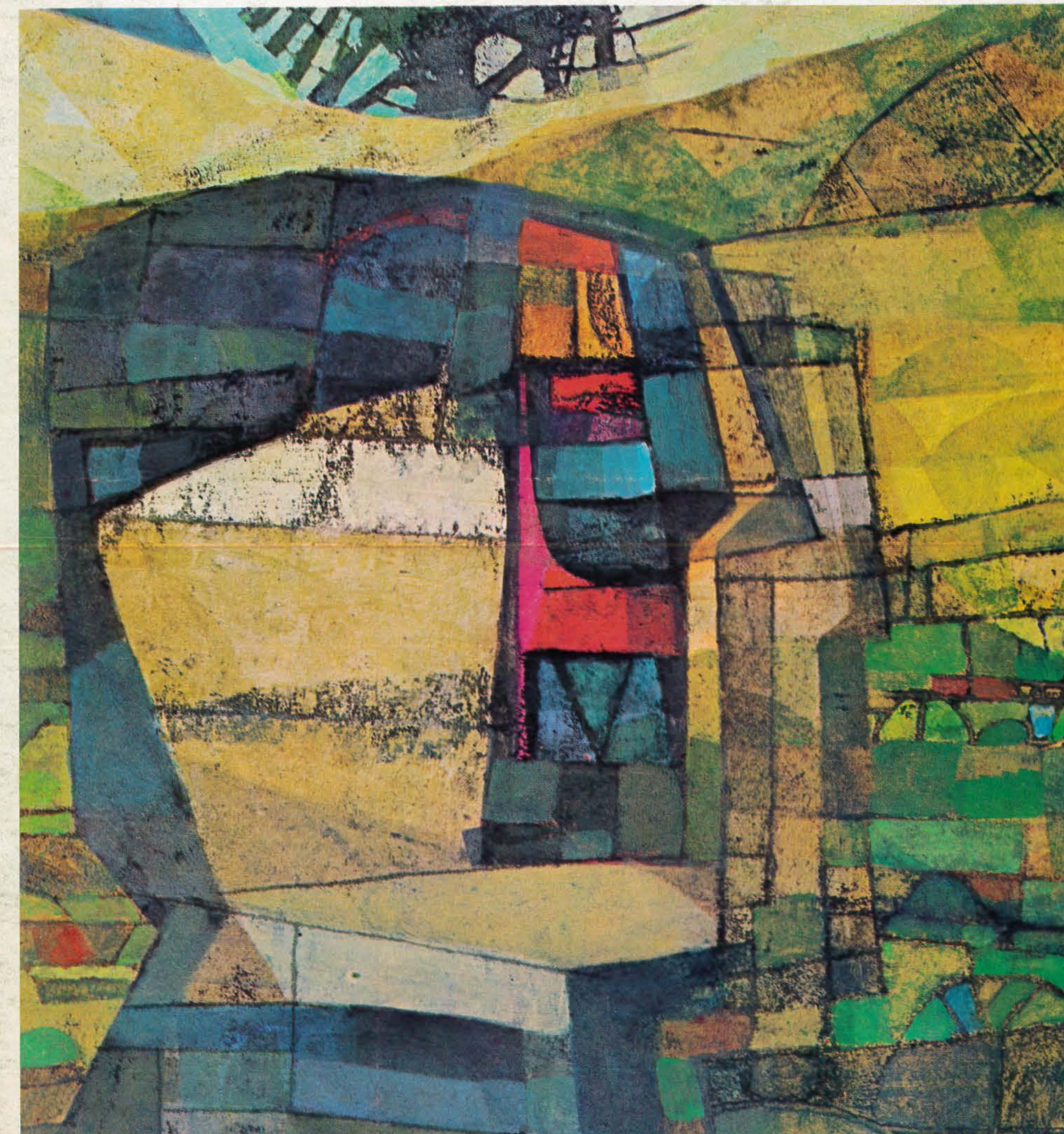
Volume 9 Number 3 May/June 1972

Information Display

The Journal of Data Display Technology



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Published bimonthly by Information Display Publications, Inc., at 825 S. Barrington Ave., Los Angeles, Calif. 90049. Controlled circulation paid at Los Angeles, Calif.
SUBSCRIPTIONS for U.S., its territories, possessions, and Canada $20 per year. Foreign countries $40 per year.

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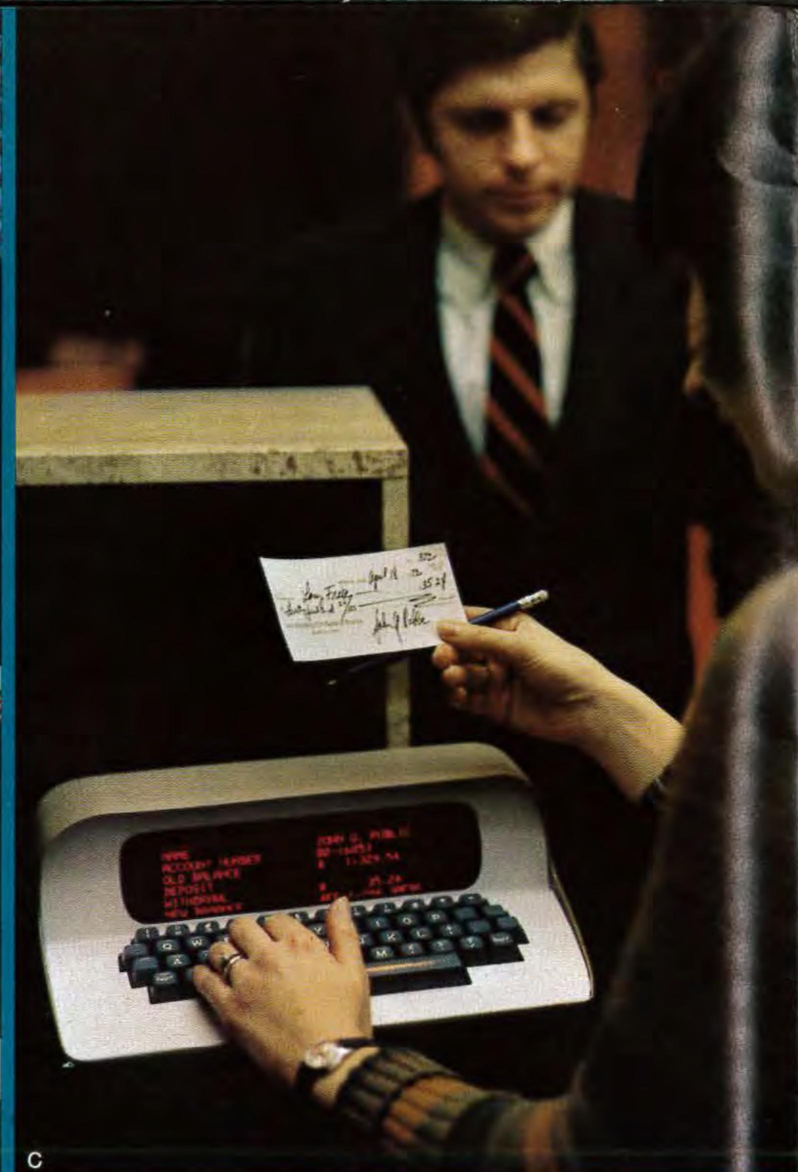

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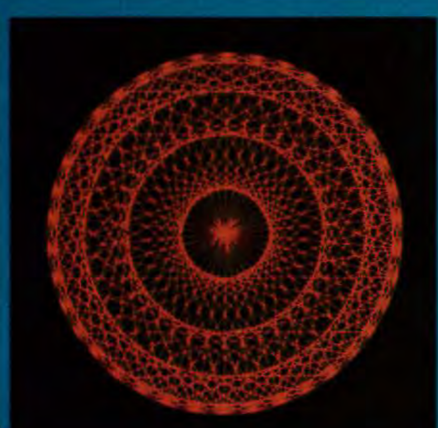

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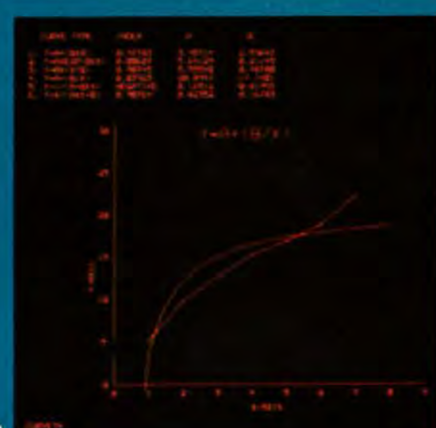

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A. Digivue 512-60 Display/Memory Unit. An 8½" x 8½" square panel of 512 x 512 lines at 60 lines per inch resolution.

B. Digivue 256-50 Display/Memory Unit. A 5½" x 10¼" panel of 256 x 512 lines at 50 lines per inch resolution.

C. Digivue 64-33 Display/Memory Unit. A 2" x 8" panel of 64 x 256 lines at 33.3 lines per inch resolution.

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Information Display

The Journal of Data Display Technology

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The Cover

Detail of a painting by Harry Bliss suggesting the mind of man contemplating interdisciplinary problems, such as those encountered in data display systems. From the collection of Cornell Aeronautical Laboratory Inc., Buffalo, N.Y.

Computer and Microfilm Combined in Phototypesetting

H. E. HAYNES

Abstract

Phototypesetting on microfilm denotes the generation and recording, onto a small-format medium, of high-quality text characters of a variety of styles and sizes. At the same time it implies high speed. Therefore, the starting point has to be the electronic generation of character images. In contrast to more conventional electronic phototypesetting, the accent on speed and the small-image format changes the balance among the factors which influence image quality. This paper discusses the interplay of these factors, describes a useful approach to image-quality prediction, and presents examples of text copy having known degrees of quality degradation which serve to link numerical descriptions of system performance to the subjective quality levels they represent.

Theoretical Background

A great deal of theoretical and experimental investigation has been done in the field of image evaluation and imaging system analysis. One type of rigorous approach is based on the derivation and manipulation of modulation transfer functions (MTF) which describe components and systems. A second approach is in terms of the corresponding spread functions.

Figure 1 illustrates a lens imaging an infinitesimally narrow slit. The plot of light intensity in the image plane is the spread function of the lens. Figure 2 shows conceptually a lens imaging a series of moving bar patterns of different spatial frequency, and having sinusoidal variation of transmission onto a narrow analyzing slit. The percentage modulation of intensity of light emerging from the slit, plotted against spatial frequency (in the image plane) is the MTF curve.

Generally, the MTF approach results in simpler calculations, since it involves point-by-point multiplication of response curves instead of the convolution operations which must be performed in combining spread functions. The two methods are however basically equivalent. They correspond respectively to time-domain and frequency-domain analysis of electrical networks. One or the other may be preferred depending on the form in which data is available, or other circumstances.

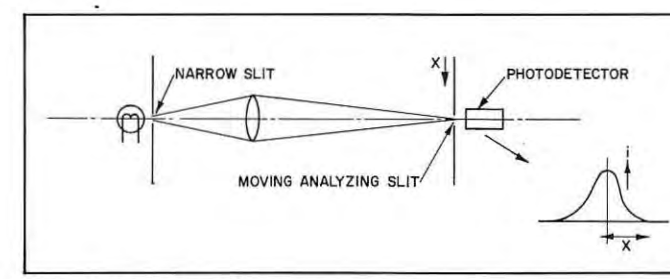

Figure 1: Spread function concept.

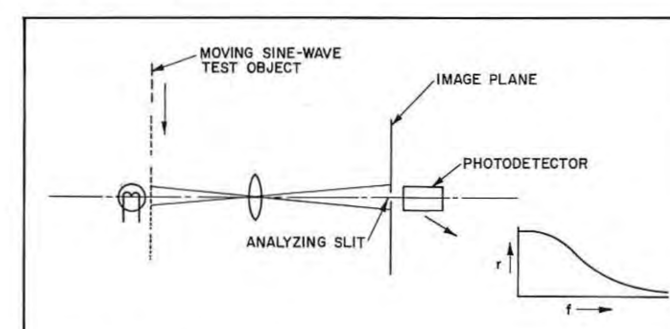

Figure 2: MTF concept.

In the particular case of a gaussian spread function, it is found that the corresponding MTF curve is also gaussian. Such a spread function has the form

$$i = \epsilon^{-bx^2} \quad (1)$$

where i is intensity, x is distance, and b is a constant.

The MTF curve corresponding to a gaussian spread function has the form

$$r = \epsilon^{-cf^2} \quad (2)$$

where r is response (percentage modulation), f is spatial frequency, and c is a constant.

Gaussian spread functions also have the property that convolution of two of them yields a third gaussian function. Likewise, of course, point-by-point multiplication of two gaussian MTF's yields a third MTF which is also gaussian.

Most elements of the imaging systems involved in phototypesetting on microfilm have reasonably gaussian spread functions. Figure 3 shows a particular CRT spot profile measured by the slit-analyzer method. Also shown is a true gaussian curve, scaled to match the CRT curve at the 50% intensity points. Figure 4 is a representative lens MTF curve, along with a gaussian curve scaled to match at the 65% response point. Figure 5 is a published MTF curve for a typical microfilm emulsion, again with the scaled gaussian curve. While the shapes are certainly not precisely gaussian, they are reasonably close; thus it seems justified in the interest of simplicity to consider them gaussian for the present purpose.

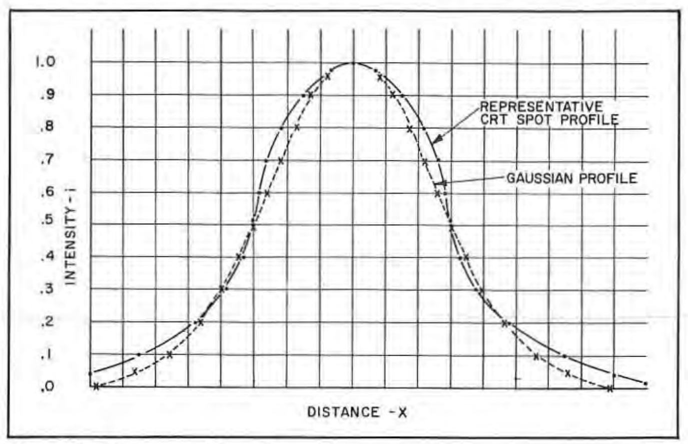

Figure 3: CRT spread function.

Gaussian spread functions and MTF curves can be combined or "cascaded" by the following simple rules:

$$\Sigma w = \sqrt{w_1^2 + w_2^2 + ----} \quad (3)$$

where w denotes width of a spread function at a specified intensity level, loosely referred to as "spot size", ϵw is the system spread function width, or system spot size, and w_1, w_2 -- are the component spot sizes.

Also $$\frac{1}{\Sigma f} = \sqrt{\frac{1}{f_1^2} + \frac{1}{f_2^2} ----} \quad (4)$$

where f denotes the frequency on an MTF curve at a specified percentage response, Σf is the frequency at which the system response is this same specified percentage and f_1, f_2 are the frequencies at which the various components exhibit the specified percent response.

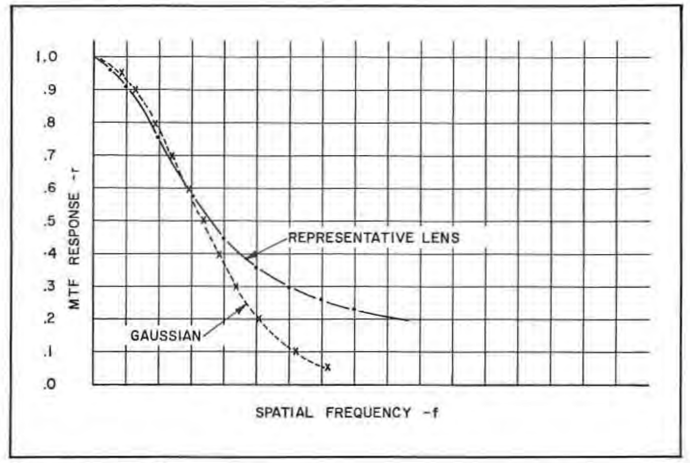

Figure 4: Lens MTF curve.

The specified intensity level chosen to define w, and the specified percentage response chosen to define f, can be any convenient values, since each is just a scale factor which fully defines a gaussian curve. Somewhat arbitrarily and somewhat by historical accident, we have chosen values of i = 50% for the spread function and r = 65% for the MTF curves. Thus the notation w_0 in this paper is understood to mean spread function width at 50% intensity points, and f_0 is understood to mean spatial frequency at 65% response.

It is often necessary to convert from one description to the other. It can be shown that for gaussian curves,

$$w_0 = \frac{.35}{f_0} \quad (5)$$

w_0 and f_0 being defined in the way just described. For example, a gaussian MTF curve showing 65% response at 50 cycles/mm would correspond to a gaussian spread function having a 50% intensity width

$$w_0 = \frac{.35}{50} = .007 \text{ mm}$$

Frequently the data available for a lens or film may be simply a "limiting resolution", defined loosely as the spatial frequency at which response has dropped to 2%, or some value approaching zero. In such cases an estimate of the frequency f_0 (corresponding to 65% response) must be made. In the case of a gaussian MTF curve, it is found that 65% response occurs at a frequency 0.33 times that at which 2% response occurs. However, in the case of typical photographic emulsions, the corresponding factor is somewhat lower, being in the vicinity of 0.25. Lens MTF curves vary substantially in shape, but here again a representative factor is 0.25. As a simple and useful approximation, the relation

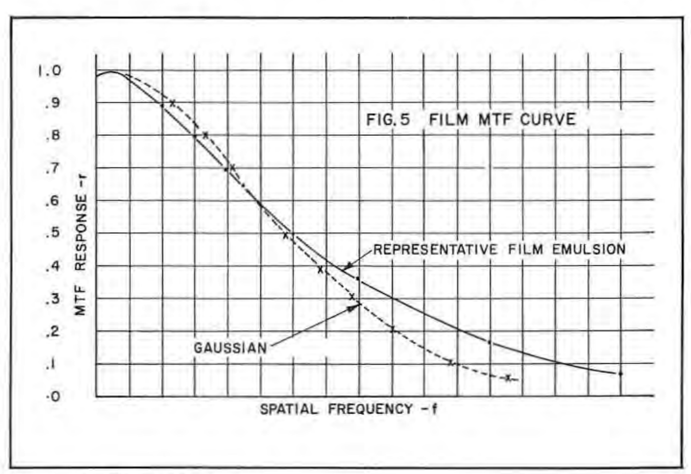

Figure 5: Film MTF curve.

$$f_0 = 0.25 f_{lim} \quad (6)$$

can be used for lenses and films if more complete data is not available. Obviously, the disparity between the factors 0.33 and 0.25 denotes a nongaussian shape; however, the use of a realistic factor relating limiting resolution to f_0 results, in effect, in substituting for the actual curve a gaussian curve which coincides with the actual curve at the 65% MTF point, and is an optimum simple approach.

Combining the effects of system elements by these methods assumes amplitude linearity, just as in the analogous linear electrical network analysis. In general, the films and subsequent processes involved in phototypesetting are far from linear, and they ordinarily constitute a very high combined gamma (contrast). The effect of restricted system MTF then appears as distortions of character shape, rather than as lack of "sharpness" or reduced contrast in fine detail. This characteristic can be considered as a "hard limiting" effect acting in addition to the classical MTF behavior. Any interpretation of the significance of system spread function must, of course, take this limiting action into account.

One further aspect of most CRT phototypesetting is the raster or stroke structure of the image. The treatment presented here assumes that raster granularity is fine enough, in comparison to the system spread function, to be unnoticeable. This condition ordinarily does exist in high-quality systems.

Application to Image-Quality Prediction

Within the framework of the simplifications which have just been discussed, it is possible with minimal effort to investigate a variety of hypothetical CRT-microfilm systems and make reasonable comparisons of their relative merits. A few examples are now presented, which both illustrate the methods and at the same time reveal trends in microfilm systems which might not be expected.

In evaluating image quality it is useful to normalize the quality factor, so as to relate it to a page dimension rather than to a unit of distance. The normalized merit factor, therefore, is indicative of true information capacity of the entire format, and allows easy comparison of systems having different format sizes. A convenient merit factor of this type is the ratio of format diagonal to spread function width, that is

$$M = \frac{D}{\epsilon w_0} \quad (7)$$

where M is the merit factor in units of "spot diameters per format diagonal", D is the diagonal dimension, and w_0 is the spread function width as defined, D and ϵw_0 being in the same units.

In Figure 6 are plotted M values for several types of system components against the format diagonal D (in inches). Note first that in the case of CRT's of a given diameter, M is independent of D, since the full useful diameter of the tube face is used, regardless of film format size, by proper choice of optical magnification. (The CRT curves shown refer to 7-inch tubes.) On the other hand, the M value for a particular film material increases linearly with D, since films have a certain resolving capability per inch or millimeter regardless of format size. For a diffraction-limited lens of a given numerical aperture, M also increases linearly with D, since the diffraction limitation is in terms of cycles per unit distance in the image and is not directly related to format size. Notice that for very small image formats, even a diffraction-limited lens of moderate speed would have a smaller M value than that attributable to a high-quality CRT.

In addition to these functional relations are shown a number of actual lenses, the M values relating to performance at the maximum off-axis condition represented by the format diagonal D at which they are plotted. The lenses shown are generally of the relatively large-aperture category necessary for high-speed phototypesetting, and they represent a rather wide range of cost. Lens A, for example, which is an f/4 lens stopped down to f/5.6 and which covers a 4.3-inch diagonal, is seen to fall considerably short of the f/7 diffraction limit. This lens is of the class used in highly exacting microelectronics fabrication, and is in the several thousand dollar class. Lens B, intended for considerably larger format, has an effective speed of f/9, but its performance departs even further from the corresponding diffraction limit. Lens B is of comparable cost to lens A. In the smaller format region, lens C, an f/2.8 lens, is seen to achieve the diffraction limit for f/6. It is also in the multi-thousand dollar class. Lenses D and E, of considerably lower capability, are in the few-hundred dollar class. Points labeled F_1, F_2, G_1 and G_2 are hypothetical lenses discussed later on.

Two trends, then, are quite evident. First, only for fairly

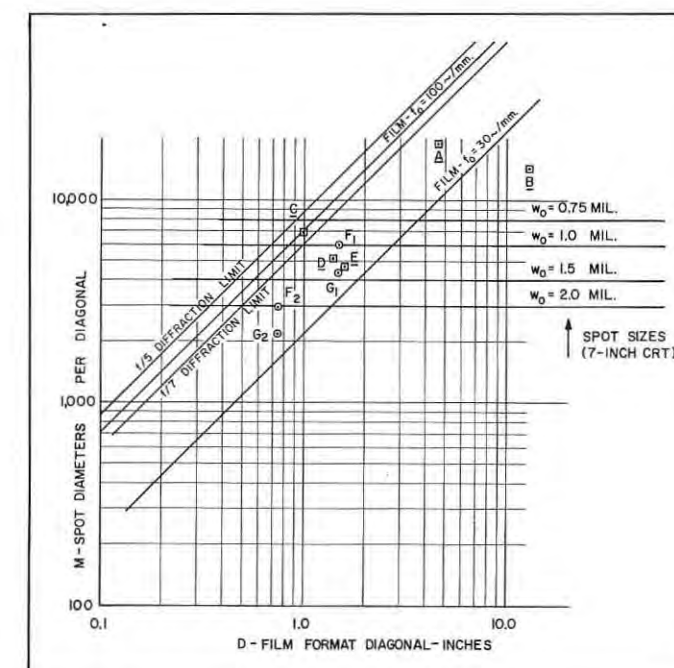

Figure 6: M-values of system components.

small formats do actual lenses approach diffraction limits at all closely, and then only at high cost; and second, there is a wide spread in performance among lenses intended for generally similar applications, performance being loosely correlated with cost.

Figure 6 shows clearly that as format size is reduced, the relationship among the quality losses introduced by CRT's lenses and films change drastically. For large formats—say when D is greater than 6 inches—the CRT tends to dominate, although in the case of high-quality CRT's in the 1.0-mil spot class, the lens choice can by no means be left to chance. Film resolution in this region is ordinarily a minor factor. For the smaller formats, lens contributions in general become more severe, and film properties also come into prominence. For example at a D value of 0.78 inch, (14 x14 mm format) the value of M for a 1.0-mil spot CRT is actually as good as either the f/7 diffraction limit or a very high resolution, relatively low speed microfilm emulsion. Therefore, in this region it is of little avail to achieve extremely small CRT spot size. Permitting a somewhat larger spot, with a substantial gain in light output, would support higher character writing rates with negligible loss in image quality.

As an example of a calculation for a hypothetical system of this type, consider a 7-inch CRT (6-inch useful diameter) having a 1.5-mil spot, i.e. $w_0 = 1.5$ mil, imaged at 4:1 reduction onto 35-mm film having 65% MTF response at 30 cycles/mm. Also, suppose that the limiting resolution of the lens is 220 cycles/mm, or greater, at all parts of the image format (F_1 in Figure 6). Further, since the microfilm image once produced has to be enlarged for viewing or other utilization, a second lens must be included. Assume this enlarging lens to have a limiting resolution of 160 cycles/mm, slightly inferior to the CRT lens. (G_1 in Figure 6). Using the approximation of Equation 6, the f_0 values for the lenses are 220 x 0.25 = 55 cycles/mm and 160 x 0.25 = 40 cycles/mm respectively.

The f_0 values for film and lenses can be converted to equivalent w_0 values using Equation 5:

Film: $w_0 = \frac{.35}{f} = \frac{.35}{30 \text{ cycles/mm}} = .0117 \text{ mm} = 0.46 \text{ mil}$

CRT Lens: $w_0 = \frac{.35}{55} = .0064 \text{ mm} = 0.25 \text{ mil}$

Enlarging Lens: $w_0 = \frac{.35}{40} = .0087 \text{ mm} = 0.34 \text{ mil}$

The CRT spot, demagnified 4:1 to the film plane, has a spread function width

$$w_0 = \frac{1.5}{4} = .38 \text{ mil}$$

The four contributing w values can now be combined according to Equation 3:

$$\epsilon w_0 = \sqrt{0.46^2 + 0.25^2 + 0.34^2 + 0.38^2} = 0.730 \text{ mil}$$

Since the format diagonal on film is 6.0 ÷ 4 = 1.50 inch, the merit factor M (Equation 6) is:

$$M = \frac{D}{\epsilon w_0} = \frac{1.50 \text{ inch}}{0.730 \text{ mil}} = 2050$$

Notice that in this particular case the film is the dominant one of the four components.

A different option might be to sacrifice somewhat on CRT spot size, thereby achieving greater light output and permitting the use of a higher resolution, less sensitive film. For example, a 2.0-mil spot might permit the use of a film having 65% MTF response at 100 cycles/mm, i.e. $f_0 = 100$. The corresponding value of w_0 would be

$$w_0 = \frac{0.35}{f_0} = \frac{0.35}{100} = .0035 \text{ mm} = 0.14 \text{ mil}$$

The four contributing w_0 factors would then be

Film: $w_0 = 0.14$ mil
CRT Lens: $w_0 = 0.25$ mil (as before)
Enlarging Lens: $w_0 = 0.34$ mil (as before)
CRT: $w_0 = \frac{2.0}{4} = 0.50$ mil

Combining these,

$$\epsilon w_0 = \sqrt{0.14^2 + 0.25^2 + 0.34^2 + 0.50^2} = 0.670 \text{ mil}$$

$$M = \frac{D}{\epsilon w_0} = \frac{1.50 \text{ inch}}{0.670 \text{ mil}} = 2240$$

Thus an increase of approximately 10% in M has been achieved by actually degrading the CRT spot size.

These examples are representative of a large format on 35-mm film. For 16-mm formats the influence of lenses and films is even greater relative to the CRT. One further example will illustrate this. Consider again the 7-inch CRT with 2.0-mil spot, but with 8:1 optical reduction, the high-resolution film ($f_0 = 100$ cycles/mm), and lenses of the same resolving capability (per mm) as before. (F_2 and G_2 in Figure 6.)

The four contributing w values are now

Film: $w_0 = 0.14$ mil (as before)
CRT Lens: $w_0 = 0.25$ mil (as before)
Enlarging Lens: $w_0 = 0.34$ mil (as before)
CRT: $w_0 = 2.0 = \frac{0.25}{8}$ mil

Combining,

$$\epsilon w_0 = \sqrt{0.14^2 + 0.25^2 + 0.34^2 + 0.25^2} = 0.51 \text{ mil}$$

Since the format diagonal is now

$$D = \frac{6.0}{8} = 0.75 \text{ inch}$$

we have

$$M = \frac{D}{\epsilon w_0} = \frac{0.75 \text{ inch}}{0.51 \text{ mil}} = 1470$$

In this case the assumed lenses now dominate, even with the compromised CRT. Note also that the M value is substantially reduced from the 35 mm cases.

Correlation with Subjective Quality

Calculations of a merit factor M for a system reveal much about how effort and cost may best be distributed in order to achieve best results. They also indicate how various proposed systems can be expected to rank in image quality. However, the M values themselves do not provide a good basis for subjective visualization of image quality.

In order to bridge this gap, a means of producing degraded images, in which the M value could be measured, can be set up and calibrated, and a variety of text material can be then reproduced with it. The subject matter can contain typographic characters of several styles and sizes. The method is as follows.

A process camera is first adjusted to 1:1 magnification, and a very narrow (0.5 mil) back-illuminated slit photographed with it. Microdensitometer analysis of the slit image on the film, in combination with the measured D-log E characteristic of the film and processing, allow the intensity profile existing in the optical image of the slit to be deduced. By stopping the lens down to very small apertures, image degradations of increasing amounts can be introduced. Figure 7 shows a number of w_0 values derived in this way, plotted against effective f/number. Also shown is the relationship to be expected from diffraction theory. At effective apertures smaller than f/40 (effective), results for this particular lens agreed quite well with the calculated curve, indicating that the system is essentially diffraction limited in this region.

A sample microdensitometer trace is shown in Figure 8. The light intensity profile derived from it is also shown. Lobes which are characteristic of diffraction images are visible. The shape is, of course, not truly gaussian; however, the true gaussian curve, also plotted in Figure 8 and scaled to coincide with the experimental profile at the 50% intensity points, does not differ drastically in shape. It can be assumed, therefore, that approximately gaussian-profile degradation effects of known amounts can be introduced with this experimental arrangement.

Figure 9 is the text page which was the original subject matter for the tests. Its overall dimensions are 8 x 10 inches (diagonal D = 12.8 inches), character sizes ranging from 5 to 18 points are represented, and the typefaces range from bold sans-serif to rather delicate serif styles. This original was of excellent quality, and can be considered "perfect" in relation to the fairly substantial degradations introduced in the tests. By selecting effective f-numbers in the range of 48 to 326, this

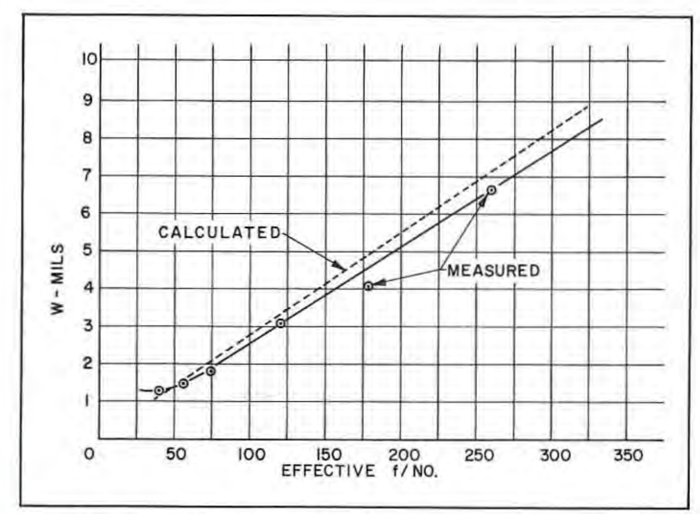

Figure 7: Calibration of image-degrading camera.

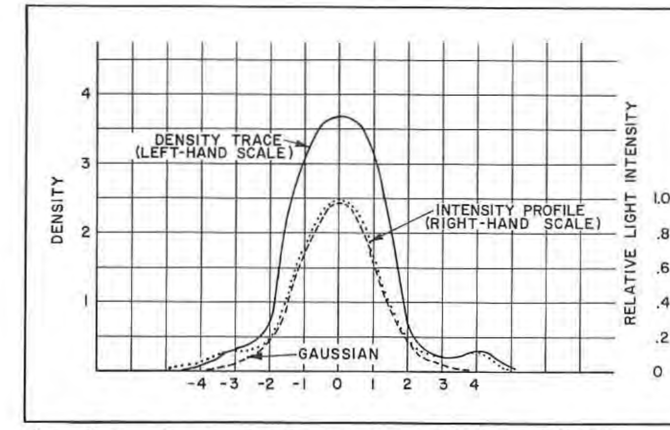

Figure 8: Sample microdensitometer trace of slit image (f/120).

page was reproduced with eleven "spot sizes" between 1.2 and 7.9 mils. The corresponding range of M values, based on the 12.8-inch diagonal, is 10,650 to 1630.

Exposures of the eleven negatives were carefully equalized using a density step tablet. Offset plates were then contact exposed from each negative, again with carefully controlled equal exposure. Proofs were then printed on an offset press, and these proofs constituted the end product of the degradation process. They, of course, contain the "hard limiting" action mentioned earlier, since the film negative process had fairly high gamma (3.5) and the plate material an even higher gamma. Further, they include the inherent limitations of the printing process itself. It is therefore possible to judge from these proofs what the effect of a given M factor should be, in a system which culminates in a very high contrast image.

Discussion

Figure 10 is a set of four magnified images of a portion of 10-point sans-serif text made from the printed proof pages which represent M values of 9150, 5100, 2900, and 1630. The original is also shown. Figures 11 and 12 are similar, but show a 10-point serif style and a 5-point sans-serif style, respectively. It is obvious from these illustrations that character styles which contain thin "hairline" portions suffer most severely as the value of M is reduced, as would be expected. Of course, some reduction of this "drop-out" tendency could have been exercised by changing the "limiting level"—for example, by increasing plate exposure—but this would have thickened the characters abnormally and might have caused fill-ins. While the rendition of a particular font might be improved this way, the general requirement for intermixing fonts rules out such individual treatment.

A great deal of information can be gained from detailed examination of these proofs. It will suffice here, however, to make a few general observations. First, it is apparent that very good legibility can be provided, even for very small characters, with fairly small values of M, provided type styles are chosen judiciously. In Figure 12, for example, even the 5-point sans-serif text is entirely legible at M = 1630. On the other hand, if the goal is to achieve truly good character form in a typographic sense, much larger values of M are required. Reference to Figure 11 shows that there is a noticeable deterioration for M = 5100 vs M = 9150. What value of M is deemed "necessary" is therefore primarily an esthetic question.

"Breakthrough" is a tired word, often abused by people who get overly excited about small improvements. But it does describe the new role of electronics in the graphic arts. *The breakthrough is a new way to compose the printed* word electronically with a new order of speed and flexibility. Called video composition, it begins with a tiny electronic dot **that is smaller than a period or flyspeck yet large enough to** overshadow all the mechanical and photographic techniques in common use today. "Breakthrough" is a tired word, often abused by people who get overly excited about small improvements. But it does describe the new role of electronics in the graphic arts. *The breakthrough is a new way to compose*

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18 Spartan Medium **Bold** *Italic* 18 Times R. *Italic ABCD* **abcd** *abcd*

Figure 9: Original text page.

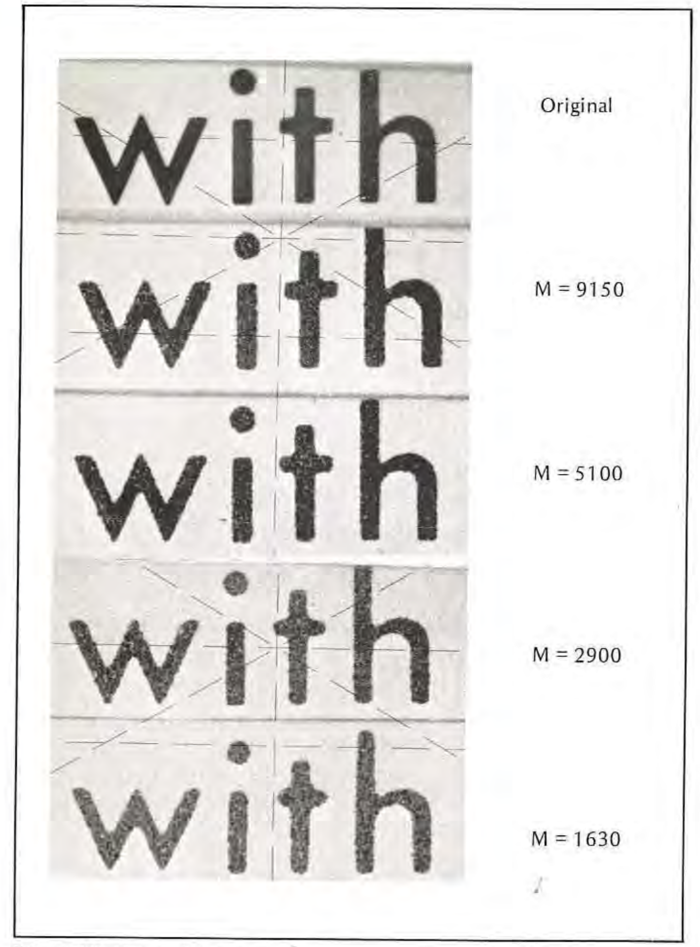

Figure 10: Ten point sans-serif.

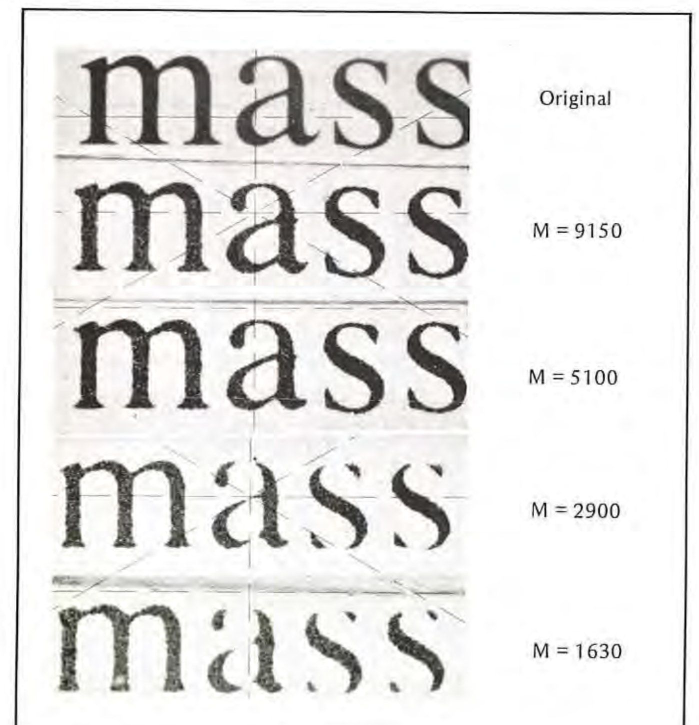

Figure 11: Ten point serif.

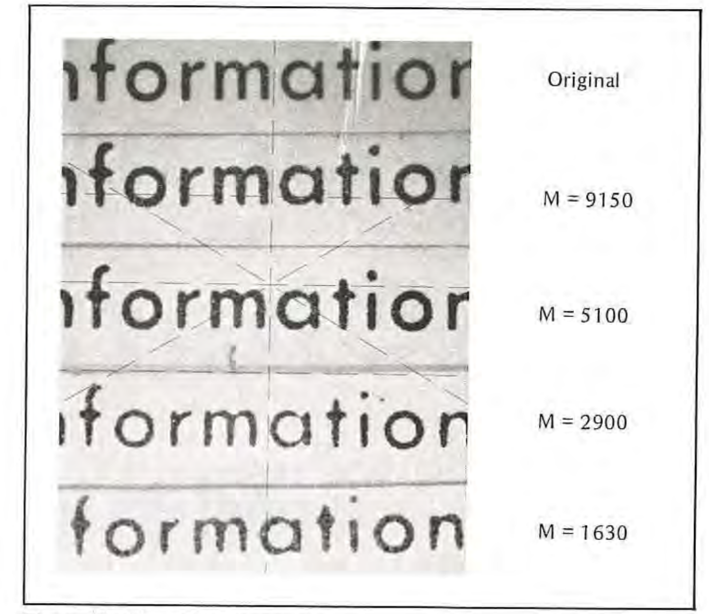

Figure 12: Five point sans-serif.

Conclusion

Electronic phototypesetting on microfilm contrasts in two major ways with more conventional or true-size typesetting. First, system components other than the CRT tend to assume dominant roles in determining final image quality. These components are the lenses and the photosensitive materials involved in the total system. This consideration, in combination with the general emphasis on high character writing rates which is characteristic of microfilm applications, may dictate CRT designs which are substantially different from those which are optimum for large format output. And second, although the microfilm formats inevitably inject quality limitations, it is still possible, for at least letter-size page formats, to substantially surpass the "excellent legibility" level and indeed produce very creditable typographic quality. This being true, most of the benefits of versatility and esthetic quality which come with true phototypesetting can be realized in the microfilm environment. ■

Harold E. Haynes received the BSEE degree from the University of Nebraska in 1939. Joining RCA in 1940, he was engaged until 1956 as an advanced development engineer in the fields of motion picture sound recording, facsimile, kinescope recording, and electronic color correction for the graphic arts. From 1956 to 1958 he was a member of the RCA Industrial Electronic Products division, working on projects in medical electronics and optical inspection techniques for industrial processes. From 1958 to 1967 he was Staff Engineer in the Advanced Technology Laboratory of RCA Defense Electronic Products, being associated with a diversity of projects in pattern recognition, data processing, magnetic recording, and electro-optical systems. In 1967 he joined RCA's Graphic Systems Engineering, where he is presently Leader, Technology Group. He has been primarily concerned with techniques for CRT photocomposition.

Optical Character Recognition

J. BRAUNBECK

What Is Character Recognition?

Before a process can be automated it must be clearly defined. Many of the advantages gained by automation are the result of this need for definition. When asking the question "what is character recognition?" we can again distinguish between "what is recognition?" and "what is character?".

What is Recognition?

Recognition implies the gradation of different signals into classes. A musician is able to classify a tone he hears according to its frequency e. g. as class "c". This class contains violin, piano and trombone tones, low c and top c. These tones are all classed as "c" on the basis of a certain characteristic. Criterion for classification is that the fundamental frequency of these tones is in a known numerical ratio to the reference frequency.

A difficult classification problem is presented by the class "Face of Miss Gerda Schulz". This class comprises Gerda Schulz wearing different hairstyles, hair colours, with and without make-up, as well as black-and-white and coloured photographs. In spite of these variations, the face of Gerda Schulz will always be recognized if one knows her, i.e. if the viewer has memorized the characteristics of the class. This example illustrates another condition important to recognition, namely the necessity of memorizing the specific characteristics of the class which is to be recognized. Colloquially speaking, only things known can be recognized. The extent of memorizing characteristics is even closer defined in colloquial language. If many characteristics have been memorized of the class which is to be recognized, the object is known well.

Somebody who knows Gerda Schulz well will also recognize her even if greatly changed in appearance, e.g. wearing glasses. On the other hand, somebody who knows her less well will either associate her when she wears glasses with another class by mistake, or else not be able to classify her at all. This example illustrates the two possible mistakes which can be made in the recognition process. It is possible to associate an object which is to be recognized with the wrong class, e.g. to mistake a photograph of Gerda Schulz for one of Frieda Maier. In technical language this mistake is termed "substitution".

[Display Engineers are primarily concerned with the display of information to a human rather than to a machine. Mr. Braunbeck's article will be of special interest to those who are concerned with the nature of information and the meaning of the term "recognition" whether such recognition is by man or machine. — Ed.]

The second possibility is the assumption of not knowing the girl in the photograph. Technically speaking this is known as "rejection". Summing up, we can define recognition as the classification of a signal into a definite class on the basis of memorized characteristics. Whether recognition be by man or machine is basically irrelevant for the time being.

What Is a Character?

A character is a signal assigned a definite meaning agreed upon at some time or other. This signal can take any form, consisting, for instance, of a series of electric pulses, a smoke signal or a knot in a string. Character recognition by machine as practiced today is limited to alphanumerical characters. An alphanumerical character is a two-dimensional contrast distributed on a carrier, usually paper, and assigned a definite meaning. Our alphabet, for example, has been assigned sounds from which we form our words. This need not necessarily be the case. Chinese writing, for instance, is constructed so that each symbol corresponds to a term. This has the disadvantage of there being as many groups of characters as there are terms. But it also has the advantage of being independent of the language. If one is familiar with Chinese writing, one is capable of reading it without understanding a word of Chinese.

It is interesting to note that in some instances, such as the operating instructions of machines, the use of symbols has again been reverted to. Our alphabet which goes back to the Phoenicians has also evolved from symbols. "A", for example, is a stylized cattle head. The most important characters in machine reading at present are figures. A figure is a two-dimensional black-and-white distribution, assigned a definite number.

Figure 1 is an example of numbers belonging to the classes "three", "five", and "six" and "eight" together with their intermediate stages. The more liberal the definition of the individual classes, the wider the rounded areas in the figure. The number of rejects in between the classes thus diminishes. At the same time there is a greater risk of assigning a character a wrong class, i.e. obtaining substitutes. This alternative of obtaining many rejects combined with few substitutes on the one hand, or few rejects and many substitutes on the other, is characteristic of the entire recognition technique.

Standardized and Stylized Fonts

Now that we have defined the problem, we can consider how best to impose the task of character recognition on a machine. It should be pointed out from the start that the machine is hardly capable of matching the flexibility of the human brain. It cannot be denied that man is extremely versatile in his ability. He tires easily, however, and is unreliable and slow. The machine on the other hand is more restricted with regard to change, but not susceptible to fatigue or diversion. Furthermore, machines usually work much faster than man doing the same task. It goes without saying that a car is hardly expected to climb stairs, yet assumed to excel by far on the road in speed and perseverance as compared to a pedestrian.

The fact that the machine is less flexible than the human brain is taken into consideration in that characters are standardized and stylized. Standardization largely implies limiting the differences between the characters of a class. Stylization means selecting character form in consideration of machine recognizability.

Figure 2 illustrates type fonts which have been stylized and standardized in three different ways. At the top is the standard

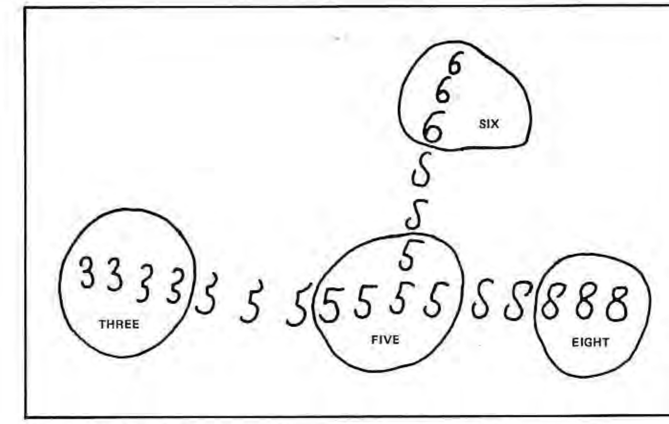

Figure 1: Continuous transition between classes of characters.

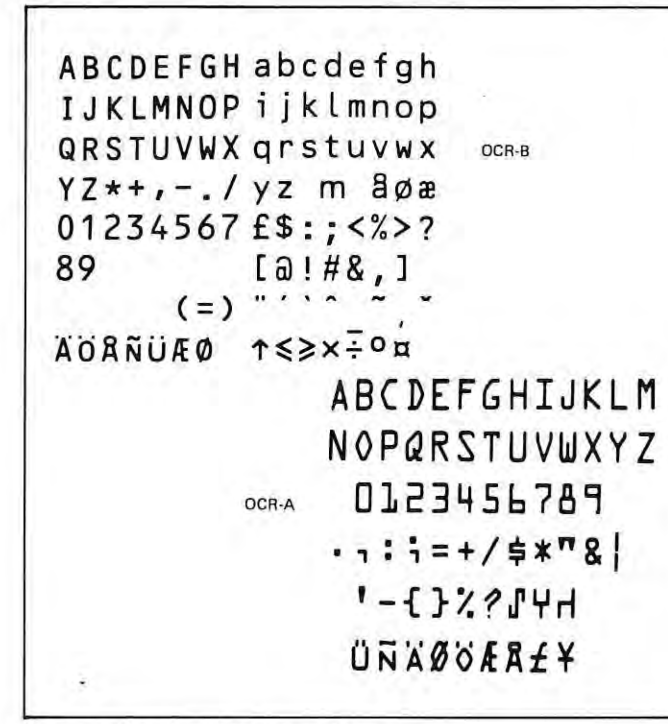

Figure 2: Machine readable type fonts.

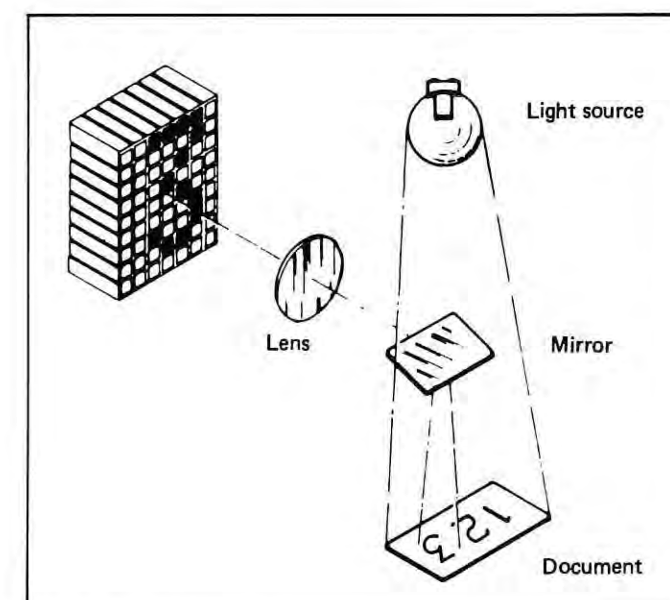

Figure 3: Parallel scanning.

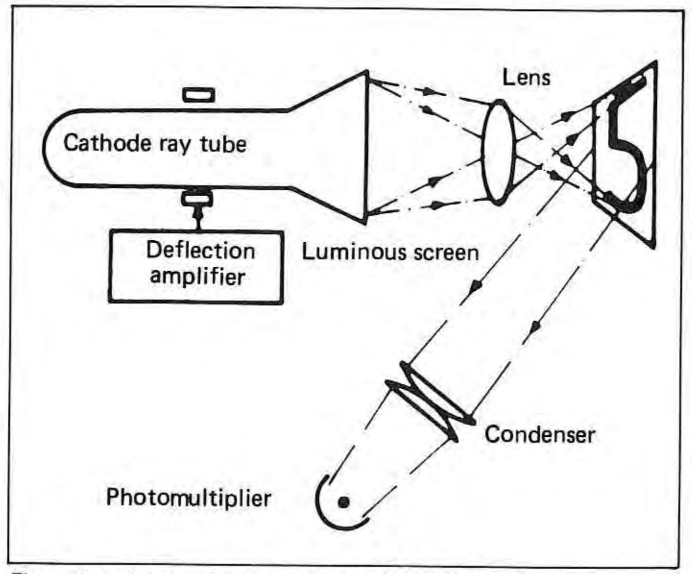

Figure 4: Serial scanning by means of a flying spot tube.

font OCR-B. This font has been only slightly stylized, so that it hardly differs from the usual typewriter or printed characters. The standard font OCR-A appearing below OCR-B is more strongly stylized, facilitating machine reading. This reduction in machine complexity and expenditure has the disadvantage of the characters being somewhat conspicuous. As they seem rather unconventional in appearance at first, their use has been objected to in some fields.

Machine Reading

Automatic reading of characters requires a series of machine parts which are found in some form or other in all character reading devices. The carrier containing the characters to be read must somehow be conveyed to the reading device and be removed again after reading. This necessitates a paper feed assembly. In the devices now in use, very often the paper feed assembly is not part of the reading machine, whereas the reader constitutes a component of the paper feeding device, e.g., the document sorting machine. The characters on paper must then be converted into electrical signals. There is no specific reason for this conversion except that electrical signals can be conveniently worked with in modern technology. This signal conversion is termed scanning. There are various scanning possibilities. Working on the principle of the human eye, each scanning element can be assigned an electric channel. This method, known as "fully parallel scanning", is illustrated in Figure 3. The advantage of fully parallel scanning is the relatively small demand made on the transmission capacity of the individual channels. The information content of the character is distributed over a great number of channels. This is the reason why the eye of the vertebrate is also equipped with a fully parallel scanning system.

If the individual scanning elements are scanned in succession, one transmission channel is all that is required. However, as this channel must process all the information, a high transmission capacity is required of the serial scanning procedure illustrated in Figure 4. Television works on the basis of fully serial scanning as it would hardly be expedient nowadays to operate with a great number of wireless transmission channels in parallel.

Technical solutions are usually found by compromise. The semi-parallel scanning procedure illustrated in Figure 5 is also an example of successful compromise. The character carrier which must in any case be moved for the purpose of transport and removal, horizontally passes along a vertical line of photo cells. Each individual channel need only possess a fraction of the transmission capacity which would be required in serial scanning. On the other hand there is none of the rather considerable line complexity involved in fully parallel scanning.

Modern data processing frequently makes use of the advantages offered by the digital technique. Character readers are no exception. In most of the devices scanning is thus followed by quantization of signals. Halftones, which would in any case play only a subordinate role in recognition, are therefore purposely dispensed with. This renunciation is compensated for by the advantages of the digital technique.

Character Recognition

Character recognition proper, i.e., assigning character classes to the scanned characters, is by means of comparing the electrical signals with samples stored in the device. This comparison can be carried out in a variety of ways, their difference lying in the design complexity involved and the extent of character stylization required.

Stroke analysis, suitable only for strongly stylized characters, such as the numbers of the standard font OCR-A, involves relatively little expenditure. As shown in Figure 6, the scanned character is examined as to vertical and horizontal strokes. In case of semi-parallel scanning, examination is conducted by supervising adjacent channels for dark-spot signals occurring simultaneously. A dark-spot signal occurring in several adjacent channels implies that a vertical stroke has appeared. Each channel is further equipped with a chronometer. A dark-spot signal delivered by a channel within a certain minimum period of time implies that a horizontal stroke has passed this channel. The supervisory circuits described above produce an electrical character description as illustrated in Figure 6. This description is compared with the descriptions of the individual character classes which were stored in the form of diode networks. If it matches one of the descriptions, the recognized character is output in the code used by the machine connected

Continued on page 31

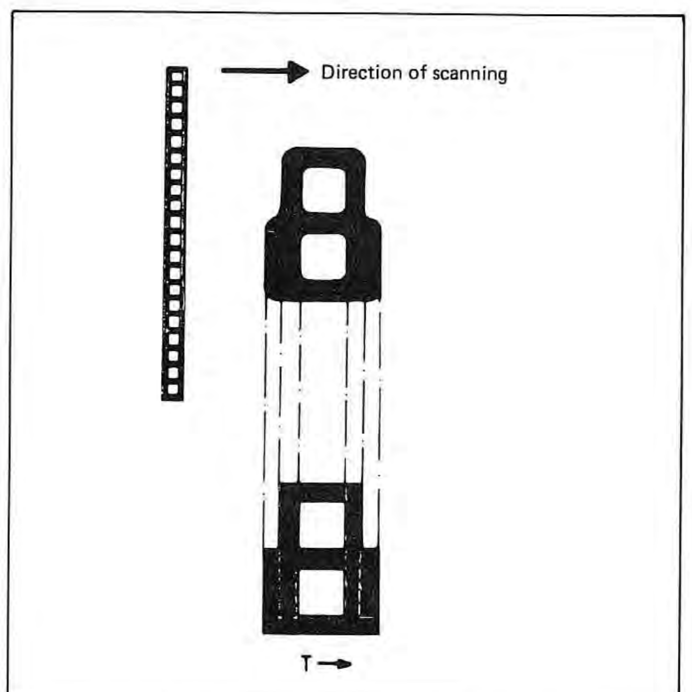

Figure 5: Semi-parallel scanning.

Rear Projection Screens: A Designer's View

J.T. MILLER

Introduction

The ever increasing use of rear projection display screens throughout the information retrieval industry has given rise to increased efforts on the part of screen manufacturers to further improve the product with new formulations in optical coatings. Contemporary design, testing, and production of newer materials, particularly the acrylic plastics, is providing new standards of quality and resolution that are challenging the imagination of the information display system designer. But just as in other industries, some basic information on the performance characteristics and accessory features of the rear projection screen is needed before the designer can take advantage of the full potential realized by this new screen technology.

Rear projection screens are widely used by manufacturers of computers, microfilm readers, teaching aids, and other audio-visual displays. For the course of this present discussion the more mundane applications such as home slide viewing devices or film editing equipment will not be covered. These applications do at times represent a considerable market for screens, but their requirements are usually centered about utility and price rather than image quality and resolution.

High quality rear projection screens such as those commonly found on computer readout consoles or high magnification ratio film-based information retrieval systems are the product of the successful merging of modern optical and chemical technology. The screens are produced in a solution which is cast as an optically precise film on a clear rigid plastic substrate. The result is a viewing surface that predictably diverges transmitted light rays into an image that possesses high resolution, sharp contrast, and high luminance at varying angles from the perpendicular. The screen's performance is spoken of in terms of diffusion, resolution, gain, angular viewing, freedom from hot spotting, scintillation, front surface specular reflection, color accuracy, and contrast.

Diffusion

In order to be effective, a rear projection screen must diffuse the light falling upon it in such a way that the desired information will appear on the screen without revealing the nature of the light source projecting it. The degree of diffusion is controlled by the thickness of an optical coating, and exists as an inverse proportion relative to total light transmission. If the diffusion is not sufficient, the source of light projecting the desired image will show up as an uneven light distribution across the screen. This effect is called "hot spotting," and is illustrated in Figure 1.

Close tolerance chemical and mechanical processing has provided screen manufacturers with the capability to accurately control the degree of light diffusion and transmission, and optimize both characteristics without hot spotting problems when used with proper projection optics.

Resolution

Resolution or the resolving power of a screen indicates how fine and detailed an image can be produced from a given set of

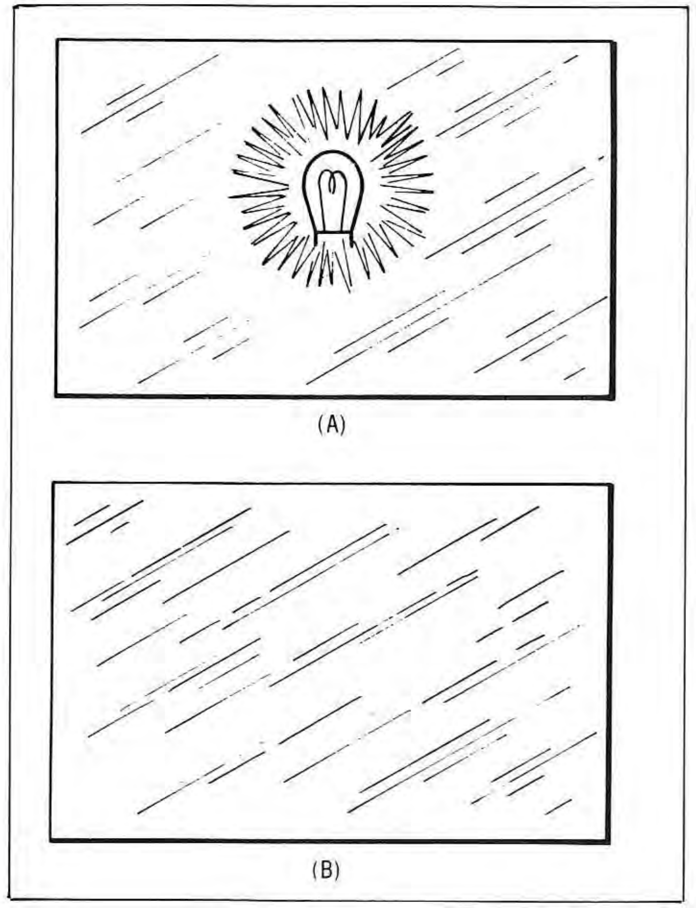

Figure 1: Poor quality rear projection screens are susceptible to "hot spotting," shown in the illustration as the rear projection light source.

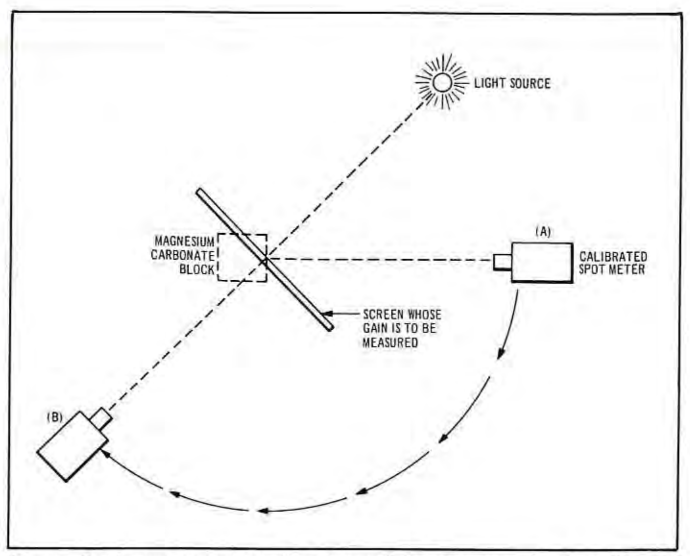

Figure 2: A test apparatus for determining screen gain. A calibrated spot meter is used to take comparative readings between a known light source passing through a screen, and that same light source reflecting off a pure white magnesium carbonate block.

illuminating optics. The resolution of a screen is closely related to the magnification ratio of an information display, quality of the microfiche or information source, and the ultimate image size. Eliminating the factors of the optical systems for various display systems which are discrete to the system in question, resolution at the screen face of 8 to 12 lines per mm is common in the current state of the art. When multiplied by the magnification ratio of the optical system, equivalent resolution at the film plane on the order of 300 lines per mm is possible. Determining such resolution requires only a simple series of tests.

To determine resolution a calibrated target of known value such as the Eastman Kodak pattern, the U.S. Air Force pattern or one accepted by the National Bureau of Standards is projected onto the screen to be measured. In all cases the test patterns have a series of bar markings of diminishing size. Determining the smallest bar groups distinguishable with a four-power optical loupe establishes, by reference to a correlating chart, the resolution in lines per mm.

Even to the casual reader it should be evident that the resolution of the final information system is as much a function of the transmitting optics as the rear projection screen itself. Currently the optics used throughout the microfilm industry and the 120 lines per mm resolution of quality rear projection screens complement each other. As reader optics are improved, so too will the need for greater resolving power in the rear projection screens; some high quality screens produced today exceed 180 lines per mm.

Gain

Gain of rear projection screens is relative to the screen application and involves the ability of the screen to transmit light. It is related to screen diffusion and defined as the ratio of observed luminance in foot lamberts to incident illumination in foot candles.

The test apparatus shown in Figure 2 has usually been used to determine screen gain. Using a good quality spotmeter, comparisons are made between the light coming through the screen and light reflected by a magnesium carbonate block. If light transmission through the screen is greater than from the block, the screen is said to have a "gain." Standard screens usually have a gain of three when measured in this manner.

An easier and more definitive method is to place a calibrated opal glass in the screen plane and compare the transmitted light through the opal glass with that transmitted through the screen. Not only is the opal glass calibrated against NBS standards, but this technique eliminates the need to rotate the spotmeter.

Gain is controlled during screen manufacturing by type and thickness of an optical coating which is used to transform light transmission within the substrate material. The trick is of course to optimize the screen gain and diffusion to meet the needs of the user through accurate chemical formulation and coating method. Low gain screens have the advantage of wider viewing angles, but are more susceptible to viewing interference from ambient lighting conditions and reflections. High gain screens produce the brightest image possible, but fall off in light intensity when viewed at wide viewing angles. Most film-based units in use today specify a middle ground between maximum viewing angle and maximum gain, with a gain factor of 2.5 to 3.5.

Angular Viewing

A useful feature of rear projection display screens is that they can be viewed several degrees off the principle axis of the light source or "head-on" viewing position without loss of image quality.

Variations in angular viewing can be designed into the screens by adjustments in the optical coating formulation and production techniques to meet specific angular viewing requirements. In the case of small screens designed for one individual in high ambient light conditions, a high gain screen having maximum on-axis directional transmission may be preferred. If the screen is to be viewed by several persons or from widely spaced viewing positions, a screen with maximum viewing angle is desired. So long as the light intensity ratio between head-on viewing and side angle viewing is maintained within a 3 to 1 ratio, the human eye will not notice the fall-off in image brightness.

Determination of screen bend angle can be judged with the use of a slide projector and a good quality spotmeter. The light source of known value (slide projector) is adjusted so that a predetermined number of foot candles of light strike the rear of a rear projection screen to be measured. Next a calibrated spotmeter is placed at a fixed distance from the other side of the screen (toward the coated side) and a reading is taken on the 0° axis as shown in Figure 3. The meter is then swung along an arc in increments of 5° for a total of 30° in each direction. From the readings taken a chart is prepared such as the one shown in Figure 4 to show the angular viewing characteristics of the screen.

Hot Spotting

Hot spotting is a deficiency of the screen to diffuse light and manifests itself as a halo effect on the screen surface. This characteristic tends to become more pronounced in the high gain, very directional type screens. A slight amount of hot spotting can be tolerated in general purpose screens, but for high quality screens it should be held to an absolute minimum.

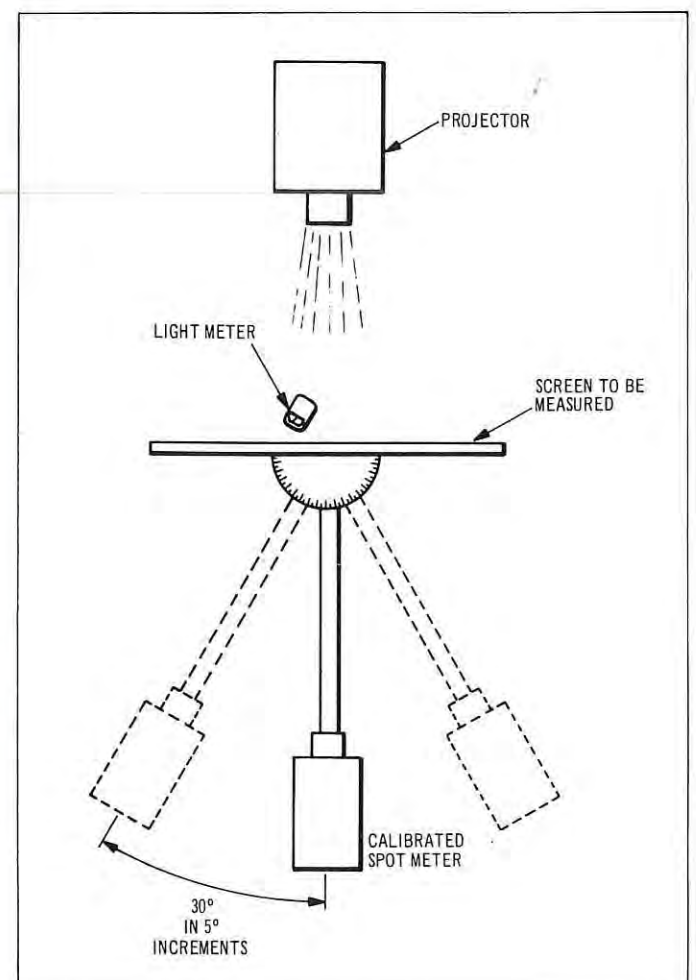

Figure 3: A test apparatus used to measure angular viewing of a rear projection screen.

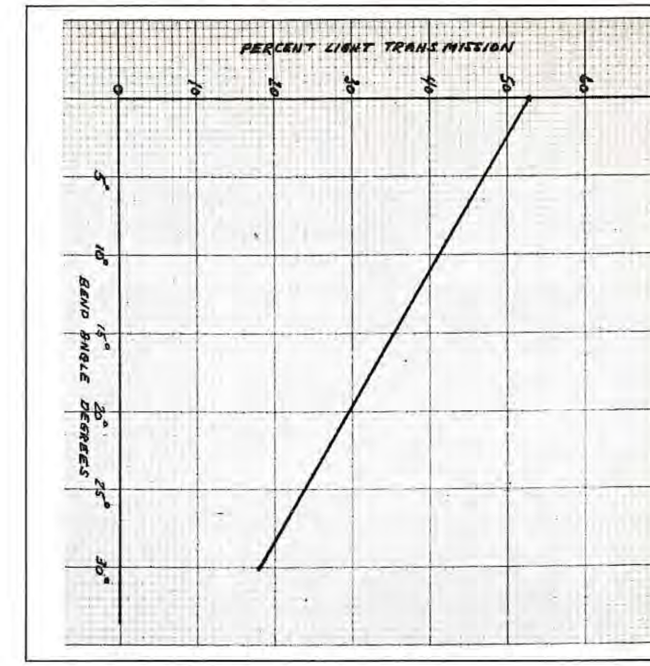

Figure 4: A properly designed and closely formulated rear projection screen set up for wide angle viewing should present a linear relationship between viewing angle and light transmission fall-off.

The cause of hot spotting can generally be traced to improper optical coating formulation causing uneven light diffusion over the screen surface.

Color

Tinting rear projection screens with various colors has opened up new and interesting possibilities for color coordinating the display system with accompanying control surfaces. But to use tinted screens properly, three considerations must be kept in mind at all times. First is the effect a tinted screen will have on the viewed color spectrum of the rear projected image. Second is the effect this screen color will have on the viewing ability of the equipment operator or viewer. And third, is the aesthetic consideration in matching or contrasting any proprietary colors adopted by an information display system manufacturer. Until recently rear projection screens were produced in a neutral grey, mildly textured finish. This is a general purpose color which meets most information display manufacturers' needs, and is the only shade that reproduces the full color spectrum accurately.

Early tinting studies conducted with medium blue or green screens, chosen to match equipment panel colors, have produced displays that are harsh on the eyes, or have reduced contrast excessively. Research conducted at Panelgraphic has produced a less intense tint of green which is satisfactory for extended periods of viewing. A shade of blue-green with the same benefits has also been developed.

Where very high contrast is desirable, such as fine line displays, a screen tinted yellow has proven to be most effective. Further research is being conducted on color shades, and sufficient data is now available to be able to indicate what effect that particular shade will have on the viewer and the image.

Based on the different effect certain colors have on rear projected images and data, a display manufacturer might consider offering his customers a choice of color tinted screens to suit their particular applications. This might even add to supplying the user with several screens in a "quick-change" configuration so that he could modify his viewing ability at will.

Contrast

Contrast can be stated as the ratio between the highest and lowest luminances in the image. To be able to read fine detail images in high ambient light conditions, a high degree of contrast is desirable. But consideration should also be given to the effect that long periods of such high contrast viewing can have on the viewer, such as pronounced eye fatigue. Care should be exercised in not overspecifying screen contrast where it will not be required, or underspecifying contrast because initial display system tests were conducted under laboratory "lights-out" conditions. A standard grey screen with a gain of 3 is generally considered satisfactory for most rear projection display applications.

Scintillation

Scintillation is an undesirable characteristic in a screen appearing as a distracting sparkling effect when the screen is viewed at near distances. Careful chemical formulation of the optical coating can usually control this effect.

The character and quality of the projection optical system also has a pronounced effect on scintillation. The situation can be aggravated by a slightly out-of-focus condition. Scintillation is a second or third order effect related to the magnification ratios being used in today's information displays.

Materials, Coatings, and Physical Appearance

Substrate

Contemporary rear projection screens produced today use a clear, optically precise acrylic plastic base in thicknesses ranging between 1/16 in. and 1/4 in. Optical coatings cast upon this base can be of varying thickness, and use the physical rigidity of the base for support. The final base thickness is a function of the screen size and use, and has little if any effect on the performance of the coatings. The object is to use sufficient thickness to maintain flatness in the image plane. An important consideration, too, for the rear projection screen is that it be free from blemishes, cracks, and other defects that could effect performance or strength over the years.

Coatings

The previously discussed characteristics of diffusion and screen gain are governed by the type and thickness of the optical coating applied to a screen, and will be tailored to the needs of the screen user.

In addition to the basic optical coating for rear projection screens, there are accessory coatings for special applications. One of these is a special anti-glare coating designed specifically to eliminate ambient lighting reflections for impinging upon the protected image and interfering with the viewer's ability to read the image shown in Figure 5.

At the same time, the anti-glare coating can provide a screen with a very hard, durable finish that can withstand considerable physical abuse. Such hardness also qualifies the screen as a working tool in that the surface can be written on with soft marking pencils and crayons. Certain versions of this hard finish also permit the use of applied graphics and tapes without endangering the screen finish or optical quality. Even if screen requirements do not necessitate using the screen as a tool, these accessory coatings are valuable as a protective agent against abrasion, chemicals, grease, and organic compounds that would otherwise attack the substrate itself.

Figure 5: A coating devised by Panelgraphic eliminates screen glare caused by bright ambient lighting.

Physical Defects and Tolerances

Chemical coating processes throughout industry are constantly faced with the danger of air-borne dust and debris contaminating the finished surface. The rear projection screen industry is not excepted from these problems, and has set up certain visual standards that maintain the screen production yields with a reasonable cost and selling price framework. The standards are directly related to the level of quality demanded by the user, and the price he is willing to pay.

The defects associated with rear projection screen manufacturing include such self-explanatory items as edge defect intrusion, minor scratches, high spots, voids, and so on. The acceptance standards are based on how many such defects per square foot of screen area are allowable when related to end use. They will be outlined in the suggested specifications appearing later.

Applied Graphics

Applied graphics are markings applied to the screen surface at the specification of the screen user. They may be flow charts, line drawings, legends, boxes, symbols, cropping marks, etc. Colors in either opaque or transparent form may be specified in almost any color combination. The screen manufacturer can advise on size and color limitations, if any, at the time of initial pricing.

Suggested Specifications for Rear Projection Screens

For the sake of convenience, a set of specifications that are well within the production realm of today's screen manufacturers is listed below. Although not all-inclusive, these specifications are a good starting point for the rear projection user.

1. Optical Performance

1.1 Resolution – The image resolution capability at the screen face shall average 8 to 12 lines per mm.

1.2 Gain – The standard screen gain is to be approximately 3 as determined in the following manner. The gain is the ratio of the transmitted light on-axis through the screen when compared with the reflected light from a clean block of magnesium carbonate, white plaster, white chalk, or magnesium oxide in the same physical position at 30° off the reflected light axis. Measurement should be made with a high quality foot-lambert meter.

1.3 Angular Viewing – The luminance fall-off at 30° viewing off the principle axis will be no more than 75% to 80%, such measurement taken from a central viewing point on the axis using a foot-lambert Spot Meter or equivalent rotated about the screen's vertical axis. The fall-off between the "on-axis" position and 30° on each side shall be relatively linear.

1.4 Uniform Gain – The screen gain shall be uniform over the area of the screen within 10%.

1.5 Hot Spotting – The screen shall not introduce distortion or chromatic halo (hot spotting) and shall be reasonably free of scintillation.

1.6 Contrast – The screen shall offer sharp contrast, allowing the viewer to readily distinguish between blacks and whites. (If appropriate: The standard neutral gray screen shall offer faithful reproduction of color images over the full color spectrum.)

2. Physical and General Appearances

2.1 The optical coating shall be free of mottle or sags and offer a uniform surface texture. Both front and rear surfaces are to be free of scratches and blemishes which would otherwise distract from easy viewing when in operation.

2.2 Border defect intrusion shall not extend inward more than 0.10 in. from the edge.

2.3 Allowable defects (per square foot)

2.3.1 Related to a screen of nominal size (one square foot), the maximum number of spots is not to exceed three. Maximum size of lint mark shall not exceed .010 in.

2.4 The acrylic substrate and optical coatings shall withstand exposure to an ambient temperature of -60°F to +160°F without evidence of performance deterioration or mechanical deformation.

Summary

The technology of both the screen manufacturer and screen user is continuing to accelerate. The future needs of modern business, technology, education, and recreation will more and more turn to compact displays of data readily available in real and near real time. As the sweeping changes so prevalent in this past decade pass on to the future, much of the information presented in this article will be replaced with yet better and newly tailored rear projection screen techniques to meet yet unseen needs in information retrieval systems. ■

J.T. Miller is Operations Manager at Panelgraphic Corp., West Caldwell, N.J.

ID Readout

Computer Shipments on Increase

To computer manufacturers, 1971 was the year of discontinuance, says P.J. McGovern, president of International Data Corp., Newtonville, Mass. "The computer makers had a net gain of only 60% in 1971, in contrast to 80% two years ago. U.S. users of EDP equipment retired or returned over $1.4 billion worth of computers to their manufacturers. At the same time, they showed their basic confidence in computers by accepting nearly $4.3 billion worth of new computers to power existing and planned applications.

"For the next two years, at least, our studies indicate that shipments will again increase at rates of 18% or 19% rather than at the relatively flat levels of the last three years. At the same time, net yield will improve," according to McGovern. In effect, McGovern explains, shipments by U.S.-based computer manufacturers are headed up again and the rate of retirements has stabilized.

Flight Training Control System

Sanders Associates Inc. of Nashua, N.H., has delivered to CAE Electronics of Canada, the ADDS/900 system that will control a DC-10 flight training simulator for pilots and flight engineers. CAE is developing the system for KLM Royal Dutch Airlines.

Featuring two 21 in. CRT consoles, the Sanders system will be mounted inside the simulator which has a hydraulically-operated six-degree motion system. It will serve as the interface between the instructors and the simulator's computer. Each display will depict a page of training information which can be selected from up to 500 pages of computer-stored data, including in-flight emergencies and failures. Using numbered function keys alongside the display, instructors can select any of 30 operational lines depicted on a page, directing the computer to simulate the required conditions such as atmospheric situations, aircraft motion, weather conditions and the like.

Each of the 30 lines may involve up to 15 items, all controlled from one button, and depending on the available core memory, could involve up to 225,000 items.

Automated Utility Billing System

The city of Richmond, Va., has automated its municipally-operated utility billing system for water, gas and sewer services. The system will serve an estimated 110,000 customers including a large number of commercial clients. Single household customers will be billed for gas, water and sewer usage; commercial customers will be billed for these services and also for suspended solids, BOD (biological oxygen demand) and fireline services. The computerized system automates billing, processing of meter reading and service orders, credit and collection and file maintenance. It renders one combined invoice, listing each service separately.

13th International SID Symposium

This year's 13th International Society for Information Display Symposium will be held on June 6-8. Earlier it had been scheduled for May 23-25. The Symposium will be at the Jack Tarr Hotel in San Francisco, Calif.

For more information about the Symposium, please contact the Society for Information Display, 654 No. Sepulveda Blvd., Los Angeles, Calif. 90049, or phone them at (213) 472-3550.

1972 IEEE Conference

The 1972 IEEE Conference on Display Devices will be held on October 11-12, 1972, in the United Engineering Center Auditorium, New York City. The Conference is sponsored by the Electron Devices Group of the IEEE and the Advisory Group on Electron Devices.

The program will cover all of the disciplines relevant to the research, development and design of electronic display devices. Among the areas of interest are the following: cathode ray tubes, solid state light emitters, plasmas, liquid crystals, lasers, holography, light valves and projection displays. Related topics such as drive address and control techniques, phosphors, fiber optics, electron optics, photochromics and cathodochromics, recording media directly applicable to displays, new phenomena, pertinent operational characteristics and measurement techniques are to be included.

June 16, 1972, is the deadline for abstracts. Prospective authors must submit a comprehensive abstract approximately 200 words long, appropriate to a 20 minute paper including discussion. The abstract must be written exactly as it may appear in the program of the Conference: complete with title, author(s), company affiliation, city and state of company location; on one side of a double-spaced typewritten page. Additional supporting material may be submitted at the discretion of the author. An original and 15 copies of all material should be sent to the address below. Late news papers will be considered if 75 word abstracts for ten minute papers are received before September 11, 1972.

Mail all material to Louis N. Heynick, Physical Electronics Group, Stanford Research Institute, Menlo Park, Calif. 94025. Louis Heynick, the Conference technical program chairman, can also be contacted by phoning (415) 326-6200, ext. 3871.

Applied Holography Course

A three-day short course on "Current Directions in Applied Holography" will be presented June 19-21, 1972, in San Francisco under sponsorships of Continuing Education in Engineering and the College of Engineering, University of California, Berkeley. The course will meet at the University of California Extension Center.

Both scientific and nonscientific applications will be covered with emphasis on commercial potential. Current capabilities and limitations as well as anticipated developments will be discussed.

Topics include recording materials for holography, digital holography, holographic optical filtering, holographic stereograms, holographic interferometry, acoustical holography, biomedical applications, holographic optical elements with applications to displays, holographic memories, commercial applications of memories and embossed holographic movies.

John Whinnery, professor of electrical engineering at Berkeley, is the UC faculty member in charge of the course; the program organizer is Joseph W. Goodman, associate professor of electrical engineering at Stanford.

Further details are available from Continuing Education in Engineering, University of California Extension, 2223 Fulton St., Berkeley, Calif. 94720; phone (415) 642-4151.

On the Move

J. Kenneth Moore has been appointed general manager of Electronic Systems for CBS Laboratories, a division of Columbia Broadcasting System Inc., Stamford, Conn.

Charles R. DeNet has been appointed merchandising manager of Bell & Howell consumer electronic products, Skokie, Ill.

Fred L. Gagnon appointed vice president-engineering for Kollsman Instrument Corp., Syosset, N.Y.

Gagnon

Rosenberg

Milton Rosenberg elected to the board of directors of Computer Transmission Corp., Los Angeles, Calif.

William T. Altmann has joined the Business and Industry Div. of Bunker Ramo Corp., Trumbull, Conn., as director of market planning, a newly created position.

SEACO Computer-Display Inc., Garland, Tex., announced the following appointments: *William M. Cramer*, president and chief executive officer; and board of directors members *William M. Cramer, James Loras* and *John Schrock*.

International Data Corp., Newtonville, Mass., appointed *Joseph L. Levy* director of eastern region marketing.

EMR Computer, Minneapolis, Minn., announces the following appointments: *Arthur Mintz*, general manager of EMR Computer; *Samuel N. Begg*, district sales manager of Pittsburgh office; *Kenneth G. Westra*, application analyst in Washington, D.C., office; and *Norman H. Petersen*, application analyst in Chicago district office.

Chicago Miniature Lamp Works, Chicago, Ill., appointed *Donald Tarver* LED product manager.

Blaise Cacciola named production manager and *Raymond V. Marchant* named manager of product engineering at Incoterm, Marlborough, Mass.

Jerry L. Koory appointed chairman of the Joint Computer Conferences Committee of the American Federation of Information Processing Societies Inc., Montvale, N.J.

The TNT Electronics Div. of TNT Communications Inc., New York, announces the appointment of *Herbert H. Marx* to the post of director of marketing.

Lawrence Becker appointed director of programming and systems for Quantel Corp., Hayward, Calif.

Snyder-Data Inc., Beverly, Mass., announces the appointment of *William K. Goolishian* as executive vice president and *Alan M. Horlick* as vice president.

Emil W. Milan joins Eastman Kodak Co., Rochester, N.Y., as patent attorney at the Kodak Park Div.

Emil G. Nichols named director of marketing for DuMont Electron Tubes Div. of Fairchild Camera & Instrument Corp., Clifton, N.J.

Herbert Freeman has been named chairman of the program committee for the International Federation for Information Processing Congress 74 to be held in Stockholm, Sweden.

Freeman

Shaw

Peter J. Shaw has been named manager of special projects for Science Accessories Corp., Southport, Conn.

Information Display

Published bimonthly by
Information Display Publications, Inc.
825 S. Barrington Ave. (213) 826-8388
Los Angeles, Calif. 90049

[Correspondence regarding feature articles, advertising, reprints and nonmembership subscriptions should be directed to the above address.]

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New Literature

AFIPS Survey

A summary report of the 1971 American Federation of Information Processing Societies (AFIPS) Personnel Survey of the membership of 13 national professional societies in the computer and information processing field is now available from AFIPS, Montvale, N.J. The eight-page report contains statistical analyses of: membership in participating societies; age, sex and race; degree levels and source of information processing training; years of experience in the information processing field; size of employer; number of years with present organization; number of employers worked for since entering the field; geographic distribution of work location; and salary distribution by percentage.

Circle Reader Service Card No. 13

Circuit Handler

A four-page brochure describes the IC-2500A integrated circuit handler, recently introduced by Integrated Mechanical Systems Inc., Minneapolis, Minn., a subsidiary of Computest Corp. The brochure contains summary sections explaining the advantages, operation and capabilities of the handler, which is designed for automatic feeding, contacting and sorting of dual-in-line packaged devices (DIP's). Overall handler specifications and drawings of the devices are also included in the brochure.

Circle Reader Service Card No. 14

Random Access Memories

Solitron Devices Inc. of San Diego, Calif., has released data sheets covering six 64 x 4 bit static and dynamic random access memories. The included static RAMS are: UA2264, UA3264, UA3864, UA2664 and UA3664. The dynamic RAMS are: UA2164, UA3164, UA2764, UA3764, UA2564 and UA3564. The features, operation characteristics, and availability of each unit are discussed in the data sheets.

Circle Reader Service Card No. 15

Computer Graphics

Dynamic Graphics Inc., Berkeley, Calif., has released a 14-page study entitled "Computer Graphics, an Emerging Tool in Architectural and Urban Design." The book describes a computer graphics project recently completed in cooperation with Skidmore, Owings & Merrill of San Francisco. The project required the generation of a series of perspective view drawings of a proposed townhouse development from the architect's original site plan and elevation drawings. Original source data and all perspective view drawings are presented, along with a history of the project and a detailed description of how it was carried out.

Circle Reader Service Card No. 16

Display Storage Tubes

An illustrated 52-page booklet provides information on display storage tubes (DST). The booklet includes background information on display storage tube operation and theory, applications data and a catalog of standard Westinghouse DST types and special tube design services. Provided by the Electronic Tube Div. of Westinghouse Electric Corp., Elmira, N.Y., the booklet provides technical information on the principles of DST operation and includes chapters on handling precautions, controlling image brightness and improving display storage tube performance. The catalog sections provide a listing of available standard DST phosphors and include a DST reference chart showing performance characteristics of standard Westinghouse tubes.

Circle Reader Service Card No. 17

Switchlights & Indicators

A series of single-lamp, illuminated pushbutton switches and matching indicators are described in Bulletin 73 issued by Control Switch Inc., Folcroft, Pa. Designed and priced for commercial and industrial applications, the 168 units shown include bushing and snap-in mounting styles with self-aligning lenses that won't seat unless lamps are in place. In addition to technical specifications, the bulletin contains part numbers for all combinations of switch actions and circuits, lens styles and colors, mounting methods etc.

Circle Reader Service Card No. 18

Parallelism in Computers

Prentice-Hall Inc., Englewood Cliffs, N.J., announces *Parallelism in Hardware and Software*, a 512-page book by Harold Lorin. Examples and non-mathematical language give keys to the problems of designing or programming high performance systems, developing compilers for highly parallel machines, designing multiprocessing hardware and multiprogramming software and determining systems goals. Contents include the following general topics: Fundamental Concepts of Coexistence in Time, High-Speed Single-Stream Systems, Multiple Machines and Multiprocessing.

Circle Reader Service Card No. 19

Power Line Stabilizer

Georator Corp., Manassas, Va., announces the distribution of literature outlining the company's 60 to 60 Hz power line stabilizer. Units detailed include a 3 phase, 60 Hz, 230/460 V, 1800 rpm brushless synduction motor; a 3 phase, 60 Hz, 230/460 V, 1800 rpm induction L.S. motor; and a 1 phase, 60 Hz, 115/230 V, 1800 rpm, CAP, start induction L.S. motor. Tables list the various inputs for 0.5-5.0 kVA outputs in graduated steps for each of these units. Similar information is given for the larger brushless synduction motors.

Circle Reader Service Card No. 20

Indicator Lights

A four-page brochure by the Eldema Div. of Genisco Technology Corp., Compton, Calif., details the BD Series B-Lites, CD Series C-Lites and ED Series E-Lites, all solid state indicator lights. Designed for a range of requirements in both military and commercial applications, the brochure emphasizes and illustrates the design characteristics incorporated in each series. The brochure includes schematic drawings for each series as well as full information on how to order by lamp number of lens shape, lens color and finish. Descriptions of materials and resistance are also provided.

Circle Reader Service Card No. 21

BRAUNBECK—Continued from page 20

to the reader. If the description matches none of the stored descriptions, the reader will transmit a signal of non-recognition, and the character is rejected.

Complex characters, such as those of standard font OCR-B, cannot be represented by horizontal or vertical strokes alone. For recognition by machine the entire character image must be processed. The signals, corresponding to the character and gained through serial, semi-parallel or fully parallel scanning, are used in assembling this character into an "electric image". Imagine a rectangular area fitted with switches instead of tiles. Each one of these light-sensitive electronic switches is now turned on or off depending on whether its associated picture element is white or black. The ideal form of a definite character class which is to be recognized will result in certain selected switches to be turned on. The floating ends of all appertaining resistors are connected to a bus. A "resistor matrix", this being the technical term, of this kind is built up not only for one single character class to be recognized but for all of them. From the fundamental laws of electrical engineering it follows that the resistor matrix in which most of the resistors were switched on shows the highest voltage between its terminals.

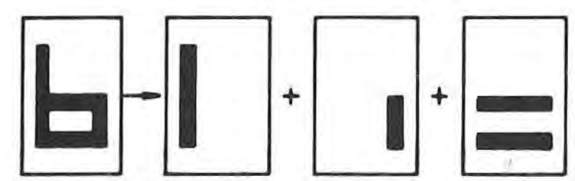


Figure 6: Stroke analysis.

This is verified by connecting the resistor matrices to a so-called maximum filter. The character corresponding to the matrix with the highest voltage is routed by the reader to the follow-up device. If several resistor matrices all yield more or less equally strong voltages, the character is rejected.

The matrix reader can read characters of any shape. There are no specific requirements with regard to stylization except that character pairs may not be too much alike. However, the matrix reader can only read one specific kind of type font. A reader capable of reading a large number of type fonts, technically known as a multifont reader, usually operates on another principle.

A form element reader is a further stage in the development of stroke analysis. The character to be recognized is examined as to the occurrence of form elements. In addition to horizontal and vertical strokes there are curvatures, hooks, open arcs, closed arcs, indentations and other form elements. The form element reader is the most versatile but also the most complex and expensive of all reading machines.

In summing up it may be said that the answer to the question of whether a definite font can be read by machine is almost always in the affirmative today. The question concerning us now is one of design complexity involved in reading a definite font. ■

Dr. Joseph Braunbeck, formerly of Hochhaus, West Germany, is now working on a highly specialized computer system in Vienna, Austria.

ID Products

Counters

Nationwide Electric Systems Inc., Itasca, Ill., is releasing its CT1220 line of electronic counters. The CT1220 series is obtainable from two to seven digits in either uni-directional or bi-directional counting capabilities, all contained within the 1¾ x 8½ x 9 in. cabinet. The company states the units are designed by the modular systems concept and are all solid-state incorporating MSI and LED readouts. Optional logging capabilities allow the logging (e.g. on a teletypewriter) of the contents of the counter.

Circle Reader Service Card No. 27

Hand Held Calculator

Burroughs Corp., Electronic Components Div., Plainfield, N.J., announces a Panaplex II panel display designed specifically for hand held cal-

culators and small instruments operating from battery power. According to Burroughs, the unit has an 0.209 in. character height, and the size of the eight digit panel is 2.65 x 0.69 x 0.197 in. Power consumption is 0.25-3.0 mW per segment, depending on the brightness needed. It is a 170 Vdc gas discharge display device, but the panel structure allows the anodes to be driven with voltage swings and current compatible with present MOS technology.

Circle Reader Service Card No. 28

Clamper/Damper Rectifiers

High voltage single junction silicon rectifiers with selected recoveries and PIV's to 1500 V are available from General Instrument Corp., Semiconductor Div., Hicksville, L.I., N.Y. According to General Instrument, these devices are suitable for use in clamping and damping applications in the horizontal deflection system for TV and CRT circuits. The maximum average forward current rating at 50°C is 1.5 A with a 1 V maximum forward drop at 1 A and 25°C.

Circle Reader Service Card No. 29

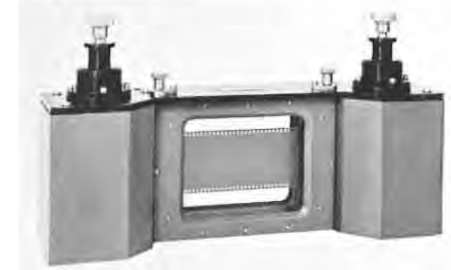
Graphic Display Terminal

The Conographic Corp., Cambridge, Mass., announces the introduction of the Conograph/10, a graphic display terminal. Conography uses conic sections said to produce any curved contour regardless of its mathematical function. The company claims the generator can directly transform parameters, allowing translation, rotation, and deformation to be performed on a graphic image without the need to access any other data base. Curves can be manipulated until the desired wave-form is attained.

Circle Reader Service Card No. 30

Roll Film Liquid Gates

Space Optics Research Laboratories Inc., Chelmsford, Mass., is supplying roll film versions of its fixed and adjustable liquid gates.



The manual film transport system of the gates allows the user to reverse direction at will and convert to automatic drive, according to the company. The transport mechanism handles up to 100 ft of any film less than 4½ in. wide and the gate can accommodate any glass plate or film up to 4 x 5 in. The roll film models have all the features of the standard SORL gates including index-matching fluid and P-grade Schlieren windows.

Circle Reader Service Card No. 31

Color Graphic Display

Ramtek Corp., Palo Alto, Calif., has developed a standard line of raster scan graphic displays. The GX-200 with an all solid state memory is a stand alone or clustered graphic display system, according to Ramtek. Sixteen 4-color or eight 8-color channels can be clustered and share a common computer interface. Standard features include end point vector generation, multi-size alphanumerics, complex graphics and one bit memory for every bit displayed.

Circle Reader Service Card No. 32

Status Display Module

Up to six captions can be evenly and individually illuminated with Dialight Corp.'s status display module. Dialight of Brooklyn, N.Y., states separate light-emitting diodes are individually controlled to light up each caption and these LEDs are partitioned by adjustable barriers. Gallium phosphide LEDs are the light source, hence, the captions are illuminated in red. The housing to the display can be disassembled to provide access to the legend and the light barriers.

Circle Reader Service Card No. 33

Flying Spot CRT

A flying spot cathode ray tube with a 30 s warm-up time and a 10 dB increase in SNR has been introduced for use in color slide scanners by Rank Precision Industries Inc., Des Plaines, Ill. According to Rank, the CRT provides the advantage of having the afterglow virtually independent of beam current and scanning speed. In addition, afterglow controls can be preset at the time of installation without requiring readjustment even after tube replacement.

Circle Reader Service Card No. 34

Keyboard-Display Unit

A self-contained solid state keyboard-display unit is announced by UniComp Inc., Northridge, Calif. The Model 522 contains keyboard, CRT display, memory, power supply and communications interface and can be substituted directly for teletype equipment. The company claims the unit features selectable transmission rates to serve low and medium speed time-sharing as well as high-speed communications (110, 150, 300, 600 or 1200 band as well as 9600 b.p.s. and higher).

Circle Reader Service Card No. 35

CRT Character Generator

Kenics Electronics Inc., Stoneham, Mass., makes available the B-103 1120 bit bipolar ROM LSI circuit, designed to simplify the making of high speed information displays. The firm claims the B-103 generates 32, 5 x 7 dot code matrix characters; Schottky diodes for an access time of 70 ns. typical; and five inputs, each capable of sinking 20 ma at 0.5 volts. The B-103 ROM pair is designed for CRT display systems where high speed and high character density are required.

Circle Reader Service Card No. 36

Read-Only Memory

Collins Radio Co., Newport Beach, Calif., introduces the MOS/LSI read-only memory system. Collins claims the system includes a 2560-bit memory matrix with full address decoding; DC output storage register and memory expansive capability; organization of 256 words x 10 bits, 256 x 9 and 256 x 8; access time of 800 ns.; operating temperature range of -55 to +125°C and power supply of 5 volts ±0.5 volts and -12.0 ±1.0 volts. The unit is available in either flat pack or DIP.

Circle Reader Service Card No. 37

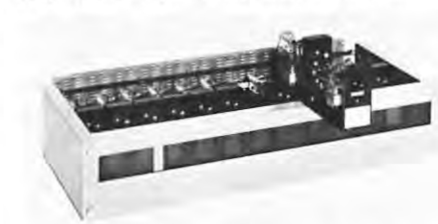
Diode Array

Monsanto Co., Cupertino, Calif., announces the availability of a four light-emitting diode array. The array consists of four gallium-arsenide-phosphide chips on a gold-plate Kovar lead frame and is intended for indicator panel and printed-circuit board applications. According to Monsanto, the array is bright, with each diode having an output of 750 foot-lamberts with an input of 1.6 volts DC at 20 milliamperes. Individual arrays can be assembled end-to-end into larger arrays.

Circle Reader Service Card No. 38

Readout Array

Major Data Corp., Costa Mesa, Calif., introduces the A-20 series Readout Array, an accessory to the Major 64 Readout Display line. The



readout array is expandable from 2-20 Major 64 readouts. This allows the user to select 1,280 different messages, according to Major Data. Each message can have 120 characters or symbols. The A-20 units are insulated and can be stacked, stood alone or mounted behind a panel. The unit permits access to any of the Major 64 Readout units in the array.

Circle Reader Service Card No. 39

Advertisers

Editorial

Liquid Crystals... Dinosaurs?

Are liquid crystals destined to join the ranks of other inventions which were equally heralded as being all things to all display designers? Assured that only minor improvements and volume production (to reduce costs) were needed, we were promised that the ultimate display element could be within our grasp.

We must admit, however, that in the diverse world of display applications, room has been found for virtually every light generation or modulation scheme proposed to date. Hence, we find the phenomena of gaseous discharge, electroluminescence, solid state light emission, photochromism, and many others – all utilized in one way or another to convey information through the visual sense.

The difficulty arises when a display can be characterized as being "equal to or better than commercial television." If color is a requirement the problem is compounded even further. A recent survey asks why liquid crystals have moved so suddenly into the forefront of displays after so many years of relative obscurity. Hopefully the answer to this question goes beyond mere publicity despite earlier disappointments with other innovations.

Not wishing to malign liquid crystal technology, we can assure the reader that display devices based on nematic or any other similar effects offer considerable promise to many aspects of display design – but not to all. Digital wristwatches and vest-pocket calculators complete with numerical display are several not-so-very-small steps removed from the full-color dynamic image which is so readily accepted as commonplace in home television receivers.

The ubiquity of the cathode-ray tube, for better or worse, is not easily overcome. There may very well be a place for an even larger number of devices than exists today. We must take pains to achieve a reasonable balance of enthusiasm for the young and new with acceptance of the proven and old. We can note in closing that despite the advent of illuminants such as the fluorescents, mercury, sodium and xenon arcs, the incandescent lamp still burns brightly throughout the land.

R.L. Kuehn