

Assume a square screen without margins. The variable "S" represents the screen edge dimension. The height "H" of each character is such that it subtends 3 milliradians at the viewing distance "D". The interline spacing is 0.5H, intercharacter spacing is 0.1H and character width is 0.65H. The curve applies to conditions of adequate luminance, high contrast (in excess of 90%) and a minimum viewing distance of 33 centimeters for observers having at least 20/30 vision.

Display Dynamics

A term often used but rarely understood by everyone in the same way is *real-time*. A cathode-ray tube display is usually considered to operate in real time, that is, no delay occurs and the information is being displayed as it takes place. In any given display situation, time delays varying from microseconds to hours and days may be encountered. At some point the display time delay will tend to degrade overall system performance. The tolerable limit presents a practical definition of real time, or "timeliness". To the pilot making an instrument landing in bad weather, real time is measured in milliseconds. To the business manager, a delay of ten minutes in displaying such data as inventory, production, and sales, is probably of little consequence to the future success of his business.

A common misconception has it that a *dynamic* display is, per se, a real-time display. It would be more appropriate to define a dynamic display as one which is capable of presenting to the observer a series of events which in a space-time continuum are so related that visual perceptions of velocity and acceleration are obtained. Whether this motion is concurrent with the real events, whether a time delay is introduced, or whether the display is predictive (as in a gun-director application) does not alter the fact that the presentation is dynamic.

With these definitions of "real-time" and "dynamic" it is possible to determine the necessity for either one or both forms of presentation, whether it is feasible to technologically achieve the requirements, and to what degree a compromise is acceptable. Assume, for example, that it is desirable to know at all times the subsatellite position of an orbiting vehicle. Let sensor data be available every 15 minutes to the control center, and assume that the display is to appear on a background world map. If the orbital period is 90 minutes, then new position data are available to the central computer six times per revolution. A real-time, and in this case, a dynamic display would appear to be manifestly impossible due to the unavailability of continuous data. Fortunately, it is possible to predict the position of the vehicle by means of known laws of motion, and to correct the predictions as data arrives so that a continuous motion, or dynamic display can be attained.

To cite another example, assume now a system which receives new data at such a rate that the display can be changed several times per second. This may occur in the case of intermittently moving units or objects that automatically report their new position. There is no requirement here for a dynamic display since the individual events are discontinuous; however, it may be important that the system display each new condition essentially as it is reported. Ignoring the problems of queueing and computation or computer process time, a real-time display would change each time a reported change in position is received.

Coding

After determining the kinds, amounts, and rates of information needed for users of the display system to perform their function, the data can be organized into formats convenient for presentation. An essential part of the latter process is visual coding. Although the written language and the independent arrangement of alphanumeric characters are essential, these are not necessarily the simplest nor the most efficient means of displaying data. Common means of coding information for display include color, shape, size, orientation, number, position, depth, blink rate (alternate light and dark excitation), and luminance level.

Selection of the coding methods to be used is ordinarily dictated by:

1. The number of reliable identifiable steps and lack of intercode confusion
2. The relative ease of code interpretation
3. The relative ease of mechanizing the method

Coding may be quantitative or qualitative. For ease of interpretation the code should be of the same type as the information it represents. Size, luminance, and length, for example, change by quantitative increments and should ordinarily be used for designating magnitudes (that is, altitude, speed, distance, etc.).

Data may be single or compound coded. The use of compound coding offers the possibility of a larger gamut of dimensions for the available information, but at the risk of higher complexity in practice and interpretation. There are two basic rules regarding compound coding:

1. Do not use compound coding for only one dimension of information where a single code is clearly distinguishable. For example, green and red respectively may distinguish friend from foe without the need of resorting to small green squares and large red circles.
2. If two or more dimensions are to be coded, use the same number of coding dimensions. Conversely, do not use one coding dimension for a variety of categories. For example, do not use red for enemy bombers and yellow for enemy fighters. Instead, use two coding dimensions: red-enemy, blue-friend; circle-bomber, square-fighter.

Occasionally, the question of stereoscopic, or three-dimensional displays is raised. Insofar as coding is concerned, stereo-depth has not been extensively employed and less is known about the ability of observers to use this method. Certain three-dimensional events may provide important qualitative information by a stereoscopic presentation, but there appears to be no quantitative advantage over the use of two-dimensional parametric equivalents.

Screen Size

Displays can be arbitrarily classified into two groups by size, choice of which is dictated generally by the system operational requirements. *Console* displays are used by one or two observers or operators and measure up to 75 centimeters on the screen diagonal. *Group* displays are used by three or more observers and their size depends upon audience configuration, amount of data simultaneously to be displayed, and the state of the art. Screens of up to 4 meters on a side have been used with moderate success.

In considering command and control centers the relative advantages of group and console displays should be weighed. Some merits of the group display are:

1. Where information requirements of a number of people are similar or identical, a group display may be more economical.
2. A working group can coordinate efforts and communicate more effectively in common session.
3. Many users are accustomed to manual mode group displays.
4. Manual backup procedures are more effective and easier to implement for group displays.
5. Less total equipment is required with consequent lower maintenance, interconnection channels, power, spares, etc.
6. Briefings are readily and effectively provided.
7. Floor space is more efficiently utilized than with many types of consoles.
8. Support personnel can anticipate the concerns and requirements of senior personnel controlling the display.
9. Multiple observation of the same displayed data is a form of operational reliability.

The advantages of console displays include:

1. Information may be displayed which is tailored to fit the individual task requirements.
2. Displayed data may be changed at the discretion of the operator or the operational routine without interrupting others.
3. Data entry and man-machine communications are more effective.
4. Redundancy of units increases reliability for critical functions.
5. The deployment of equipment and personnel is more flexible than with group displays.

CONCLUSION

The above material has covered some of the principal functional parameters of display systems, the limitations imposed by the human visual mechanism, and the interrelationship of the two. To be sure, but an overview of the latter in command and control displays has been presented. It should be clear, however, that the specification and design of displays can be based upon sound scientific and engineering precepts with a minimum of intuitive judgment. By considering the pertinent factors in connection with specific applications, system effectiveness can be improved, human error and cost can be reduced, and overall performance can be made more satisfactory.

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LIST OF SYMBOLS

B	Surface luminance, candela/meter^2 or meter-lambert
C	Contrast
C_R	Contrast ratio
H	Character height
D	Viewing distance

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Labor-Management Strife

[The following editorial by Publishers Hal Spector and Martin H. Waldman is presented here in the firm belief that the ideas incorporated may be of value at least as a starting point toward new thinking in the critical area of labor-management problems.]

When we heard the question, "Must everyone, including the public, suffer as a result of work stoppages in labor-management strife?", we pricked up our ears.

The question was quite seriously asked by prominent Chicago businessman and philanthropist, Paul D. Bezazian, who answers his question with a resounding "No!" Then he goes on to outline a plan whereby labor strikes could be conducted *without loss to labor, management, or the public, and with no government involvement!* Although some rather revolutionary remedies are proposed to underscore his thesis, Bezazian is grinding no axe. He has no personal stake except a sincere desire to benefit Society. (He and others in his family have long been associated with several important philanthropies).

Bezazian is concerned because the work-stoppage strike has become so common a tool in labor-management strife that, today, its frequency causes extreme hardship, not only for labor participants and management, but also for the general public which is not even party to the negotiations. Is there a better way? Bezazian says Yes!

Under his plan, labor leaders would still be able to call a strike as they do now. However, the men would *continue working.* Kookie idea? Hear the rest. If there is no work stoppage, there would be no picketing, no violence, lost wages, lost business, and (extremely significant, in our opinion) no public inconvenience.

How could such a strike exert pressure on management?

Beginning the day the strike is called, the "struck" company would be obligated to deposit incoming money in a special account. Withdrawals would be allowed only to pay normal operating expense. Profits tied up. No dividends permitted. When the strike is settled, the balance in the account would be used in the purchase of long-term government bonds, to be cashed only upon maturity.

A key provision is that settlement would *not* be retroactive. Speedy agreement would therefore be to the advantage of labor and management equally, because benefits and profits would be available only from the date of settlement.

A few of the obvious benefits include elimination of huge unrecoverable financial losses (for both union and management), customer ill-will, market distortion, damage to franchised firms, loss of paychecks, loss of workers' personal savings, etc. The right to strike would be preserved. But civil disorder, tax losses, and drain of union treasuries would be eliminated.

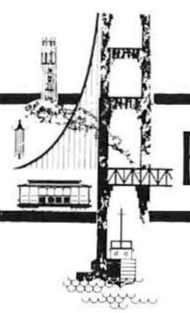
In addition, the government would be excluded from private business disputes, leaving it free to devote attention to other pressing matters.

This plan is currently being disseminated by media throughout the country in the same spirit that Bezazian has proposed it . . . to provide a foundation for new thinking on means to settle labor disputes without waste, without hardship, and without harm to the public.

What has been the response? Bezazian told us he discussed the plan with prominent businessmen who commented: "It looks good, but labor won't accept it." He then showed it to a top union official, who declared: "It might work, but management would never go for it."

Bezazian does not consider his plan a panacea for all labor-management problems. But he does believe it is a good basis for new thinking which could yield numerous benefits to labor, to management, and to the public.

It's certainly food for thought. — *HS AND MHW* •



FJCC Attendance May Hit 5000

A splendid technical program complemented with an outstanding technical exhibit by more than 100 leading information processing equipment manufacturers will attract an estimated 5000 professionals to the 1966 Fall Joint Computer Conference in San Francisco, Nov. 8-10.

The Conference is being held in San Francisco's Civic Center, which includes the Civic Auditorium and Brooks Hall. The Conference Headquarters Hotel is the Jack Tar.

The opening session, theatres, and all technical sessions except those on analog computing will be held in the Civic Auditorium. The exhibits will be in Brooks Hall, which is connected to the Civic Auditorium by an underground ramp. Round trip shuttle bus service will be provided free of charge by the Conference between the Jack Tar Hotel and the Civic Auditorium, the downtown hotels and the Civic Auditorium, and the downtown hotels and the Jack Tar Hotel.

Technical Highlights

William H. Davidow, Hewlett-Packard Co., Technical Program Chairman, reports that 72 papers were selected from 300 submitted to the Conference. In addition to the high calibre of papers, several "Discuss Only" sessions are planned, for floor-discussion by authors of papers printed and distributed in advance.

"A unique aspect of the 1966 FJCC is the Workshop on Complements of Man/Computer Interactions," Davidow says. "This session will enable workers and authorities in the field to interact with one another and to exchange new ideas."

A number of sessions focus on different aspects of time sharing. At these sessions, an attendee should gain an insight into time sharing triumphs and pitfalls, Davidow reports.

Conference Chairman R. George Glaser, McKinsey & Company Inc., and Vice-Chairman Louis J. Lauler, Lockheed Missiles & Space Co., noted, "A number of sessions will deal with the impact of our technology on the world around us . . . We believe that this focus on 'impact' is appropriate in this case, for our technology is indeed changing our world in a real, dramatic, and in some cases, alarming way."

The technical program is complemented by a Keynote Session, Tuesday, Nov. 8, 9:30 to 11:30 a.m. in the Main Auditorium of the Civic Center. Keynote address at this session will be delivered by Gerald Phillippe, Chairman of the Board, General Electric Co., New York City. Session Coordinator is Peter Cannon, General Electric Co., Charlottesville, Va., and other participants include:

Patrick Suppes, Stanford University, *Prospects for Computers in Education;*

Harry M. Runyan, Management Consultant, Brookline, Mass., *Which Way the Computer Revolution?* and,

Ulric Neisser, Department of Psychiatry, University of Pennsylvania, Philadelphia, Pa., *Is there a Computer Revolution?*

FJCC Luncheon

Congressman Jack Brooks (Tex.), who authored the Brooks Bill dealing with the acquisition and use of computers in the federal government, will address the conference luncheon, Nov. 9, in the International Room of the Jack Tar Hotel. He will discuss the significance of automatic data processing within the federal government, with particular emphasis on the adaption of ADP to the decision-making processes for both the executive and legislative branches. He will also describe the increasing requirements for higher qualified personnel, and the revolutionary changes in the management of equipment expected to accompany mounting uses of ADP by the government.

Presentaiton of the AFIPS Harry Goode Award is also planned during the luncheon.

The Conference Reception is also in the International Room of the Jack Tar, Wednesday, 6 to 8 p.m.

Other Highlights

Other FJCC highlights include:

TUTORIAL SESSION: A special tutorial session on *Error Coding and its Implications to Computer Technology* will be conducted Wednesday, Nov. 9, 8 to 10 p.m., in the Gas Buggy Room of the Jack Tar. Speaker is James P. Lipp, General Electric Co., Oklahoma City, Okla. The session will cover the basic principles of error coding, illustrate several coder embodiments, describe resulting performance, and discuss implications for computer use.

COMPUTER SCIENCE THEATER: Outstanding films on computers, data processing, and computer applications will be shown Tuesday, 1 to 5:30 p.m.; Wednesday, 9 a.m. to 5:30 p.m.; and Thursday, 9 a.m. to noon. Two theaters will operate simultaneously these hours at the Civic Center, in Rooms 306 and 326.

SPECIAL EDUCATION: A one-day seminar for high school and junior college students from the San Francisco Bay Area counties (by invitation only) will be offered in conjunction with the Conference, in the Del Webb Town House, across the street from Brooks Hall.

Goode Memorial Award

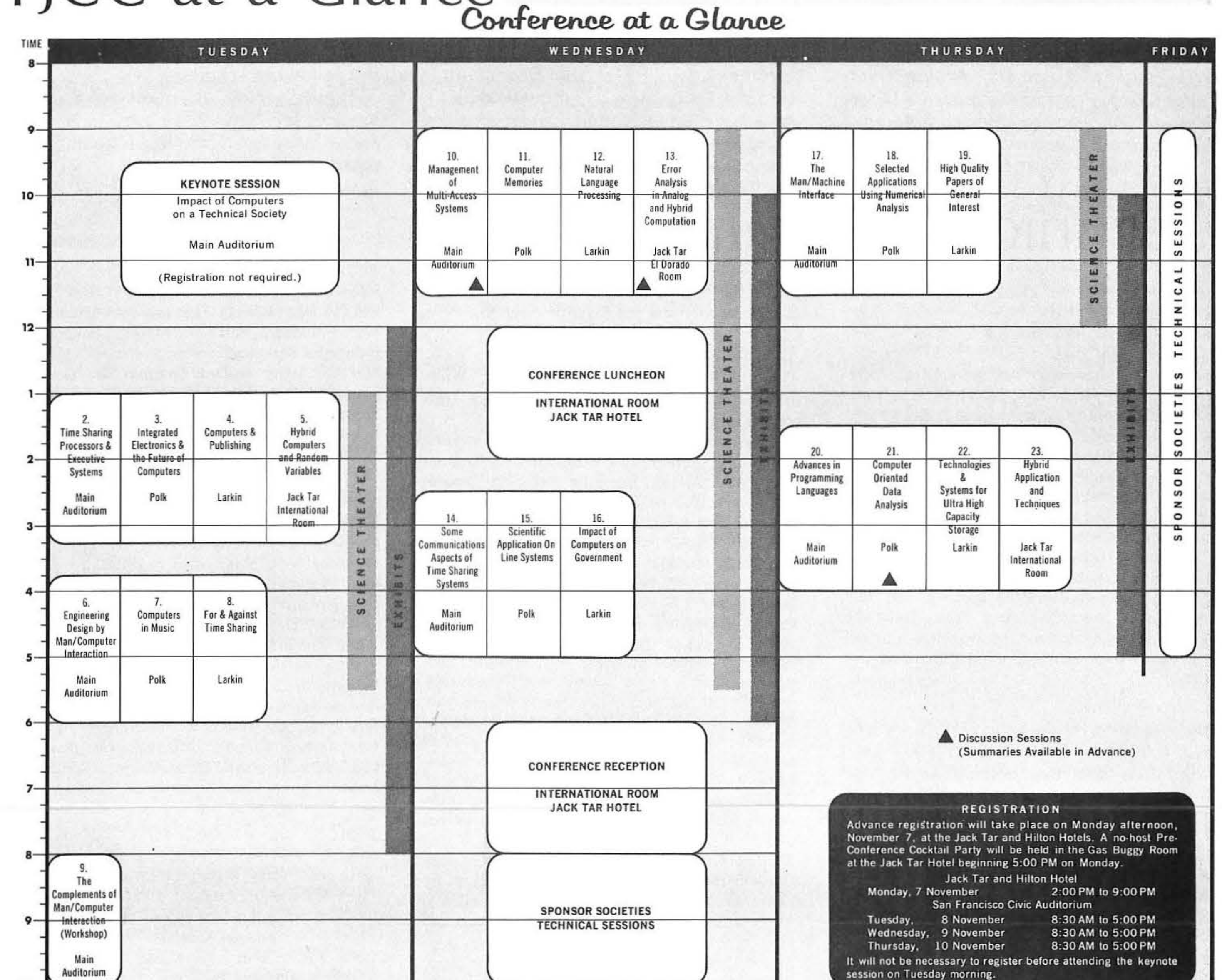
For their pioneering contributions to automatic computing, J. Presper Eckert and John W. Mauchly will receive the Harry Goode Memorial Award at the conference luncheon.

Both are being cited for participating in the design and construction of the ENIAC, the world's first all-electronic computer, and of the BINAC and the UNIVAC I.

Mr. Eckert is also being honored for his continuing work in the design of electronic computing systems. Dr. Mauchly will also be cited for his pioneering efforts in the application of electronic computers to the solution of scientific and business problems.

The Harry Goode Memorial Award was established by AFIPS to encourage and honor outstanding contributions to the information processing arts. The award, named after Dr. Harry H. Goode, former Chairman of the National Joint Computer Conference, consists of a medal and certificate.

FJCC at a Glance



Messages for conferees will be accepted at the conference message center, and the names of persons receiving messages will be posted on a message board. The telephone number will be (415) 863-1394, at both the following locations as scheduled:

Monday and Friday, and evenings (5 to 9 p.m.) on the Jack Tar mezzanine.

Tuesday, Wednesday, and Thursday, 8:30 a.m. to 5 p.m., main lobby of Civic Auditorium.

Conference highlights will be posted daily at the above message centers.

Sponsoring Society Programs

Sponsoring Societies, members of the American Federation of Information Processing Studies, are: (Members) The Association for Computing Machinery, The Institute of Electrical and Electronics Engineers Computer Group, and Simulation Councils Inc.; (Associate Member) American Documentation Institute; and, (Affiliate Member) Association for Machine Translation and Computational Linguistics.

Four of the above Societies will conduct their own technical sessions in conjunction with FJCC, on the following schedule:

AMERICAN DOCUMENTATION INSTITUTE: Wednesday, Nov. 9, 8 to 10 p.m., Garden Room, Jack Tar Hotel — *Selective Dissemination of Information (SDI) Systems . . . Present Status, Future Prospects.* Chairman is Charles P. Bourne, Advanced Information Systems Div., Programming Services Inc., Palo Alto, Calif.

ASSOCIATION FOR COMPUTING MACHINERY: Special Interest Committee Symbolic and Algebraic Manipulation: Wednesday, Nov. 9, 8 to 10 p.m., El Dorado Room, Jack Tar Hotel — *Meaning and Impact of Symbol Manipulation.* Chairman is Jean E. Sammet, IBM Corp., Cambridge, Mass.

ASSOCIATION FOR COMPUTING MACHINERY: Special Interest Committee on Real-Time Processing: Friday, Nov. 11, 9 a.m. to noon, Telegraph Hill Room, Jack Tar Hotel — *The Future of Real Time Processing in Business and Industry.* Chairman is Sherman C. Blumenthal, Union Carbide Corp., New York City.

ASSOCIATION FOR COMPUTING MACHINERY: Special Inteest Committee on Time Sharing: Friday, Nov. 11, 9 a.m. to noon, California Room, Jack Tar Hotel — Designer-oriented symposium. Moderator, Walter J. Kosinski, General Electric Co., Phoenix, Ariz.

ASSOCIATION FOR MACHINE TRANSLATION AND COMPUTATIONAL LINGUISTICS: Friday, Nov. 11, 2 to 4 p.m., Twin Peaks Room, Jack Tar Hotel — *Machine Translation — State-of-the-Art.* Chairman, R. M. Worthy, The Bunker-Ramo Corp., Canoga Park, Calif.

SIMULATION COUNCILS INC.: Friday, Nov. 11, 8 a.m. to 5 p.m., International Room, Jack Tar Hotel. The Following papers are to be presented:

COMRADE: On-line Design Systems; A Non-Linear Simulation System; Hybrid Computer Simulation of a Moving Bed Catalyst Regenerator; Identification of Linear and Non-Linear Systems; PATCH — An Automatic Analog Computer Check Program; Lyapunov's Direct Method Applied to Model Reference Control; and Determination of Chemical Rate Coefficients from Experimental Data. Chairman, Maurice I. Stein, ADAGE Inc., Boston, Mass.

Conference Exhibits

Conference exhibits featuring over 100 exhibitors will be at the Civic Center (Brooks Hall), which connects directly to a large underground garage and the Civic Auditorium where the technical sessions will be held. Exhibits Chairman is Raymond D. Smith, of SCM Corp.

A separate Exhibit Guide listing exhibitors and giving their booth locations will be available at registration areas. The exhibits will be open according to the following schedule:

Tuesday, Nov. 8, noon to 8 p.m.; Wednesday, Nov. 9, 10 a.m. to 6 p.m.; and Thursday, Nov. 10, 10 a.m. to 5 p.m.

Technical Program

SESSION 2: TIME-SHARING PROCESSORS AND EXECUTIVE SYSTEMS (Tuesday 1-3:15 p.m., Main Auditorium): Chairman, Gene M. Amdahl, IBM/San Jose.
PAPERS: *A Conversational System for Incremental Compilation and Execution in a Time-Sharing Environment*, by James L. Ryan (Tymshare Inc.), Richard L. Crandall (Com-Share Inc.), and Marion C. Medwedeff (Scientific Data Systems). *Performance of a Monitor for Real-Time Control System*, by Erna S. Hoover (Bell Telephone Laboratories) and Barry J. Eckhart (Bell Telephone Co. of Canada). *On-Line Debugging Techniques: A Survey*, by Thomas G. Evans (AF Cambridge Research Laboratories) and D. Lucille Darley (Bolt, Beranek, and Newman Inc.). *The SDS Sigma 7, a Real-Time, Time-Sharing Computer*, by Myron J. Mendelson and A. W. England (Scientific Data Systems).

SESSION 3: INTEGRATED ELECTRONICS AND THE FUTURE OF COMPUTERS (Tuesday 1-3:15 p.m., Polk): Chairman, James B. Angell, Stanford University.
PAPERS: *Technological Foundations and Future Directions of Large-Scale Integrated Electronics*, by Richard L. Petritz (Texas Instruments) *A Look at Future Costs of Large Integrated Arrays*, by Robert N. Noyce (Fairchild Camera & Instrument Corp.). *Effects of Large Arrays on Machine Organization and Hardware/Software Trade-Offs*, by L. C. Hobbs (Hobbs Associates Inc.). *A Prospectus on Integrated Circuit Computer Architecture*, by Michael J. Flynn (University of Illinois). *The System/Semiconductor Interface with Complex Integrated Circuits*, by Wendell B. Sander (Fairchild Semiconductor R&D Laboratory).

SESSION 4: COMPUTERS AND PUBLISHING (Tuesday 1-3:15 p.m., Larkin): Chairman: William R. Nugent, Infronics Corp., Maynard, Mass.
PAPERS: *A Systems Approach to Computer Typesetting: Application of a Multiprogrammed Teleprocessing System*, by B. E. Nabel (Los Angeles Times). *Integrated Automation in Newspaper and Book Production*, by John H. Perry Jr. (Perry Publications Inc.). *Special Purpose Computer for High-Speed Page Composition*, by Constantine J. Makris (Mergenthaler Linotype Co.). *Publishing Automation in Britain and Europe: A Survey and Progress Report*, by C. J. Duncan and J. L. Colby (The University of Newcastle-upon-Tyne, Northumberland, England). *Computerized Typesetting of Complex Scientific Material*, by J. H. Kuney, B. J. Lazorchak, and S. W. Walcavich (American Chemical Society), and Don Sherman (Inforonics Inc.). *A Computer-Assisted Page Composing System (Featuring Hyphenless Justification)*, by George Z. Kunkel (Central Intelligence Agency).

SESSION 5: HYBRID COMPUTERS AND RANDOM VARIABLES (Tuesday 1-3:15 p.m., International Room): Chairman, A. C. Soudack, University of British Columbia.
PAPERS: *A General Method for Generating Random Variables in a Computer*, by George Marsaglia (Boeing Scientific Research Laboratories). *A Unified Approach to Deterministic and Random Errors in Hybrid Loops*, by Jacques J. Vidal (UCLA). *Hybrid Computer Solutions of Partial Differential Equations by Monte Carlo Methods*, by Warren D. Little (Canadian General Electric). *Parameter Optimization by Random Search using Hybrid Computer Technique*, by G. A. Bekey (USC), and A. E. Sabroff and M. H. Gran (TRW Systems).

SESSION 6: ENGINEERING DESIGN BY MAN/COMPUTER INTERACTION (Tuesday) 3:45-6 p.m., Main Auditorium): Chairman, Thurber J. Moffett, Lockheed-California Co., Burbank.
PAPERS: *A Parametric Graphical Display Technique for On-Line Use*, by M. L. Dertouzos and H. L. Graham (MIT). *A System for Time-Sharing Graphic Consoles*, by J. R. Kennedy (Lockheed-Georgia Co.). *The Lincoln Wand*, by Lawrence G. Roberts (Lincoln Laboratory). *Using a Graphic Data Processing System to Design Artwork for Manufacturing Hybrid Integrated Circuits*, by J. S. Koford, P. R. Stickland, G. A. Sporzynski, and E. M. Hubacher (IBM Components Div., Hopewell Junction, N.Y.). *Automated Logic Design Techniques Applicable to Integrated Circuit Technology*, by R. Waxman, M. T. McMahon, B. J. Crawford, and A. B. DeAndrade (IBM Components Div.).

SESSION 7: COMPUTERS IN MUSIC (Tuesday, 3:45-6 p.m., Polk): Chairman, Heinz Von Foerster, University of Illinois, Urbana.
PAPERS: PART I: PROGRAMS AND SYSTEMS: *Simulation Models for Transient Musical Instrument Tones*, by James W. Beauchamp (University of Illinois). *The Computer as Orchestra*, by Arthur Roberts (Argonne National Laboratory). *Computer Generation of Music in Real Time*, by David Freeman (University of Illinois).
PAPERS: PART II: ESTHETICS: *Control of Consonance and Dissonance with Nonharmonic Overtones*, by Max Mathews (Bell Telephone Laboratories). *Operations on Waveforms*, by Jim K. Randall (Princeton University). *The Problem of Imperfection in Computer Music*, by Gerald Strang (California State College).
PAPERS: PART III: COMPOSITION: *Graphical Scores*, by Max Mathews (Bell Telephone Laboratories). *Composing Music with a Computer*, by L. A. Hiller Jr. (University of Illinois).

SESSION 8: FOR AND AGAINST TIME-SHARING (A Discussion): (Tuesday, 3:45-6 p.m., Larkin): Chairman, Harry D. Huskey, University of California Berkeley.
TOPICS: *What Is Time-Sharing?*, by David L. Evans (University of Utah). *Problems Which Should Not Be Run on Time-Sharing Systems*, by Abe Taub (UC Berkeley). *Problems Best Solved on Time-Sharing Systems*, by J. C. R. Licklider (IBM Corp., Yorktown Heights, N.Y.).

SESSION 9: THE COMPLEMENTS OF MAN/COMPUTER INTERACTION (A Workshop): (Tuesday, 8-10 p.m., Main Auditorium): Chairman, Thurber J. Moffett, Lockheed-California Co., Burbank.
TOPICS: *Design Applications*, by Edwin L. Jacks (General Motors Research Laboratories, Warren, Mich.). *Graphic Consoles*, by John T. Gilmore Jr. and Frank S. Greatorex Jr. (Adams Associates, Cambridge, Mass.). *Graphical Data Structures*, by Lawrence G. Roberts (Lincoln Laboratory). *Graphic Software*, by James L. Laushine (Control Data Corp., Burlington, Mass.).

SESSION 10: MANAGEMENT OF MULTI-ACCESS SYSTEMS (Discussion Only)—(9-11:30 a.m., Wednesday, Main Auditorium): Chairman, Richard G. Mills, MIT.
PANELISTS: John W. Weil (GE, Phoenix); Charles W. Adams (Charles W. Adams Associates Inc., Cambridge, Mass.); Thomas J. O'-Rourke (Tymshare Inc., Los Altos, Calif.); and Claggett A. Jones (C-E-I-R Inc., Arlington, Va.).

SESSION 11: COMPUTER MEMORIES (Wednesday, 9-11:30 a.m., Polk): Chairman, Jan A. Rajchman, RCA Laboratories.
PAPERS: *Cost Performance Analysis of Integrated-Circuit Core Memories*, by Dana W. Moore (Computer Control Co. Inc.). *A 200-Nanosecond Thin Film Main Memory System*, by S. A. Meddaugh and K. L. Pearson (UNIVAC, St. Paul). *A Rotationally-Switched Rod Memory with a 100-Nanosecond Cycle Time*, by Bruce A. Kaufman, Paul B. Ellinger, and H. J. Kuno (The National Cash Register Co., Hawthorne, Calif.). *A 500-Nanosecond Main Computer Memory Utilizing Plated-Wire Elements*, by James P. McCallister and Carlos F. Chong (UNIVAC, Blue Bell, Pa.). *A High Speed Integrated Circuit Scratchpad Memory*, by Ivor Catt, Emory Garth, and Donald E. Murray (Motorola Inc., Phoenix). *Sonic Film Memory*, by Hillel Weinstein (Xerox Corp., Webster, N.Y.) and Lubomyr S. Onyshevych, Kaare Karstad, Rabah A. Shahbender (RCA, Princeton).

SESSION 12: NATURAL LANGUAGE PROCESSING (Wednesday, 9-11:30 a.m., Larkin): Chairman: H. R. J. Grosch, General Electric, Santa Barbara, Calif.
PAPERS: *English for the Computer*, by Frederick B. Thompson (CIT, Pasadena). *DEACON: Direct English Access and CONtrol*, by James A. Craig, Susan C. Berezner, Homer C. Carney and Christopher R. Longyear (GE, Santa Barbara). *Computer Assisted Interrogation*, by Charles T. Meadow and Douglas W. Waugh (IBM Corp., Rockville, Md.). *An Approach toward Answering English Questions from Text*, by R. F. Simmons, J. F. Burger and R. E. Long (System Development Corp., Santa Monica).

SESSION 13: ERROR ANALYSIS IN ANALOG AND HYBRID COMPUTATION (Discussion Only)—(Wednesday, 9-11:30 a.m., El Dorado Room, Jack Tar Hotel): Chairman, Robert Vichnevetsky, Electronic Associates Inc., Princeton, N.J.
PANELISTS: *Interrelation of Error Analysis, Sensitivity Analysis and Parameters Identification*, by Hans F. Meissinger (TRW Inc., Redondo Beach). *Error Analysis and Error Prediction in Fast Iterative Hybrid Computers*, by Granino A. Korn (University of Arizona, Tucson). *Error Analysis of Hybrid Field Simulations*, by Walter J. Karplus (UCLA). *Error Analysis of Hybrid Computer Loops*, by Elmer G. Gilbert (University of Michigan, Ann Arbor). *Spectral Analysis of Hybrid Subroutines*, by Max C. Gilliland (Computer Research Inc., Orinda, Calif.). *The Analysis of Errors due to Sampling Rate Variations*, by George E. Bekey (USC, Los Angeles).

SESSION 14: SOME COMMUNICATIONS ASPECTS OF TIME-SHARING SYSTEMS (Wednesday, 2:30-5 p.m., Main Auditorium): Chairman, Paul Baran, The Rand Corp., Santa Monica, Calif.
PAPERS: *A Review of Some of the Real-World Problems in Establishing Data Communications between Users and the Computer*, by L. A. Hittell (GE, Phoenix). *The User's Requirements for Data Communications in a Management Information System*, by Donald J. Dantine (Clark Equipment Co., Buchanan, Mich.). *Experiments using High-Speed Communications Between Computers*, by Henry McDonald (Bell Telephone Laboratories). *Elementary Telephone Switching Theory Applied To the Design of Message Switching Systems*, by Leon Stambler (RCA Communication Systems Div., New York City). *A Proposed Communications Network To Tie Together Existing Computers*, by Thomas Marill and Lawrence G. Roberts (Computer Corporation of America, Cambridge, Mass.)

SESSION 15: SCIENTIFIC APPLICATION ON-LINE SYSTEMS (Wednesday, 2:30-5 p.m., Polk): Chairman, L. H. Amaya, Lockheed Missiles & Space Co., Sunnyvale. Panel: Charles R. DeCarlo (IBM, White Plains), Francis V. Wagner (Informatics Inc., Los Angeles), and William H. Wattenburg (Berkeley Scientific Laboratories).
PAPERS: *The Lincoln Reckoner: An Operation-Oriented On-Line Facility with Distributed Control*, by Arthur N. Stowe, Raymond A. Wiesen, Douwe B. Yntema, and James W. Forgie (MIT). *TELSIM, a User-Oriented Language for Simulating Continuous Systems at a Remote Terminal*, by Kenneth J. Busch (Bell Telephone Laboratories). *Man Machine Communications in On-Line Mathematical Analysis*, by Roy Kaplow, John W. Brackett, and Stephen L. Strong (MIT).

SESSION 16: IMPACT OF COMPUTERS ON GOVERNMENT: FEDERAL, STATE, AND LOCAL (Wedesday, 2:30-5 p.m., Larkin): Chairman, Norman J. Ream, Center for Computer Sciences and Technology, U.S. Department of Commerce, National Bureau of Standards, Washington; Panelist, Paul Armer (Rand Corp.)
PAPERS: *The Check Payment and Reconciliation Program of the U.S. Treasury*, by George F. Stickney (U.S. Treasury Department). *Problems of Information Systems in State Governments*, by Dennis G. Price (Div. of the Budget, Albany, N.Y.). *Impact of Computers on Local and Regional Government*, by Herbert H. Isaacs, (Research & Consulting Inc., Los Angeles). *An Information System for Law Enforcement*, by L. B. McCabe and L. Farr (System Development Corp., Santa Monica). *Transfer of Space and Computer Technology to the Urban Security (Police) Functions*, by Richard B. Hoffman (California State College at Hayward).

SESSION 17: THE MAN-MACHINE INTERFACE (A Discussion)—(Thursday, 9-11:30 a.m., Main Auditorium): Chairman, Sidney Fernbach, Lawrence Radiation Laboratory, Livermore. Panelists, Burton D. Fried (Department of Physics, UCLA); Jerome A. G. Russell (Presbyterian Medical Center, San Francisco); S. H. Chasen (Lockheed-Georgia Co.); Robert Glaser (Psychology Department, University of Pittsburgh); and J. C. R. Licklider (IBM Thomas J. Watson Research Center).
PAPERS: *Recent Progress on a High Resolution Meshless Direct View Storage Tube*, by Norman H. Lehrer and R. D. Ketchpel (Hughes Research Laboratories, Malibu, Calif.). *The Plasma Display Panel—A Digitally Addressable Display with Inherent Memory*, by Donald L. Bitzer and H. Gene Slottow (Coordinated Science Laboratory, University of Illinois).

SESSION 18: SELECTED APPLICATIONS USING NUMERICAL ANALYSIS (Thursday, 9-11:30 a.m., Polk): Chairman, R. W. Hamming, Bell Telephone Laboratories, Murray Hill, N.J.
PAPERS: *The Use of Semi-Recursive Polynomials in the Design of Numerical Filters*, by Charles B. Stallings (Martin Co., Orlando). *Fast Fourier Transforms—For Fun and Profit*, by W. M. Gentleman and G. Sande (Bell Telephone Laboratories and Princeton University). *Programs for the Computer Analysis of Finite Groups*, by Kemel George, Raymundo Segovia and Harold McIntosh (Ciudad Universitaria, Mexico).

SESSION 19: HIGH QUALITY PAPERS OF GENERAL INTEREST (Thursday, 9-11:30 a.m., Larkin): Chairman, Rex Rice, Fairchild Research Laboratories, Palo Alto, California.
PAPERS: *A System for Automatic Value Exchange*, by Vern E. Hakola (Touche, Ross, Bailey & Smart, Los Angeles) and Sherman C. Blumenthal (Union Carbide Corp.). *Real-Time Recognition of Hand-Printed Text*, by Gabriel F. Groner (Rand Corp.). *Basic Hytran Simulation Language (BHSL)*, by John C. Strauss (Electronic Associates Inc., Princeton, N.J.).

SESSION 20: ADVANCES IN PROGRAMMING LANGUAGES (Thursday, 1:30-4 p.m., Main Auditorium): Chairman, W. C. McGee, IBM Corp., Palo Alto. Panelists: T. B. Steel (System Development Corp.); Nicklaus Wirth (Stanford University); and Richard V. Smith (IBM Thomas J. Watson Research Center).
PAPERS: *A Processor-Building System for Experimental Programming Languages*, by Terrence W. Pratt (Michigan State University). *The Introduction of Definitional Facilities into Higher Level Programming Languages*, by T. E. Cheatham Jr. (Computer Associates Inc., Wakefield, Mass.) *Foundations of the Case for Natural-Language Programming*, by Mark I. Halpern (Lockheed Missiles & Space Co.). *Explicit Parallel Processing Description and Control in Programs for Multi- and Uni-Processor Computers*, by J. A. Gosden (Auerbach Corp., Arlington, Va.). *The LISP 2 Programming Language and System*, by Paul W. Abrahams (Information International, New York City) and Clark Weissman (System Development Corp., Santa Monica). *APL—A Language for Associative Data Handling*, by George G. Dodd (General Motors Research Laboratories, Warren, Mich.).

SESSION 21: COMPUTER-ORIENTED DATA ANALYSIS (Discussion Only)—(Thursday, 1:30-4 p.m., Polk): Chairman, Geoffrey H. Ball, Stanford Research Institute, Menlo Park, California. Panelists: Doug Engelbart (SRI); Herman Friedman (IBM New York Scientific Center); David Hall (SRI); Dan Keehn (CIT); and Oliver Selfridge (Lincoln Laboratories).
PAPERS: *Automatic Off-Line Multivariate Data Analysis*, by George S. Sebestyen (Office of the Secretary of Defense, Washington). *Data Analysis and Statistics: An Expository Overview*, by J. W. Tukey and M. B. Wilk (Bell Telephone Laboratories).

SESSION 22: TECHNOLOGIES AND SYSTEMS FOR ULTRA-HIGH CAPACITY STORAGE (Thursday, 1:30-4 p.m., Larkin): Chairman, J. D. Kuehler, IBM Corp., San Jose.
PAPERS: *The Unicon Computer Mass Memory System*, by C. H. Becker (Precision Instrument Co., Palo Alto, Calif.). *An Electron Optical Technique for Large Capacity Random Access Memories*, by Sterling P. Newbery ((GE, Schenectady). *A System of Recording Digital Data on Photographic Film using Superimposed Grating Patterns*, by R. L. Lamberts and G. D. Higgins (Eastman Kodak Co.). *A Photo-Digital Mass Storage System*, by J. D. Kuehler and H. R. Kerby (IBM Corp., Harrison, N.J.).

SESSION 23: HYBRID APPLICATIONS AND TECHNIQUES (1:30-4 p.m., Thursday, International Room, Jack Tar Hotel): Chairman, Walter Brunner, Electronic Associates, Princeton, N.J. Panelists: Jim Wolle (General Electric, Philadelphia); Robert Howe (University of Michigan); and Alan Rogers (University of Delaware).
PAPERS: *Hybrid Computers in the Analysis of Feedback Control Systems*, by C. K. Sanathanan, J. C. Carter, Lawrence T. Bryant and Lawrence W. Amiot (Argonne National Laboratory). *Hybrid Computer Solution of the Double-Pipe Sturm-Liouville Problem*, by Lawrence T. Bryant, Lawrence W. Amiot, and Ralph P. Stein (Argonne National Laboratory). *A General Purpose Analog Translational Trajectory Program for Orbiting and Re-entry Vehicles*, by Arthur I. Rubin and Lloyd A. Shepps (Martin Co. Baltimore). *Trajectory Optimization using Fast-Time Repetitive Computation*, by James S. Raby and Rodney C. Wingrove (NASA Ames Research Center). *Satellite Lifetime Program*, by Wayne W. Miessner and John L. Stricker (Martin Co. Baltimore). •

ID Readout

1967 Symposium

The 8th National SID Symposium will convene in San Francisco in May, 1967. Tentative dates are May 24, 25, and 26. Hosts will be the Bay Area chapter of the Society for Information Display.

Chairman of the 8th Symposium is Donald Cone, Stanford Research Institute, Menlo Park, California, Telephone (415) 326-6200. Publicity Chairman is Ralph Seitle, Philco Western Development Laboratory, Palo Alto, who may be contacted at 35 Skywood Way, Woodside, California, or telephone (415) DAvenport 6-4350. Exhibits Chairman is W. D. Fuller, Lockheed Missiles and Space Co., Sunnyvale, California, telephone (408) 742-0962.

Additional details will be published immediately, as they are made available to the editors, so that members may plan accordingly.

SAN DIEGO ID SEMINAR

A full day technical seminar, to be held on March 14, is being planned by SID's San Diego Chapter. Similar to the L.A. Chapter-sponsored meeting in March of this year, the seminar will consist of selected technical papers on new concepts in display technology. The Society's annual business meeting will be held concurrently. More detailed announcements are forthcoming. Meanwhile, authors and other interested parties are invited to contact Robert Peterson, Stromberg-Carlson Corp., Data Products Div., P.O. Box 2449, San Diego, Calif. 92112.

CHAPTER NEWS

The *Los Angeles Chapter* recently completed its annual election of officers for the 1966-1967 activity year. During the chapter meeting to be held on Oct. 27, 1966, outgoing Chairman Dr. Ray Bernberg was to welcome the new cadre as follows: Chairman, Erwin A. Ulbrich, Genisco; Chairman-elect, Fred E. Smith, Litton Data Systems; Secretary-Treasurer, Richard Winner, Hughes Aircraft; Secretary-Treasurer-elect, Lester E. Haining, Hughes Aircraft; Executive Board — (a) Raymond E. Bernberg, Litton Guidance and Controls; (b) George H. Turner Jr., RCA West Coast; and (c) Walter E. Deutsch, Hughes Aircraft. The October meeting at the Engineer's Club in downtown Los Angeles will feature a discussion on "External Visual Displays Used For Flight Simulation", by Kenneth Dyda, Flight Simulation Supervisor, Flight Simulation Laboratory, NAA, Los Angeles Division. Mr. Dyda will show movies and slides of the displays used by NAA in their Flight Simulation Laboratory and will discuss concepts that have been used or are being developed for external visual simulation. — L. M. SEEBERGER, Publicity, Los Angeles Chapter.

CALLS FOR PAPERS

NAECON '67: The Nineteenth Annual National Aerospace Electronics Conference will convene in Dayton, O. May 15,

16 and 17, 1967, under sponsorship of the IEEE, ION, and AIAA. Following the theme "1967 NAECON Spotlights the Future", the program will highlight four general areas: Aerospace Sensors and Components, Man-Machine Symbiosis, Aerospace Information Processing, and Systems Aspects of the Aerospace Mission. Deadlines for prospective authors include Nov. 15, 1966 for a 300-word abstract and biographical sketch of the author, all in triplicate; Jan. 1, 1967, notification of acceptance or rejection, March 1, 1967, Complete paper, five copies, typed, double-spaced, complete with illustrations. Address all material to Dr. Charles C. Goldman, Chairman, Technical Program, 1967 NAECON, 2505 England Avenue, Dayton, O., 45406.

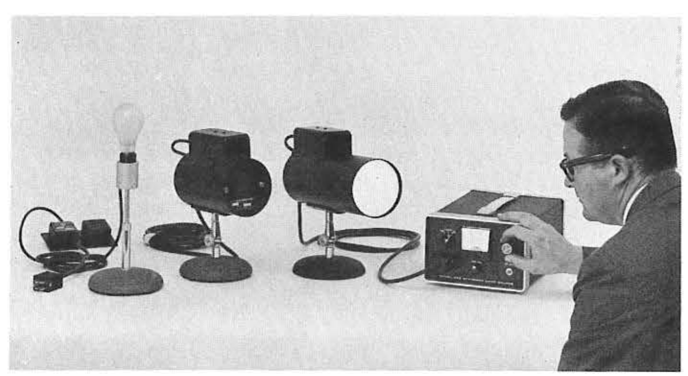
8TH ANNUAL IEEE SYMPOSIUM: A call for papers has been issued for the 8th Annual IEEE Symposium on Human Factors in Electronics, which convenes May 3, 4 and 5, 1967, in the Cabana Motor Hotel, Palo Alto, Calif. Conference theme is Automation-Performance-Acceptance Compromises in System Design. Categories include Education and Training, Safety, Information Processing, Command/Control Systems, Man-Machine Interface, Vehicle Control, and Transportation. Deadline is Dec. 15 for a 100-word program abstract AND a 500-word selection abstract, which should be mailed to Dr. James C. Bliss, Electrical Engineering Department, Stanford University, Stanford, California 94305. Acceptance notice is planned by February 1.

BUSINESS NEWS

The NAVAL RESEARCH LABORATORY has purchased an Advance Series 6050 Computer System for acquisition and processing of data; it will be supplied by the ELECTRO-MECHANICAL RESEARCH INC. ASI Computer Div., Minneapolis. Used on-line during progress of low-energy nuclear physics experiments, data will be stored on mag tape and results will be displayed on a CRT . . . A sharp increase has been noted during the past year in the demand for precision deflection yokes, with a significant portion of demand in the display field . . . NASA has awarded two contracts totaling $193,000 to B-R DATA SYSTEMS INC., a subsidiary of THE BUNKER-RAMO CORP. one is for installation and operation of an automated program and management system for OART, and the other for ADP programming services at NASA headquarters . . . SANDERS ASSOCIATES INC. will construct a two-story, 32,000 sq. ft. addition to its Geospace Electronics Div. plant in Plainview, L.I., N.Y. . . . BUSINESS COMPUTER SERVICES INC., Boston, has ordered a DATA PRODUCTS CORP. L/PM-1000 off-line print station for production of upper and lower case text and conventional upper case output at speeds up to 1200 lines/min. . . . CALMA CO., Santa Clara, Calif., has received a $64,321 contract from Eglin AFB for procurement of a Model 302/G digitizing system . . . Telemetrics Div. of TECHNICAL MEASUREMENT CORP., Santa Ana, Calif., has announced a new unit which simultaneously displays changing information from up to 128 data channels in bar-graph form on a compact, 17-in. CRT . . . ARGUS INC. has received $1.7 million in military contracts from the Army's Frankford Arsenal, Philadelphia, to manufacture M-19 periscopes and M-117 panoramic periscopes . . . INTERNATIONAL BUSINESS MACHINES CORP. has developed a laser beam deflection system which utilizes a specially-designed CRT as one of the mirrors . . . CALIFORNIA COMPUTER PRODUCTS INC. is installing a digital plotting system for use at the Air Force Military Personnel Center, Randolph AFB, Tex.; the firm has also received two NASA contracts totaling over $390,000.

GENERAL PRECISION's Link Group, Binghamton, N.Y., is manufacturing an Automated Microfilm Aperture Card Updating System (AMACUS) for the ARMY WEAPONS COMMAND, Rock Island, Ill., under a $500,000 contract . . . RAYTHEON production has passed the 100 millionth mark in cold cathode tubes at its Components Div. plant, Quincy, Mass. . . . DOUGLAS AIRCRAFT CO. has established a new Information Systems Subdivision within its Missile and Space Systems Div., Huntington Beach, Calif. . . . CORNING GLASS WORKS OF CANADA, LTD., is constructing a new plant at Bracebridge, Ont., which will manufacture glass for TV tubes for the Canadian market . . . A display console combining electronically generated symbols and slide-projected images has been announced by ITT FEDERAL LABORATORIES, Ft. Wayne, Ind.; the console, called MACC (Modular Alter & Compose Console) is said to be easily interfaced with high-speed computers . . . A computer-plotter system that compensates for distortion in aerial photographs for use in map revision has been delivered to the U.S. ARMY ENGINEERS GEODESY INTELLIGENCE MAPPING RESEARCH AND DEVELOPMENT AGENCY according to ELECTRONIC ASSOCIATES INC., West Long Branch, N.J. . . . ITEK CORP., Lexington, Mass., is expanding its Business Products Div., Rochester, N.Y., to add nearly 58,000 feet of floor space at a cost of $1.2 million . . . GENERAL ELECTRIC CO. has established a new Visual Communications Products Department within its Consumer Electronics Div.; James M. McDonald has been named to head the department, reporting to Robert C. Wilson, VP/gen. mgr. of the division . . . THOMAS ELECTRONICS INC. has moved its operations to a 59,000 sq. ft. plant in Wayne, N.J.; the firm was formerly located at Passaic. New telephone is (201) 696-5200, and TWX (510) 234-5836 . . . ULTRONIC SYSTEMS CORP. has signed a major contract with American Totalisator Div. of UNIVERSAL CONTROLS INC. for an integrated uni-tote/validator system to be installed in the 28 stores of the Joseph Magnin Co. of California . . . COHERENT RADIATION LABORATORIES, a recently formed Palo Alto, Calif., laser manufacturing firm, has been awarded a research contract by E. I. DU PONT DE NEMOURS & CO., for investigation of applications of various types of existing laser devices to holography . . . BURROUGHS CORP. Electronic Components Div., Plainfield, N.J. has introduced five new BCD-decoder/driver modules to its standard line.

ABSOLUTE ENERGY MEASUREMENTS



A new comprehensive system for standardizing absolute energy measurement in the visible spectrum has been announced by Gamma Scientific Inc., San Diego, Calif. The new Model 220 Calibrated Optical Source System can be used as a standard of radiance and irradiance, or luminance and illuminance through the use of a number of different types of heads. Different color temperatures, spectral outputs and levels can also be produced through the use of special filters and attenuators. Because the system is supplied ready to operate, the user saves set-up time, trouble and expense; output can be standardized traceable to NBS in less than 30 seconds, the firm states. The Model 220 system includes a power unit, consisting of a precisely regulated dc power supply, a highly stable absolute reference of dc voltage and an electronic galvanometer, and a series of standard heads containing special tungsten filament lamps. It is a completely portable system.

DISPLAY SYSTEM TO SCOTTISH LAB

Computer generated graphic displays, ideally suited for on-line, computer-aided design systems, can be produced readily and economically by a new computer controlled display system recently delivered to Univac for installation at Glasgow's National Engineering Laboratories. The unique display system was engineered and produced by Information Displays Inc., Mount Vernon, N.Y. The completely solid state Type CM 10058 display system features a fast response, large screen 21-in. CRT, high-speed dot, vector, and character writing capabilities, and digitally controlled size, intensity and line structures. The system which has separately packaged display-generator and display console, includes an interface which permits operation directly from the Univac 1108, Compatible 1108 channel. Up to 80,000 characters a second can be generated by the CM 10058 which displays points, strung characters in four sizes, and vectors in four line structures — dot, dot-dash, dash, and solid.

TRANSLUCENT CERAMIC COATING

A new ceramic material promising excellent thermal protection for the outer surfaces of aircraft and space vehicles has been developed by scientists at the Air Force Materials Laboratory, Wright-Patterson AFB, Ohio. The white translucent material, called "Zircolite", is described as the best ceramic of its type ever developed for high-temperature applications. The polychristalline, refractory zirconium oxide ceramic withstands 4500°F and has been tested continuously for 260 hrs. at 4000°F in the lab without measurable deterioration or atmospheric erosion. It has very high density, strength and corrosion resistance characteristics. *The ultra-high purity of the finished material gives it superior translucent properties. Ground to ⅛ in. or less, it is glass-like and transmits enough light to make legible printed material placed beneath it.* This property gives it a potential application in high temperature elements for electric lamps, and for ir and other em radiation windows.

NEW INFRARED GLASS

A new glass composition with extended infrared transmission serves as part of the "eye" of Redeye — the shoulder-fired surface-to-air missile. The new material, trademarked Cortran, is used in the 2½-inch-diameter nose dome on the heat-seeking Redeye. The glass, Corning Code 9753, transmits 82 per cent of infrared energy at 4 microns (40,000 Angstroms). Transmittance at shorter wavelengths is essentially the same down to about 400 millimicrons (4,000 Angstroms). Sharp cutoffs occur at each end of the transmission band. Code 9753 glass is a calcium aluminosilicate composition developed by Corning Glass Works, Corning, N.Y. The glass has excellent resistance to corrosion and rain erosion, and also has high mechanical strength, Corning states. Most glasses transmit infrared, but generally only to a wavelength of about 2.7 microns. Corning Code 7905, a 96% silica composition that has been used for numerous infrared transmitting applications, has a transmittance curve similar to that of Code 9753, but cutoff occurs at about 3.3 microns. Extending the range to 4 microns is equivalent to extending sensing ability from 1200°F to 800°F — thus allowing greater sensitivity to heat sources.

Binary to decimal decoding system using neon lamps and a photoconductor matrix

[This is the first article to be published in a new feature series utilizing specially-prepared product-oriented technical articles. Such articles will be published as made available, after the Publications Chairman and Editorial Advisory Board have assessed the material and found it to have sufficient technical merit for presentation to Information Display readers.]

by MARVIN WILLRODT
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Palo Alto, California

Electronic counters are extensively used today to make accurate frequency, period, time interval and ratio measurements. These measurements are made by counting the number of electrical impulses of input signals at rates greater than 100 million per second in some of the more sophisticated counters.

Hewlett-Packard has been designing and manufacturing electronic counters for more than 15 years. The earlier tube models were the forerunners of today's solid state counters, which provide greater measurement capability in smaller, more portable cases.

Inside the box, counting is accomplished by using a modified binary number system. It is binary in that each counting stage is a binary with four of these binaries interconnected in such a way that the circuit will cycle in 10 counts instead of the 16 counts required by a straight binary system.

Once the counter has accumulated the desired information it must be put in a format acceptable to people; i.e., the binary coded decimal information in which the counter had been operating must be converted to decimal information which will operate a visual display. This is where the neon lamps come into the picture.

A counting decade consists of four binary circuits of the kind shown in Figure 1 together with appropriate interconnections. Each binary has two neon lamps, DS1 and DS2, associated with it. The lamps are Type AO16 manufactured by Signalite Inc., Neptune, N.J. with the following characteristics: Breakdown voltage is selected to within ±1 volt between 64 and 80 volts. Maintaining voltage is held to within ±½ volt for a value selected between 52 and 60 volts. If diodes CR1 and CR2 were not in the circuit, DS1 would light when Q1 conducts, and DS2 would light when Q2 conducts. Since a common load resistor R6 is used, both neons will not light at the same time.

Neon lamps are also connected to the other three binaries of the decade so that four, and only four, of the eight lamps will be on at any one time. These are the input lamps shown at the bottom of Figure 2. Light from each of these lamps, when lit can fall on two, or in some cases, three photoconductor elements on the photo cell plate, which is shown both pictorially and schematically on Figure 2. Since this whole assembly is in a light-tight plastic mounting, photoconductor elements are illuminated only when the associated neon lamp is turned on. These photoconductive elements behave electrically as resistors which have a resistance of under 10K when illuminated and above 10 megohms when in the dark. In short, they behave as if they were light activated switches which turn on when illuminated, and are off when dark.

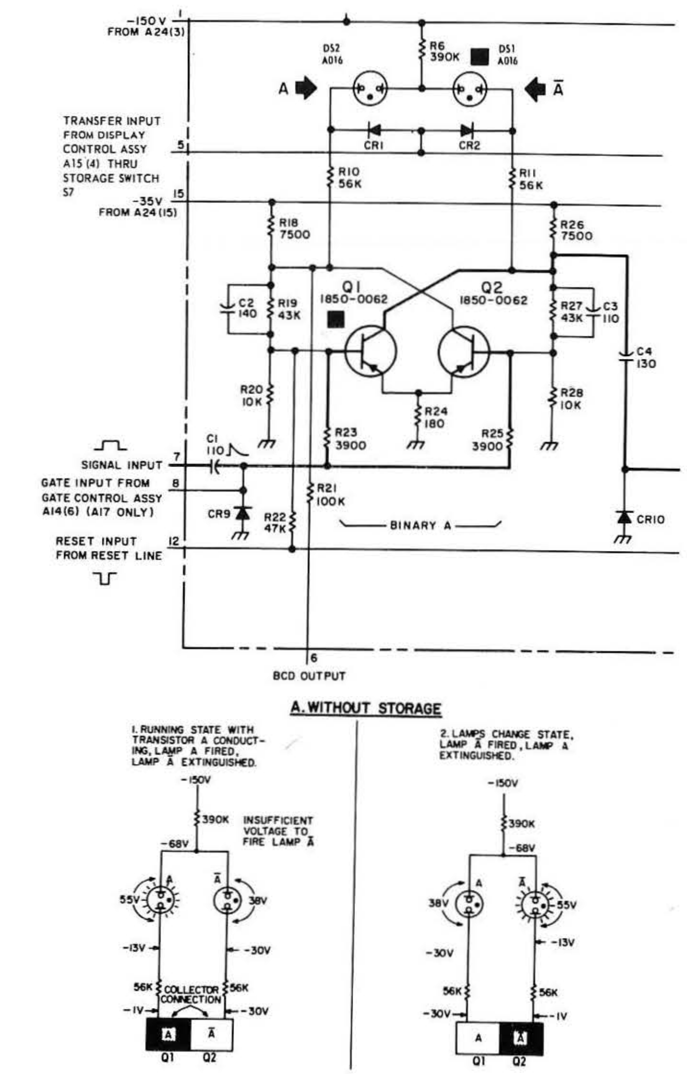


FIGURE 1: Single binary counter circuit with associated Signalite AO16 neon lamps.

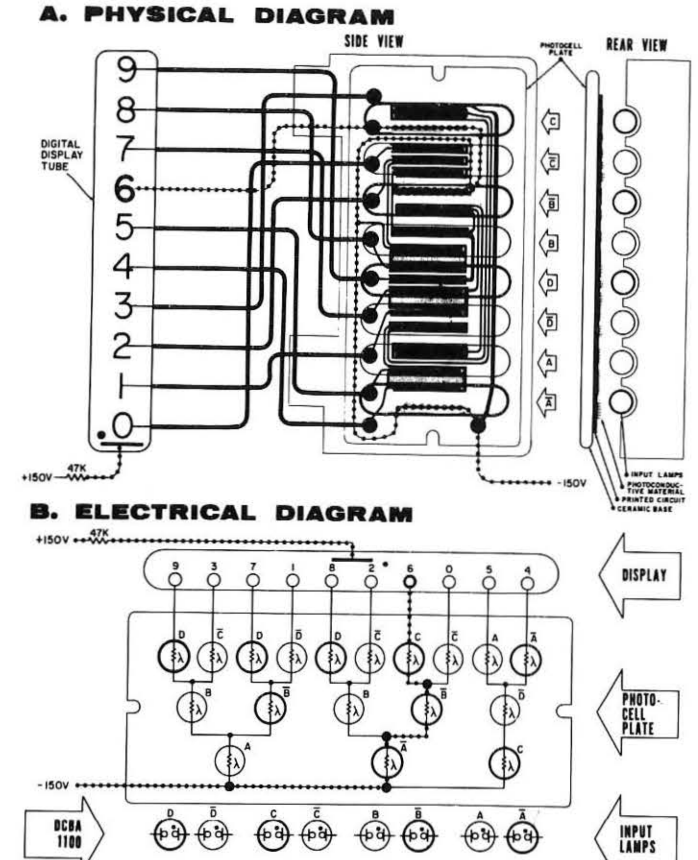


FIGURE 2: Display matrix.

By interconnecting 18 of these photoconductive elements as in Figure 2B (physical arrangement shown in Figure 2A) a circuit is produced which always has three photoconductive cells in series. Of the sixteen combinations of four lamps on and four lamps off, the ten that are used permit only one path at a time in order to have each of the three photoconductor elements illuminated. All other paths have at least one element that is not illuminated. The illuminated path having low resistance all the way from the common −150 volts can carry current to deflect a meter, light a gas display tube, light another neon lamp or operate some other readout system. In Figure 2 the path to the "6" is the one which is complete.

For this decoding function the neon lamps must fire reliably in total darkness at voltages available from the transistor binary. This is only part of the story, however. By using neon lamps which have stable, carefully controlled firing and maintaining voltages, they can also be used as circuit elements to give the counter a display storage capability. That is, a previous reading can be retained as long as desired, even though the transistor binary might be switching back and forth to accumulate a new count.

Storage is achieved by adding diodes CR1 and CR2 to the basic binary. To enter new information into storage, these diodes are back biased by a transfer pulse from the logic section of the counter. When back biased, the diodes look like open circuits; therefore, neon lamp DS1 will light when transistor Q1 conducts, and vice versa as mentioned earlier. To achieve a maximum number of samples in a given time, this transfer pulse should be kept as narrow as possible. Storage is achieved by keeping these diodes in a conducting state. When conducting, these diodes tie one end of DS1 and one end of DS2 effectively to ground. Thus, the switching of the transistors will not cause the neon lamps to change state. Figure 3 indicates the voltage during the "transfer" and "store" cycle. Requirements which the neon lamps must meet to make this feature reliable are:

1. Rapid firing in complete darkness with a narrow pulse; and
2. Carefully controlled firing and maintaining voltages, not only initially but throughout the life of the lamp.

Signalite AO16 lamps meet this requirement. The resultant decoding and storage system uses many less components than systems using diode or resistive decoders driving transistorized readout amplifier and storage systems.

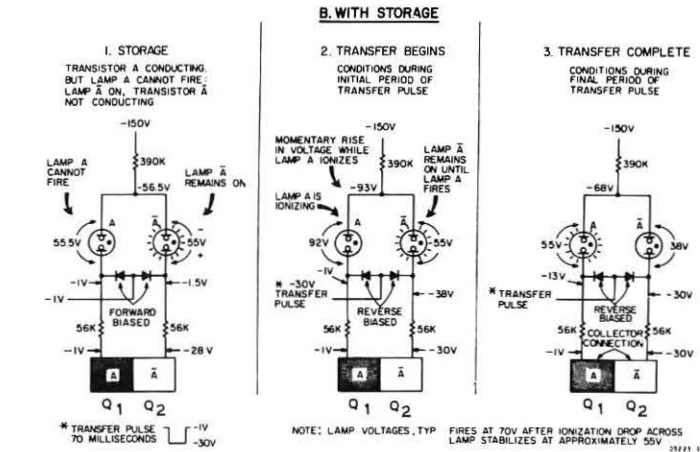


FIGURE 3: Lamp control in storage mode.

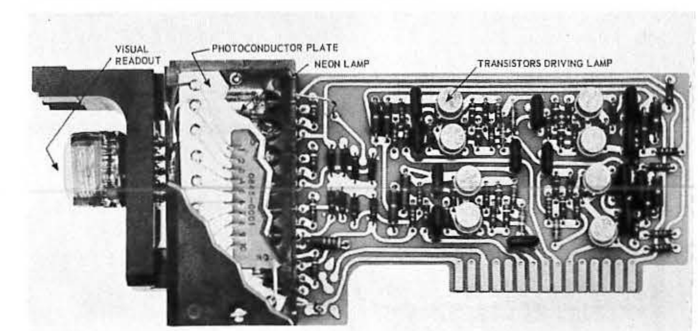


FIGURE 4: Decimal counting assembly photograph showing component location.

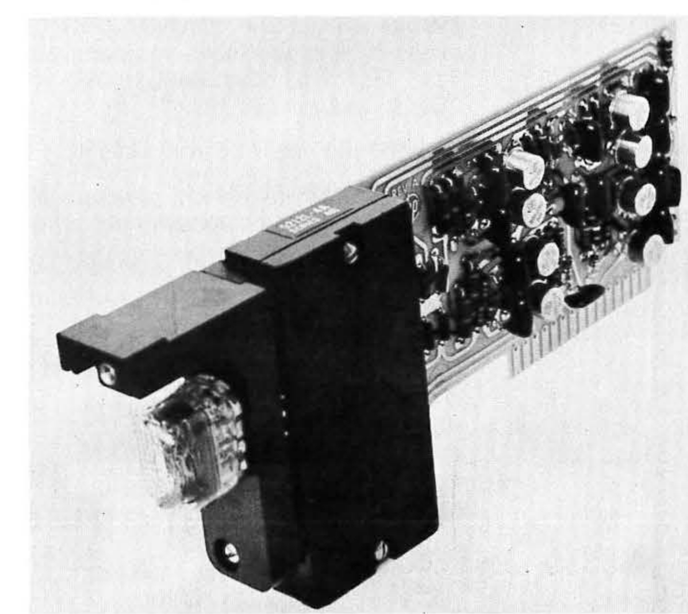
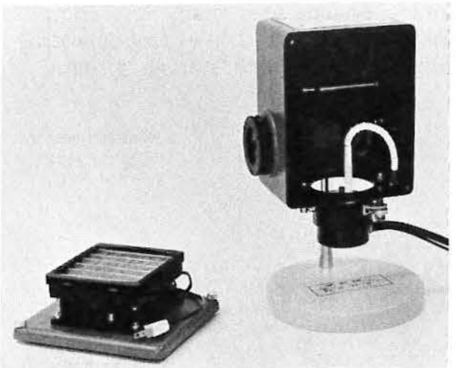


FIGURE 5: Hewlett-Packard Co. binary to decimal decoding system uses printed circuit-plug-in modules driving a Nixie® readout.

ID Products

LAMP HOUSINGS. New forced-air cooled lamp housings designed to meet mounting and cooling requirements of the PEK 500-2 500-w mercury short-arc lamp



have been introduced by PEK Labs Inc., Sunnyvale, Calif. The new lamp housings are available in three models — M914, M915 and M916. All three models include a cooling fan assembly and a variable-focus lens system. Optical equipment allows operation as an image projector or collimating system. Models M915 and M916 also include a front-surface deposited-aluminum mirror, adjustable for focus and position. This option equips the unit to collect twice the normal solid angle and transmit 65% more light, the manufacturer claims. In addition to the reflector assembly, Model M916 also includes an ultra-violet filter and an air-operated solenoid which removes it from the optical path. All three models operate on 115 v ac, 60 cps power.

Circle Reader Service Card No. 58

MINIVIDICON TV CAMERA. Canoga Electronics, Corp., Torrance, Calif., has announced a Model CH-1070-T all solid-state miniature vidicon TV camera of plug-in modular construction incorporating a vidicon protection circuit and offering 750-line resolution. Operable with 2000 ft. of cable, the camera head is 4 in. diam. by 9 in. long and weighs 4 lbs. The camera control is 3½ in. high by 19 in. wide by 14½ in. deep, weighing 10 lbs. Available accessories include high radiation nuvistor head, binary sync generator, 729 line scan rate, optics cover, remote optical focus, remote 4-lens turret, stainless steel case, and dual camera control unit.

Circle Reader Service Card No. 59

LASER FOCUS-VIEWER. Korad Corp., Santa Monica, Calif., has developed a laser focus-viewer designed to facilitate optical aiming of a laser beam. It can locate precisely the exact area of the focused energy, and can maintain the desired spacing from shot to shot — assuring a contiguous chain of laser radiated spots, the company states. The focus-viewer is especially suited for medical research on tissue destruction, determination of laser radiation efefcts on materials and the location of focused energy in hole-drilling applications. The new device — designated the K-FV — consists of a microscopic eye piece and an objective lens mount, capable of accepting one inch diameter lenses, with focal lengths from 5 cm to 100 cm.

Circle Reader Service Card No. 60

CRT DISPLAY CONVERTER. Pacific Measurement Inc., Palo Alto, Calif., has announced a new CRT Display Converter which the firm says provides the convenience and legibility of X-Y and strip-chart recordings for high-speed waveform measurements. The converter enables a recorder to provide a large, precisely scaled plot of a CRT display for the cost of a sheet of graph paper. The converter, with a price small compared to the cost of oscilloscopes and recorders already available in most labs, provides the long-sought interface that permits those devices to work together for recording repetitive CRT displays up to 50 MHz. The all solid state converter is designed to replace the more costly, less convenient photographic method of recording CRT displays. It does not degrade the oscilloscope performance or interfere with visual observation of the display while a record is being made. The full-page, thin-line pen plot obtained from the recorder has better accuracy and resolution than the display itself, PMI states.

Circle Reader Service Card No. 61

NEW DRY COPIER. A new electrostatic dry copier about the size and cost of an electric typewriter according to the manufacturer, has been developed by A. B. Dick Co. Termed the Model 610 Copier, it is reportedly compact, speedy, and economical, making it useful for business and professional offices. No warmup is required. The machine copies writing, printing, drawing, and a wide range of colors. It accepts flexible originals of paper stock to 36 lb., in sheets to 8½ by 14 in. It holds up to 100 sheets of copying paper in any of the following dimensions: 8½ x 11, 8½ by 14, 5½ by 8½, 8 by 10½, or 8 by 13 in.

Circle Reader Service Card No. 62

MAGNETIC BEAM CENTERING. A new Type C428 permanent magnet beam centering unit offered by Syntronic Instruments Inc., Addison, Ill., provides a simple and economical method of centering displays or accurately aligning electron beams for proper focus and deflection; permanent magnet rings are easily adjusted with convenient tabs. After correct centering or alignment is obtained, the magnet rings are held immovably in place by a simple locking device. No auxiliary power supply or complicated spot centering circuits are required. The unit mounts easily on the rear of Syntronic's standard 1½ in. neck diameter stator type deflection yokes, adding only 21/32 in. to overall yoke length. Materials and finishes meet MIL-E-5400. The unit improves electron optics by properly aligning the electron beam to the focus coil and deflection yoke. In addition, electron gun misalignment and poor aperture flooding can be corrected to obtain better shaped and brighter spots. Applications include radar displays, high resolution displays, data displays, precision closed circuit TV monitors, scan converters, flying spot scanners, film scanning systems, etc.

Circle Reader Service Card No. 63

VISUAL CONTROL BOARD. The Wm. A. Stewart Co., Somerset, Calif., has announced a new visual control board especially suited to the long-range scheduling of projects, production, orders, maintenance, as well as R&D and sales and advertising campaigns. Termed the Rol-a-chart 5200 Magnetic, it schedules 100 items for 52 weeks in advance, and requires wall space of only 29 in. high by 49 in. wide. It utilizes the firm's patented rotating sleeve but achieves full-year capactiy through an arrangement of four interior rollers and a Mylar sleeve that is 15 ft. long. Schedules are posted with simple written entries, or with magnets. As the sleeve is turned ahead each day, all schedules move up, so that no deadlines can be overlooked. It is available with motor drive. The entire sleeve can be scanned in seconds, or moved forward, or backward, a space at a time.

Circle Reader Service Card No. 64

PROJECTION ACCESSORY. A new film projection system by CALMA Co., Santa lara, Calif., is a modular accessory to the firm's Model 302 digitizer. Termed the Model M Film Projection System, it enables any CALMA digitizing system to reduce data from 35 and 70 mm film, in addition to the wide variety of paper records (sheets, photos, rolls and fanfold paper) normally digitized on this equipment. The film drive mechanism transports 35 and 70 mm film safely and smoothly, the firm states. Servo-controlled reel drive motors provide a constant, controlled tension throughout the film path. The section of the film being projected is kept flat by a solenoid actuated glass pressure plate which is automatically raised before the film is driven in either direction. This drive system will transport film from reels carrying up to 1000 feet.

Circle Reader Service Card No. 65

4-COLOR CONTOUR PLOTTER. A new instrument that quickly and automatically converts information on photographic films to a four-color map of equal density contours has been introduced by Technical Operations Inc., Burlington, Mass. Called the Four-Color Isodensitracer, the new instrument scans all points on a photograph or radiograph and then plots the measured data as a quantitative, sequentially colored contour map. The color IDT is designed to incorporate the Joyce-Loebl microdensitometer. Contours of equal density, object brightness, or other functions are generated as the microdensitometer automatically makes a series of successive parallel scans covering the image. The instrument will detect points as small as one micron and provide printout magnification of up to 2000 times the scanned image. The color IDT can also operate with input signals from other sensors and transducers that read two-dimensional information such as radar systems, depth sounders, and magnetometers.

Circle Reader Service Card No. 66

BEAM CENTERING COILS. CELCO, Mahwah, N.J., has announced the availability of new electron beam centering coils. Used to position the undeflected beam in the center of a CRT face, the new coil eliminates the use of permanent magnets and reduces fringing fields in high resolution systems. Controls for spot and beam centering may be placed in any convenient location. In addition, a combination of coils will correct CRT gun angle errors. Special deflection systems are available which combine the new centering coil with focus and deflection components in a single housing.

Circle Reader Service Card No. 67

DRAFTING POINT. The Boeing Co. Commercial Airplane Div. and Koh-I-Noor Inc. have released information on a jointly-developed drafting point for use in programmed automated drafting machines. The point fits individual and multiple turret heads of computerized automated drafting machines. Its dimensions are held to 0.0005 in. of concentricity within holder and within the replacement nib of the body of the pen. The pen body is made of hard rubber, permitting use of drawing or acetate inks. The metal tube is of special tungsten carbide construction to assure high speed drafting and extreme durability. Full range of point widths are available from No. 000 to No. 4. Both companies have agreed in the public interest to make the results of this joint development available to all qualified industrial users.

Circle Reader Service Card No. 68

¼-IN. CUBE ALPHABET. Pinlites Inc., Fairfield, N.J., has announced a new "Alpha-Lite" for visual alphanumeric microminiature readout displays. The Alpha-Lite is a 16 segment incandescent light bar arrangement which can make numbers, letters, and symbols. Total size of the lights is ¼ in. cube. All light bars are on the same plane. Shock and vibration characteristics are excellent for aerospace applications. Because segments are actually tungsten incandescent light sources, brightness can be controlled for various ambient light conditions by adjusting input voltage to the unit. Uniformity of illumination of each segment, and of speed of response, are inherent, the manufacturer states. The Alpha-Lite is a modular unit, and encoders for all types of logic input will be offered to mate with them, according to Pinlites.

Circle Reader Service Card No. 69

COMPUTER INPUT. IBM's Data Processing Div., White Plains, N.Y., has introduced a new system which allows up to 80 customers at different locations to use a single computer to type, edit, and update text material. The system, called Datatext, was recently introduced in the San Francisco Bay area; during 1967, it is to be made available in Chicago, Cleveland, Los Angeles, New York, and Philadelphia. With Datatext, a customer need only type any document once for computer input. The computer then accepts revisions to any part of the material at any time, and holds the latest version available for immediate printout at the customer's typewriter-like terminal. Each customer using the system will have a terminal at his location linked by telephone line to a computer at an IBM Datatext Center.

Circle Reader Service Card No. 70

FAN-BLOWER. Rotron Mfg. Co. Inc., Woodstock, N.Y., has introduced the "Tarzan" fan, a compact air moving device measuring less than 7 in. square, capable of delivering performance of much larger and

more costly squirrel-cage blowers. The new fan, which is the subject of several aerodynamic patents, now pending, is designed for cooling micro-electronic modules, compact air-to-liquid heat exchangers, printed circuit card chassis for discrete components, computers and communications transmitters. With its new aerodynamic design, the Tarzan fan develops more than twice the pressure of comparably-sized axial flow fans, according to the manufacturer. Its shallow axial depth of 4-11/32 in. provides large reductions in the amount of package volume which must be devoted to the air moving device.

Circle Reader Service Card No. 83

TV SWITCHING SYSTEM. Dynair Electronics Inc., San Diego, Calif., is producing a solid-state modular switching system designed to meet the need for a high-performance remote-controlled switcher readily adaptable to installations of any size. The basic Series 5100 switching system consists of twenty SW-5100A switching modules and five DA-5150B video output modules in a single mounting frame. Each switch module has five switch junctions, providing a 20-input, 5-output basic building block when a frame is completely filled. Any number of these frames may be combined to provide a system of virtually any desired size. Series 5100 is available with a wide variety of local and remote control panels combining amplifiers and sync-adding output amplifiers, simplifying the build-up of systems of any size. Control panels may be of the standard lighted or unlighted push-button variety. A dial control is also available for selection of signals. The dial control uses a standard telephone dial which requires only a 2-wire cable between the dial control unit and the switcher. A slightly different version, Series 5110, may be utilized in smaller systems.

Circle Reader Service Card No. 86

"TAPE LIFT" DRAFTING AIDS. The By-Buk Co., Los Angeles, offers its line of "Tape Lift" printed circuit drafting aids, which feature press-and-peel application for quick, easy and accurate printed circuit drawing. The firm also manufactures transparent red and blue tapes for two-color photographically-filterable layout systems; quick-adjustable Universal Component Leads Bending Blocks; and a complete line of high-heat resistant crepe, mylar and electroplater's masking tapes.

Circle Reader Service Card No. 87

14-CONTACT SOCKET. A 14-contact dual in-line socket for testing and packaging plug-in integrated circuits is available from Augat Inc., Attleboro, Mass. Comprised of a molded diallyl phthalate body with gold-plated beryllium copper contacts, the socket will accept packages with flat or round leads of 100 mil spacing between leads and 300 mil spacing between rows. Contoured entry holes guide the IC leads into the sockets with gentle wiping leaf contacts provided for high reliability. The sockets are available with a stainless steel saddle for panel mounting or without saddle for printed circuit applications. Contact terminal is dual purpose — printed circuit, dip solder or wire hookup. Wire-wrap terminations are also available. Optional accessories include a simple extractor tool and an ejectro key which becomes an integral part of the socket. Overall maximum dimensions of the socket are 0.5 length by 0.5 width by 0.37 height (without mounting saddle).

Circle Reader Service Card No. 90

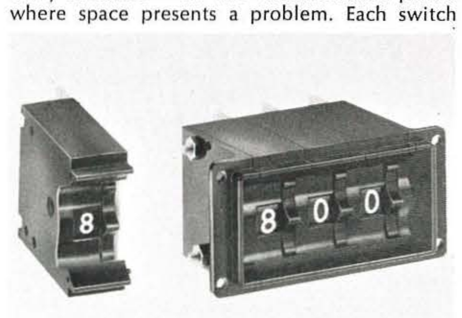
VIDEO PLOTTER. Colorado Video Inc., Boulder, Colo., has introduced a CVI Model 401 video plotter which utilizes a magnetic disc video "memory" to scan convert a wide variety of input data to standard TV format. The unit may be used as an X-Y-Z plotter, storage oscilloscope, slow-scan TV to reali-time converter, and in many other applications. Data may be displayed indefinitely on standard TV monitors, or erased in 1/30 of a second. Both selective erasure/data insertion and multi-color displays are practical.

Circle Reader Service Card No. 91

VIDEO AMPLIFIER. Beta Instrument Corp., Newton Upper Falls, Mass., has announced the availability of a new Model VA 548 video amplifier, a dc-coupled, 10 MHz, all-silicon solid-state amplifier featuring plug-in convenience and economy. The amplifier is designed for application in any CRT or storage tube display system where up to 40 v grid drive is required. The Model VA548 is a feedback amplifier to provide optimum linearity and gain stability, and may be directly coupled to the CRT grid or ac-coupled to a dc restoring level. The amplifier is fully compatible with all other modular Beta display system components.

Circle Reader Service Card No. 92

THUMBWHEEL SWITCH. The Digitran Co., Pasadena, Calif., is now delivering the new Series 8000 Miniswitch — the smallest thumbwheel switch commercially available — for use on instrument panels where space presents a problem. Each switch



module requires a panel cutout only 0.96 in. high by 0.5 in. wide. Modular construction permits the ganging of any combination of switch modules into a single, unitized assembly. Series 8000 Miniswitches are available in two, eight, or ten position, for decimal or coded electrical output. Dial stops and internal lighting are optional. Some models have provisions for mounting components directly onto the printed circuit board.

Circle Reader Service Card No. 93

GP DIGITAL COMPUTER. A new general-purpose digital computer utilizing all integrated circuits has been announced by Interstate Electronics Corp., Anaheim, Calif., a wholly-owned subsidiary of Interstate Engineering Corp. Designated the IEC 1010, it offers a 16-bit word length (plus parity and protect bits) which facilitates an 8-bit-byte (ASCII) manipulation. It is a single-address machine which operates in 1- or 2-word format. The memory is expandable from 4K to 65K, in 4K increments, all directly addressable. Using CTL integrated circuits, processing clock time is 150 nanoseconds, add time is 2 usec, multiply time is 7 usec, and divide time is 7 usec. The IEC 1010 has more than 80 instructions, nine registers, up to 28 devices on a standard I/O bus (200KC — 16 bit words plus parity) and four I/O processors, each handling up to eight devices; word rate is 900KC. Software will include FORTRAN IV, test and utility programs, symbolic assembler and math subroutines.

Circle Reader Service Card No. 94

VERTICAL PRECISION LAYOUT. Visual Inspection Products, Lynn, Mass., is delivering its Mark 42 precision vertical layout machine in increasing numbers, including shipments to Europe. The Mark 42 is typical of the firm's precision micro-photo laboratory aids. It incorporates a 42-in. rotary table graduated in whole or half degrees calibrated to within 15 secs. of true location. Angular vernier in 100 or 60 divisions (optional). X and Y scales are graduated in 0.050 increments, each increment within 0.0002 of true location, and position and readout capability to plus or minus 0.0001 through non-contact optical 10X readout heads. Over-all inherent accuracy is plus or minus 0.0005. Adjustment features include horizontal; variable-speed motorized vertical; adjustable synchromatic scribe-scope; 90-degree. The rotary table is designed for use of glass, vinyl, and mylar layout material in sizes to 42 in. diam. Larger sizes may be used in step processes.

Circle Reader Service Card No. 95

WATERCOOLED ARC LAMP. EG&G Inc. (Edgerton, Germeshausen & Grier), Boston, Mass., is offering a capillary dc Xenon arc lamp capable of continuous operation at 2000 w maximum average power input. Designated the Model FX-99-3, it is a watercooled tube having an easily-removable water jacket, and is reported to be capable of an initial light output of 70,000 lumens (35 lumens per watt). The tube has an approximate color temperature of 5000°K. EG&G also manufactures Lite-Mikes, for use in measuring continuous and pulsed light signals; radiometers; spectrometers; silicon photodiodes; and a new series of three-pole active elliptic low pass filters.

Circle Reader Service Card No. 96

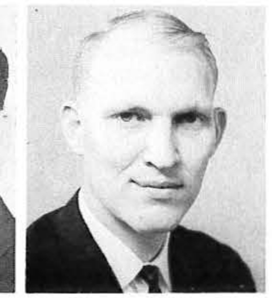
1000 CHARACTER SPOOLER. A 1000-characters-per-second paper tape spooler has been recently introduced by Remex Electronics, Hawthorne, Calif., a division of the Ex-Cello Corp. The spooler is a further extension to the firm's complete line of photocell punched tape readers and tape spoolers. Designated the Model RS-1000, the unit combines many new features heretofore unavailable in any tape spooler, Remex says. These features include: full proportionate servo operation of the reeling speed; availability of models with up to 10½-in.-diam. reels; high-speed bidirectional rewind independent of the associate reader; operation on 50- to 400-cycle, 115 volt input; operating temperature range of 0° to 70°C.

Circle Reader Service Card No. 97

on the move

JOHN L. CODDINGTON has been appointed gen. mgr. of Perfection Mica Co. and its Magnetic Shield Div., according to N. J. VANCE, pres.

CODDINGTON



HILL

Milgo Electronic Corp. has announced the appointment of GORDON HILL as central regional sls. mgr., to head the firm's new sls. office in Park Ridge, Ill.

GEORGE KONKOL has been named VP/operations for the Electronic Tube Div. of Sylvania Electric Products Inc., a GT&E subsidiary.

FRANK A. GUERRERA has been appointed to the new position of Eastern regional mgr. for Mark Systems Inc., Santa Clara, Calif.; he will be located in the Boston area.

RICHARD F. MAYHEW has been named associate mgr. of Computer Sciences Corp. operations at the Marshall Space Flight Center, Huntsville, Ala.

The Magnavox Co. has named DAN R. FISHER VP/gen. mgr. of its Fort Wayne Government Operations.

Sigmatron Inc., Santa Barbara, Calif., has named DR. WILLIAM A. SMITH a sr. research scientist, and PAUL W. CALLOWAY as an EE on key programs.

In addition to the election of RICHARD C. LEMMONS to the post of VP/Washington D.C. region, Informatics Inc. has announced the appointment of MINORU TONAI to the post of Controller, and REID HAYWOOD has been appointed mgr. of its Houston Operations.

ALLAN L. RUDELL has been named to the new position of VP/administration at Honeywell's Electronic Data Processing Div.

ERNEST A. LOFGREN has been named gen. sls. mgr. for Transistor Electronic Corp., of Minneapolis. The firm also announced promotion of JOHN J. BASTYS as sls. mgr. for Tec-Lite Indicator Devices, and MRS. WILLIAM (MARLENE) MORGAN as successor to Bastys in the post of Tec-Lite mfg. mgr.

Master Specialties Co., Costa Mesa, Calif., has named ROBERT K. YOUNG to the new post of National OEM sls. mgr., and the following regional managers have been named: THOMAS A. DE STEFANO (Northeast); NORBERT C. CICHON (Midwest); ROBERT J. OWEN (South & Southwest); and COVA K. KELLY (West Coast). The firm is establishing new sls offices in Boston, Cleveland, Houston, and Seattle, bringing the number to 14.

Adams Associates, Cambridge, Mass., has announced the addition of three senior systems analysts to its technical staff: LEONARD M. HANTMAN, JOSEPH A. O'BRIEN, and ARTHUR E. LEMAY.

Amperex Electronic Corp. has named JOHN NIELSEN prod. mgr., Communication Tubes, according to JOHN MESSERSCHMITT, VP.

JULES COHEN has been appointed asst. mgr. of the Itek Corp. Optics Directorate, Lexington, Mass.

New Literature

PEANUT-SIZED LAMPS. Hudson Lamp Co., Gearney, N.J., offers a 12-p catalog describing nearly all miniature, submin, and micromin lamps now available in the industry. All data presented in the catalog (termed Catalog 104) conform to standards for the industry in effect at the time of publication.

Circle Reader Service Card No. 51

DEFLECTION YOKES. Two new stator-type deflection yokes designed specificaly for standard 1½-in. neck diam. scan converter storage tubes are described in Advance Technical Bulletin No. 66-4, offered by Syntronic Instruments Inc., Addison, Ill. Included are dimensional drawing, two tables of typical electrical values, and schematic push-pull and single ended drawing.

Circle Reader Service Card No. 52

RESOLVER BROCHURES. Reeves Instrument Co., a division of Dynamics Corporation of America, announces two new brochures on its compensated and uncompensated size 15 and 23 resolvers. All specs and performance data, as well as wiring diagrams, for both compensated and uncompensated models are contained. Complete dimensional data, in outline drawing form, are also included.

Circle Reader Service Card No. 53

VISUAL INDICATOR. A new 20-p catalog describing and illustrating a complete line of rectangular visual word warning indicators is now available from Marco-Oak Industries, Anaheim, Calif., a division of Oak Electro/Netics Corp. Called Missilites®, the visual indicators are obtainable in a wide variety of styles, types, and colors. The catalog shows press-to-test units, RFI-shielded units, non-press-to-test indicators, and multiple indicator assemblies.

Circle Reader Service Card No. 54

TIME DISPLAY. A new 2-p technical bulletin describing time display units with serial or parallel input capability is now available from Electronic Engineering Co. of California, Santa Ana. Specifications include visual display (6 or 9 digit), using Nixie display tubes and polarized filters for sharp images, input code, auxiliary output, mounting, signal source, and other technical data.

Circle Reader Service Card No. 55

FLUIDLESS PROCESSOR. Fluidless, automatic, on-line recording and processing of transient data are described in a new data sheet currently being distributed by Photomechanisms Inc., Huntington Station, N.Y. A combination camera/processor/viewer, the system uses Kodak Bimat, a photographic developing material that requires no free fluids. CRT-displayed transient data are recorded and made available for study in as little as 3 min. Data sheet for Model 1380.

Circle Reader Service Card No. 56

ELECTRONIC TUBES. Fairchild Du Mont Electron Tubes Div. of Fairchild Camera and Instrument Corp., Clifton, N.J., has re-isued its general catalog listing over 4000 types of cathode-ray tubes, storage tubes, photomultiplier tubes, and power tubes. The 48-page catalog indexes the tubes by standard EIA number designations, and provides the user with all required electrical, mechanical and performance characteristics. In addition, tubes are indexed by class of special feature, so that the designer may examine all types available within a class. Numerous optional combinations of features are shown, which permits tube selection on what is virtually custom-order basis. Also listed are available tube accessories and parts.

Circle Reader Service Card No. 57

DATA INTO PICTURES? PICTURES INTO DATA? USE LINK DATA CONVERSION SYSTEMS.

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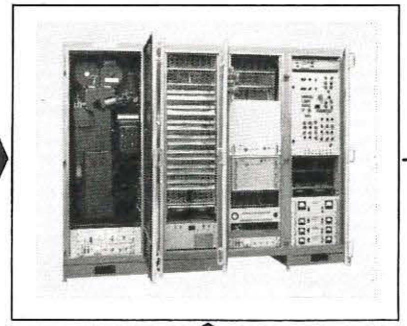
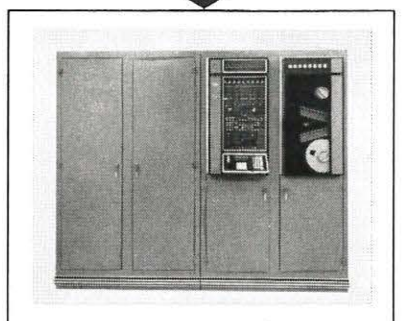
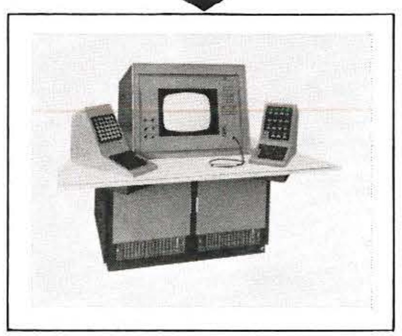
Bubble Chamber Films
Mathematical Models







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Circle Reader Service Card No. 33

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Circle Reader Service Card No. 29

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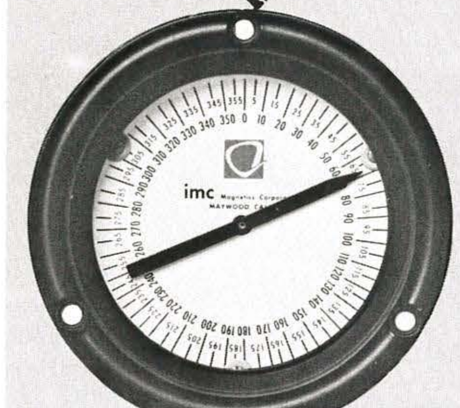

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