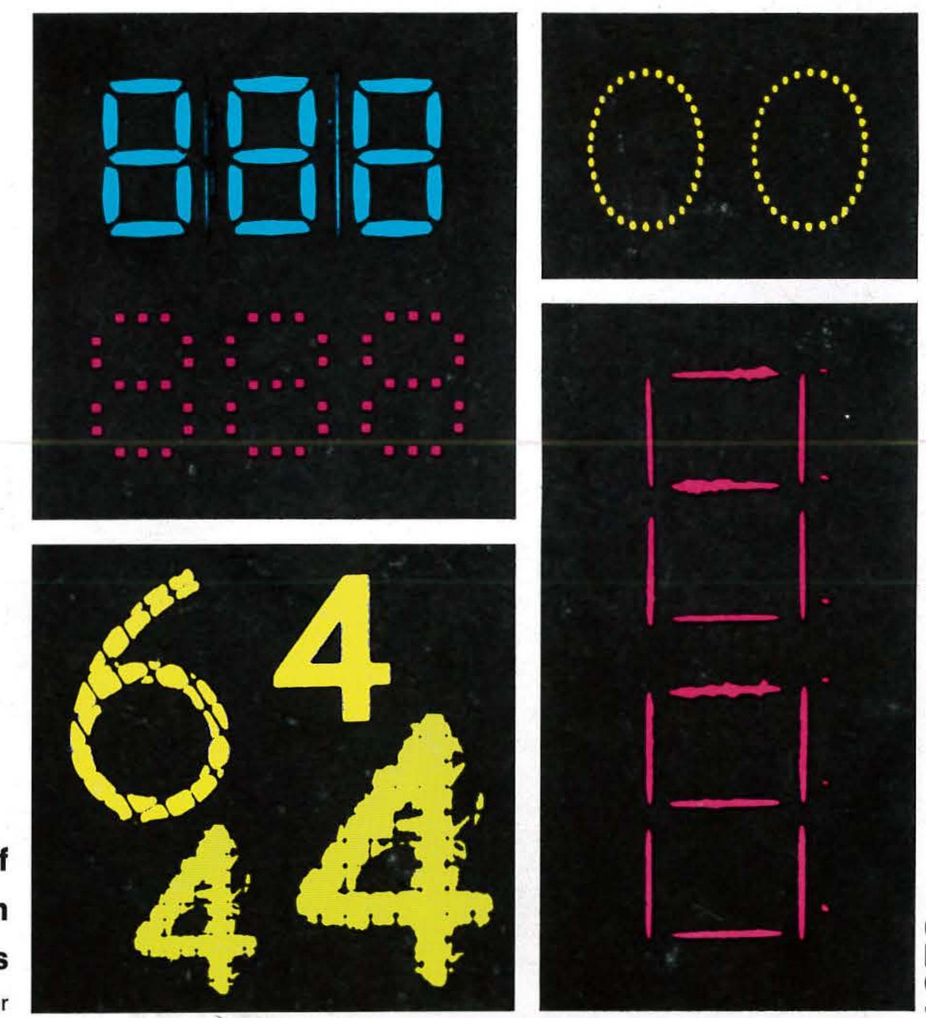

# SID JOURNAL

The Official Journal of the Society For Information Display



**The Future of Information Displays**

By C. Machover

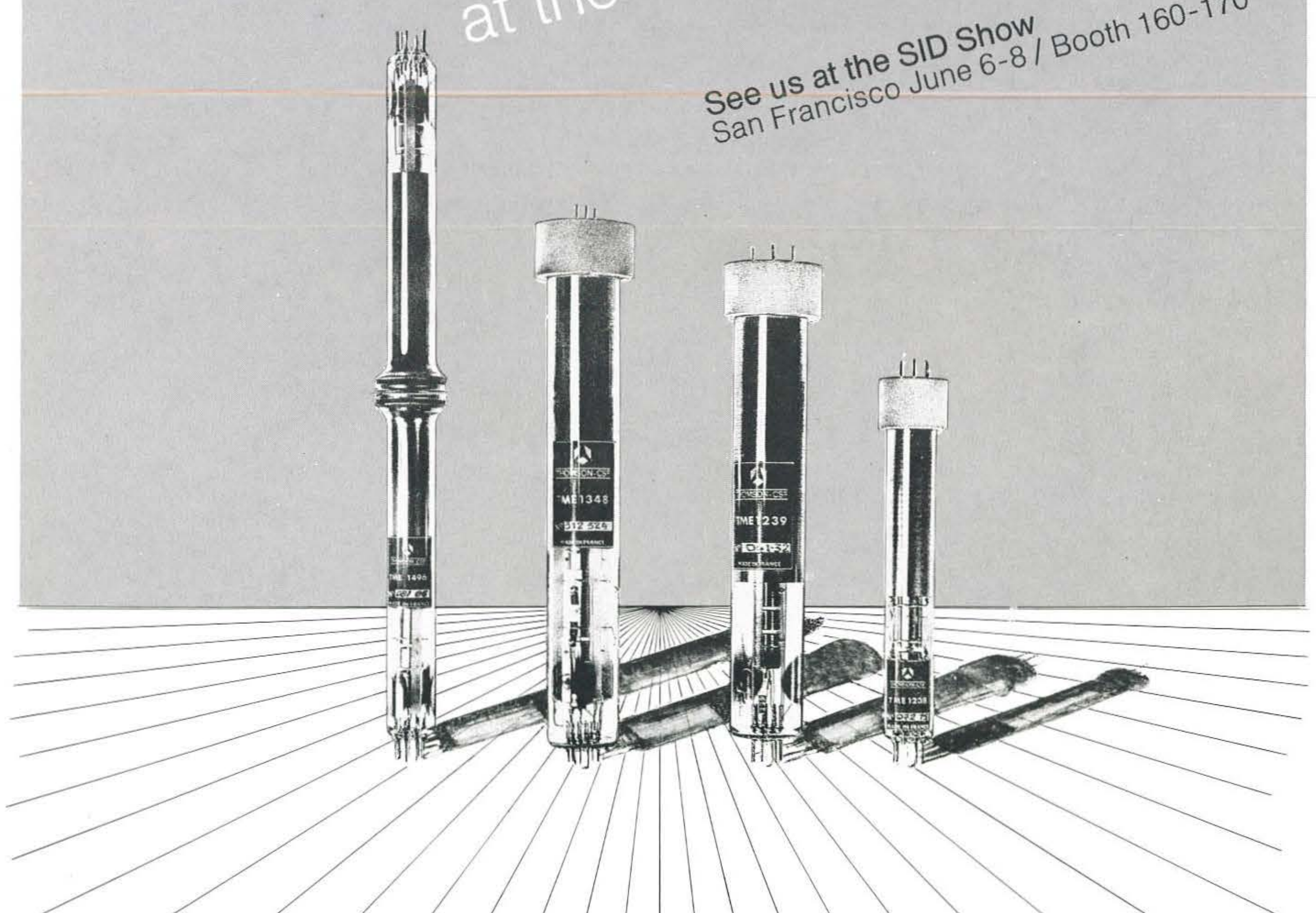
**Comparative Studies of the Legibility of Light Emitting Numerals**

By Hannelore Radl-Koethe and Ernst Schubert

PARAMETERS

may/june 1972

vol. 1, number 1



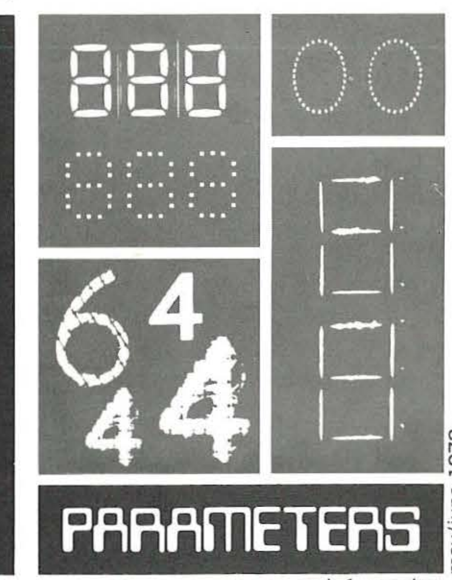


**SID JOURNAL**

The Official Journal of the Society For Information Display



# table of contents





may/june 1972
vol. 1, number 1

**CLOSING DATES:** Editorial closing date is the first of the month preceding month of issue. Advertising closing date is the 15th of the month preceding date of issue.
**SUBSCRIPTIONS:** U.S., its territories and Canada $7.50 per year. $12.00 for 2 years. Foreign Countries $15.00 per year.
**EDITORIAL CONTRIBUTIONS:** All material must be accompanied by stamped return envelopes. While all reasonable care will be taken with editorial submissions the publisher assumes no responsibility for art work, manuscripts or photographs.

Application to mail at controlled circulation rate is pending at Los Angeles, Calif.

THE OFFICIAL JOURNAL OF THE SOCIETY FOR INFORMATION DISPLAY. Published bimonthly by Blackwent Publishing Company, 1605 Cahuenga Boulevard, Los Angeles, California 90028, 213/463-4891. Correspondence regarding advertising, reprints and subscriptions should be sent to the above address.

**Publisher,** Robert Black/**Editor,** Harley Bjelland/**Editorial Coordinator,** Roby Wentz/**Advertising Manager,** William R. Brand/**Production Manager,** Joyce Wallace/**Circulation Manager,** S. Rocklin.

SID NATIONAL OFFICERS: **President,** Phillip P. Damon/**Vice President,** Dr. Carlo P. Crocetti/**Secretary,** Robert C. Klein/**Treasurer,** Erwin A. Ulbrich.

# ENT'S MESSAGE PRESIDENT'S M

## A Debut — SID JOURNAL

**SID, The Society for Information Display, communicates. The 1972 SID International Symposium and Exhibition in San Francisco June 6-8 with a superb technical program and many operational exhibits will provide unparalleled interaction for the anticipated 1000 attendees. Distribution of the 175-page SID Digest of these papers benefits a yet broader audience.**

**Proceedings of the SID is a quarterly professional publication sent primarily to members of the Society and libraries. The first two issues of 1972 highlight Matrix Displays and Liquid Crystal Displays.**

**Now, with this first issue of SID JOURNAL, which you are reading, the publications program is rounded out, reaching a much larger audience with the latest technical articles, trends, and products of Information Display. As SID's only publication with advertising, SID JOURNAL is essential to those who must know of the latest products and product improvements. In few fields is pictorial presentation more important than in information display. I encourage you to avail yourselves of the extensive supplementary information which these companies offer. Your response to them through the SID JOURNAL will encourage additional advertising, providing support for more editorial material.**

**Authors are encouraged to submit articles to the SID Publications Committee for review. SID JOURNAL provides an audience of over ten thousand makers, users, and scholars from diverse backgrounds having a common interest—Information Display.**

**The Publications Committee seeks quality editorial material, product announcements, and news relating to information display. Harley Bjelland and his committee are off to a good start. With your support and constructive ideas success is assured for SID Journal, The Official Journal of the Society for Information Display.**

**Phillip Damon**
**President**





● *A comparative investigation of nine different readout systems of light emitting numerals is described. Parameters relevant to the legibility threshold are discussed and the technical problems of quantifying these parameters are mentioned. Threshold performances vary considerably with respect to exposure times necessary for correct readings, as well as the kind and amount of misreadings. Rank orders, according to legibility results, differ markedly from subjective rankings. Mis-readings are analyzed qualitatively, and an attempt is made to explain the results obtained by estimating the relative influence of all relevant parameters. Suggestions for future investigations of light emitting displays are given.*

# Comparative Studies of the Legibility of Light Emitting Numerals

By HANNELORE RADL-KOETHE
and ERNST SCHUBERT

● WITHIN THE PAST FEW YEARS many light emitting numerals have reached the market. These are based on a variety of technologies, the respective advantages of which are relatively unknown. This results in a need for aid in selecting suitable readout systems for different applications. Such considerations should be partially based on psychological and physiological theories of human perception, permitting a quantitative estimation of the influence of all relevant parameters on the perceptual processes involved.

In this study the legibilities of several readout technologies were compared. The following parameters were considered predominant in evaluating the readout systems:

1. Technical parameters:
   technology, electronic control devices, energy dissipation, technical realiability
2. Optical parameters:
   luminous density, spectral luminance, contrast, spatial and temporal distribution of luminance, geometry (form, height, width, etc.)
3. Viewing condition:
   visual angle, environmental illumination
4. Subjective parameters:
   legibility thresholds, accuracy of legibility

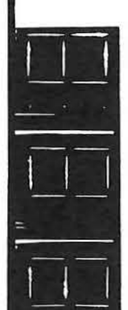
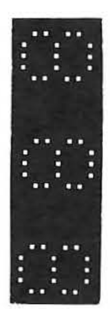
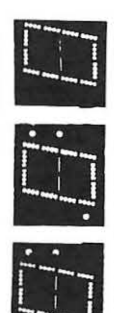
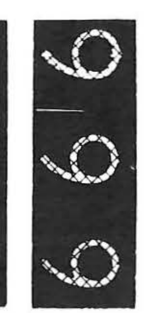
| readout system | | technology | intensity rise-time constant $T_R$ [msec] | maximal intensity (asb) | letter generation | color | width to height ratio W/H (H = 24') | space between numeral positions |
|---|---|---|---|---|---|---|---|---|
|  | a) | incandescent bulb | 150 | 12 000 | 7 segments | white | 0,60 | 1.45 · H |
|  | b) | incandescent bulb | 40 | 16 500 | modified 7 segments dot resolved | white | 0,55 | 1.16 · H |
|  | c) | incandescent bulb | 150 | 25 500 | 7 segments | white | 0,60 | 0.79 · H |
|  | d) | LED (light emitting diodes) | < 1 | 9 | 5 x 7 x-y-array | red | 0,70 | 1.46 · H |
|  | e) | LED | < 1 | 145 | 7 segments dot resolved | red | 0,90 | 1.69 · H |
|  | f) | incandescent bulb | 200 | 295 | projected arabic numerals | white | 0,80 | 1.38 · H |
|  | g) | glow-discharge tube | < 1 | 4 200 | arabic numerals incandescent filaments | red-orange | 0,70 | 2.09 · H |
|  | h) | glow-discharge tube | < 1 | 2 300 | arabic numerals incandescent filaments | red-orange | 0,65 | 1.15 · H |
|  | i) | incandescent bulb | 100 | 330 | arabic numerals dot resolved | white | 0,80 | 1.39 · H |

*Table 1. Relevant parameters of the read-out-systems*



By HANNELORE RADL-KOETHE
and ERNST SCHUBERT

This experiment was performed to estimate the relative effects of the various parameters mentioned upon legibility. Legibility here is defined as the subject's ability to identify one symbol out of a limited set of symbols, shown at a given short exposure time, under defined visual conditions. Beyond this the method chosen was to be evaluated with regard to its validity for real life display observation situations as well as for its heuristic value for the understanding of the perceptual processes involved.

### Choice of stimulus material

The stimuli chosen varied with respect to a number of relevant parameters. It had been decided to investigate readout systems available from industry according to the technical specifications described in the data sheets of the readout systems. Thus there was no chance of varying systematically the relevant parameters, but these parameters had to be measured as exactly as possible, and their respective influence on the legibility had to be estimated afterwards. Some of the relevant parameters are given in Table 1.

From this table it is easily seen that there are large differences between the parameters, which are supposed to influence the legibility of numerals. Other relevant parameters measured were numerical height, stroke width and slanted vs. upright presentation of symbols.

### Presentation of Numerals

Numerical height *H* varied from 7 to 15 mm. Accordingly the viewing distance varied from 100 to 215 cm to maintain a constant viewing angle of 24 minutes. Seven readout systems showed the numerals in an upright position, numerals of systems *b* and *e* were slightly slanted (10°). Another important difference of the readout systems concerns the presentation of numerals in different planes. While the first six systems show all numerals in one plane, numerals of system *g*, *h*, *i*, are presented in different planes, i.e. in the cases of systems *g* and *h* ten cathodes are arranged one behind the other, while in the case of system *i*, arabic numerals are dot resolved, the dots being engraved in ten glass plates in series.

As far as the stroke width is concerned, extensive photometric measurements resulted in distinctly different spatial distributions of luminance. Irradiation proved to be one of the main characteristics of light emitting numerals. Though the photometric curves of the spatial distributions of luminance were of obviously different shapes, stroke widths and contrast ratios of the symbol-background luminances were not defined. These parameters depend on the threshold luminance which is to be measured in further investigations by variation of the light intensity emitted. The technical problems arising from such measurements are discussed in detail in a paper of the authors (9).

### Stimulus Presentation

All numerals were presented in groups of three in a block. The blocks were installed in the middle of a 100x100 cm panel painted with a non reflecting black color. Behind the blackboard a black curtain provided a uniform background of the stimulus situation.

The subjects sat in front of the blackboard in a comfortable chair. The heads of the subjects were not fixed in order to avoid discomfort and muscle fatigue during the relatively long experiment. The subjects were instructed to remain leaning back in the chair while reading the numerals, since the viewing angle was to be kept constant. Room illumination was artificial daylight of about 200 lx at the blackboard. The lamps were installed at the ceiling behind the subjects to avoid glare.

The experimenter sat behind the subject controlling the whole experiment and wrote down the responses of the subject. After each reading period, the experimenter exchanged the readout systems, while the subject had a few minutes' rest. After about 90 minutes the subject had a longer rest.

Each numeral of one readout system was presented in five different exposure intervals near threshold. Exposure intervals are assumed to be identical with the electronic switching times, since the rise-time of the intensity (see table 1) is in all cases negligible. The same exposure interval appeared three times. This results in 150 presentations for the ten numerals. Since they were given in groups of three, each subject had to give 450 responses to one readout system. The numerals were presented in random order. Each readout system was read by 19 subjects. Subjects were 40 normal sighted males of an average age of 20.5 years.

### Procedure

After a short introduction to the

| readout systems | thresholds: single numerals 50 % msec | thresholds: three numerals 90 % msec | mis-readings % | objective rankings 50 % | objective rankings 90 % | subjective rankings |
|---|---|---|---|---|---|---|
| a) | 480 | 2100 | 5,4 | 5. | 5. | 6. |
| b) | 140 | 290 | 5,0 | 2. | 2. | 7. |
| c) | 760 | 3200 | 9,4 | 8. | 7. | 8. |
| d) | 70 | 240 | 8,3 | 1. | 1. | 4. |
| e) | 840 | - | 14,8 | 9. | 9. | 9. |
| f) | 730 | 1070 | 1,5 | 7. | 4. | 3. |
| g) | 380 | > 1000 | 11,5 | 4. | 8. | 2. |
| h) | 170 | > 2700 | 5,5 | 3. | 6. | 1. |
| i) | 600 | 940 | 3,7 | 6. | 3. | 5. |

*Table 2. Comparative representation of experimental results*

task the vision of each subject was tested by Rodatest R 3 apparatus. Then the different readout systems were presented and the subject read the numerals. The experimenter asked the subject to read the numerals as soon as he had identified at least part of them and not to wait until he was sure of what he had totally perceived. By this instruction a maximum of possible misreadings was to be obtained. The method of forced choice was not applied to avoid mere guessing, which was not based on the features of the stimuli.

Reading started as soon as the subject was sure about what he had to do. There was no learning period before the beginning of the experiment, though the practical value of the results obtained might be limited by this fact. The shortcomings and the advantages of the method chosen will be discussed together with the results.

At the end of the experiment subjects were asked to rank the readout systems they had seen and to criticize them with regard to their legibility.

The successive order of the presentation of readout system was randomized to control the effects of training and fatigue.

#### Results

About 8000 responses for each readout system were obtained. The responses were categorized into "correct responses", "misreadings", and "missed signals". Average percentages of correct responses and misreadings were counted separately for every exposure time.

Legibility thresholds were computed in two different ways:

1. According to the psychophysical definition those exposure intervals were considered as thresholds values, which were necessary for 50% correct responses to occur.
2. With respect to the problem of practical applicability of the results, those exposure intervals were considered as suitable data, at which 90% correct readings of groups of three numerals occurred.

These threshold values together with percentages of misreadings are given in table 2.

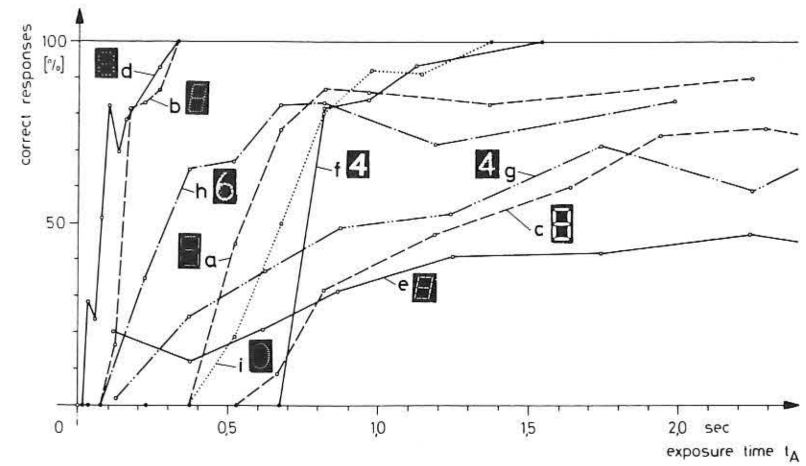



*Figure 1. Legibility of three numerals as a function of the exposure time*

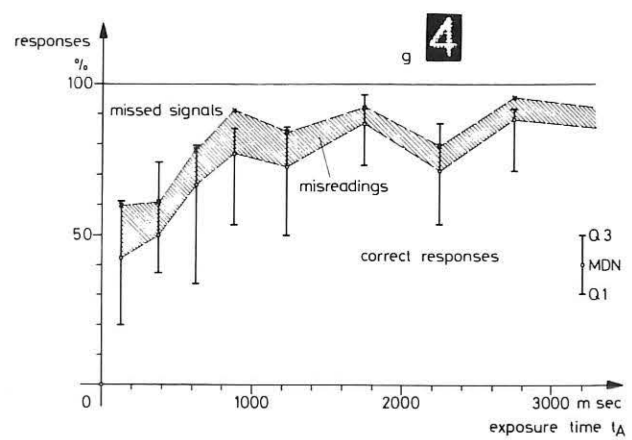



*Figure 2. Legibility of single numerals as a function of the exposure time $t_A$*

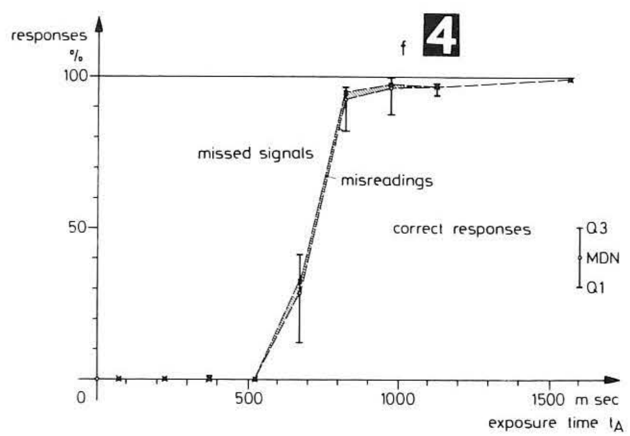



*Figure 3. Legibility of single numerals as a function of the exposure time $t_A$*



To help interpret the results, the readout systems were ranked objectively according to the thresholds obtained. In the last row the subjective rankings are presented. They show a marked difference compared with the objective rankings, with the exception of the poor systems *e* and *c*. Subjects showed a distinct preference for arabic numerals (*h, g, f, d, i*). Systems *e, c, a, b* were most often criticized because of their shape, while system *i* showed glare effects. The results indicate the need for pretraining periods, especially for unusual numerical shapes.

Either the method of measuring legibility by exposing the numerals for a limited time is inadequate (as Gibney [1968] suggests) or the learning period should be much longer since there was no learning effect to be seen in the course of 450 readings. These factors will be considered when the readout systems are to be valued.

#### Obvious Differences

For the objective rankings, quite obvious differences can be seen between 50% "single numerals thresholds" and 90% "three numerals thresholds". An explanation of these results may be found by the inspection of Figure 1, representing the curves of the percentages of correct naming of three numerals as a function of the exposure time. The curves of readout systems *b* and *d* show a steep increase and reach 100% correct responses at very short exposure times. Their objective ranks are 1. and 2., accordingly. The next curves to reach the 50% threshold are *h* and *a*, but only the following two curves *i* and *f* go up to 100%, while all other curves do not raise above a certain lower level. Since the greatest discrepancies occur with systems *g* and *f*, these curves will be discussed in some detail.

#### Spacing of Numerals

Considering readout system *g*, figure 2 shows that 50% of correct readings of single numerals are given at an exposure time of 380 msec, on the average. From Figure 2 and from Table 1, there is an important difference between reading of single numerals and reading of three numerals simultaneously. It takes nearly three times longer to read 50% of groups of three numerals correctly. This effect occurs only with this particular system. It may result from the large space between the numerals which is demonstrated in Table 1. The spacing of these numerals was most often criticized by the subjects. At the same time a high percentage of misreadings occur even at exposure times longer than 3 seconds. Thus it may be assumed that these numerals are difficult to identify even though their subjective ranking is quite high.

A somewhat opposite effect occurs with system *f* (see Figure 3). Subjects needed 730 msec on the average to read 50% of the numerals correctly. Once they were able to identify the numerals, it did not take more than 1070 msec to read

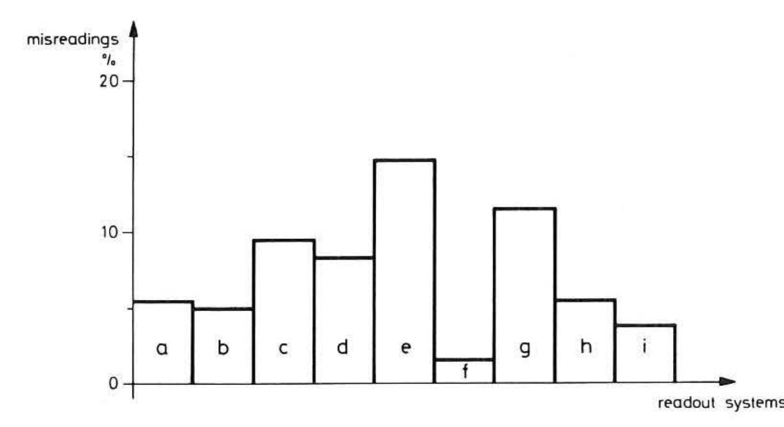



*Figure 4. Relative frequencies of misreadings in percentages*



90% of groups of three numerals correctly. From 1.5 seconds on 100% correct responses were given. The percentages of misreadings are extremely low as can be seen from Fgure 4. For practical application this readout system might be considered the most suitable one since the exclusion of misreadings is certainly of highest importance.

A more detailed description of the results of the other readout systems will not be given here because of space limitations. To end the presentation of the results, the percentages of misreadings shown in Figure 4 will be discussed briefly.

With the exception of system *i*, where only very few misreadings occur at exposure times between 600 and 1000 msec, a nearly constant percentage of misreadings occurs over the whole range of exposure times with all other readout systems not reaching 100% of correct responses. Thus it may be assumed that the numerals of systems *a, c g, h* and *e* will always be confused because of unsuitable form characteristics.

The qualitative analysis of misreadings yields some predominant confusions for the different readout systems, some examples of which will be given. Considering the systems with highest percentages of misreadings it is most striking that numerals of systems *e, c, d,* and *a* are seven segmented, while only the numerals of system *g* are arabic ones. As to system *e*, about 60% of the misreadings occur with numerals 3, 8 and 7, 3 most often being read as 9, 8 being read as 0, 9, or 6, and 7 identified as 1. In general, with these systems, the numerals 3, 6, 7, 8 and 9 are most often misread. For system *g*, 75% of the misreadings are equally distributed over the numerals 1, 3, 6, 8 and 0. This system, as well as system *h*, uses incandescent filaments to generate numerals in ten different planes. Both are highly preferred by the subjects, though legibility performances are quite poor, and in spite of the criticism with respect to the spacing of the numerals of system g already mentioned.

## discussion

Even without determining exactly the statistical significance of the differences between thresholds values, one can obviously distinguish between four groups of readout systems with respect to their legibility: Systems *b* and *d* turned out to be the best ones, closely followed by systems *f* and *i*. Systems *a* and *h* might be considered as being of acceptable quality, while systems *c*, *e*, and *g* represent the worst ones.

The analysis of the relevant parameters results in the following conclusions:

1. There is no indication that segmented numerals are necessarily inferior to standard Arabic. This strongly supports the findings of Gibney (4). It may be explained by the results of von Benda (1), who obtained the factors width (factor I) and round-straight (factor II) as basic factors for the similarity ratings of letters. Though similarity had no direct influence on identification thresholds, the factor round-straight proved to be of great influence on legibility, straight lines being much more easily identified than round ones.
2. There is a strong likelihood that dot resolution might be superior in legibility to stroke symbol generation, as in Vartebedian's experiment (10). In our cases this may be due to the fact that with dot resolution the regularity of the light emission of the whole symbol is much better than with stroke written ones. This is true for systems *b*, *d*, and *i*, but not for system *e*. Here the advantages of dot resolution are concealed by reflections due to unplanar surface.
3. Sharpness of contours turned out to be a very important parameter affecting symbol legibility. Those symbols with relatively wide strokes resulting from irradiation (*c* and *g*) showed blurred contours and were easily misread.
4. Unlike Vartebedian we did not find definite superiority of upright versus slanted symbols. But it should be noted that our symbols were only half as slanted as Vartebedian's, i.e., this parameter apparently has been of no effect at all on the legibility in our experiment.
5. Considerations for design of illuminated symbols given by McCormick (6), Murrell (7), and others, turned out to be inadequate, or of less importance to evaluate light emitting numerals since parameters such as height, width, spacing, intensity and color of illumination did not show direct influence on legibility.

### Background Noise

They are concealed by "background noise" occurring with most of the light emitting readout systems. Such background noise is given by reflections within the glass tubes (*e*, *g*, *h*), spreading effects or light absorption in the cases of representation of symbols in different planes (*g*, *h*, *i*), irregular light emission (*c*), simultaneous lighting of parts of other symbols or of other filaments (*e* and *g*), and similar phenomena.

Summarizing the results of this experiment, the method chosen proved to be suitable to evaluate the legibility of readout systems. Further research should include longer learning periods for new numerical displays. The effect, and tolerable limits of such background noise as mentioned above (point 5), are to be investigated.

In human engineering research efforts should be made to combine the results of experiments on the legibility of alphanumeric symbols and experiments on the effect of visual noise on form perception, thus enabling designers of light emitting readout systems to estimate the relative influence of the parameters involved. The human engineering research done up to now appears to be of very limited value for the application to real life numerical display observation situations. In the near future, much more emphasis should be placed on the quantification of photometric parameters, and suggestions should be given how to overcome the disadvantages of some of the systems presented in this study. ●

### References


(1) von Benda, H.: "Untersuchungen uber die Abhangigkeit der Wahrnehmungs-schwelle fur komplexe Sehzeichen von den Parametern Zeit, Intensitat und Form", Psychologische Beitrage, 1968, Vol. 10 (Part 1, p. 236-302, Part 2, p. 321-374)

(2) Burkardt, F. & Scholz, H.: "Licht und Leistung", in Hdb. der Psychologie, Vol. 9 "Betriebspsychologie" Eds. MAYER & HERWIG (1970)

(3) Cornog, D. Y. Rose, F. C.: "Legibility of alphanumeric characters and other symbols" US Dept. of Commerce, National Bureau of Standards, 1967

(4) Gibney, T. K.: "Legibility of segmented vs. standard numerals: the influence of the observer's task." Wright Patterson Air Force Base, Ohio, AMRL-TR-68-124, 1968

(5) Klemmer, E. T.: "The perception of all patterns produced by a seven-line matrix", J. exp. Psychol., 1961, Vol. 61, p. 274-282

(6) McCormick, E. J.: "Human factors engineering" McGraw-Hill, N.Y. 1964, p. 125-168

(7) Murrell, K. F. H.: "Ergonomics", London, 1965, p. 154-194

(8) Neumann, J. & Timpe, K.-P.: "Arbeitsgestaltung" VEB Deutscher Verlag der Wissenschaften, Berlin, 1970

(9) Radl-Koethe, H., Saupe, I. & Schubert, E.: 'Vergleichende Untersuchungen zur Lesbarkeit selbstleuchtender numerischer Anzeigen." Forschungsbericht Nr. 6, FAT Meckenheim, 1971

(10) Vartebedian, A. G.: "Effects of parameters of symbol formation on legibility." Information Display, May, 1970, Vol. 7, No. 5, p. 23-26

# EXHIBITS PREVIEW

## SID 1972 International Symposium and Exposition

Following are highlights of some of the exhibits which will accompany the 1972 Symposium:

### Aerojet-General Data Systems

*Illustration Number 1.*

Spectrovision Computer output imaging system producing "ultravivid" 3-dimensional simulation video picture with high resolution, accuracy, flicker-free display.

### Burroughs Corporation

*Illustration Number 2.*

The new Panaplex II panel display for handheld calculators and small instruments operating from battery power. Character heights of .209" said to provide display twice the size of "the most popular LED."

### Celco—Pacific

*Illustration Number 3.*

Celco Precision cathode ray tube display system designed for extremely high resolution film recording applications. System produces spot size of 0.00065 inches over entire CRT face, providing up to 6,500 resolvable elements across diameter of tube. Also provides "high degree of linearity and stability consistent with its multi-thousand-line resolution capability."

### Computer Power Systems Inc.

*Illustration not available at time of publication.*

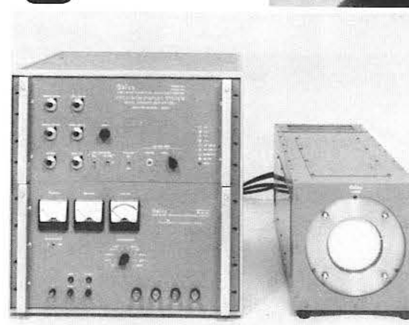
CPS VPD-1 Variable Persistence Display demonstrates the operational characteristics of a dual persistence beam penetration CRT applied to air traffic control radar displays. Transponder targets and range marks are simulated with a long persistence phosphor. Alphanumeric tags, updated at 60Hz during radar dead time, are displayed with short persistence. Target velocity, radar PRF, antenna rotation period and display ranges may be changed to determine their effect on the display. A key component of the VPD-1 is the CPS-7003 Penetration CRT Driver. The 7003 is capable of changing the tube operating potential through 10kV in 16$\mu$sec at greater than 20,000 transitions/second.

### General Electric Company

*Illustration Number 4.*

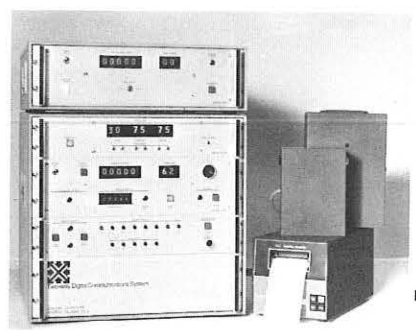
The new General Electric PJ500 Color TV Video Projector will be continuously demonstrated on a 3′ x 4′ rear projection screen using video tape and computer generated signals. It will also be used to display the output of the KQED "Video - Synthesizer" at the Wednesday luncheon program. This new concept in video projectors uses a single-electron-gun light-valve in which the three color pictures are written simultaneously on the same control layer in the form of diffraction gratings. The resulting optical spectra are filtered at the output bar plane to give the desired colors

1



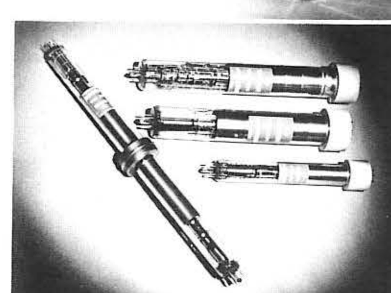
3

4

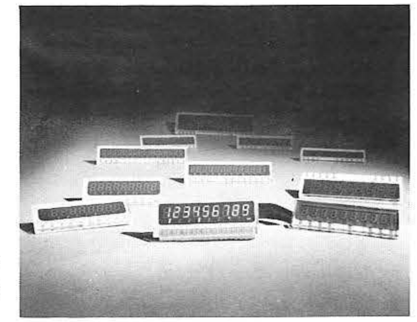


7

8

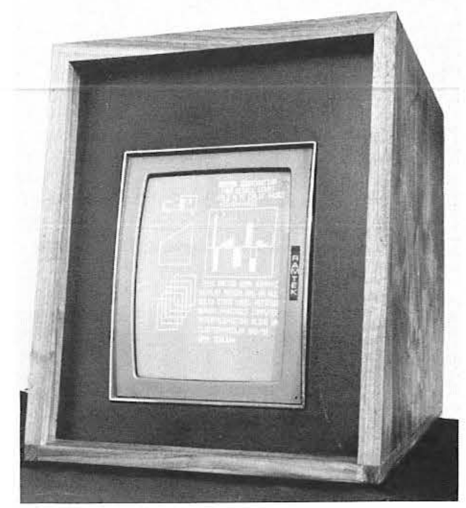


10

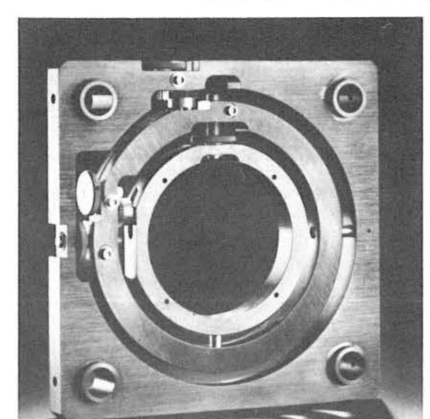


2

5



6



9

and then projected to the screen by a single projection lens. Thus, a single-gun color tube is realized that requires no registration.

### Owens-Illinois

*Illustration Number 5.*

The Divigue® display/memory unit, display device consisting of a gas-filled display matrix. Electric signal addresses points in the matrix, causing selected cells to glow with gaseous discharges. Glow is emitted in pulses which appear continuous to human eye.

### Ramtek Corporation

*Illustration Number 6.*

Ramtek will demonstrate its line of all solid state graphic display systems. The systems operate using standard television monitors as output devices. Up to 32 independent solid state refresh memory channels can be interfaced to a single computer interface. By combining channels, this allows the user to display color and/or grey scale digitally generated pictures. Display resolutions vary from $256^2$ to $1024^2$, each point addressable. The complex controller calculates end point vectors, graphic plot multi-size characters, color or grey scale selection through 16 basic computer instructions. The interface is 16 bits parallel.

### Scientific-Atlanta

*Illustration Number 7.*

Two-way digital communications system for cable TV, consisting of central monitoring station, subscriber station, and 2-way cable distribution system, operating on master-slave principle, with each subscriber station programmed to respond only to unique address code.

### Spatial Data Systems Inc.

*Illustration Number 8.*

First West Coast showing of "Graficolor" System, which produce full color simulations of design variations for fabrics, etc. at push of button. "Datacolor" densitometer system yields monitor screen displays of isodensity contours. "Edge Enhancer" enhances fine-line detail of X-rays, etc. "Picture Digitizer" digitizes picture information in digital matrix 512x438x256 levels of gray.

### Syntronic Instruments, Inc.

*Illustration Number 9.*

New lowcost micropositioners for CRT deflection yokes and focus coils or for optical bench applications.

### Thomson-CSF Electron Tubes, Inc.

*Illustration Number 10.*

Dual-gun tube, a storage tube incorporating two guns which aim at common target, enabling one gun to write, the other gun to read it. Essential feature is that two operations are completely independent of one another, can occur simultaneously, in contrast to single-ended systems. Two single-ended tubes, 1" and 1.5" model, have been developed with 1,200 and 1,800 TV lines limiting resolution and 800 and 1,200 TV lines at 50% modulation. Used for storage of binary information, have capacity to store 640,000 and 1,440,-000 bits. Each point can be written in 10 halftones, theoretically assuring coding of same amount of information but selected amount 5.12 million and 11.52 information bits.

# SID 1972 INTERNATIONAL SYMPOSIUM and EXHIBITION

*A DYNAMIC INTERNATIONAL EVENT, SID 72* will feature the largest number of information display technology progress sessions, papers and speakers from here and abroad: 12 topical day sessions with over 60 papers authored by more than 100 global specialists from US-England-Switzerland-Germany-Australia-Japan, and six timely evening panel discussions with over 25 experts participating . . . *LUNCHEON* on Wednesday, June 7, with dramatic presentation of color videography and large-screen color demonstration . . . *DIGEST OF TECHNICAL PAPERS* with over 150 pages of illustrated 800-1000 word condensations of contributed and invited papers, distributed to all registrants. Additional copy costs in center-fold form . . . *DAILY SPEAKER INTERVIEWS* for face-to-face discussions of papers. Schedule announcements by session chairman . . . *COCKTAIL HOUR* on Tuesday, June 6, in Garden Room of hotel . . . *THREE–DAY EXHIBITION* on mezzanine floor of hotel, reflecting latest technological developments, supported by operational demonstrations of systems, components and accessories, including graphic color displays-cable TV systems-color TV projectors-digital processing systems-precision CRTs-memory/digital units-hard copy equipment, numeric indicators.

*THE 1972 SID INTERNATIONAL SYMPOSIUM AND EXHIBITION*, the 13th annual event, is sponsored by the Society for Information Display, with headquarters in Los Angeles, Cal. . . . Complete information on SID membership, publications, as well as regional activities, will be available in the SID booth in the exhibition area.

*A MESSAGE CENTER* will be in operation during the entire SID 72 meeting to receive incoming calls for registrants: Tues., Wed., Thurs., June 6-8, from 8:30 A.M.-5:00 P.M. . . . Special telephone number assigned to SID is 415-771-1630.

*A SPECIAL TWO–DAY* program, covering Information Display Mechanisms, in juxtaposition with SID 72, has been scheduled for the day before, June 5, and day after the SID Symposium, June 9, under the sponsorship of the University of California, Berkeley, Continuing Education in Engineering Extension and the College of Engineering, so that those registering for SID may also attend faculty and industry lectures on display devices and techniques .

**SID 72 will be held in the Jack Tar Hotel, San Francisco.**

## TUES./JUNE 6/INT'L. ROOM/9:00 - 10:15 A.M.

### FORMAL OPENING OF SYMPOSIUM

**Welcoming Remarks–**

*H. C. Hendrickson*
General Chairman, SID 72

*J. H. Becker*
Program Chairman, SID 72

**Annual SID Business Meeting**

**Presiding–**

*C. P. Crocetti*
President SID

**SID Honors and Awards Presentations–**

*A. Debons*
Chairman, SID Honors and Awards Committee

**1971 Symposium Best-Paper-Awards–**

*H. C. Hendrickson*

### KEYNOTE ADDRESS

**The Impact of Information Display on Society**

*H. R. Luxenberg*

California State University
Chico, Cal.

*SEE THE*
Largest Operational Exhibition of the Latest Information Display Developments
Mezzanine Floor
Tues., June 6: 10:00 A.M. 5:30 P.M.
Wed., June 7: 9:00 A.M. 5:00 P.M.
Thurs., June 8: 9:00 A.M. 3:15 P.M.

## TUES./JUNE 6/INT'L. ROOM/10:30 A.M. - 12:00 NOON

### SESSION I; Solid-State Display Technology I

Chairman: *J. Markin*
Zenith Radio Corp.
Evanston, Ill.

1.1: **Ferroelectric Ceramic Light Scattering Devices for Image Storage and Display**

*W. D. Smith and C. E. Land*
Sandia Laboratories
Albuquerque, N.M.

1.2: **Electrooptic Variable Density Optical Filter**

*J. O. Harris, Jr. and J. T. Cutchen*
Sandia Laboratories
Albuquerque, N.M.

1.3: **A Survey of Electronic Numeric Indicator Devices**

*A. Sobel*
Zenith Radio Corp.
Chicago, Ill.

## TUES./JUNE 6/8:00 P.M.

### INFORMAL DISCUSSION SESSIONS

E-1: **Numeric Displays: Which and Why?** (International Room)
Moderator: *A. Sobel*
Zenith Radio Corp., Chicago, Ill.

E-2: **Image Storage in Display Terminals** (California Room)
Moderator: *B. J. Lechner*
RCA Laboratories, Princeton, N.J.

E-3: **Developments in Large-Scale Information Processing and Display Systems** (Gas Buggy Room)
Moderator: *P. Reimers*
Library of Congress, Washington, D.C.

Registration fees: advance - $30 (members), $40 (nonmembers); conference - $40 (members), $50 (nonmembers).

*Continued on page 16*

Continued from page 14



## WED./JUNE 7/GARDEN ROOM/12:00 NOON - 1:50 P.M.

LUNCH

INVITED ADDRESS/DEMONSTRATION

**Direct Video Synthesis: an Electronic Artform for Color TV**

*S. C. Beck,* Circuit Engineer/Electronic Videographer
*P. Kaufman,* Executive Director
National Center for Experiments in TV/KQED
San Francisco, Cal.

## TUES./JUNE 6/CALIF. ROOM/10:30 A.M. - 12:00 NOON

**SESSION II: Display Consoles**

Chairman: *Y. Smith*
Rome Air Development Center
Griffis AFB, N.Y.

2.1: **Trends in Low-Cost Graphic Display Terminals**
*C. Machover*
Information Displays, Inc.
Mt. Kisco, N.Y.

2.2: **Multi-Station-Type Color Character Display System**
*E. Yamazaki and K. Ohkawa*
Mitsubishi Electric Corp.
Kanagawa-Pref., Japan

2.3: **The Design of a Multi-Purpose Display Console for Command and Control Systems**
*A. L. Riggs and P. W. Yows*
Litton Data Systems
Van Nuys, Cal.

## WED./JUNE 7/8:00 P.M.

INFORMAL DISCUSSION SESSIONS

E-4: **Interactive Cable TV: Can it Meet the Challenge** (International Room)
Moderator: *E. Swarthe*
National Bureau of Standards
Washington, D.C.

E-5: **Interfacing with Human Factors** (California Room)
Moderator: *E. Sutherland*
Trans-A-File Systems Company
Sunnyvale, Cal.

E-6: **Need for Information Presentation Theory to Evaluate Role and Purpose of Displays in Man-Machine Systems** (Gas Buggy Room)
Moderator: *A. Debons*
University of Pittsburgh
Pittsburgh, Pa.

## TUES./JUNE 6/INT'L. ROOM/1:45 - 5:00 P.M.

**SESSION III: Plasma Displays**

Chairman: *H. G. Slottow*
Owens-Illinois, Inc.
Perrysburg, O.

3.1: **Low Voltage Plasma Panel**
*N. Nakayama and M. Osawa*
Fujitsu Laboratories, Ltd., Hyogo Pref., Japan

3.2: **A Gas Display Panel with Quasi-Axial Electrode Configurations**
*B. Welber and E. E. Tynan*
IBM T.J. Watson Res. Ctr., Yorktown Heights, N.Y.

3.3: **Numerical Computation of the Temporal Development of the Current in an AC Plasma Panel**
*H. Veron and C. C. Wang*
Sperry Rand Res. Ctr., Sudbury, Mass.

3.4: **Pulsed Gas Discharge Display with Memory**
*G. E. Holz*
Burroughs Corp., Plainfield, N.J.

3.5: **Self-Shift Plasma Display**
*S. Umeda and T. Hirose*
Fujitsu Labs., Ltd., Hyogo Pref., Japan

3.6: **A Parallel Addressed, Multiplexed-Driver Plasma Display**
*D. E. Liddle*
Owens-Illinois, Inc., Toledo, O.

3.7: **Design of a Low-Cost, Compact, Versatile Airborne Plasma Alphanumeric Control and Display Unit**
*E. R. Strandt*
General Motors Corp., Milwaukee, Wis.

## TUES./JUNE 6/CALIF. ROOM/1:45 - 5:00 P.M.

**SESSION IV: Software for Display Terminals**

Chairman: *D. A. Thompson*
Stanford University
Stanford, Cal.

4.1: **CRT Terminal Access from High-Level Languages**
*J. W. Gwynn*
Stanford University
Stanford, Cal.

4.2: **PL/OT: An Interactive Machine-Independent Graphics Language**
*R. C. Uzgalis, R. Chewings, P. Gruen, J. Laub, B. Speckart, J. Spencer, C. Switzky, K. Zierhut and D. Zweiban*
University of Cal./Los Angeles
Los Angeles, Cal.

4.3: **3-D Pictures**
*Y. Takasawa*
University of Tokyo
Tokyo, Japan
*S. Takehana and M. Isshiki*
Nippon Kogaku K.K.
Tokyo, Japan

4.4: **A High-Speed Microprogrammed List Processor for Computer Graphics**
*J. V. Camet and D. Weller*
Bell Telephone Laboratories, Inc.
Murray Hill, N.J.





## WED./JUNE 7/INT'L. ROOM/9:00 - 11:45 A.M.

**SESSION V: Liquid Crystal Displays I**

Chairman: *J. E. Bigelow*
General Electric Co.
Schenectady, N.Y.

5.1: **Matrix-Addressed Liquid Crystal Projection Display**
*P. J. Wild*
Brown Boveri Research Center
Baden, Switzerland

5.2: **Recent Advances in Frequency Coincidence Matrix Addressing of Liquid Crystal Displays**
*C. R. Stein and R. A. Kashnow*
General Electric Co.
Schenectady, N.Y.

5.3: **Experimental Comparison of Multiplexing Techniques for Liquid Crystal Displays**
*A. R. Kmetz*
Texas Instruments, Inc.
Dallas, Tex.

5.4: **Preparation of Alphanumeric Indicators with Liquid Crystals**
*S. Kobayashi*
Inst. of Phys./Chem. Res., Saitama, Japan
*T. Shimojo and K. Kasano*
Ise Central Laboratory, Inc.
Mie, Japan
*I. Tsunoda*
Tokai University
Tokyo, Japan

5.5: **Photoactivated Liquid-Crystal Light Valve**
*A. D. Jacobson*
Hughes Research Laboratories
Malibu, Cal.

## WED./JUNE 7/CALIF. ROOM/9:00 - 11:45 A.M.

**SESSION VI: CRT Devices**

Chairman: *F. J. Kahn*
Bell Telephone Laboratories, Inc.
Murray Hill, N.J.

6.1: **An Experimental Single-Gun Simultaneous Color Kinescope**
*M. Macaulay*
Information Elec., Ltd., Canberra City, Australia

6.2: **Multi-Beam CRT Displays**
*D. S. Hills*
Rank Precision Industries Ltd., Kent, England

6.3: **Photo-Erasable Cathodochromic Storage-Display Tube and its Applications**
*Y. Uno and H. Maeda*
Matsushita Res. Inst., Tokyo, Inc., Kawasaki, Japan

6.4: **An Alphanumeric/Graphic Time-Sharing Terminal using a Cathodochromic Storage Tube**
*F. Marlowe and P. Heyman*
RCA Laboratories, Princeton, N.J.

6.5: **A High Resolution, Meshless Storage Tube**
*J. S. Snyder and C. P. Stephens*
Hughes Aircraft Co., Oceanside, Cal.

6.6: **Developments in Simplified Direct View Storage**
*R. Frankland*
Tektronix, Inc., Beaverton, Ore.

## WED./JUNE 7/INT'L. ROOM/2:00 - 5:30 P.M.

**SESSION VII: Liquid Crystal Displays II**

Chairman: *A. H. Meitzler*
Bell Telephone Laboratories, Inc.
Murray Hill, N.J.

7.1: **Performance Advantages of Liquid Crystal Displays with Surfactant-Produced Homogeneous Alignment**
*Linda T. Creah and A. R. Kmetz*
Texas Instruments, Inc.
Dallas, Tex.

7.2 **Effect of Boundary Conditions on the Performance of Nematic Liquid Crystal Displays**
*S. Aftergut and H. S. Cole*
General Electric Co.
Schenectady, N.Y.

7.3: **Optical Storage in Mixtures of Nematics and Non-Mesomorphic Optically Active Compounds**
*W. Haas, J. Adams and G. Dir*
Xerox Corp.
Webster, N.Y.

7.4: **A Nematic Liquid Crystal as a Phase Grating of Electrically Variable Spatial Frequency**
*R. A. Kashnow and J. E. Bigelow*
General Electric Co.
Schenectady, N.Y.

7.5: **Multicolor Matrix-Displays Based on Deformation of Vertically-Aligned Nematic Liquid Crystal Phases**
*M. F. Schiekel and K. Fahrenschon*
AEG-Telefunken
Ulm, Germany

7.6: **Field-Effect Liquid Crystal Display Devices**
*D. Jones and S. Lu*
Riker-Maxson Corp.
Great River, L.I., N.Y.

## WED./JUNE 7/CALIF. ROOM/2:00 - 5:30 P.M.

**SESSION VIII: Displays and Processors**

Chairman: *G. W. Hrbek*
Zenith Radio Corp.
Chicago, Ill.

8.1: **A New Technique for Displaying Side-Looking Sonar Data using a Television Monitor and a Video Disc Recorder**
*J. T. O'Farrell and K. E. Wood*
Westinghouse Electric Corp., Annapolis, Md.

8.2: **Fibre Optics for Information Display: Some Traffic Engineering Applications**
*C. Barron and D. J. Morgan*
Rank Precision Industries Ltd., Leeds, England

8.3: **An Electrostatic Sign: The Distec System**
*W. R. Aiken*
Display Technology Corp., Cupertino, Cal.

8.4: **Charge-Coupled Linear and Area Imaging Devices**
*H. A. Watson*
Bell Tel. Labs., Inc., Murray Hill, N.J.

8.5: **Comparison of Photolastic Films of High and Low Reflectivity for Different Applications**
*S. Aftergut*
General Electric Co., Schenectady, N.Y.

8.6: **An Electrooptic Display Processor for Phased-Array Antenna Data**
*D. Casasent*
Carnegie-Mellon Univ., Pittsburgh, Pa.

8.7: **A Device for Spatial Modulation of a Light Beam**
*C. E. Catchpole and G. G. Goetz*
Bendix Research Labs., Southfield, Mich.

## SID '72 PROGRAM

### THURS./JUNE 8/INT'L. ROOM/9:00 - 11:45 A.M.

**SESSION IX: Driving and Access Circuitry**

Chairman: *G. Chodil*
Zenith Radio Corp.
Chicago, Ill.

**9.1: A Monolithic Liquid Crystal Decoder-Driver**
*B. H. Hellman*
Solid State Scientific, Inc.
Montgomeryville, Pa.

**9.2: VLED Interface Circuits**
*C. E. Smith*
Texas Instruments, Inc.
Dallas, Tex.

**9.3: A High-Performance Decoder/Driver for Seven-Segment Gas-Discharge Displays**
*D. Priebe*
National Semiconductor Corp.
Santa Clara, Cal.

**9.4: XY Coordinate Detection using a Passive Stylus in an Infrared Diode Matrix**
*B. L. Richardson*
Bell Telephone Laboratories, Inc.
Holmdel, N.J.

**9.5: A Scanned Infrared Light-Beam Touch-Entry System**
*F.A. Ebeling, R.S. Godlhor and R.L. Johnson*
University of Illinois
Urbana, Ill.

**9.6: Simple Access Circuitry for Electrical Data Sensing of Plasma Display/Memory Panels**
*L. F. Weber and R. L. Johnson*
University of Illinois
Urbana, Ill.

### THURS./JUNE 8/CALIF. ROOM/9:00 - 11:45 A.M.

**SESSION X: Visual Phenomena**

Chairman: *J. L. Simonds*
Eastman Kodak Co., Rochester, N.Y.

**10.1: Minimum Legibility Requirements for High Resolution Graphics Displays**
*A. H. Marsh*
Bell Telephone Labs., Inc., Holmdel, N.J.

**10.2: Human Factors in Helicopter Displays ?**
*J. A. Barnes*
U.S. Army Aberdeen Res. and Dev. Ctr.,
Aberdeen Proving Ground, Md.

**10.3: Target Acquisition's Achilles Heel or the Display's the Thing**
*F. D. Fowler and D. B. Jones*
Martin Marietta Corp., Orlando, Fla.

**10.4: Performance with Computer Generated and TV Model Visual Displays for Visual Simulation of the Landing Approach**
*W. D. Chase*
NASA Ames Res. Ctr., Moffett Field, Cal.

**10.5: Effects of Target Size, Target Contrast, Viewing Distance and Scan Line Orientation on Dynamic Televisual Target Detection and Identification**
*R.A. Bruns, A.C. Bittner, Jr. and R.C. Stevenson*
Naval Missile Ctr., Point Mugu, Cal.

**10.6: The Limits of Stereopsis as a Cue for Depth Perception in Dynamic Visual Situations**
*T. Gold*
Sperry Gyroscope Corp., Great Neck, N.Y.

**10.7: Stereoscopic and Eye Acuity Matching TV System**
*A. Schwartz*
MB Associates, San Mateo, Cal.

### THURS./JUNE 8/INT'L. ROOM/1:00 - 3:00 P.M.

**SESSION XI: Unique Peripheral Equipment**

Chairman: *G. Kaelin*
Litton Industries, Inc.
Van Nuys, Cal.

**11.1: A Computer-Controlled Graphic Laser Display**
*W. Thust*
Elektro Spezial Hamburg GmbH
Hamburg, Germany

**11.2: SID: A Fast Low-Cost Graphic Scanner**
*R. K. Cover*
Sandia Laboratories
Albuquerque, N.M.

**11.3: A Hard Copy Device for Digital Video Signals**
*J. C. Mutton*
Tektronix, Inc.
Beaverton, Ore.

**11.4: A Computer Controllable, Random-Access Microfilm System with Multiparameter Display Capability**
*R.S. Stites and J.T. Polhemus*
Martin Marietta Corp.
Denver, Col.

### THURS./JUNE 8/CALIF. ROOM/1:00 - 3:00 P.M.

**SESSION XII: Solid-State Display Technology II**

Chairman: *C. E. Land*
Sandia Laboratories
Albuquerque, N.M.

**12.1: Light Emitting Film Display System with Two Axis Time Multiplex Circuitry**
*R. D. Ketchpel*
Sigmatron, Inc.
Santa Barbara, Cal.

**12.2: Physics and Failure Analysis of High Reliability LEF Displays**
*M. E. Lippman*
Sigmatron, Inc.
Santa Barbara, Cal.

**12.3: The Potential of Zinc Sulphide Solid-State Displays**
*N. J. Werring, R. Ellis, P. J. F. Smith, J. H. Williamson, A. Vecht*
Thames Polytechnic
London, England

*A UNIQUE OPPORTUNITY TO HEAR*
In-Depth Discussions of
Display Devices and Techniques by
University of California/Berkeley
Continuing Education in Engineering Extension
Faculty and Industry Specialists
Mon., June 5/Fri., June 9.



# The Future of Information Displays

By C. MACHOVER

● Those of you who saw Stanley Kubrik's production "2001: A Space Odyssey", can have no reservations about the future of information displays. This three-decade-from-now prophecy features a Pan American Airlines Space Shuttle built in space and a Howard Johnson Earth-View Restaurant . . . and dozens of information displays. And this is not the only indication that there is a display in your future. Philco-Ford recently produced a movie called "Home of 1999" and sure enough there are displays in every room. Even the science fiction writers are including information displays as one of their standard accouterments in the world of tomorrow.

Just what do we mean by an Information Display? Quite non-rigorously, I think of Information Display as any device which translates machine generated data into some kind of graphic form readable by people. Of course, such a broad designation would force us to include billboards, newspapers, scoreboards, as well as the more conventionally considered devices such as alphanumeric CRT terminals, interactive graphic terminals, projection displays, and a variety of numeric readouts.

Since this presentation is concerned both with market and technology forecasting (each of which is something less than an exact science), I will be something less than exact in my definition of information display. That is, anything I consider in this paper will, by definition, be an information tion display . . . but it is not necessarily true that I will consider every information display in this paper.

In addition to discussing specific market and technology forecasts, I will consider some of the techniques currently being used for forecasting purposes.

### Technology Forecast

There are a number of means currently being used to forecast the technology over the next five or more years. Looking farthest into the future, a most fascinating book was published several years ago which speculated on, among other things, the technology future. This book, "The Year 2000" by Herman J. Kahn and Anthony J. Weiner, was published in 1967 by the MacMillan Company. The study "arises out of the joint interest of the American Academy of Arts and Sciences in the Hudson Institute in sketching 'alternate futures'. In October 1965, the Academy created a commission on the year 2000, composed of 30 individuals, to stimulate such research. Discussion at

## about the author

*As Vice President of Marketing for Information Displays, Inc., Mr. Machover has been concerned with the design and marketing of display systems and computer graphics. He has been with Information Displays, Inc., since 1960. Mr. Machover was Manager of Sales for Skiatron Electronics Television Corporation before joining Information Displays, Inc. During the prior eight years, he was with the Norden Division of United Aircraft Corporation, involved with engineering and marketing servo components, gyroscopes, displays, BOMB/NAV systems, and precision test equipment.*

*Mr. Machover has published numerous articles on displays, and has delivered lectures on the subject at technical conferences and universities in the United States, Europe and Australia. Mr. Machover is also the author of books on gyroscopes, and holds patents on gyroscope devices. Mr. Machover is a member of SID, ACM (SICGRAPH), IEEE, Sigma XI, Tau Beta Pi and Eta Kappa Nu. He is a Past President ('68-'70) of the Society for Information Display (SID), and a Fellow of that organization.*

the first Plenary Session of the Commission established the need for statistical and other 'base lines of the future'; that is, a compilation of likely and possible future developments that the Commission could take as a starting point for more detailed consideration of policy consequences and alternatives." Some of their projections relating to information display are summarized in Table 1.

### What 'Could' Be

In the 1969 report, "A Fifteen-Year Forecast of Information Processing Technology," Mr. George Bernstein gave a very informative review of the SEER method used several years ago by the Naval Systems Command for their forecast. The report states:

> "The usual forecast attempts to predict what *could* be—DELPHI tries to predict what *will* be. DELPHI could be described as an elegant method for developing a consensus; it is a polling technique employed for systematically soliciting the opinions of experts. DELPHI bears deeper investigation because it is directed toward the prediction of the future as it will develop in a situation influenced by many factors beyond the control of the company or agency making the forecast. Its methodology includes the polling of experts representing the controlling factors and from this developing a consensus which can be used in planning. Its advantage consists in the systematic treatment of data that includes the experts' intuitive assessment of related imponderables . . . a variation of the DELPHI approach, SEER (System for Event Evaluation and Review), to produce a technological forecast of what is expected to occur in the information-processing industry. Since any single organization will have only very limited influence on the future decisions and outcomes in an industry, a technique that incorporates the consensus of participant experts should be of inestimable value in planning. . ."

In my Figure 1, I have abstracted from that final report items particularly related to information displays. Also, in the Figure 1, I have reorganized the data slightly in order to emphasize time range . . . note that some of the forecasts go out as far as 1990.

This year, the Naval Electronics Laboratory Center in San Diego, California, circularized industry in hopes of formalizing the Navy Technology Projection. Their approach is slightly different in that they have asked responders to predict the year in which a particular development will become cost-effective to production equipment; predict the probability (from 1 to 9) that that forecast will become a reality; and to predict, if it does become a reality, what percentage of the market will be captured by the technique. Figure 2 shows the way their forecast was requested, while Table 2 shows some of the display categories as some of the devices for which they wanted projections. I believe that the categories given in Table 2 are quite representative of the probable technology over the next ten years.

### Content of Seminars

Another interesting way to develop technological forecasts is to examine the content of contemporary technical seminars. One such symposium, sponsored by the Society for Information Display, on May 4 thru 6, 1971, in Philadelphia, considered a variety of techniques that undoubtedly will become important within the next five to ten years. These include Cathodochromatic storage displays, light valve projection displays, large screen stereoscopic random access lasar displays, photographic color projection displays, inorganic polymers as read-out devices, liquid crystals, light emitting diodes, and a variety of plasma display techniques.

### How Good Are They?

Of course, consulting firms are not above making technological predictions either. For example, the Diebold Group recently forecasted that thermachromic, photochromic, fluidic, and magnetic optical techniques would become important in the displays of the future.

One can reasonably ask the question, just how good are such

*Figure 1. Some Information Display Long-Range Technology Forecasts*

- Improvements in Machine-Aided-Design systems can be expected with an output to accommodate machine made functional systems, including active & passive devices & machine made documentation including fabrication masks of necessary, logic diagrams, schematics, interconnecting diagrams, test parameters & testing diagrams. Inputs to these systems will be:
  - (1) Functional relation expressions.
  - (2) Manual input of data (i.e., schematics)
  - (3) Optical scanning of rouch circuit sketches.
- Development of flat panel, digitally addressed displays with inherent storage & selective erasure.
- The plasma panel will be perfected to provide a low cost, flat, easily driven, high resolution color display with selective write, intensity storage & read-out capacity.
- High resolution (750-1000 line) TV refreshed from an analog or digital mass storage device (e.g., disc) either in clusters or individually will provide low cost, high performance graphics consoles.
- A hardware display generator which can draw curves, lines, points & characters with edge clipping, fast & accurately will be available at a low cost ($1-5K).
- Graphics capabilities will assume tremendous importance.
- The capabilities of the output display system will increase as it becomes more economical to incorporate greater amounts of storage & data handling facilities within the peripheral equipment rather than the CPU.
- Newly developed, hot-pressed ferroelectric ceramics will be used for at least the following:
  - (1) Controlled persistence displays.
  - (2) Electro-optic & acousto-optic deflection & modulation devices.
- A color display, 1024 x 1024 resolution, low cost-$1-10K including storage, will be available.
- TV-raster I/o devices will be replacement for many direct CRT displays because of capability for accepting both digital & vido (background data from optical storage) inputs.
- A hardware picture generator which can generate a raster scan in color given the specifications of all the homogeneous areas will be available.
- Development of low-cost, high-resolution, direct view storage CRT.
- Development of dynamic real-time large screen displays.
- Standard television sets will come into substantial use as I/o terminals.
- Personal terminals which "simulate" routine activities of employees in functional departments (e.g., personnel, contract administration, pricing, etc.) so as to increase productivity of administrative work.
- Use of light emitting diodes & similar electronics for data processing, reading, and display.
  - (1) ten-fold
  - (2) hundred-fold.
- Digigraphic systems will use as a data base both graphical & digital information. Output will be in the form of film chips.
- Wall displays 4' to 12' square with resolution of at least 40 lines/inch & color will be feasible.
- Solid state direct view display devices with selective erasure characteristics will be available.
- Development of low cost remote graphic terminals.
- A flat TV tube providing reduced glare, will be available on the market at reduced cost.
- Development of solid-state X-Y-Z displays of integral memory.

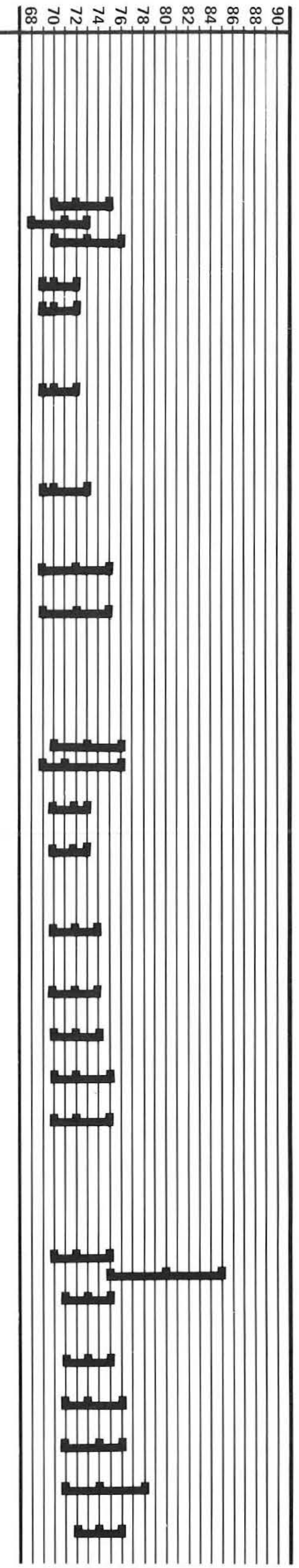
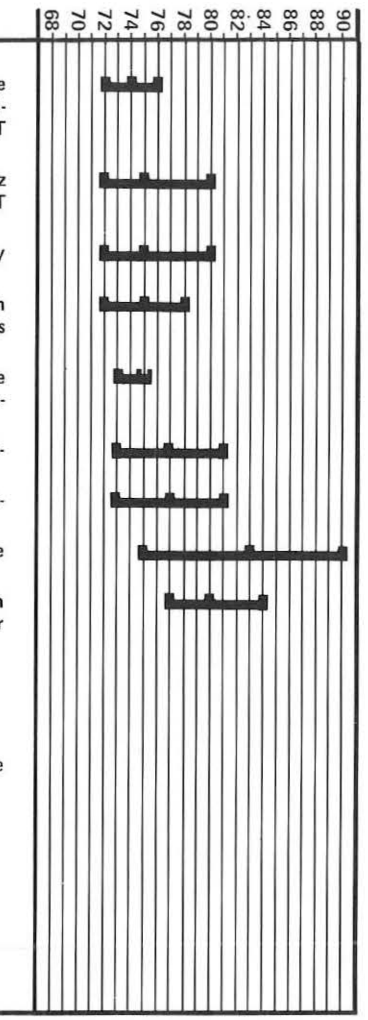
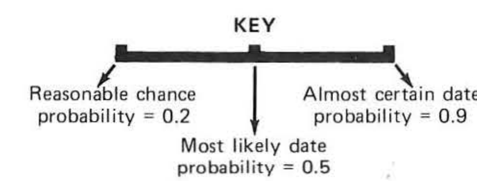
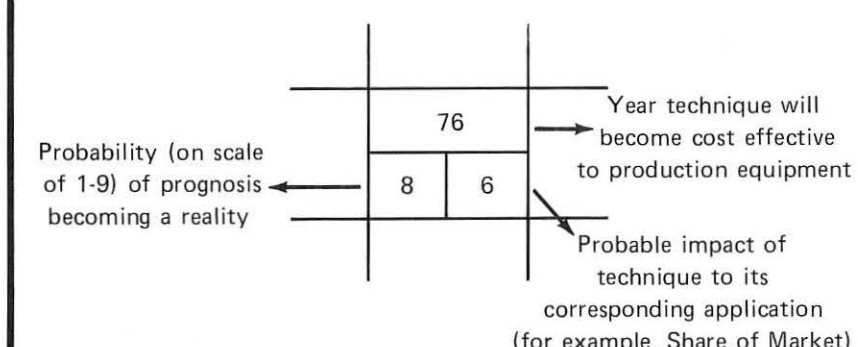



*Figure 1. Some Information Display Long-Range Technology Forecasts — Continued*

- Low-cost, fast selective erase variable storage time CRT capable of data readout to significantly reduce cost of graphic man-machine CRT terminals.
- Low-cost fast mass memory ($10^7$ bits, 300 Hz bit rate) provides basis for low-cost TV CRT graphic terminal.
- Teleprinters will commonly be supplanted by CRT's (cathode ray tubes).
- An inexpensive alphanumeric terminal (with limited graphic capability) will revolutionize this field at about $1K per terminal.
- Telephone couples soft copy capability can be commonly used for information retrieval & presented to the individual viewer.
- 3-D replication of moving objects will be technically feasible.
- Development of effective solid-state laser deflection techniques.
- A solid state, thin, large screen display device will be in general use as a TV display.
- Holographic techniques may compete with and/or supersede the use of TV consoles for man/machine interface.




**As shown, responder felt that there was an 80% chance that a particular technique could be used for a particular application, and that the technique would provide 60% of the devices for that application.**

*Figure 2. Naval Electronics Laboratory CenterForecasting Matrix*

*TABLE 1*
*Some Long Range Technological Forecasts Involving Information Displays*

*From:* "The Year 2000"
By Herman Kahn and Anthony J. Weiner.
The MacMillan Company,
New York, N.Y., 1967

- Three-dimensional photography, illustrations, movies, and television.
- Extensive and intensive centralization (or automatic interconnection) of current and past personal and business information in high-speed data processors.
- Inexpensive design and procurement of "one of a kind" items through use of computerized analysis and automated production.
- Practical use of direct electronic communication with, and simulation of, the brain.
- Automated universal (real-time) credit, audit, and banking systems.
- Practical home and business use of "wired" video communication for both telephone and TV . . . and rapid transmission and reception of facsimiles (possibly including news, library material, commercial announcements, instantaneous mail delivery, other printouts, and so on).
- Home education via video and computerized and programmed learning.

informed technological forecasts, coming from government study groups, "think-tanks", consultants, and professional societies. On the whole, do they have much more validity than some of the forecasts we are used to finding among our various science fiction writers? Certainly as an engineer turned marketeer, I would hope so. However, I know of few long-range forecasts that were as correct as the classic atomic bomb story that got ASTOUNDING science fiction magazine in so much trouble during World War II!

### Market Forecasts

It appears that in our marketing oriented culture, there is very little difficulty in getting a market forecast for almost anything you want to consider . . . and certainly Information Display is not an exception.

There are a number of ways in which these forecasts can be made. Some are based on analyzing applications and predicting the number of devices that can be used for these applications. Others are based on interviews with prospective users. Still others depend on various kinds of demographic data bases with projections based on the number of devices that could be used in each of these environments. Others are based on counting an existing market which can be replaced by a new device.

For example, consider the application approach. One writer, several months ago, estimated that there would be some 4,000,000 data terminals in use by 1980 for applications as shown in Table 3. Assuming that forecast and distribution is correct (although you have the right to ask how he arrived at that particular distribution for a time period ten years from now), one could look at his own information display device and decide upon its appropriateness for each of the applications; and then make an estimate of what percentage of that part of the market could be captured. As an example, assume one makes the assumption that his alphanumeric CRT terminals can be used in information services. According to Table 3, there will be 800,000 such terminals in use by 1980. Therefore, if he can capture only 1% of that projected market,



he has a prospect of selling 8000 terminals . . . and if he figures that his units are worth $2000 a piece, he is looking at some $16,000,000 over the next nine years.

### Use of Interviews

It is also possible to establish a potential market by conducting interviews with knowledgeable users. One company that did that concluded that the current CRT population is about 130,000 units and that can be expected to grow at about 20% per year over the next few years. I might comment that such projections are not very precise (perhaps not unexpectedly so) because other similarly qualified researchers talk about a current CRT terminal population ranging from 75,000 now and going to 240,000 by 1976. Another market research group says that by 1975 there will be approximately 258,000 CRT terminals installed, about three times as many as there are currently being used. Incidentally, just to round out the CRT terminal picture, at least one other research service claims that by 1975 there will be 85,000 high quality CRT terminals installed (of which 30% will have been sold by independent manufacturers) and that there will be about 50,000 low quality terminals installed (of which half will have been sold by independent manufacturers).

### Magazine Prediction

On a dollar basis, one group recently reported that there are now $6 million worth of low cost graphic terminals and $20 million worth of high cost graphic terminals installed, with the value of the installations to grow to $55 million and $60 million, respectively, by 1975.

As you can see, one can expect a rather wide range of forecasts presumably covering the same devices

The data base technique is a fairly interesting and perhaps valid way of projecting growth. For example, several years ago, one of the trade magazines projected that there would be about 210,000 computers installed by 1975 and 355,000 by 1980. Incidentally, they also estimated that there would be about 110,000 installed by the close of 1970, compared with the results of the Computers and Automation Monthly Computer Census (February 1971) which lists about 50,000 installed by the end of 1970. However, the significance of that kind of a data base is that the magazine went further and based on studies made about five years ago, said that there would be an average of 0.3 displays per CPU. In other words, the display population was being projected based on a predicated ratio and predictable data base. Incidentally, this kind of data base calculation points out one other problem. That is, the comparison of units and dollars. For example, one consultant also makes predictions about the computer population, except that he does it in terms of dollars. He says that there were $1 billion worth of computers installed in 1960, $12 billion installed by 1970, and probably $27 billion installed by 1975. By 1975 about 2,000,000 terminals would be in use, of which 700,000 of these will be CRT units. Incidentally, this same consultant estimated that there were 75,000 CRT units installed in that environment at the end of 1970.

#### Conflicting Forecasts

Based on these various kinds of projections, a wide variety of often conflicting market forecasts have been developed. A few of these various forecasts are summarized in Table 4.

Finally, another fairly common technique for market forecasting is to identify specific devices that the unit one is interested in can replace. For example, one can identify that there are about 500,000 key punch units presently installed, if your device can potentially replace a key punch unit, then the potential market for your unit is 500,000.

Incidentally, where does this kind of data come from? Market projections are frequently reported in the trade press.

There are also a number of servives that prepare specific market forecasts on the speculation basis and sell these as individual reports or on a subscription basis for typically $200 to $300 per report.

Finally, there are companies that are quite anxious to do customized market surveys in the information display field, either for a single client (where the cost of the survey can be in the tens of thousands of dollars), or on a multiple client basis where the cost per client will be in the order of $3000 to $10,000.

How accurate are these studies? An extremely difficult question to answer. Perhaps your experience has followed mine, where some of the researchers interview you, telling you that your estimate will be combined with many others in order to reach a composite opinion. They kindly send you copies of the report and, as you review the figures, you find either that your guesstimate was extremely well-informed since it matches the report's conclusions . . . or more probably, you were the only one they talked with.

It seems to me that the only generalization that one can safely make about market forecasts is that you can get one from almost anybody, and you can find one that can prove almost anything you want proved!

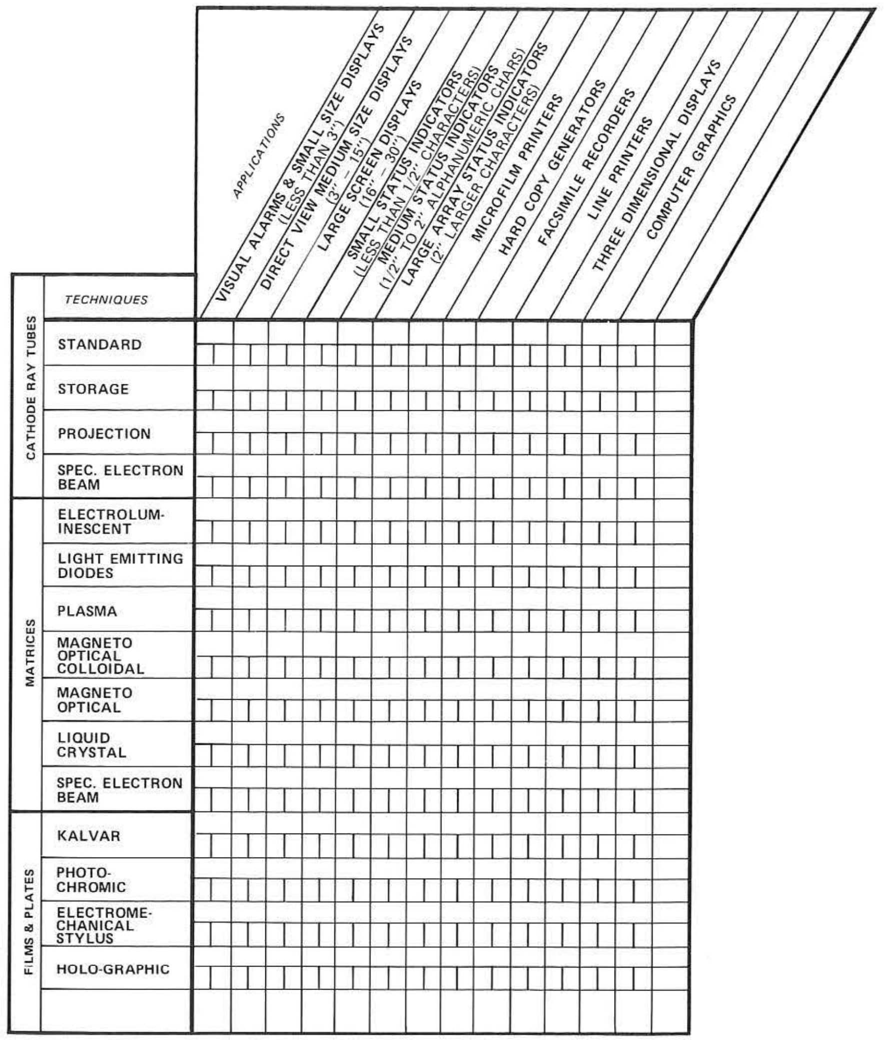



*Table 2. Information Display Technique/Application Forecast*

**TABLE 3**
***Distribution of Data Terminals in 1980 by Application***

| *APPLICATION* | *% TOTAL* |
|---|---|
| Computer Time-Sharing | 14 |
| Information Service | 20 |
| Facsimile | 28 |
| Health Care | 9 |
| Plants/Warehouse | 4 |
| Sales Offices | 9 |
| Retail Point-of-Sale | 16 |
| | *Total Units*: 4,000,000 |

Estimate By:
Alberto Socolovsky, Editor ELECTRONIC ENGINEERING Magazine (before EIA Meeting, Washington, D.C., as reported in PERIPHERALS WEEKLY, 11 March 1971)

**TABLE 4**
***Information Displays Representative Market Forecasts***

1. *INFORMATION DISPLAYS (TOTAL)*
   a. Estimated growth — 30%/Year
   b. Present and forecasted market

| | *Units Installed* | *Sales* |
|---|---|---|
| 1970 | — | $1,000,000,000 |
| 1975 | — | $2,000,000,000 (+) |

2. *CATHODE RAY TUBES (CRT)*
   a. Estimated growth — 25%/Year
   b. Present and forecasted market

| | *Units Installed* | *Sales* |
|---|---|---|
| 1970 | — | $20,000,000 |

3. *CRT TERMINALS (including Alphanumeric & Graphic)*
   a. Estimated growth — 20%/Year
   b. Present and forecasted market

| | *Units Installed* | *Sales* |
|---|---|---|
| 1970 | 75,000 — 130,000 | $425,000,000 |
| 1971 | 120,000 | $800,000,000 |
| 1975/76 | 135,000 —700,000 | $190,000,000 — $1,000,000,000 |

4. *CRT GRAPHIC TERMINALS*
   a. Estimated growth — Low Cost 70%/Year
   High Cost 33%/Year

| | *Units Installed* | *Value of Installed Units* *Low Cost* | *High Cost* |
|---|---|---|---|
| 1970 | 2,000 | $ 6,000,000 | $20,000,000 |
| 1975 | 10,000 | $55,000,000 | $60,000,000 |

5. *COMPUTERS*
   a. Estimated growth — 15%/Year
   b. Present and forecasted market

| | *Units Installed* | *Sales* |
|---|---|---|
| 1970 | 50,000 — 110,000 | $12,000,000,000 |
| 1973 | 82,000 | — |
| 1975 | 210,000 | $27,000,000,000 |
| 1980 | 355,000 | — |

6. *DATA TERMINALS (General, including CRT, Digital, Plasma & Other Information Display plus Electromechanical)*
   a. Estimated growth – 40%/Year
   b. Present and forecasted market

| | *Units Installed* | *Sales* |
|---|---|---|
| 1970 | 127,000 | — |
| 1972 | — | $ 860,000,000 |
| 1975 | — | $4,500,000,000 |
| 1976 | 900,000 (shipped) | — |
| 1980 | 3,300,000 | — |

#### One Forecast . . .

I have tried to do some cross checking of various market forecasts. As an example of what I would consider to be fairly typical results, I would like to cite the projections published by Electronics Magazine over the last several years.

Each year, Electronics Magazine makes a forecast for the total electronics market, typically dividing their projections into the categories of Federal Electronics, Industrial Electronics, Consumer Electronics, and Replacement Components. As most of the information display technology tends to fall within the Federal Electronics or Industrial Electronics classification (although that comment may be inaccurate), I thought it would be interesting to examine how the forecasts varied from year to year, and how the forecasts compared with actual results. Figure 3 plots the Federal Electronics forecast made by Electronics Magazine in 1963, 1966 and 1968; while Figure 4 shows the same data for Industrial Electronics.

#### . . . And Another

With respect to Federal Electronics, the 1963 forecast for 1965 was 30% high when compared to actual 1965 results, and for 1967 was 13% high when compared to actual 1967 results. The 1966 forecast for 1967 was 2% low when compared to actual 1967 results.

With respect to Industrial Electronics, the 1963 forecast for 1965 was 20% low when compared to actual 1965 results, and for 1967 was 24% low compared to actual 1967 results. The 1966 forecast for 1967 was within 1% of the actual

1967 results. Based on these comparisons, I believe these forecasts were remarkably good.

Further, I consider that Electronic Design has great courage in publishing forecasts which cannot be conveniently forgotten the following year!

**Conclusions**

It is a great boost to one's ego to pontificate . . . and project the growth of technology and markets over the next five to ten years. It is easy to generalize, and, for example, project that every home will have some kind of an information display terminal within the next fifteen years. Using present TV installations as a guide, one could argue that the information display market over the next fifteen years is in the order of 100,000,000 units!

But the proof of the pudding comes when you must make hard business decisions . . . and hard professional decisions . . . based on these forecasts. Where is a company to invest its money? Where is an individual to direct his professional efforts? The answer in the real world is that we are forced to make binding decisions based on incomplete information, and that's where the accuracy of forecasting becomes critically important. Many companies use this data . . . (because there isn't anything else) . . . to play the stimulating game of "you bet your company!" If you have followed reports in the business press, you know that companies like Viatron and Cogar invested literally millions of dollars to develop devices for which enormous markets were forecasted . . . but to-date, have been able to sell only a million dollars worth more-or-less. On the other hand, the stories are legion . . . the computer industry being a prime example . . . of forecasters predicting a limited market for a device which immediately scores a huge success.

If these conclusions are unsettling, then perhaps I have accomplished several objectives . . . to cause you to critically examine any market forecast . . . to seek consensus . . . and to generously apply your own good judgment. ●

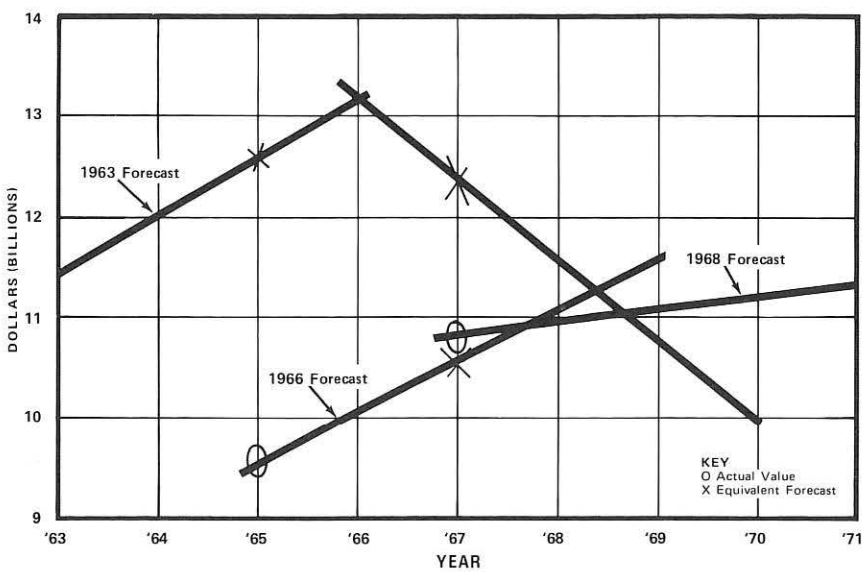
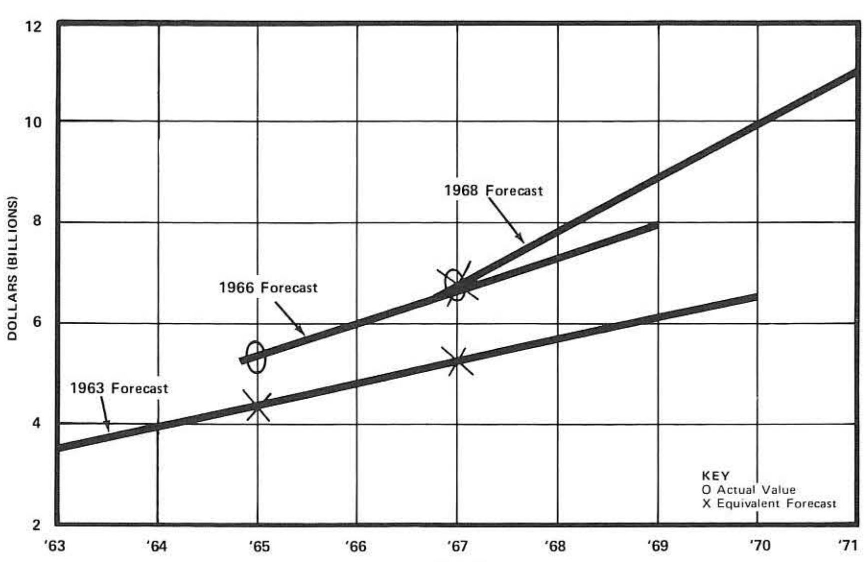



*Figure 3. Federal Electronics Market*




*Data adapted from "Electronics" Magazine 1963/1966/1968 Electronics Markets Section*

*Figure 4. Industrial Electronics Market*

## ACM '72

The 1972 National Conference of the Association for Computing Machinery will be held in Boston next August 14-16. Sessions on all aspects of computer technology, both hardware and software, and on many of its applications, to fields such as business, medicine, engineering, and education will be presented.

For information contact ACM 72, c/o Carol Goltner, P.O. Box 73, Lexington, Mass. 02173.

## Keypunch Still A Major Factor

Despite predictions that keypunches are all but disappearing from the data entry scene, a study just released by International Data Corporation estimates that almost half of today's 524,000 data entry units are still keypunches and that the total number will continue to grow, exceeding 263,000 by the end of this year.

This continued dominance by keypunches will be based on increased installations of 80-column buffered models and the 96-column buffered keypunch for use with IBM's System/3 computer. The unbuffered 80-column units, meanwhile, have already began to disappear.



# Huntsville SID Community Series

The Huntsville chapter of the Society for Information Display is offering a lecture series to the community. The series was initially developed for, but not limited to, high school and college students. The intent is to make available a comprehensive series of progressively more technical lectures that describe theory, technology and methods used in "Communicating With The Computer." The work was done in the interest of community and self-development.

This effort should provide a vital industry/professional channel to our young people as well as better prepare them for the technological requirements they will surely face in the future. Learning to communicate with these young people will certainly be more important than their possibly learning to communicate with a computer but the objective as a community minded professional organization (of engineers, scientists and programmers) is to accomplish both.

The lecture series was designed to describe the computer, identify its role in our society and provide insight into what is felt to be the most promising form of trying to communicate with it. It is a challenge to SID members to present the lectures and the usually dry material in an attractive manner. Further development of this series will employ every means attainable to accomplish the objective: slides, films, flip charts, hands-on equipment demonstrations and eventually actual classroom construction of a model computer.

The first run of this series entitled "Communicating with a Computer" was presented at Grissom High School in December, 1971, and from all appearances, met with considerable success. Students, teachers and the principal reacted very favorably. U.S. Senator John Sparkman was able to visit for the demonstration portion of the program and cited his pronounced pleasure at the efforts between professional and community interest in accomplishing such a necessary and worthwhile project.

The society was able to conduct this series due in no small part to the assistance of its various membership, outside help and the gratuitous consent of NASA in use of its equipment and facilities. It is felt that this will be a very important role for NASA in the future: that of sharing aerospace technology with society.

The series was presented in five one hour lectures:

1. Communicating with the Computer (Introduction and Definition)
2. The Psychology of Information Displays
3. Component of a Computer System
4. Computer Programming
5. Application and Use (Demonstration)

This lecture series introduces the computer and defines how the computer is useful in processing information. It defines what is meant by information and what its current role is in society. Some insight must

**symposium program p.14**

be provided as to what job the computer is doing and how it can do this job in the future. This is why communicating with the computer is so important.

In an effort to move closer to the community, the chapter fostered the idea in working with its membership and the City Board of Education, designed the lecture series to be presented first in a pilot form for a selected math class at Grissom High School in Huntsville. The chapter is composed of interested computer professionals in this area. The idea of sharing their technology with todays young people was felt to be key in understanding people and our community and how that the understanding of computers might lead to the more effective use of our young peoples talent as they grow to take the burden of leadership.

The Huntsville chapter of the Society for Information Display is a member chapter of the southeastern region. The Southeastern Regional Director of the Society for Information Display is Mr. Stewart A. Finley of Huntsville. Mr. Finley works at the NASA Computation Laboratory at Marshall Space Flight Center. He has been a key to the success of S.I.D. activities in Huntsville and the success of this lecture series in particular. He also served as lecturer for two out of five of the presentations. His patience and personal efforts cannot be too greatly applauded. The Chairman of the Huntsville organization is H. K. Johnson, Vice Chairman: Mr. Jim Kennedy, Secretary: Mr. Bill Peek, and Treasurer: Mr. Carl Wright. The head of the Steering Committee directing effort for this lecture series was Mr. Tom Rowan. Members to be noted for special effort and contributions to this series are Mr. Lewis Amis and Mr. Ray Sparks. The Principal of Grissom High, Dr. Davis, and special guest visitor U.S. Senator John Sparkman were so favorably impressed with student response and the potential of this experience that the students were given the rest of the day (several hours) to experiment with the display.

The Huntsville chapter of S.I.D. was of course pleased with the results of their effort and is currently entertaining requests for other presentation of its new lecture series.

—H. K. "Bud" Johnson





## SID Membership Committee

Each member of SID should consider himself an extension of the Membership Committee, helping to motivate qualified people to join the Society for Information Display, after having renewed your own membership in a timely manner. Chapter Chairmen were recently encouraged to appoint Membership Chairmen to initiate and coordinate recruiting of new and renewal of present members.

We solicit assistance from members in encouraging their organizations to consider sustaining membership in SID and to suggest other appropriate organizations for such membership. The present sustaining member organizations are listed on page 34.

Donald Cone, Chmn.

## SID Program and Chapter Formation

Speakers' Bureau—Over the past few years various SID Chapters and National Meetings had an opportunity to hear presentations from a vast number of speakers. Many individuals have created much excitement and interest because of the topics they discussed or because of their unique means of presentation. SID is considering ways in which presentations from such outstanding speakers can be shared among the chapters.

To pursue this idea a letter was sent to all SID officers, directors, committee and chapter chairmen. An interesting response was received to the mailing providing a long listing of potential speakers and topics of interest. From this response a Speakers' Bureau list will be formed. In some cases the availability of the speaker simply will be made known to the chapter. In other cases, the Society may take the responsibility, in conjunction with the Chapter, for scheduling a particular speaker among several chapters.

The proposed Speakers' Bureau is planned as a service to the individual Chapters. The National Office has no intention of imposing programs on the Chapters, but rather to offer a service the Chapters may wish to take advantage of.

Carl Machover, Chmn.

# NEW PRODUCTS

SID SID SID SID

## Scan Converter

A miniaturized scan converter, designed for video data processing in a wide range of information display applications, has been introduced by Hughes Aircraft Company's industrial products division in Oceanside, Calif. The new unit, designated Model MSC-1, offers high speed and high resolution, as well as selective erasure and rewriting capability. It utilizes the Hughes Type H-1268A vidicon-size scan converter tube.


Basic functions of the MSC-1 are to write and store externally originated video information—both sequentially (raster) scanned or randomly positioned—in the scan converter tube, and to read out the stored video pattern in 525/625-line, 2:1 interlaced raster format, suitable for display on conventional television monitors.

By making the proper internal circuit adjustments, the unit can be made to operate in a variety of ways, including 525/625-line TV signal input/output, PPI - to - TV scan conversion, picture freeze, alphanumerics and/or graphics storage with selective update, superpositioned TV pictures and XY-positioned data, and XY-positioned READ output.

Resolution of the new unit is greater than 700 TV lines per target diameter, writing speed is less than 30 microseconds per scan line (or 25 nanoseconds per dot), and erase time is less than 300 milliseconds to 5 percent residual for a fully-inscribed square. Gray scale is comparable to broadcast TV, and storage is adjustable up to 25 minutes typical, continuously read.

Model MSC-1 operates from 90-260 volts, 50/60Hz, and requires approximately 65 watts power. Dimensions of the standard desk-top enclosure are 8½x4x11, thus permitting two units to be installed in a standard 19-inch rack. Weight is approximately 12 pounds.

Circle #102 on Readers Service Card

## New Photometer

New "Spectra"® Model 1980 Pritchard™ Photometer features: full-scale sensitivity from 0.00001 to 10,000,000 ($10^{-5}$ to $10^{7}$) foot-lamberts; Auto-Comp™ direct digital readout; and precision measurement of luminance from 0.001" to infinity with complete freedom from polarization error. A large, bright viewing field adjustable from 4X to 20X is said to permit easy targeting, while built-in apertures allow selection of measuring fields ranging from 2 minutes to 3 degrees.

Circle #101 on Readers Service Card

## Power for CRT

For CRT displays, the series 4000 is a low-cost, compact, high voltage, all solid state multiple output CRT power supply. The supply is a DC to DC converter which operates from 28VDC and is capable of delivering 15kV @ 200$\mu$A, .1 to 1kV for G2 and —50 to —200V for G1. The supply is short circuit and arc-over protected. In addition, the input is reverse polarity protected. Anode pk-pk ripple or line regulation is specified at .1%; load regulation is 0.05%. The HV portion of the unit is fully epoxy encapsulated and the package size is 2" x 4" x 5.5". The supply is furnished with CRT anode cable and edge connector for other output voltages and input power.

Circle #103 on Readers Service Card

## Accumulating Digital Printer

Veeder-Root's new Series 7726 accumulating digital printer records production for processing, inventory, and production control. It's ideal for cut-to-length applications.

This low cost printer/totalizer utilizes a conventional adding machine printing mechanism and standard adding machine tape. Integrated circuit electronics operate at up to 3 seconds per line from parallel BCD data input and is compatible with TTL, DTL, or unloaded RTL.

It has a full 7 column print capacity and 8 columns for totalizing. Totals print in red. Tape and ribbon are easily refilled. The sturdy, lightweight case makes it ideal for desk top use.

Circle #104 on Readers Service Card



## TV for Textiles

A new color television system for the design and marketing of textile fabrics, the Graficolor 903, electronically produces full-color design combinations from cloth samples or gray scale artwork. The instant-changing color display presents a full gamut of color patterns —instantaneously—for presentation to customers and designers. A copy-camera can be provided to yield permanent records of the results.

Developed by "image expert" Spatial Data Systems, Goleta, California for the fashion/textile industry, this unique blending of electronic and television techniques, just introduced, is already creating an avalanche of color production "visuals" at many Eastern installations of a major textile manufacturer.

Applications appear evident in many other divergent industries and operations.

As keyboard created, split-second, display-screen pictures are processed from any input: black-and-white sketch, design, fabric, or other objects. Electronically mixed, matched and shown in individualized color treatments, or totally recreated in differing color combinations, the amazing capability of new Graficolor 903 includes a selection of over 320,000 differing colors.

Stunning fill-in background treatments (impossible to humanly achieve) may be added to a given design. Unrelated or weaker color or design elements may be dropped from the picture. In effect, the operator with the simple keyboard push-button and color wheel controls becomes the computer-painter, analyzing, experimenting or being directed as he goes; often achieving spontaneously spectacular arrays of finished "visuals" quite by accident. Under pre-arranged plan, sketch, or direction, of course, precise color translations also may be developed.

Circle #105 on Readers Service Card

## Indicator Lights

Industrial Devices, Inc., are now supplying Mini-Slide 3000 Series Indicator Lights with .187" and .060" terminals to facilitate wire-wrap connections. Available in round or rectangular styles, the lights mount in either a ½" round hole or a standard "D" shaped hole. Push-on speednuts are supplied.

Lights utilize miniature slide-base incandescent lamps. A complete line of these convenient high intensity lamps are available covering a wide range of voltages up to 120 volts and ratings up to 3 watts. The lamps are easily replaceable from the front of the panel and are energized by means of nickel plated contacts inside the socket. The indicator lights are designed to enhance the appearance of the equipment in which they are installed and they can be used under any ambient light condition. Lenses come in a variety of colors and are made of high clear polypropylene

or Pyrex caps each of which permit full 180° visibility, true color light and easy color indentification when the lamp is off.

Circle #106 on Readers Service Card

# new products

## Photoelectric Reader

Now being offered from Pivan Data Systems is a Tally R5000 Photoelectric Reader interfaced to Data General's Nova computers.


Designated as the *N105* this system is capable of responding to all paper tape reader (PTR) commands and loads programs fifty times faster than the Model 33 Teletypewriter while operating at 500 characters per second. The *N105* is compatible with standard NOVA software when in the forward incremental mode. Five additional modes of operation are available under program control. These are: forward slew, forward rewind, reverse incremental, reverse slew, reverse rewind. Operating speeds are 300 CPS for incremental, 500 CPS for slew, and 1200 CPS for rewind. Complete price for the N105 mounted on the N100 is available on request. Delivery is 60 to 90 days upon receipt of order.

Circle #107 on Readers Service Card

## Please Pass the SID

We'd like this issue of SID JOURNAL to get as wide circulation as possible. So, let your co-workers, maybe even your boss, read this issue.

# Activities

## Calendar

| | |
|---|---|
| **1972 —** | |
| May 9-11 | Spring Joint Computer Conference Atlantic City, New Jersey |
| June 6-8 | 13th International SID Symposium Jack Tar Hotel San Francisco, California |
| Oct. 3-5 | The USA-Japan Computer Conference, AFIPS Tokyo, Japan |
| Dec. 5-7 | Fall Joint Computer Conference Anaheim, Calif. |
| Dec. 8 | 5th Annual SID Technical Conference, San Diego California |
| **1973 —** | |
| May 1-3 | Spring Joint Computer Conference Philadelphia, Pennsylvania |
| May 15-17 | 14th International SID Symposium Statler-Hilton Hotel New York City |
| Fall | 6th Annual SID Technical Conference |
| Dec. 4-6 | Fall Joint Computer Conference San Francisco, California |
| **1974 —** | |
| Apr. 23-25 | Spring Joint Computer Conference Chicago, Illinois |
| May 21-23 | 15th International SID Symposium Town & Country Hotel, San Diego, California |
| Fall | 7th Annual SID Technical Conference |
| Nov. 19-21 | Fall Joint Computer Conference Anaheim, Calif. |

## Late Notes on SID Chapter Meetings

*Listed below are reports the SID office has received of chapter meetings in the past few months. Because of space limitation we can only provide an abbreviated report. However, for future issues of the SID Journal we'd like to receive not only your chapter meeting announcements, but also copies of photos taken and possibly a report on the success of your meetings.*

*We hope that the reports provided for this column will permit an interchange of ideas and information on topics which will aid and inspire other chapters to provide interesting and timely subjects and speakers. Please send all your future reports to the SID National office.*

### New England Chapter

Topic: Logan Airport Air Traffic Control Display Tour

Topic: Television Technology in Information Display and Related Advanced Media Systems. Speaker. Ken Lager

Topic: Project Intrex: Background and System Demonstrations. Speaker: Mr. Donald Knudson of MIT

### Delaware Valley Chapter

Topic: The Many Applications of Alphanumeric Displays. Speaker: R. C. Novak of IBM

### Mid Atlantic Chapter

Topic: Laser Beam Color TV Film Recorder. Speaker: Renville H. McMann of CBS Laboratories

Topic: Recent Advances Electroluminescent Display Device Technology. Speakers: Thomas Robinson and Kevin Kean of Astronics Corporation

### Los Angeles Chapter

Topic: Tour and Demonstration of Displays at the Ontario Motor Speedway. Speakers: Al Lansberger and Joe Thompson of Conrac

Topic: TACFIRE—Lecture and Demonstration. Speakers: Bill Ross and Bob White of Litton

Topic: Tour of Destroyer Escort, U.S.S. Lang at the Long Beach Naval Shipyard

Topic: Processing and Printing of Color Films—Presented by Alpha-Color, a subsidiary of Alfred and Fabris.

Topic: Real time Projection Display. Speaker: Dick Thoman of General Dynamics

### San Diego Chapter

Topic: Airborne Sensor Displays. Speaker: Gerry Slocum of Hughes Aircraft

Topic: Color Evoked Responses. Speaker: Dr. James I. Martin of NELC

Topic: Advanced Design in Color Film Cameras. Speakers: James Kimball and David Cooper of Cohn Electronics

Topic: NELC's Program in Biomedical Engineering. Speaker: Monns Turntine of NELC

### Bay Area

Topic: Multispectral Acquisition and Analysis Equipment for Earth Sciences. Speaker: Don Ross of International Imaging Systems

Topic: Electron Beams in Information Storage. Speaker: John Kelly of SRI

Topic: The Processing of Image Information. Speaker: Dr. Paul Roetling of Zerox

Topic: Cable Television. Speaker: Don Bennett of Sunnyvale Cablevision

### Good Word for the Day

ANDABATARIANISM

From Andaba'blind contention, gladiator used to fight with helmet over eyes.

*Andabatarianism* may be used to describe upper management of a company, blindly groping for solutions.



## Many New Members Given Welcome

The Society for Information Display welcomes the following new members:

Lennart V. Alfredsson, Sweden; John E. Anderson, Boulder, Co.; George Bayer, Jackson, Mi; Philip M. Blood, Los Alamos, N.M.; Raymond A. Brengs, Jr., Bethesda, Md.; Francis A. Brierly, Palo Alto, Ca.; James E. Bubash, St. Louis, Mo.; George K. Buck, New York; Dan M. Butler, Irving, Tx.; Robert C. Carter, Jr., Troy, N.Y.; Thomas H. Davis, Louisville, Ky.; Donald E. DeBlance, Dallas, Tx.; Roger K. DeBry, Salt Lake City, Ut.; Wayne Dietrich, Mt. Prospect, Ill.; Gerhard Dirks, Sunnyvale, Ca.; Lawrence W. Dobbins, Collingswood, N.J.; R. W. Dobles, Rochester, N.Y.; Donald R. Dobson, Lexington, Ky.; John D. Dure, Ottawa, Canada; Raymond L. Elliott, Los Alamos, N.M.; David W. Evans, Louisville, Ky.; Michael G. Florimbi, Paoli, Pa.; Roger Frankland, Beaverton, Or.; Barbro Friberg, Sweden; Donald S. Galbraith, Quebec, Canada; Eiichi Goto, Japan; Ernest L. Hall, Columbia, Mo.; Robert E. Hoffman, Mt. View, Ca.; Brian R. Holgate, Dallas, Tx.; John R. Hornsby, Australia; Koich Ichihara, Japan; Ronald A. Javitch, Montreal, Canada; Lou Katz, New York, N.Y.; Kengo Kawano, Pasadena, Ca.; Louis Kelem, Hillside, N.J.; Robert M. Kiendra, San Diego, Ca.; Jesse H. King, Orange, Ca.; Herman Koretzsky, Poughkeepsie, N.Y.; Jeannine Lamar, Santa Monica, Ca.; Les Levitan, Arlington, Va.; James Lime, Los Angeles, Ca.; William D. Luce, Las Vegas, Ne.; Richard L. McCutcheon, Silver Spring, Md.; Herbert G. McKenna, Phoenix, Az.; Brian P. Maloney, Paramus, N.J.; Leonard H. Manson, Jr., Metrairie, La.; Morton H. Marks, Oakton, Va.; Harvey Mendelson, New York, N.Y.; Roy H. Nakahara, Sun Valley, Ca.; Donald L. Neumann, Vicksburg, Ms.; Robert L. Olsen, East Meadow, New York; Andrew W. O'Sullivan, Sunnyvale, Ca.; Bala Parasuraman, Stanford, Ca.; John L. Patterson, Plainfield, N.J.; Jerry A. Pickering, Fort Worth, Tx.; Harold E. Pryor, Gaithersburg, Md.; William E. Rashford, Placentia, Ca.; John E. Robinson, Jr., Orange, Ca.; Harold W. Roper, LaPorte, Tx.; Charles Ruckstuhl, Jr., New Orleans, La.; Robert Rutherford, Pittsburgh, Pa.; Glenn A. Scharp, Salt Lake City, Ut.; Jay R. Schrand, Downey, Ca.; Betsy Schumacker, Cambridge, Ma.; John P. Shannon, Ottawa, Canada; Frank A. Sigmund, Akron, Oh.; Edmund E. Snuggs, Dallas, Tx.; S. C. Stephan, Houston, Tx.; Stuart P. Stone, Livermore, Ca.; Bernard J. Stortecky, Wilton, Ct.; Eugene Sturdevant, Wilmington, De.; John R. Sykes, Rochester, New York; Masamiki Takagi, Japan; Ted R. Thomas, Dallas, Tx.; Charles W. Turner, Alexandria, Va.; Masanobu Wada, Japan; Ronald H. Walecki, Hermosa Beach, Ca.; Gerald S. Walker, Aurora, Co.; Walter E. Weiss, La Canada, Ca.; Eric W. Wolf, Arlington, Va.; Arthur R. Yandle, Lafayette, La.

***Bernie Lechner (right) is shown receiving the Frances Rice Darne Memorial Award for his outstanding services to SID. Mr. Lechner received the award at the 1971 SID Symposium in Philadelphia.***

***Three SID members and the wives who insisted on following them to the Fall Joint Computer Conference (Las Vegas) last Autumn: From left: Mr. and Mrs. Phil Damon; Mr. and Mrs. Harley Bjelland (Harley is SID Publications Chairman); Mr. and Mrs. Erwin Ulbrich.***

***Meet your officers — In case you didn't get a chance to see who you voted for at the last election, here are the four SID national officers, congratulating one another on what a fine job they're doing: Dr. Carlo P. Crocetti, SID Vice President, RADC; Philip P. Damon, SID President, Hughes Aircraft; Erwin A. Ulbrich, SID Treasurer, McDonnell Douglas; Robert C. Klein, SID Secretary, Kollsman Instrument.***

## SID Sustaining Members

ALLGEMEINE ELEKTRICITATS—GESELLSCHAFT
AEG-Telefunken
Vorstandssekretaruat
6 Frankfurt/Main-Sud
West Germany
AEG Hochhaus

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

COURIER TERMINAL SYSTEMS, INC.
2202 E. University Drive
Phoenix, Arizona

DUMONT ELECTRON TUBES DIVISION
Clifton, New Jersey

FERRANTI ELECTRIC COMPANY
Plainview, New York

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

GML CORPORATION
594 Marrett Road
Lexington, Massachusetts 02173

HUGHES AIRCRAFT COMPANY
Culver City, California 90230

IBM CORPORATION
Armonk, New York

INFORMATION DISPLAYS, INC.
Mt. Kisco, New York

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

OY NOKIA AB ELECTRONICS
P.O. Box 10780
Helsinki 10, Finland

PHILCO-FORD CORPORATION
Palo Alto, California

RADIATION, INC.
Melbourne, Florida

RCA
Electromagnetic & Aviation Systems Division
8500 Balboa Blvd.
Van Nuys, California 91409

SIEMENS AG
Tubes Division
76 St. Martinstr
Munich, West Germany

SINGER-LIBRASCOPE
Aerospace & Marine Systems Group
Glendale, California

SYLVANIA ELECTRIC PRODUCTS, INC.
Seneca Falls, New York

SYNTRONIC INSTRUMENTS, INC.
100 Industrial Road
Addison, Illinois

TEKTRONIX, INC.
Information Display Products
P.O. Box 500
Beaverton, Oregon 97005

THOMAS ELECTRONICS, INC.
100 Riverview Drive
Wayne, New Jersey 07470

THOMSON-CSF
Paris, France

WEAPONS RESEARCH ESTABLISHMENT
Salisbury
Stores & Transport Branch
Pennington, South Australia

WESTINGHOUSE ELECTRIC CORPORATION
Electronic Tube Division
P.O. Box 284
Elmira, New York 14902

XEROX DATA SYSTEMS
El Segundo, California 90245

## Academic Committee

The information which follows was mailed to some 280 colleges throughout the U.S. and Canada:

One of the functions of SID is the dissemination of educational material. Accordingly, the enclosed outline is made available should you wish to offer a course in Information Display Systems. Notice that two textbooks are available for this purpose. The course is presently being offered at the Polytechnic Institute of Brooklyn and at Chico State College (California), but it is certainly possible that similar courses are also offered elsewhere.

The SID is also preparing a program under which financial support will be made available to students for research in Information Display.

Course Outline: *Information Display Systems*

1) Introduction to Display Systems
Photometry
Parameters of Vision
2) Colorimetry
Theories of Color Vision
Human Factors Parameters
3) Direct View CRTs
Color CRTs
Special CRTs
4) Lasers
Optics
5) Photographic Materials
Holographic Displays
6) Projection Systems
Electroluminescence
Matrix Displays
7) Analog Systems
Digital Systems
Special Systems
8) Consoles
Group Displays
Three-Dimensional Displays
9) Digital to Analog Conversion
Character Generators
TV Image Converter Equipment
10) Deflection Amplifiers
Special Circuits
Data Recording Techniques
11) Image Recording Media
Projection Equipment
Screens
12) Photometry Measurements
CRT Measurements
13) Electrovisual Measurements
Optical Measurements

Textbooks: Luxenberg & Kuehn, "Display Systems Engineering," McGraw-Hill Book Co., 1968

Sherr, "Fundamentals of Display System Design," John Wiley & Sons, 1970.

Dr. Sid Deutsch, Chmn.

## Advertisers