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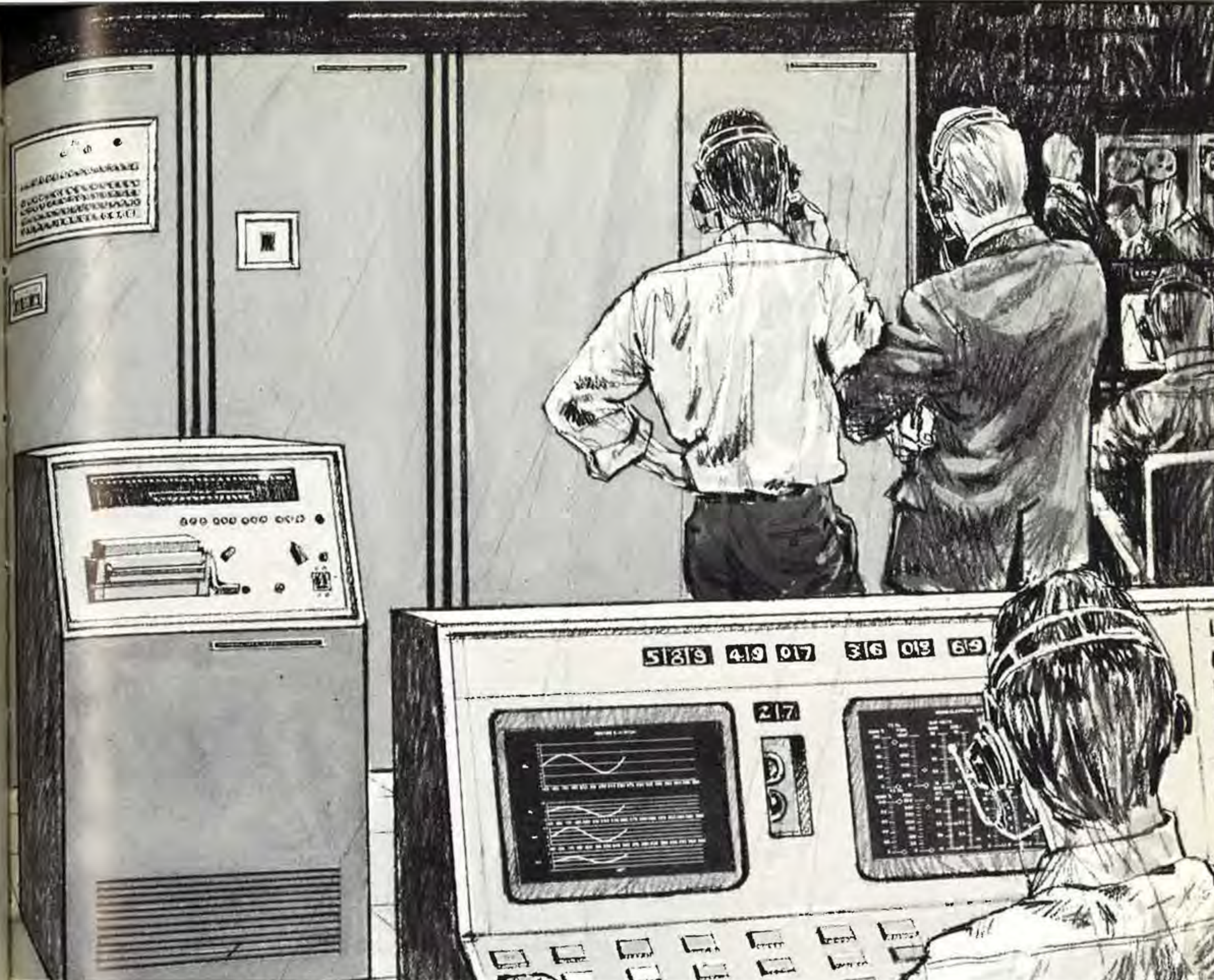
Information Display

Journal of the Society for Information Display



Announcing the S-C 1200...

NOW! Translate computer data into visual format for display on multiple TV monitors

The S-C 1200 display system produced by Stromberg-Carlson Corporation is a completely integrated equipment complex for translating digital data generated by computers into high resolution readouts. Data are presented on TV monitors, which may be operated at any number of remote locations. The technique makes it possible to present an essentially unlimited number of channels of information to each monitor. For example, digital data pertaining to a space launch may occupy one or more channels while video observation of the launch may occupy another channel.

Output may be sent to remote locations on standard TV transmission systems. Options available permit making microfilm or paper records of displayed data. The system may be modified to accept data from magnetic tape instead of on-line from a computer or to display data in a three-color format. Repetitious background data such as graph lines, maps, business forms, etc., may be superimposed on the tube image using a built-in film projector to save valuable computer time.

A complete S-C 1200 system consists of data distributor, buffers, display generators, video switching unit and TV monitors. Heart of the display generator is the CHARACTRON® Shaped Beam Tube. This unique cathode ray tube produces letters, numbers, symbols, lines and graphs of any kind on its face. The displayed information is transmitted by video camera to the TV monitors. Systems using these techniques have been installed in a major display system for the National Aeronautics & Space Administration's Manned Spacecraft Center in Houston, Texas.

If you are interested in systems for displaying computer data at a series of remote points, write for our brochure on the S-C 1200. Stromberg-Carlson Corporation, Dept. F-19, P.O. Box 2449, San Diego, California 92112.

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You can be sure if it's Westinghouse

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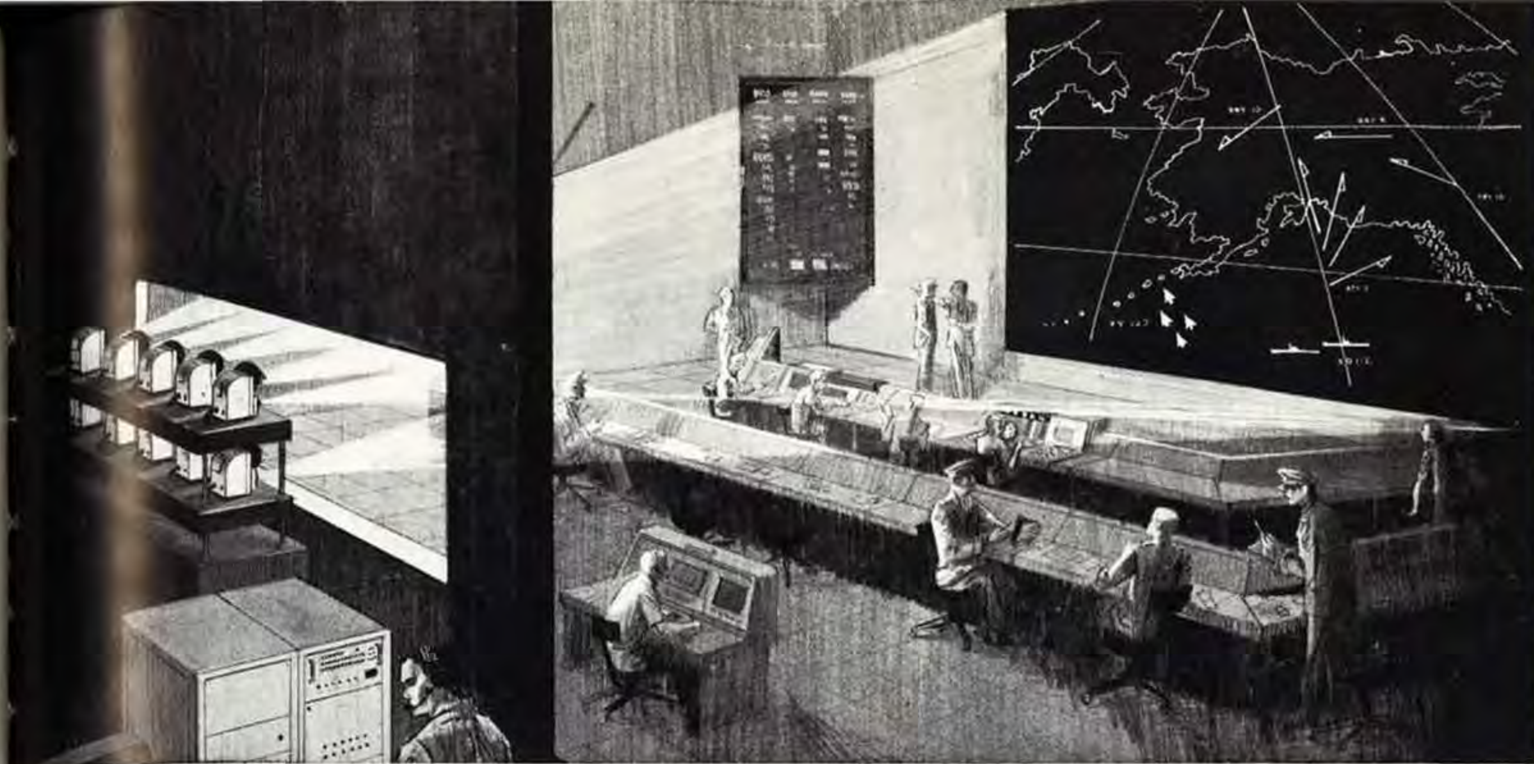

VOL. 2, NO. 1 JAN./FEB., 1965

Information Display

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ARTICLES

FEATURES

THE COVER

Designer's conception of computer-generated numeric and alpha-numeric displays, as depicted by *Information Display* artist, Howard Goldstein, portrays rapidly changing symbols on the faces of cathode ray tubes.

8 Years of life tests are part of the package

Complete verification of product claims is one of the things included in the package when you buy a Burroughs readout. We happen to feel it's the manufacturer's responsibility to prove his claims .... not the specifying engineer's.

That's why for 8 years Burroughs has been continuously testing and improving Nixie® Tubes. When you buy a long life Nixie Tube, you know we've had its counterpart operating continuously for over 50,000 hours. Our average life figures (600,000 hours) and MTBF figures (1,000,000 hours at 90% confidence level) are solid fact, proven over and over in our own plant, as well as in our customers' equipment. Those tubes haven't faded or failed partially, either .... they're bright as new (which of course means they're brighter than any other readout going).

And remember Nixie Tubes are smallest size, lightest weight, most readable and simplest to drive.

So don't check out your readout claims the expensive way. Just specify Burroughs Nixie Tubes .... they've been checked out for you.

Write for the new NIXIE Tube catalog.

Only Burroughs manufactures NIXIE Tubes.

Burroughs Corporation / ELECTRONIC COMPONENTS DIVISION
PLAINFIELD, NEW JERSEY

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Information Display

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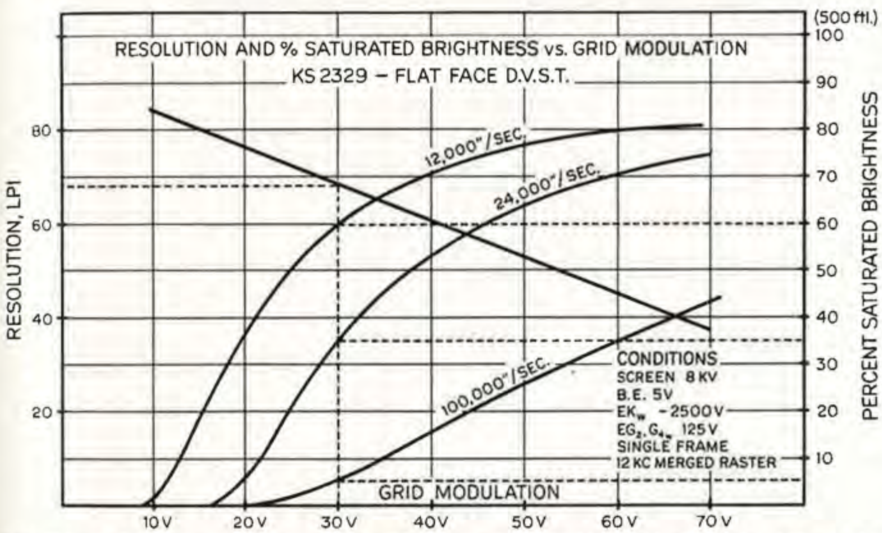
FAIRCHILD DU MONT TUBE TECHNOLOGY



NEW STORAGE TUBE SHARPENS TRACKING SYSTEM'S VISION

The newest generation of tracking and radar systems demands a new generation of direct view storage tubes with improved dynamic display uniformity and resolution capabilities. Du Mont engineers have taken on this problem with marked success.

Case in point: the storage tube originally specified for the PPI of a certain missile tracking system (not Du Mont) lacked center-to-edge uniformity of writing, erasing and brightness. The area at the center of the screen built up a disproportionately high signal charge level. This increased background brightness to the point of obscuring nearby targets. The condition could be partially compensated by increasing storage electrode bias, but this reduced sensitivity to remote weak targets displayed in the peripheral area. Another alternative, equally unsatisfactory, was to erase the image completely every two or three minutes. This left the system blind during the interval required for a complete antenna rotation.

The problem was eliminated by the storage tube Du Mont designed and built for this application. This tube, Type KS2329, achieves substantially uniform dynamic characteristics over the entire storage surface. Resolution capability—600 TV lines in the useful diameter—is 60% greater than that of the original tube. And, with no increase in length, a 12% increase in useful diameter (to 9") was achieved.

Reliability in severe environments was another requirement. So, with its integral mu-metal shield, the Type KS2329 is potted in a resilient, fungus-resistant compound, and is fitted with multiple pin locking connectors and rugged mounting lugs.

The final result was a significant advance in storage tube technology—or, from the customer's viewpoint, a tracking system with greatly improved vision. Now both strong and weak targets are displayed with excellent resolution, persistence and brightness. Additional features include internal feedback correction electrodes for high pattern geometry accuracy and zero DP current operation to overcome deflection non-linearities resulting from unpredictable collection of writing beam current and reflected flood beam current.

COMPACT PACKAGING

Another new storage tube developed by Du Mont packs unusual performance into a small envelope—and even that is designed to provide extra space for circuitry in the area around the yoke. This tube has a screen diameter of 5", overall length of only 8". Resolution is better than 125 lines/in.; writing speed is 300,000 in./sec. Since the tube has the same excellent integration characteristics as the KS2329, it is expected to find wide application as an indicator in airborne radars, or as a radar indicator and TV display monitor.

Other Du Mont storage tube developments include an on-axis writing gun. This considerable feat, never successfully accomplished in larger tubes, hinged on locating the flood gun or guns off-axis while retaining uniform illumination. The Du Mont tube does not depend on physical alignment to do this. Instead, three off-axis guns are used with split anodes which direct the beam from each toward or away from the tube axis. Uniform illumination is achieved, the write gun is located on-axis—and the DVST can replace a CRT with no change in deflection components.

CUSTOM DESIGN OR OFF-THE-SHELF

Over the years, the solution of many individual tube problems has resulted in the availability of more than 4,000 types of Du Mont tubes. These fall into four general categories: Cathode-ray Tubes, Photomultiplier Tubes, Power Tubes and Storage Tubes. The latter includes both direct view and electrical output tubes. If you need a special purpose tube, you'll probably find it listed in the latest Du Mont tube catalog. If it isn't, we will design and build it for you. For your copy of the catalog, write (letterhead, please) to Fairchild-Du Mont Laboratories, Dept. 7B, 750 Bloomfield Ave., Clifton, N. J.

FAIRCHILD
DU MONT LABORATORIES
ELECTRONIC TUBE DIVISION

Circle Reader Service Card No. 8

IN YOUR OPINION, HOW WELL DOES THIS CHECK LIST FOR SELECTING READOUTS STACK UP?

☐ **A READOUT MUST BE READABLE.** No ifs or buts about it. Legible presentation of the message is a readout's only mission.

☐ **IT MUST PROVIDE DISPLAY VERSATILITY.** You should be able to select the message medium best suited to your needs: letters, numbers, words, colors, symbols, or a combination of any of these.

☐ **WIDE VIEWING ANGLES.** The operator can't be chained to his post. A good readout should be readable from fairly wide angles to permit freedom of movement.

☐ **PROPER BRIGHTNESS / CONTRAST RATIO.** The two should work together to assure crisp, legible display under varying ambient light conditions, without eye fatigue.

☐ **DISPLAY CHARACTERS MUST BE FAIL-SAFE.** A readout using shared character segments can give a wrong reading if one of the segments fails. It's much safer when the readout indicates trouble by showing no message at all.

☐ **VARIETY OF CHARACTER SIZES.** Why marry your designs to one or two sizes? The readout you select should provide the height character you require, from 1/16" to 3⅜"

☐ ______________________
(You add one)

☐ ______________________
(One more)

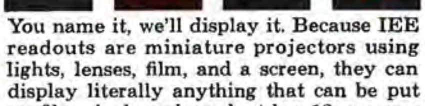
If this seems like a reasonable list of reasons to specify just about any readout, you'll be interested in an equally reasonable list of reasons to specify IEE readouts.

HERE ARE AT LEAST TEN GOOD REASONS TO SPECIFY IEE REAR-PROJECTION READOUTS. TAKE YOUR PICK.

GOOD REASON 1: SINGLE-PLANE PRESENTATION

IEE rear-projection readouts display the required messages, one at a time, on a non-glare viewing screen. Only the message that's "on" is visible for visual crispness and easy readability.

GOOD REASON 2: INFINITE DISPLAY VERSATILITY



You name it, we'll display it. Because IEE readouts are miniature projectors using lights, lenses, film, and a screen, they can display literally anything that can be put on film. And, *each* readout has 12 message positions which may be used singly or in any combination to display letters, words, numbers, colors, symbols.

GOOD REASON 3: MOST READABLE CHARACTERS

Since we can put anything on film, our readouts may be ordered with any style characters, Mil Spec or otherwise, you specify. Human factors studies have shown that
and
are the character styles providing the optimal stroke/width/height ratio for good legibility.

GOOD REASON 4: BALANCED RATIO OF BRIGHTNESS TO CONTRAST

It's not enough to display bright characters! Excessive brightness in itself leads to eye strain. On the other hand, a character of comfortable brightness displayed against a dark, glare-free screen is actually more readable than a glaring filament against an illuminated background.

GOOD REASON 5: WIDE-ANGLE READABILITY

The combination of single-plane projection, flat viewing screen, proper ratio of brightness to contrast and big, bold characters offers wide-angle readability and longer viewing distances.

GOOD REASON 6: CLARITY IN HIGH AMBIENT LIGHT

IEE readouts remain readable in brightly lighted surroundings, with no filters, screens, or shades required. Equally important, our readouts may be dimmed in dark areas for greater eye comfort.

GOOD REASON 7: FAIL-SAFE CHARACTERS

False indications are impossible with IEE readouts. Failure of a single lamp is detected in an instant, and just as rapidly replaced without tools of any kind. The commercial or MS lamps used provide up to 30,000 hours of operation per lamp; the rest of the readout has no moving parts, hence, offers unlimited unit life.

GOOD REASON 8: EASY TO OPERATE

IEE readouts are available with voltage requirements from 6 to 28 volts, depending on lamps specified. Operate from straight decimal input or driver/decoders with low current levels are available to accept conventional binary codes. Additional internal translation is not required.

GOOD REASON 9: SELECTION OF MAXIMUM CHARACTER HEIGHTS

IEE readouts come in four sizes to supply maximum character heights of ⅝", 1", 2", and 3⅜". The smallest readout has an effective viewing distance of up to 30 feet; the largest can be read from 100 feet away!

GOOD REASON 10: We are one of the largest readout manufacturers. That's because our rear-projection readouts do their job better than any other readouts. All of our customers feel the same way. Let us demonstrate our readouts for you—you just might feel the same as our customers do.

CIRCLE OUR READER SERVICE NUMBER OR WRITE DIRECTLY TO US. WE'LL SEND YOU ILLUSTRATED LITERATURE, AND IF YOU PERMIT, WE'LL ARRANGE A PRODUCT DEMONSTRATION AT YOUR CONVENIENCE.

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Circle Reader Service Card No. 9

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EDITORIAL

AIMS AND OBJECTIVES OF SID REVIEWED AT SECOND ANNIVERSARY

January 14, 1965 marked the second anniversary of the signing of the articles of incorporation of the *Society for Information Display*. The principal purposes of the Society, as stated in the by-laws are:

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

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

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

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

In its two years of existence, the Society has fulfilled at least some of these objectives, with four national symposia, published proceedings of those symposia, an informal newsletter, the *SID* Readout, and now, the Journal. A committee for definitions and standards has been established, and repository plans are being formulated. Support is being provided to several universities in establishing courses in the information display field.

During this time it has grown into an impressive-sized organization, with ten sustaining members and four active chapters throughout the country. Membership provides the benefits of free copies of all *Society* publications and reduced fees for symposium attendance. With your continued support the Society will continue to fill the information gap in the information display field.

H. R. LUXENBERG
Past President, SID

Currently Staff Assistant for Information Display to the Director of the Information Technology Laboratory of The Bunker-Ramo Corporation, Canoga Park, California, and Instructor, Physical Sciences Extension, University of California of Los Angeles, Dr. Luxenberg was one of the founders of SID, which had its origins in a series of summer short courses on Informatoin Display given at UCLA in 1961, 62, *and* 63.

Previously, he was Vice President and Dir. of Engineering at Houston-Fearless Corp.; Manager, Display Dept., Ramo-Wooldridge Corp.; Manager, Computing Center, Litton Industries; Head Simulation and Analysis Group, Remington-Rand UNIVAC Division; and (1951-52) *Research Physicist, Hughes Aircraft Co.*

From 1942-45, *Dr. Luxenberg served as Weather Officer and Instructor in Meteorology, in the Aleutian Islands.*

His computer experience ranges from operation, checkout and maintenance of the Natn'l Bureau of Standards Western Automatic Computer to programming, logical design, system analysis and simulation for many command and control systems. He has recently been concentrating on problems of image enhancement, data display and data storage and retrieval.

A LOOK AT FUTURE MANAGEMENT DATA DISPLAY TECHNOLOGY

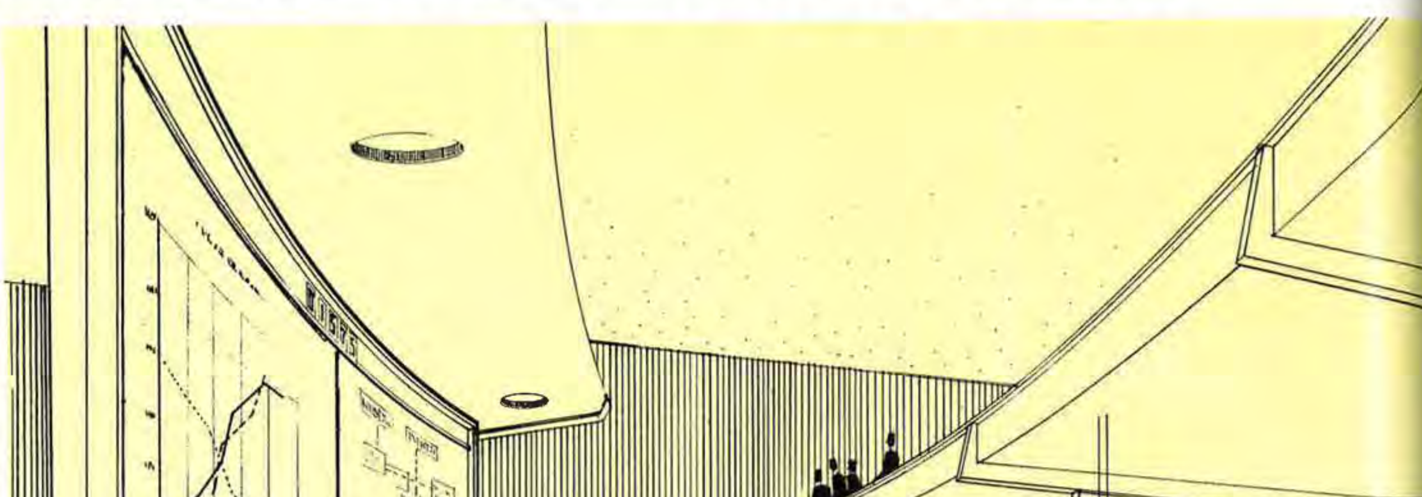
by Raymond E. Bernberg

Introduction

The purpose of this paper is twofold. Data Display Technology is discussed at some length and, also, the general background of management control systems as an analysis of future management data display technology. The purpose is to understand the breadth of the problems which are associated with and attendant to the development of such future technology. A discussion of Display Technology of the future must encompass technical areas associated with the performance of such display systems.

If we are to define management data display systems in a rather broad and extensive manner, we would cover the areas of concern associated with many systems involved in monitoring data of three categories: indirect non-strategic, strategic, and tactical. For example: the Defense National Communications Control Center and the Area Communications Control Center systems of the Defense Communication Agency handle data of a primarily management nature. The data of these systems are optimal output presentations for the purposes of controlling and optimizing the international networks of communications systems of the major military services and other government agencies; that is, the data presentations are not tracks of intruder weapon systems; they are not positions of ships or submarines. The data are the status of the conditions of the circuits, trunks, etc., of relay stations and other relatively important communications conditions throughout the world which permits traffic routing, traffic analysis, etc. Basically, this is definitely a management system. There are other things such as the 473L program which provides a generalized condition of data presentation for broad management requirements of the Air Force Headquarters, whereby a knowledge of where and to what degree the resources and capabilities of this military service are available. This I cannot discuss at length, but you can see that there may be strategic consequence of the data itself, just as with the Defense Communications Agency; which in essence is a management data system.

There are other examples, such as the Damage Assessment Center which is a DOD agency. It provides a very strong management function in the assessment of damage due to nuclear and other kinds of associative catastrophes and, although again they may have strategic consequence, basically they are providing a management function rather than a commission of weapon systems to military strategy or tactics. Many



LARGE AREA DISPLAY

This work was done while the author was with the Bissett - Berman Corp., Santa Monica, Calif.

aspects of the SACC's system can be put into the same category. The 9th Aerospace Defense Division of the Air Defense Command located at NORAD is another agency whose command function is to control the operating wings of such agencies as the Ballistic Missile Early Warning System, the Spadats, etc. Their arm tends to end up being an evaluation center, that will provide eventually a housekeeping function for managing the reliability of these systems. The output of an analysis of these data will be presented to high-level command people for purposes of evaluation, or automated evaluation within the data processing system. The end products of display data provide the basis for which command decision-making and/or problem-solving are facilitated.

There are many other systems that are to become more full blown in military agencies. The 480L system, an Air Force communication system will be a management system for which management data display presentation will be required. There are aspects of the CincPac, CincLant etc., systems which have management aspects as contrasted with the strategic or tactical commission of weapons concepts. Other examples of management systems in existence are NDAC, National Damage Assessment Center, which also has the requirement to provide a function of monitoring and control, which in essence is what we say in defining the concept of management itself.

The nature of the problem within the military services or within governmental agencies themselves, is that many systems exist which are to a great degree different from the usual command and control center: in essence a primary mission of a command and control system is to evaluate threat and thereby provide some kind of decision as relates to use of force. Therefore, the difference between a generalized management control system and what we might call a command and control system would generally be the basic factor: whether or not forces and resources have been evaluated after some kind of threat. Thereby, conditions are changed as the result of committing of weapons or the usage of weapons for the purposes of acting on the information or the data which have been displayed in the fashion which best optimizes the presentation of the condition.

Management control systems therefore would provide data of a nature which would not be true for and decisions which are not made for and problems which are not solved by the changing conditions which may affect weapons systems themselves; nor which would not directly, inherently, deal with weapon systems in a specific strategic or tactical manner. However, this is not a realistic difference in that, in order for management data display systems to develop broadly, they would not only deal with such data as nuclear damage or communications network outages, but also deal with the kinds of management data which are financial in relation to conducting a program in research and development management, or dealing with the schedule of a program as relates to its research and development and then actual fabrication and testing, etc. These are the areas of management control systems on which management data displays for the future will have, I believe, a tremendous impact.

The logic here is to carry over beyond command and control systems into and beyond the management control systems we have discussed which were typified by the DCA, 473L, etc. This means, for example, the Headquarters of a military R and D agency could handle the means by which summarizing report data is a progressive reporting system would provide the Command Commander a useful tool with which to conduct his evaluation of money expenditures, conditions of programs, etc., and therefore utilize all of the technology which has been developed and already paid for by operational commands. This would also allow a rapid analysis of highly valid data and the Commander would conduct his business in a more rapid "hands-in" manner. In other words, there are extensive technical advances which have been developed for operating commands in all the major services. The state-of-the-art in this general area has been developed in command center arrangements, communication methods such as rapid updating, large-scale display systems, real-time data handling, and data organization and programming techniques. All these can be adopted or adapted to provide a successful input within a management control system whose purpose is to provide data for display which would be useful in general program management, high-level conferences and in monitoring results, reports, schedules and inter-program coordination within a given government or industrial environment. The results of problems of scheduling, long-range planning, expenditures of funds and analysis of expenditure of funds could be provided within a management conference situation to key individuals. The data processing and display management system, per se, can do the leg work which is so difficult and which is so time-consuming within an ordinary situation today.

We are now talking about taking those concepts which have been developed for operational purposes within the government and military related mainly to tactical-strategic systems and to what has been given the highest priority in terms of the general management systems, and create a management system which will conduct rapid analysis of summary reports, which will have ready access to detail as required, which can manipulate hypothetical data, and which will construct cross-program surveys. It is necessary to rationally establish control steps which are basically similar within strategic and tactical control operations and that which is generally called the system management, program management or generalized management control areas. For example, we can see within governmental agencies how any of the arms which manage research and development such as the Air Force Systems Command, the various centers of the National Aeronautics & Space Agency, the Bureau of Ships, the Bureau of Naval Weapons, the Army Materiel Command, even the State Department, CIA, and DIA, all have realistic needs of management control of the kind with which we are familiar in command and control systems. There is no reason why such organizations could and should not make use of that technology which has been developed and take the step from tactical-strategic needs over into actual business-running, business-operation needs in the development of management control systems which could satisfy these functions and develop for them optimal data presentation as well as data handling methods to allow the best kind of management to occur. Many have moved to this direction in industry, such as Lockheed Aircraft Corporation, United Technology Corporation, the Martin Corporation, and others.

Briefly, the problems that relate to evaluation of the present situation where needed actions in terms of their means, plans and priorities, are from the situation, the means of action, the plans of action, and priorities for action can be said to be inherently a problem of a command and control system and logically, therefore, the basic problems of a system management.

Problems Concerned with Present State-of-The-Art

The present state-of-the-art inherently creates a problem about moving ahead. I can see several areas of importance which need to be discussed and which should be fairly clearly understood in attempting to advance utilization of the display systems field.

The first aspect of this is the cost of systems. A concern of a corporation which, theoretically, does a $1.5 billion total a year cannot afford, for example, to spend $100 million for a management system any more than an agency of the government whose function is by priority not faced with the threats or the problems of threat in the defense of the nation or those concerned with posture making, as international aerospace science. Such agencies appear never to be given funding to any large degree to handle their problems by advanced automated or exotic methods. Costs themselves are difficult to analyze inasmuch as practically every major command center or control center of importance throughout the Department of Defense and other government agencies have many data processing equipments. If you analyze these data processing equipments, you will find that they really do many kinds of tasks. The real cost of a new management system, for example, in a military agency need not be as large as one might evaluate it to be because of the present existence of computer systems.

However, looking at many of the display systems that exist today, there isn't one of them in which the output device is the total display system. The gathering of the data, processing, collating, filing, editing, conditioning to whatever degree is necessary, the communication networks which provide it, the control agencies, and parity measures which are made to make sure that the data are valid, the various input-output equipments to assist them are all costly and all part of the system. There is no doubt about this whatsoever.

The next step in evaluation is to ask: "What about the operational effectiveness of the systems?" Here you come up against something which probably is a real bug to analyze. If one were to take the cost dollars of the implementation of a new command and control system of one of the more recent management control systems of a broader definition, and try to evaluate their operational effectiveness versus dollars, I am afraid that we'd come up with a very low figure of merit no matter how we analyze it. We seem to be in a constant state of development. No sooner have new methods been brought out upon the market than the fight is for more advanced methods. The criteria go higher and higher and higher in establishing military requirements and the R and D costs are going up with them, unfortunately.

Also, if we were to evaluate the general effectiveness of the present state-of-the-art of data display techniques, I think you would find many methods which work quite well. However, the tendency has been not to accept things which work quite well because these are in terms of, shall we say, writing speeds, resolution capabilities, and general handling characteristics which are not as fancy as future things which are continually being invented, discussed, and their design brought forward. There is the tendency to want something more advanced, such that it becomes difficult, in the display area, to production anything.

Another aspect of this problem is that within the military or government agencies where management systems could, and have to some degree, moved forward, they tend to get into the wrong part of the funding picture. If you analyze the major space agencies, you notice that the major amount of dollars go toward the actual R and D program management, technical program management and the technical system management. Other parts of these agencies which are to provide management services and have requirements to provide, in essence, management sciences work do not get funding. In fact, many of them are completely unfunded, except in terms of manpower itself and, therefore, have to struggle at the management problem in terms of their data display requirements in a rather hopeless fashion.

In fact, if you look at the major offices today which handle or are responsible for dealing with, for example, program analysis and evaluation, managerial data presentation and/or management control centers, the limit and gamut of their hardware is a random access slide projector or an opaque projector of some kind. Even though their responsibilities are covered by intelligence and high capability, it is not easy to manage these huge programs without good-sized help.

The management control systems of governmental agencies, defined broadly, are comparable to the technical level of command and control systems as we knew them in the military services during the early part of World War II. This gives us an approximate 20 year lag for the management data presentation area to catch up. As a result, most systems, government or corporations, are faced with overhead costs and their administrative sections' operating activities come in for very close scrutiny. Their funding usually is nominal compared to the operating arms which produce products and sell them and distribute them. So we see many hand-made, manual systems, manual in the sense that data are presented very much like the grease pencil and overlay that was so dominant through all branches of the service in early World War II.

We also see a strong tendency toward the focusing of the problem-solving and decision-making act within the highest policy management group, and toward a control center operation which is reaching toward the kinds of things that have been solved to a great degree in command and control systems. This is the focusing of gathering data in

SMALL AREA DISPLAY

Figure 2

elaborate way which insures, to a great degree, the kinds and value of data needed, the communication of the data, its handling by data processing equipment, its availability cyclically, as far as requirements of formats which are readily understandable.

So, evolution in management systems is taking place in the industrial-governmental scheme but, compared to command and control systems, they have a tremendous lag in technology and in the use of technology which as a nation we have spent so much money on.

Actually, if a military agency or a governmental agency, or an industrial corporation, desired to set up a management center with its own electronic data processing equipment already available, it would have organized programs of financial data, scheduling methods, personnel rosters, etc. It also would have a variety of programs or routines written, which could provide them with over-all views of certain program data at various levels of program management. This would barely scratch the surface of beginning the development of a total management control system. To implement a complete system initially, taking even the best viewpoint toward spending money, we are talking about many hundreds of thousands of dollars to provide access to data processing equipment, use of relatively inexpensive output equipment, development of data presentation formats, and development into presentation methods. The ability to turn out data already conditioned for purposes of management reports may not satisfy the end product of what could or should be used or needed in an actual management control center.

The rules of the game become different at this point, and it is possible, therefore, that the system itself needs to be completely re-devised. The programming requirements with their accompanying continuous use of people in developing software are a never-ending process. The major items of cost which are inherent to the present state-of-the-art of equipment are involved in (A) the cost of computers themselves, (B) the cost of software to make computers do what we want them to do, (C) the inherent cost of input-output equipment with the flexibility that we are interested in, and (D) the actual determination, system-wise, of what it is we want as far as output is concerned.

So, if we are to look to the future in the technology for management data display presentation, we need to solve many of the basic problems that relate to how costs are created so that the effectiveness of what we do can be optimized against dollars spent to get the most out of a management control system.

DESK TOP DISPLAY

Figure 3.

Basic Assumptions

Before we establish the requirements of a management data presentation system in the 1970 era, which is what I want to look at, it is most appropriate to analyze the assumptions concerning the management data display system.

Assumption one is that this is a data handling system. This means that there has been specified within a certain meaningful fashion that a certain dimensionality of data pertinent to our data presentation exists. In addition, the generation of data which eventually ends up in presentation is reached at its source in a regular fashion such that its movement forward is a process of rather easy flow.

I refer to a "data handling system" because the data which ends up in the presentation form is of the same order that is generated and gathered at some source, and therefore consistent from input to output.

Assumption two is that we have "real time processors." The reason for this assumption is that within the next 5 to 10 years the advances in data processing equipment are of the order where their actual existence demands utilization. Their cost will demand utilization and their speeds, therefore, set certain requirements. Processors will be a central driving force of the management system, per se, and therefore would be fed at a continuous input rate. Also, there will be strong demands on its output channels and strong demands for data manipulation for passing on and meeting the demands of system requirements. I believe that the need for validity of the processors will force the systems within the framework to be used, otherwise their cost utility would be so low in efficiency that we couldn't justify their existence. Here the state-of-the-art is going to dictate, to a great degree, basic factors of operation itself.

Assumption three is "long-line, rapid, multi-channel communications." In the next 5 to 10 years when we view the rapid advances of digitized communications, both in terms of actual coaxial, microwave relay and telemetry developments, we can see how there will be available for real time processing the transmission of data from its source in rapid transference. Advances here in the state-of-the-art will move up rapidly and the assumptions become more valid as their costs will go down. The ability to operate real time systems is here today and rather costly, but the advances in state-of-the-art are underway and their developments are being paid for.

Again, in concept the state-of-the-art developments will dictate capabilities in the next 5 to 10 years and, therefore, their advancements will also minimize the cost. A good example is PCM telemetry which today is becoming a real fine state-of-the-art capability. It is rather costly, yet its existence as part of advanced space booster instrumentation and measurement systems, as well as space vehicle communications, provide the ability to hold large quantities of digitized data transmitted across many channels, and transmit them rapidly. This should become, in a few years from now, a capability which can easily be utilized within relative low costs for our areas of concern. In fact, theoretically, if we could minimize this lag which appears to be a twenty-year lag in technology down to where within the next few years our lag is only 5 years, then our present state-of-the-art equipment five years from today would be very similar to the utilization of what we know today as being advanced state-of-the-art capability. The gap would close rapidly and our purposes would be served well.

Assumption four is the ability to manipulate data. The manipulation of data implies not just the ability of doing the normal functions of filing, editing, collating, compressing, and a certain amount of calculation that goes with the natural output requirement for analysis. Beyond this is the ability to manipulate data based upon a variety of mathematical models which might be established so that we deal with the hypotheses of what signification needs to be represented. This becomes an aid in solving the basic problem of automated decision-making or facilitating decision actions. Therefore, the manipulation of such data would imply that basic models had been established from appropriate operations research techniques, deterministic techniques, stochastic processes, and general theory. Within the scope of dealing with the establishing of what to do with the data itself, we presume we are able to manipulate it; that is, to ask it questions and come out with certain answers that would facilitate the whole process of management decision-making itself.

Assumption five is the existence of *large, mass storage devices* and, of course, appropriate to this is random access to these large mass storage devices in terms of hierarchical filing techniques so that retrieval is a rapid, uncomplicated process. I am talking about storage devices that go with a data processing-display system and these devices would be of magnitude of billions of bits. In addition, the storage system should have the ability to build upon basic storage requirements and amplify its size to billions more bits and still maintain rapid random access through some type of automated or semi-automated function. This is important to continue to make good use of all data inherent to the system.

This assumption is, I believe, one of the most important of all. This lies in the fact that the reporting cycles of any kind of agency (government, business, corporate, military, etc.) are the continuous input of necessary data which will provide: a) what is the situation now, microscopically, and b) a summary form of the generalized situation now, macroscopically. However, the summary data comes from and is made up of a vast amount of data which have been compiled previous to the call for a summary. A continuance of this, day after day, week in-week out, year in and year out, so to speak, signifies that as we go further on in business activity dealing with our management control system, we are building up vast stores of data which have certain significations. These meanings exist in relation to data presentation format and display presentations themselves in the natural course of display results. Many times, in order to meet some of the assumptions we discussed previously, as manipulation of data, making comparisons of conditions and events in terms of facilitating our decision-making process in order to do the normal work duties involved with these requests, access to a vast store of data is necessary. The comparisons requested must have access to the previous data down to its basic entry.

In this sense, then, a very important problem becomes our ability to develop a centralized, bulk storage system within the management control system from which human decision makers have access by means of data control display consoles, or other kinds of entry or input devices, and these previous entities of data must be available. They must be available in the sense of random access to them by means of some type of document and/or information retrieval system, and by means of a variety of search techniques. The requirement would be for a call up, comparisons made, manipulations made, new summaries made, etc. Validation of our present means of solving problems against data display presentations could be effected through the fact that we have maintained storage of what has occurred in the past from some given time.

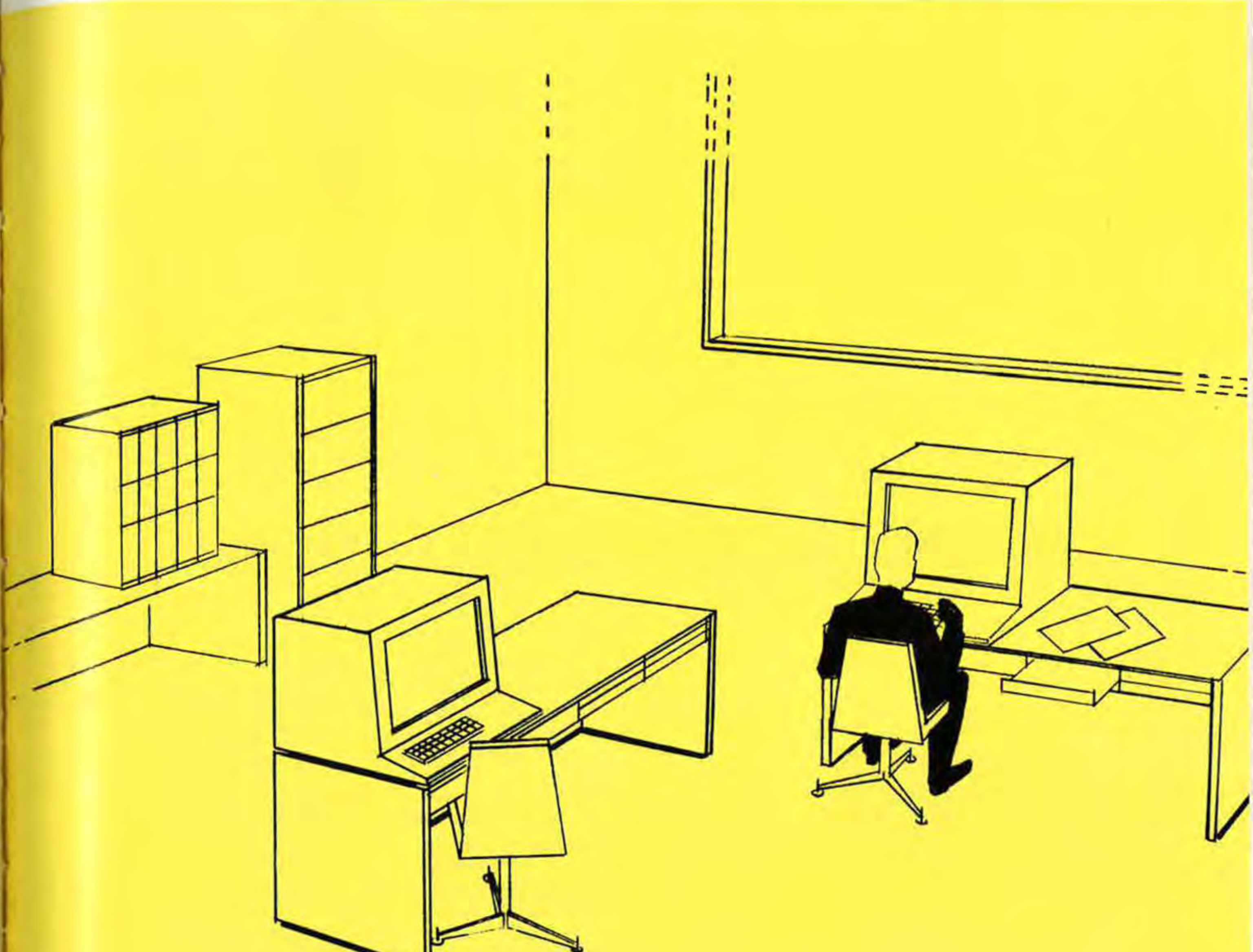
Many strides are being made in the storage area. Many more are going to have to be made, as any large system which continually processes input, a command and control system for example, is bound to amass an overwhelming amount of data as time goes by, unless it purges these inputs. In terms of our data processing-display system we are faced with what happened to the entities of yesteryear. Regardless of how thin you slice it, it's going to still require a large storage system per se within the bigger data processing-display system. This kind of large man-machine system has data storage irretrievably fixed as an integral part of the system. We don't go searching down in the basement for tapes of an unknown vintage, etc. The storage elements will exist inherently within the system such that we have electronic or electromechanical access to them.

The sixth assumption (and this is really a key to why we are discussing these problems) is that our *display presentation is the culmination, the end emphasis, of a vast complex man-machine system* wherein human decision processes must occur. It is natural to presume that if we have a completely automated system at some point, some day, the problems inherently required to be solved and the decisions required to be made will be made by these big slaves and man will not enter the system. I do not think this will ever occur. I believe that the more automation we develop the more this will require special skills of man-machine relations and human analytical skills. Our major machine devices, which would be computers, input/output equipment and special storage devices, could be set up for automatic handling of data and solutions would be obtained by mathematical or other kinds of empirical models established for these data. However, the ultimate criterion to which appeal will be made will be the rational judgment of a human decision-maker or makers.

I think it is fallacious to believe that the total automated system will ever occur. I think that the complexities of a data processing system inherently require major human intelligence. The purpose of our automated system is to provide us with a "mercury on wings" with which such data can be handled, transmitted over long distances, and by which they can be compiled through calculations and other types of manipulations. This kind of a machine system becomes a major facilitation where at least the highest distillation of the course of events is provided the human decision-maker upon which to act. We are talking here concerning visual data presentation technology as a means by which human decision-makers become associatively acquainted and briefed from the end products of machine actions.

Assumption 7 is a very difficult one, maybe even elusive. It presumes that the *formatting of data within visual* *presentation constraints allows for a positive feedback system* which is optimum. It means that the end products of visual presentation do not stand by themselves. It requires that decisions which are made are fed back into the system and the results of these actions are seen as a result of putting the system to work. The feedback which occurs through the system is such that we can see an effect on the end goals of our general management system, or the business purpose itself. That is, the product at some time is the ability to see the total loop in operation where feedback in decisions can solve problems by moving the system to where we now are able to see ultimate success in a goal or criterion which has been established objectively, encompassing the purpose and basis for the management control system itself, to be in existence. Therefore, we place the major consideration on the display devices themselves, coupled with their effect on human beings, as a sort of transducer within the system.

The eighth assumption is one in which I think a lot of technical strides will have to be made in the near future and on which not much has been done. *Display Compiler Optimization.* What I mean is: we have a data processing system; this data processing system is one in which human beings can operate as recipients of the visual presentations for which machine actions are provided through the normal operations which have been set for them, in order to provide the feedbacks which I have discussed, in order to provide the total loop situation. Therefore, the decision maker must communicate with the system. To communicate with the system means that through some input agent such as a console device, a keyboard device, or only an electronic typewriter, the operator gives instructions into the system and perhaps asks such questions as: "We change our scheduling such that Event A now is held up for three more weeks and that product materials, XY, will be delivered with a five-week lag. . . . How does this affect the initial programming of our Phase 1 objectives?"



INTEGRATED DESK DISPLAYS

Figure 4

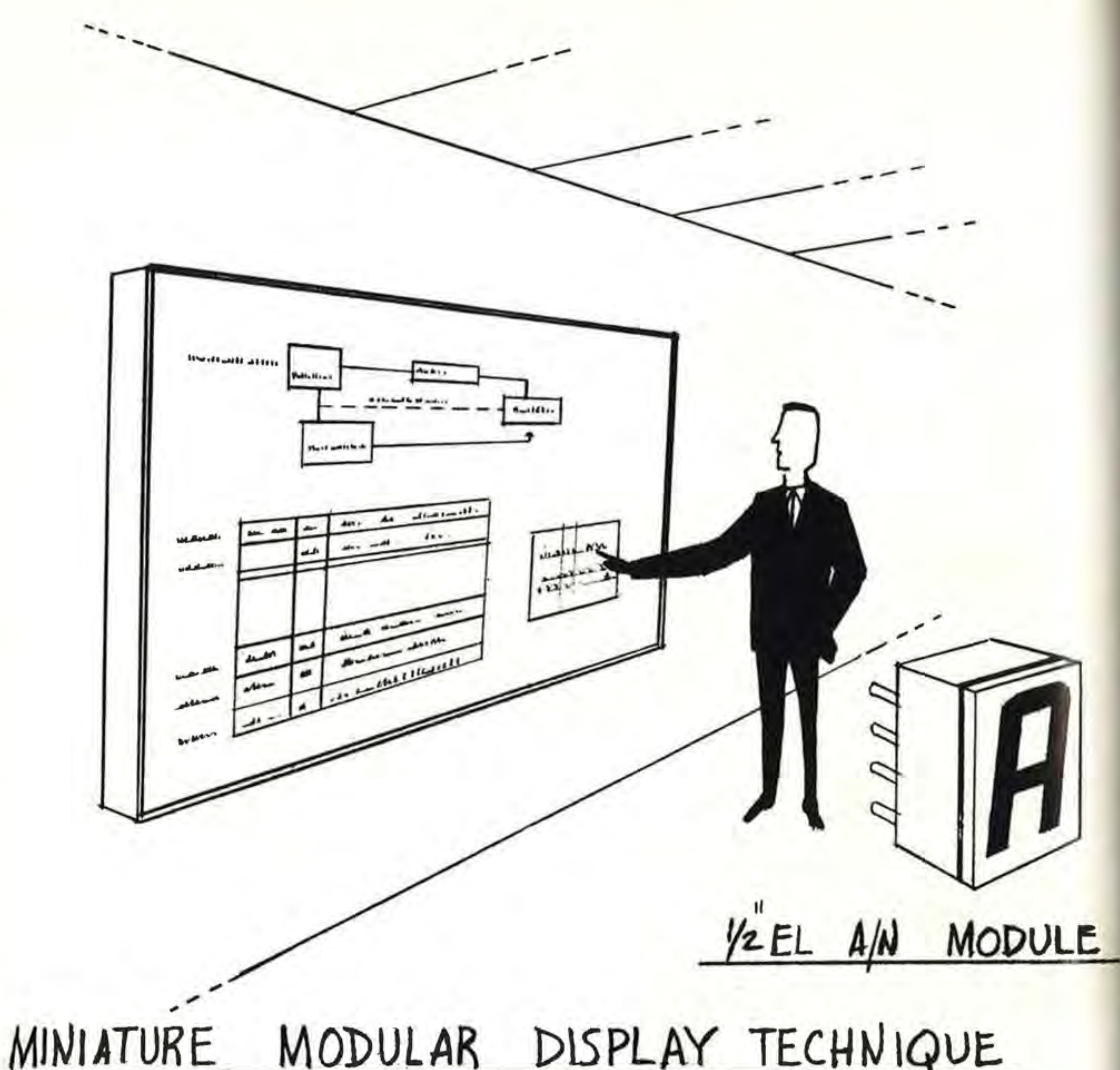


Figure 5.

This is a real knotty problem, because what we need now in order for our management data display system to operate effectively is a basic compiler system which optimizes the use of perhaps special language that relates to display driving, display instructions, and develops through the interface equipment some kind of optimization trade-off in language and buffer equipment. Through this optimization of special language, interface equipment itself, logic equipment, etc., we are now hypothetically capable of developing a strong ability to operate the display device beyond just the normal set routines for formatted data. We can achieve new results in data based upon special calculations, new summaries, and in general new products in handling the data in flexible ways.

Assumption 9 is a very fundamental one: — the *management data display system itself is an all encompassing system and has been globally viewed and developed properly.* It assumes that the requirements which have been set for it have been established upon basic analysis and that an over-all look has been taken so that the system design is fundamental and sound. It assumes that the system basically meets with the objectives for which the system has been created.

If you will think back over the nine assumptions which I have stipulated, we already see, in taking a future look at display technology, that much improvement is needed in many areas to make data display presentation an end product or an output item by which a human being as a transducer provides feedback within a loop; and there is much to be done in the next five to ten years if we are to have effective systems such as we presume we want.

Requirements of Management Data Displays: 1970 Era

Data requirements for 1970 are basic to the establishment of our management control system itself. It is my personal belief, — I don't know whether this has been brought out by any extensive empirical studies in any way, — that it will be a function of the nature of corporate structure at that time. That is, management data presentation or management data displays in the industrial setting require us to define them in relation to the basic problems associated with the nature of the corporate structure. In fact, we should set up a concept of "differentiation of levels of operating effectiveness."

Obviously, data presentation is needed at different levels of management within the corporate structure. It would be related to those levels that were appropriate to certain aspects of the operating effectiveness of the business. These levels are those at which important decision making occurs to an extent that justifies developing and implementing an elaborate system. In addition to decision making levels we are concerned with where record keeping occurs, because it is the gathering base from which we take off onto the handling of broad aspects of management data for purposes of data display.

I perceive of five distinct levels which would provide fundamental requirements for management data display in the future in terms of the data or the information within the data.

The first level is summary corporate data. This level sets a basic requirement which would naturally exist, it would appear to me, where major business decisions occur. This may be mostly financial type data; then again, it may relate to other information basically associated with financial data. This would be the highest level of functioning for the operating effectiveness of the business where policies and end decisions are made that affect the total corporation.

The second level is the development of control data for manufacturing, inventory control, reliability, etc. I refer to the need to provide the basis for maintaining schedules and their manipulation. Simulation and gaming is a possibility to hypothesize what needs to be accomplished in terms of future desires. Thus, by simulating, we establish the constraints and the framework within which the future business policy becomes formulated.

A third level is what may be called the managerial access to data, both individual and group viewing, in that middle management is involved in the handling of specific programs and with briefings.

A fourth level is an area which probably, in terms of its impact on business, needs much attention in the future. Without doubt much can be accomplished through a data processing-display system in marketing sales analyses, and market or business forecasting.

The fifth level of operation within the corporate structure is technical information access, or technical libraries, presuming of course that industries will more and more require almost instantaneous information related to technical and scientific matters, e.g., general engineering organizations in the aerospace and electronic business. I refer to both document and information retrieval, access to libraries of data filed and stored in a specific fashion, and even language translation if possible. A large corporation typical of our top five or ten within this country, all of which have many divisions spread throughout the country, could very easily be tied together within a total management system through long line communications with devices which could provide them a common access to data. They could afford this kind of system. Smaller corporations could possibly be tied to central library facilities. Assuming the library sciences make advances within the next ten years, it is possible to tie a communication line from a small business or a fairly small corporation to a library and within certain priority levels and proprietary safeguards have access to data, both document and information, to be retrieved and displayed to technical or scientific people who are requesting it. I think that this is an area which has been slow in coming, but will spiral as advances in technology, standards, and compatibility are made which bring the costs down.

Criteria for Display Hardware: 1970 Era

I see four areas of displays or four categories of display hardware as needed or related to what we have discussed as requirements up to this point. For example, number one would be the large area display. (Fig. 1) — The large area display, of course, would be used entirely for group viewing for Boards of Directors, meetings of stockholders, and other such large audience viewing. Within certain other group requirements, large area display devices could be used for briefing presentations and other means of displaying data which could address large numbers of people.

Naturally, criteria necessary for large area display are: (a) high resolution, (b) ability to operate in high ambient environments, and (c) self-contained and compact packaging such that it fits against the wall. Such a display should be able to show graphic data, tabular data, and geographic data. This is a big package — one of the major things we are working hard on now is to get high resolution and operation at high ambient lighting. Making it a small package is difficult enough; combining alphanumeric with half-tones creates more and more problems. There is a need, it appears, for large area display devices from 3 or 4 feet by 3 or 4 feet up to the kind that we see in a NORAD headquarters. It should not, however, be a display face that takes up a lot of room relative to the space within which it resides. In this sense, wide angle viewing and lack of interference with operations within the room in which it exists, as well as other such criteria, should be met. Although these are ideal criteria for a large area display, I don't believe they really exist today. We hope that in the next ten years much improvement and advanced technology will be accomplished.

The second category is the small area display (Fig. 2) which deals with the same kind of data as a large area display but the sizes of characters, figures, and resolution requirements are inherently those within the smaller order of 9 square feet, 10 square feet, or 16 square feet. Naturally, small area displays probably have more difficulty in meeting the criteria above in that the requirements for associative equipment and peripheral equipment, that go with display devices will have to be advanced to meet the small area room space requirements.

The third display category is a desk top type display (Fig. 3). I don't mean a console, — I mean a display device, a display face, which as a small package can be pulled up from the side of one desk and, in a small viewing area, can with appropriate inquiry type keyboard make requests, send messages, etc. It returns information from storage or from processing so that it can be viewed in a continuous fashion. Further, it should not have to be held constant within visual view but, perhaps, could have frames stored so that recurring requests for them can be called back. This calls for solid state construction, solid state techniques, per se, which can be packaged small, perhaps microcircuitry, and other such advances which would allow a high level executive communication access to data which ordinarily if requested through secretaries or "leg" men might take weeks to accumulate.

The fourth area is the integrated desk-display device (Fig. 4). In addition to the small package, we can see the need for the combined or the integrated desk-console display package which permits more extensive operation and viewing. For example, such a device could be a video mixing system, providing share capabilities between closed circuit television and long line television communication. In addition to the use of the technique for purposes of generating displays of general management data, alphanumeric and graphic, as needed, it would allow for compiler manipulation as we discussed in the display compiler optimization assumption. This device would also print documents which had been retrieved from document storage or printed information as required. This hard copy of all presentation materials could be achieved from the data presentation itself and, of course, the integrated desk-display-console would have computer control. It would be a device for a man-computer-interface, such that entrance into a processor, access to its core, reprogramming, actual programming itself, by permitting individuals to work at a very highly intellectual or highly technical level of operation for purposes of manipulation. This is not a VIP device; this is a device for hard-working program managers, devices for people at the manufacturing scheduling levels, inventory process control, quality control, reliability control, the areas where major concern is in continuation in operating on the system.

The general criteria, of course, for all four items are that they are relatively inexpensive. This cannot be stressed too much. The costs for equipments, their maintenance for general display systems and subsystems as they are part of data processing-display systems have risen continuously. Consequently, I think that if you correlate costs with requirements you will see that there is high correlation. So, maybe a re-examining of requirements related to causes of increased cost is necessary so that we will not work toward providing in our advance designs of the future more and more expensive devices because of more and more expensive requirements. Working practically at requirements, taking advantage of engineering advances toward accomplishing basic design goals, making solutions which go toward providing inexpensive displays will better our chances. Reliability, of course, is another aspect, but reliability in itself can be furthered by engineering solutions such as removing mechanical parts, providing optimal circuitry, providing components of long life, and preventive maintenance procedures which will inherently provide reliability, and so on.

We recognize that to achieve our practical goals, inexpensiveness and reliability are the major criteria. However, then to recognize that this is part of a vast data handling system, we see that the job within the next ten years is an immense one because data handling systems have become more complex and therefore more expensive. Of course, at the same time, advances have been made in engineering solutions which have achieved high reliability because of the nature of discoveries of materials and treatment of materials. Therefore, in some ways, we have achieved perhaps a movement toward less expensive hardware. I firmly believe that management science systems of the future will not be implemented into management control systems, as we liken them to command and control systems, unless we achieve a complete re-examination of hardware, hardware capability, and its associate cost. More advanced requirements are going to kill the use of such equipments within corporate industrial use unless a more realistic approach to the problem is taken.

Advanced Display Techniques

I believe that the greatest contributions in advanced display techniques are in the solid state area – solid state in terms of the techniques of providing visual output display system operation as well as solid stae in terms of the problems of translating, decoding, decommutating, etc., data which are going to be pushed out of large processors at rapid speeds.

But this is the area in which primary caution should be taken. We can make many advances, for example, in the future use of a semiconductor device such as silicon slabs which are photosensitive. They can be handled easily and fabricated into many element PNPN junction light-activated switches. There are means by which this kind of material can be light activated and actually create the end point by emission of light through, for example, other semi-conductor materials such as gallium arsenide, or by injection of electrons from the N point to electro-luminescent phosphors to create the lighted resolution element. PC/EL phosphors combined appear to be another possibility in which some success exists today. Another is the immersion of the N elements in an electro-chemical bath, an area we have been considering recently, combining the semi-conductor material itself, using the light activated switches for addressing and, furthermore, using the actual N points themselves as a reflective display face, etc.

So, if we can be cautious about advanced developments, for example, a basic scheme of use of semi-conductor materials, and not try to develop such tremendously gross arrays as are being talked about at the moment for military requirements in many areas, I think we can be realistic in our accomplishments in the next five years. If we continue to demand higher resolution, we are going to have to settle for some other kinds of generalized addressing schemes to be able to meet these demands. That is, the higher and higher we go in resolution, the more and more resolution elements we create and therefore the greater the addressing and decoding problem becomes in being able to develop the N point or resolution element as a display technique. I would say this is the greatest area of potential improvement. With it needs to go basic analysis as to the visual output requirements so that we don't get carried away by thousands of lines to the inch which will only break our back in attempting to provide a buffer decoding device interfacing with computers which provide the data.

In another area, for example, for large area display we can see the possibility of miniaturization of alphanumeric electroluminescent fonts from which appropriately switched segments will provide one kind of data as an excellent basis for row by column, charting type displays (Fig. 5). Also, the combination of doped semi-conductors with injection to EL holds a great deal of promise for medium sized area displays. If we can develop appropriate semi-conductor switching and addressing such as light addressing and use the value of PNPN junction switches and monolithic circuits which exist in this area, we probably can inject a sufficient amount of electrons into the electroluminescent phosphor to create a display element which optimizes a color contrast value rather than light contrast when appropriately placed within a figure-ground relationship.

I think the attempt to achieve light contrast values in electroluminescence is a completely wrong approach to the future value of this area. The value lies almost entirely in optimizing the value of color and color contrast itself. As you can see, in this one area alone where we are either developing large or medium and small area displays with many resolution elements or in row by column fonts which need to switch segments that make up the numbers or characters, a basic improvement needed is in the switching problem itself.

This is where a major area of research needs to be placed today, and within the next five years: moving away from matrix xy addressing schemes which can only get into large expensive troubles. We need to solve the problems of light addressing methods which will eliminate the fantastic cost and amount of work which goes into the development of cores and the like. Even if we use non-linear resistor techniques and make use of the hysteresis loop, we involve ourselves with having to get at every element in some way and therefore must amass a large logic which has to be developed with associated complex circuits for achieving this particular xy location. Light addressing schemes as a variety of light sources or as lasers where light is deflected or modulated in such a way that it creates the ability to energize and activate switches, could create a model somewhat akin to the

why emphasize more resolution?

general cathode ray tube. It would eliminate all the problems which are attendant to the nature of matrix array decoding, and it in itself is limited to certain sizes. Actually, a light addressing scheme becomes an important way or means of eliminating the tremendous amount of equipment which goes into the particular areas of buffer decoding. Once perfected, it can bring the cost for addressing a display technique down tremendously.

Another solid state area which has a great deal of potential and the advantage of eliminating the possibility of a tremendous matrix decoding, and integration as a switch display element and circuit all in one, is the piezoelectric method. I think this is an area that decidedly needs more emphasis than it has today and that much research money should be going into it. The achievements so far are excellent. Research published through mid-1963 discusses the use of piezoelectric ceramic materials in which the resolution capability of coincidence of traveling elastic waves is at the .080 inch spot size. This is a tremendous achievement over the last several years, and if it is now down to an 80 mil spot size I am sure, with enough activity in research in this area to control the energizing of the acoustic wave, we can probably achieve smaller resolution sizes which sufficiently satisfy our resolution problems. I don't think, however, that this will ever rise to the point at which we are getting to the photographic quality resolution with piezoelectric material, but I don't think that's our problem. The problem is to integrate material like lead zirconate titanate as a switching material, charging material, and display element all in one. This can be used as a solid state injection device or as a solid state electrochemical device as a display face and light addressing schemes could probably be developed with it. A tremendous saving in cost could be provided in the elimination of all extraneous hardware which has been required by the general matrix addressing schemes up to this point. However, it will never be accomplished by casual research; it requires heavy concentrated research efforts. If this is done, I believe it will be a very promising area for the future.

Another area of techniques which probably needs to be discussed—whether it holds promise or not I am not sure — is colored video. Military agencies have installed the use of closed circuit TV, some in color, and in fact several corporations within the country have closed circuit TV. It seems to be gaining momentum. It is used for conferences, for briefing purposes, for the developing of tapes which are played back at various times to provide specialized briefings. One thing about colored video today is its adequacy for generalized purposes of briefings. There does exist a high resolution tube and conceptual systems have been designed around it.

This has been done by a major manufacturer; however, it is not really in use as a system anywhere. It is expensive to provide color in a generalized video mixing system and, when you come right down to it, an equivalent 1,000 line resolution system for the generalized requirement of high definition is questionable. However, if properly researched, I feel sure that a 1,000 TV line resolution system, in black and white with a 21-inch diameter tube, would be highly adequate for the purposes of alphanumeric and for certain kinds of geographic data.

The use of color has a dramatic appeal. It becomes questionable, to some degree, except as empirical evidence substantiates its value in color coding and impact. Probably for some time to come, we will see the development of closed circuit black and white video systems being put into use within industry and military and government agencies as part of management control systems for briefing and other purposes. Probably the higher resolution systems which exist today will be expanded and we might well see relatively less expensive black and white 1,000 to 2,000 line resolution systems developed within the next five years or so such that, with a wide angle tube, it will take up very small space by use of solid state circuitry. Power source components of the future will also take up smaller spaces and be rather convenient items which will enable black and white TV to be placed into a typical video mixing system which could satisfy the integrated console display device which I discussed earlier. The real use and value of a closed circuit television system within the needs of a managerial structure would be interesting to consider. I believe no objective studies have been made about realistic values in practice. I have seen these closed circuit systems around and observed the amount of use being made of them; with the momentum that is being gathered, no doubt an inherent validity itself will be at face value.

I would say that beyond these areas, there is much present existing equipment in the transillumination projection areas which use photographic means for the basis of presentation of data. In addition, other systems use scribing devices, either light scribers, diamond needle scribers, and photochromic materials plus other kinds of equipment which can be controlled by a computer. For some years to come, these devices will probably provide the best kind of technology within the means available or within the low cost areas that could do a proper job in management data display presentation. I think that it will be a long time before we go over the hump in the things I have discussed, as well as within the general areas of development such as light modulation and other techniques which exist today, before they have become justified for management data display presentation.

A group that worked for me a short while back did a basic study in developing a data model for a hypothetical governmental agency which could use a management control system, and from this hypothetical data model developed a basic hardware configuration of processor and associated equipment with display devices which can handle these requirements. The resulting least hardware cost configuration was surprisingly inexpensive. Surprisingly, there are equipments in the areas I have discussed which, for some time to come, will still be effective and least cost if they can be accepted without trying to look for something better, something new, and something more advanced. Unfortunately, one gets into trouble by getting immersed into advanced R and D and the accompanying conflicts and expenses which go with it. The long time cycle for bringing something around to market creates frustrations for those who want the new display to be operational before it can be available.

I believe that the advanced display technology which has promise is: (a) the possibility of microminiature electroluminescence, in modular packaging; (b) the semi-conductor injection EL type elements for large arrays of elements; (c) the semi-conductor, light-addressed switching techniques (*reflective techniques*) and (d) the use of micro-electronics and piezoelectric materials for combined switching, decoding and resolution elements. They are here for the 1970 era if we spend some effective time in research development with good artistry and relate them to reasonable requirements. They can be brought to the point of least cost materials and least cost fabrication. These advanced techniques will, I believe, give us a sound capability to meet the requirements of management data displays of the future.

This paper was delivered at the Second Institute on Electronic Information Displays held at the American University, Washington, D.C. It appeared initially in Bulletin No. 10 published by the University's Center for Technology and Administration.

IBM reports to the industry

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IBM's all-purpose SYSTEM/360 offers the widest range of data communication capabilities available.

It can be expanded, in stages, to take input from one to 256 communication lines. You may start with only one line and add as many as you need.

The system allows message data to arrive simultaneously while normal processing operations are underway. Its fast, multiple interrupt plan minimizes the time needed to make a program switch, identify the interrupt, and act on it. Control programs automatically relocate programs when necessary.

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Four units of this new system provide these data communication capabilities. The 2280 Film Recorder takes data from the computer (for example, a digital description of an engineering drawing), and reproduces it in graphic form on 35 mm film. Up to 20,000 lines of alphameric information per minute can be reproduced by the Film Recorder.

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The IBM 1092/1093 Programmed Keyboard comes with unmarked keys—100, 150 or 160 of them, depending on the model.

Over the blank keyboard, you place a keymat. Words printed on the keymat match your business language and your application.

Each key illuminates when you press it... giving you instant visual verification of the data entered.

Attach the 1092 or 1093 to an IBM 1050 Data Communications System and you can transmit data to a remote 1050 or a computer. For operation without a 1050, a 1092 must be connected to a 1093. The 1092 thus connected, or a 1093 used independently, can then be attached to a telephone subset and transmit data to a modified 24/26 Card Punch.

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The new IBM 7404 Graphic Output Unit automatically plots graphs, maps or diagrams from computer generated information.

Particularly suited to producing graphic displays of scientific computations and engineering design data, the 7404 may be used in either of two configurations: linked to a computer (the IBM 7040, 7044, 7090, 7094 or 7094 II) or used alone with an IBM 729 or any of the 2400 series magnetic tape units.

It plots points, prints symbols or draws lines (at a rate of up to 280 inches per minute) on a 29" square surface.

In science and engineering, it can be used to evaluate results of wind-tunnel tests, prepare census and weather maps, draw portraits of underground petroleum fields, simulate and test piping networks—and many more.

It can also be used for visual presentation of management data.

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Pick up a telephone. Dial an inquiry. In seconds, you receive a spoken reply from your computer—via an IBM 7770 or 7772 Audio Response Unit.

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These units can be attached to the IBM SYSTEM/360, as well as to any of IBM's 1400 series of computers.

IBM 1015 Terminal to be available to 1410 or 7010 users

It's the IBM 1015 Inquiry Display Terminal that was announced last April as part of the all-purpose SYSTEM/360.

In mid 1965, this same visual communications terminal will be available to users of 1410 or 7010 systems. A new adapter feature for the 1414 I/O synchronizer (model 4 or 5) makes this connection possible. Up to 60 display terminals can be connected to either system.

The 1015 rapidly displays keyboard inquiries and computes replies on a circular viewing screen. By pressing a button, the operator may clear the screen.

The IBM 1015 Terminal is ideal for such uses as information retrieval, inventory and production control, credit checking and customer record status reporting—wherever quick response and much data is needed to answer inquiries.

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DATA PROCESSING

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PHOTO SENSOR PROBLEMS IN DISPLAY LUMINANCE MEASUREMENT

Many engineers trained in electronics are now pursuing interests where the measurement of light is necessary. It is not uncommon in electrical laboratories to make measurements to better than 1% accuracy. And, with the advent of the digital voltmeter, measurements to four places are routine.

The neophyte light measurer is, therefore, inclined to be somewhat horrified to hear photometric engineers talk about accuracies of 10% for ordinary measurements. The first impulse is to assume that the field is behind the state-of-the-art and mount one's charger in an attempt to bring light and order. As an example, why not just connect a cell to a digital voltmeter and achieve four-place accuracy?

My thesis here is that one should know the variables and possible sources of error in his equipment, then do his best to minimize these, and after all that, try to be satisfied if he achieves 5% accuracy.

Probably the outstanding problem encountered in light measurement, which does not appear in the electrical laboratory, is that of optical system geometry. In coupling the photo sensor to the unknown luminous source, an assortment of geometrical and transmission variables must be tied down. This includes the directional response of the sensor and its optical system, the directivity of the source, the curious and often unpredictable effects of interposed elements, such as lenses and apertures, and even fly specks deposited on these optical parts.

Now, supposing that by some magical means (or by several weeks of effort), we have eliminated all of the unknowns in attenuation and directivity between the source and the sensor, another important problem faces us, which is that of the spectral response of the sensor. For many years light measurements have been made using the photometric system in which all sensors should have the same spectral response as the average human eye. Figure 1 shows a synthetic curve of the average human eye as established by averaging the spectral response curves of a large number of persons. Footcandles, footlamberts, lumens, etc., are among the units of the photometric system. (The metric equivalents are now becoming common in this country, including the candela, lux, etc.)

When working to *radiometric* standards, a sensor may be used which has an equal power response over the desired spectral region. Hopefully in this case, the sensor will have an equal output for a given number of watts per millimicron of band width over the entire desired spectral range. What is occasionally overlooked here is Planck's Law, which says that the energy of a photon is equal to "H nu" where H is Planck's constant and nu is the frequency of the energy. This means a quantum at 400 millimicrons has twice the energy of one at 800 millimicrons. Now, since most photo sensors are quantum detectors (or quantum counters), they have a built-in frequency dependent energy error so that the eventual radiometric calibration must be done by a heat or energy sensitive device such as a thermopile or Golay detector.

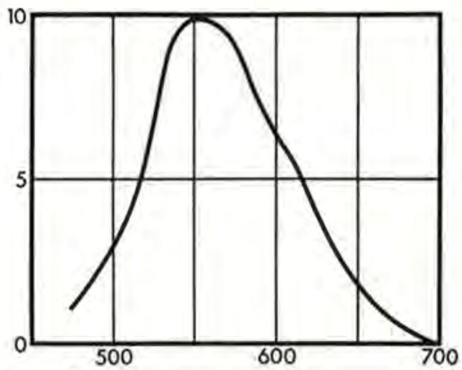


Figure 1.

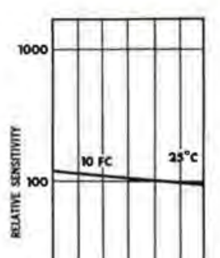


Figure 2A.

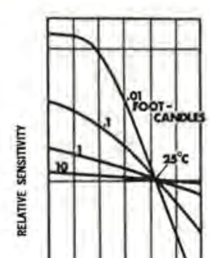


Figure 2B.

by Royal H. Akin

We will pursue the photometric approach in this paper, although I am sure that many engineers are dissatisfied with the photometric standards and several have proposed to me that new standards be set up. This is all well and good, but people have been thinking about this subject for 75 years, at least, and there are good reasons for a CIE standard.

I recently had a discussion with a scientist who is trying to find out what the fish do after the sun goes down. Mainly, if they are schooling fish, they quit schooling. He is trying to measure exactly when it gets too dark to go to school, and his problem is what kind of units to use. If he uses the standard human eye curve, he may be in error because, if the fish does not see red (which he probably doesn't), the sun will go down for the fish before it does for the human.

If he uses radiometric units (watts), he has the question of what happens to the light spectrally after it enters the water and, also, the problem of generating a light which, in his laboratory, has the same spectral output as the sun and whose color is modified the same way as the sun when the sun goes below the horizon.

What he really needs is a dectector which exactly matches the fish's eye (and he admits that this is not too well known). He thought that certain studies of the photosensitive dyes in the fish's eye could allow him to predict within at least 20% of what the curve would be and he plans to use a sensor with this response for his experiment. Now, the problem arises for him, how

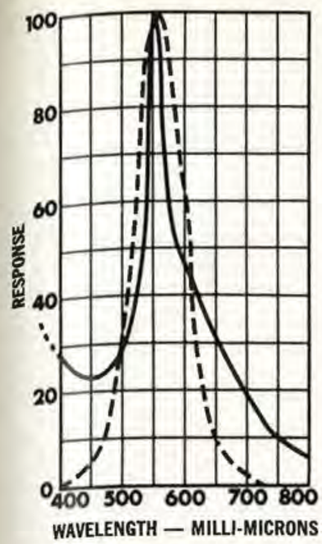


Figure 3.

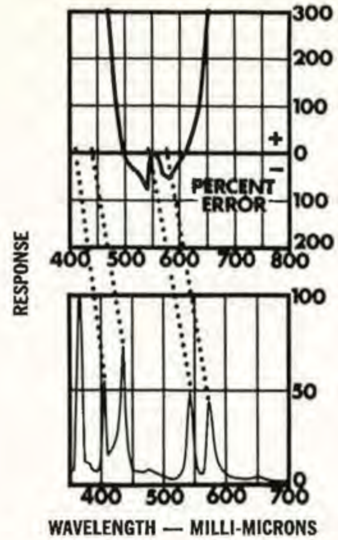


Figure 4A. Figure 4B.

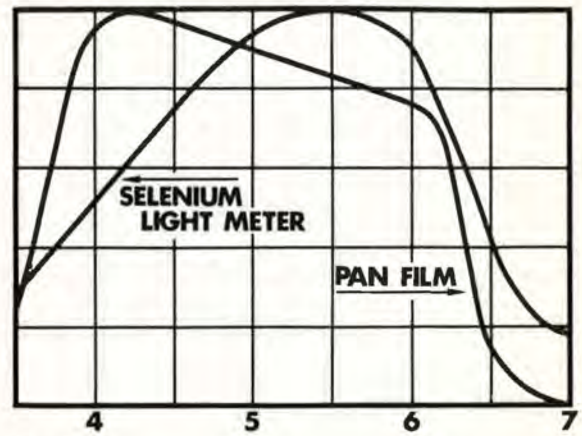


Figure 5.

does he report his studies so that other investigators may duplicate or refute his experiment?

This is the kind of problem which everyone wrestles with who originates any kind of a new energy standard. In his case, a method which might be suitable would be to use a photopic sensor; that is, a footcandle meter together with a known source (such as an incandescent bulb at 2854° K) and then standardize his nonphotopic underwater sensor in "fishcandles" at a specified luminance; for instance, one footcandle. This is a neat touch because it avoids the mathematical integration problem, (which is more easily said than done), and it provides a point where another experimenter may re-establish the variables of the experiment.

I will say, again, that a lot of very astute people have considered this problem for many years, and the footcandle—with all of its weaknesses – is still a very useful unit.

An important variable in precision photometric measurement is that of the sensitivity of the detector. There is a large loss of energy in many collecting systems, particularly those that are directive. The human eye is such a sensitive device that it is often desirable to measure light at levels bordering the threshold of the usable sensitivity of most sensors. At these low energy levels, the problems of instability due to temperature, time, accidental overloads (and, as has been suggested, the phase of the moon) become significant. These are not insurmountable problems, but they must be reckoned with before any dependable measurements can be achieved. The accompanying figures help to illustrate some of these difficulties.

In recent years the cadmium sulfide cell has become very popular. This is understandable because it is inexpensive, small, rugged, and very sensitive. It is about 2 orders of magnitude better than the best photovoltaic cells and about 2 or 3 orders of magnitude less sensitive than the larger and more complicated photomultiplier. Figure 2A shows the temperature effect on a cadmium sulfide

Figure 6.

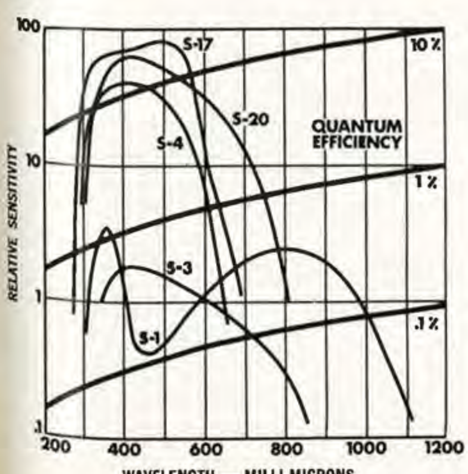
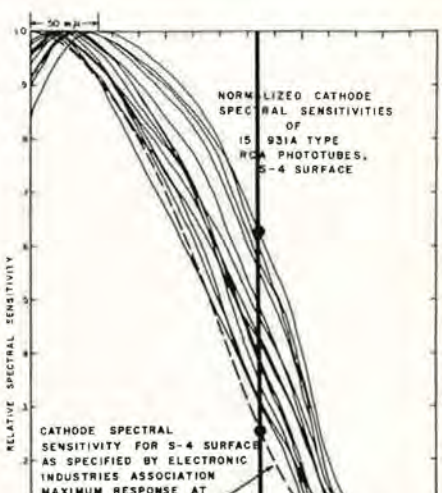


Figure 7.



The following chart is far from comprehensive but will give the reader some place to start in selecting a photo sensor for his application. It should be remembered that this data was gathered from the published data sheets of many manufacturers, in some cases tempered by sober experience and in general believed to be accurate. It should be remembered that manufacturers' data sheets often omit many of the unpleasant properties of their products.

In addition, the state-of-the-art, particularly with respect to solid state photo sensors, is rapidly advancing and the various factors which lead to instability with time and temperature are gradually being minimized.

Regarding the typical uses, it should be remembered that any of these sensors could probably be made to serve in 75% of the uses listed, however, there is an optimum sensor for each service and this listing is therefore limited to the most wide spread application for the particular cell.

Where N. A. is entered in the chart it indicates that the author did not have available to him any information on this factor. The line marked **Relative Sensitivity** is admittedly somewhat subjective; however, the word **sensitivity** itself is subject to interpretation by each manufacturer and user.

FACTOR	CADMIUM SULFIDE	CADMIUM SELENIDE	LEAD SULFIDE	PHOTO DIODES	PHOTO TRANSISTORS	SILICON VOLTAIC	SELENIUM VOLTAIC	VACUUM DIODE	PHOTO MULTIPLIER
RELATIVE SENSITIVITY	GOOD	VERY GOOD	GOOD TO EXCELLENT	GOOD	FAIR	POOR	POOR	POOR	EXCELLENT
(NANOMETERS) SPECTRAL CHARACTERISTICS	VARIABLE 400-800 NM	500-900 NM	500-3000 NM	400-1100 NM	400-1100 NM	380-800 NM	350-800 NM	many types see fig. 6	many types see fig. 6
RUGGEDNESS SIZE TEMPERATURE SENSITIVITY	GOOD VERY SMALL POOR	GOOD VERY SMALL VERY POOR	GOOD VERY SMALL POOR	GOOD VERY SMALL FAIR	GOOD VERY SMALL POOR	FAIR MEDIUM VERY GOOD	GOOD MEDIUM VERY GOOD	POOR TO FAIR MEDIUM VERY GOOD	POOR TO GOOD MEDIUM TO LARGE VERY GOOD
FATIGUE RESISTANCE	POOR	POOR	N.A.	N.A.	N.A.	GOOD	VERY GOOD	GOOD WITH LOW LIGHT LEVELS	GOOD IF LIGHT LEVELS & ANODE CURRENT KEPT LOW
TYPICAL COST RANGE	.25 - 3.00	.35 - 5.00	5.00 - 200.00	10.00 - 100.00	5.00 - 50.00	1.00 - 10.00	1.00 - 50.00	5.00 - 20.00	9.00 - 750.00
ASSOCIATED EQUIPMENT COMPLEXITY	SIMPLE IF NOT TEMP. COMPENSATED	SIMPLE	USUALLY COMPLEX	DEPENDS ON APPLICATION	DEPENDS ON APPLICATION	SIMPLE	SIMPLE	MODERATE	MODERATE TO COMPLEX
STABILITY WITH TIME	N.A. BETTER THAN CdSe	N.A.	FAIR	N.A.	N.A.	GOOD	EXCELLENT	EXCELLENT IF NOT ABUSED	EXCELLENT IF NOT ABUSED
RESPONSE TIME	MILLISECONDS - - - - - - BUT VERY DEPENDENT ON LIGHT LEVEL VERY SLOW AT LOW LEVELS			TENTHS OF MICROSECONDS	MICROSECONDS	MILLISECONDS	TENTHS OF MILLISECONDS	MICROSECONDS	HUNDREDTHS OF MICROSECONDS
TYPICAL USES	INEXPENSIVE LIGHT METERS PHOTO RELAYS CAMERA EXPOSURE CONTROLS PHOTO CHOPPERS		COOLED I.R. DETECTORS RADIOMETERS	LASER DEMODULATOR RADIOMETERS PHOTO CHOPPERS CARD READOUT	LASER DEMODULATOR PHOTO RELAY PHOTO CHOPPERS	SOLAR CELLS CARD READOUT PHOTO RELAYS	PRECISION FOOTCANDLE METERS EXPOSURE METERS	COLORIMETERS RADIATION PULSE INTEGRATORS LIGHT METERS	SCINTILLATORS LABORATORY PHOTOMETRY SENSITIVE LIGHT METERS STAR TRACKERS *SPECTRO-PHOTO METERS* *DENSITOMETERS*

sensor at a 10-footcandle level. Curves similar to this are often published by manufacturers of cadmium sulfide cells. Looks great, doesn't it? There are a few manufacturers (this curve was supplied by the Radio Corporation of America) who also give you the temperature curve at low light levels, as we see by Fig. 2B. Notice that at the .01 footcandle level the error is 400 to 1 when the temperature drops from 25° C. to freezing. Of course, .01 footcandles is indeed a low level, but a person can read a newspaper at 1 footcandle and, since a 10-to-1 loss is not uncommon in a photometric device, it is not hard to see that you can get into trouble on a cold day. This error is very difficult to correct completely by means of thermistors or other temperature sensitive devices. Fatigue is also serious in cadmium sulfide cells.

The state of the art is definitely improving and I think we can expect these sensors to get better.

Figure 3 reveals the spectral response of a well-known cadmium sulfide cell, recommended by its manufacturer for light measurement purposes, superimposed on the photopic response curve of the eye. I would like to read you verbatim from the manufacturer's specifications for this device: "Although the monochromatic spectral response is not identical with the eye, the curves share a common peak and axis of symmetry." *This is not sufficient* for general measurement.

The error curve in Fig. 4A shows how large the error can be for certain light sources. (This was derived by dividing the photopic curve into that of the cell.) As you can see, in the blue and in the red it is tremendously in error. For instance, with the mercury vapor lamp of the type commonly used for high-level illumination of parking lots and so forth (Fig. 4B), you can see that much of the energy lies in the blue with little near the sensor's peak. One of the peaks is at 410 millimicrons, lying in an area where the error is practically infinite because the eye has almost no response and the cell considerable sensitivity.

Some of these errors can be corrected with filters, but it is a task to make a good correction. This is because there is a large variation from cell to cell and because the sensitivity variation with wave length is so enormous that very violent correction factors are required. In addition, such a filter might reduce the sensitivity by a factor of 100 or so, getting us back into the nasty problem of temperature sensitivity.

Another type of cell which has been used for many years and has a fine record for stability and repeatability is the photovoltaic selenium cell, known also as the Weston cell. If properly electrically loaded, this cell is almost independent of temperature and very nearly linear in output, with respect to radiation level, over a large dynamic range. Unfortunately, under these conditions the voltage output is exceedingly small and requires a great deal of amplification. With the stable high-gain instrumentation amplifiers that are now available, very accurate readings can be repeatedly obtained with care.

A failing of this cell is its somewhat poor response in the blue. This is not much of a problem if the response is to match the eye, and a photopically corrected cell is directly available from several manufacturers. However, if one wishes to match the spectral response of the selenium photovoltaic cell to a blue sensitive curve, such as that of panchromatic film, an impasse is reached. In fact, most users of selenium type light meters would be surprised to know how different the response of their meter is to that of the film in their camera. This problem is usually resolved by daylight vs. tungsten correction factors.

Figure 5 shows the response curve of a well-known light meter together with that of Eastman Kodak Verichrome-panchromatic film. I have heard an expert photographer, with many years' experience, say, "This meter works fine under incandescent light, but something just seems to go wrong when you get it out in the open." His problem could have been the lack of blue response.

I might point out here, again, that the cadmium sulfide exposure meters are, in general, as bad or worse in the blue spectrum.

Along this line, here is part of the specification from the American Standards Association publication on general purpose photographic exposure meters. "The spectral sensitivity of the exposure meter shall be continuous in the range of 3,500 angstroms to 7,000 angstroms when the meter is exposed to a source of equal energy at all wave lengths, and not more than 5% of the total response of the meter shall be due to wave lengths shorter than 3,500 angstroms when tested in the same manner."

An enormous peak in the infrared or ultraviolet could occur and still not violate this standard (this usually doesn't happen). I will say that most manufacturers of exposure meters do very much better than this, but it does indicate how sloppy some of these alleged specifications may be.

Two new devices which have been marketed in recent years are the photodiode and the photo transistor. Until recently the main use seems to be that of reading punch cards or other on/off sensing devices. They combine small sizes and great sensitivity. Some of these would make very good light sensitive thermometers, if you happen to need such a device. In the last year much progress has been made in reducing the noise and temperature dependence of these units. They can be very useful in radiometric measurements because of their broad spectral response.

Another class of cell is the lead sulfide, lead telluride, and so forth, commonly used in infrared detection systems. Most of these are used with choppers and reference radiators and cooled to liquid air temperatures so that their vagaries of sensitivity are effectively eliminated. They are not commonly used in ordinary light measuring instruments, mainly because of the poor blue response and complicated associated equipment.

Vacuum photoemissive cells have a long history and many variations are available. The low sensitivity of these devices is rapidly making them obsolete except for special uses. One interesting embodiment of this cell is the series of photodiodes made by IT&T which have linear output over enormous dynamic ranges. Some of these are capable of carrying peak currents on the order of many amperes and yet are linear down to currents in the microampere range. These are useful in the measurement of pulses of tremendous brightness, such as nuclear bomb bursts or plasma discharges.

The photomultiplier, in recent years, has come out of the scientific laboratory and become a part of generally used instruments. The greatest advantage of the photomultiplier is its sensitivity, which is unexcelled except, perhaps, for the new laser light amplifiers. This sensitivity, coupled with the availability of numerous photocathode materials with varied spectral responses, makes the photomultiplier useful in practically all applications where small amounts of light are to be measured.

Figure 6 illustrates the spectral response of five common photo surfaces. This is a logarithmic graph so that the variation in response is really greater than it might appear at the first viewing. You will notice that the S-1 has perhaps only 1/50th the sensitivity of the S-17. However, the S-1 does respond over into the infrared.

It is interesting to note the quantum efficiency lines. The 10% line indicates that for each 10 quanta striking the cathode, one photoelectron will be ejected. Recent calculations by R. Clark Jones indicate that the 1P21 photomultiplier, which has the S-4 surface, is on a par with the human eye as far as being the ultimate in sensitive detectors. Of course, this is a pretty rubbery subject and any calculations have to be highly qualified.

It has been estimated that the eye

sees, in the case of a faint star, approximately one out of every eight quanta incident on the cornea. This very fact of the eye's enormous sensitivity is one of the things that makes light measurement a challenging matter.

In the past many people have avoided photomultipliers because of the complicated circuitry and high voltages. The technological advances of the last few years have minimized this problem and the photomultiplier is beginning to find use in portable instruments.

Again, however, we must take the specifications given by even the most reliable manufacturers with a slight grain of salt. Fig. 7, which is due to A. R. Boileau at the Scripps Institute of Oceanography, shows the red response of fifteen 931A photomultipliers as compared with the spectral sensitivity for the S-4 surfaces as specified by the Electronic Industries Association. You will note that there are four or five of the tubes which come close. You will also note that there is a 50 millimicron variation in the peak response and that the response at 570 millimicrons can be as much as 2 to 1 in error from the specified curve.

One reason for showing this particular set of curves is that a filter is made by Eastman Kodak Company, No. 106, intended specifically for the correction of S-4 surfaces to match the photopic response. I have high respect for Eastman Wratten filters and have found them to be remarkably consistent. But you can see from this slide that any one filter cannot be used to correct properly every tube. We have found it desirable in our work to check all of these tubes and, where necessary, supply different filters.

Just because you have a photometer with an S-4 surface and the standard Wratten filter, it "ain't necessarily photopic".

It is often useful to match the spectral response of your instrument to the curve of the eventual sensor in the system, be it the eye, film, or TV camera. In one instance in a Combat Information Center display, fluorescent chalk was being observed both by operators and a vidicon-type TV camera. Measurements made with a photopic photometer indicated that the chalk, which, as I remember was fluorescent orange, was suitable for both purposes. But the TV camera, having a much better response in the blue, showed little contrast between the chalked-in lines and the background. A green fluorescent chalk was much more distinct. Measurement of this display with the proper photometer could have saved a lot of orange fluorescent chalk.

The last point that I would like to bring out is the desirability of having a good luminance standard with both known color and brightness, and referring all of your measurements back to it.

Then, after you have taken great care, you probably will have errors of less than 10%. And, if you are off that much, who's going to tell you differently?

I would not like my message to be interpreted as a plea for sloppy measurements, but rather one of caution that it is easy to be misled in measuring radiation when all of the variables are not exactly known.

This paper was presented at the Third National Symposium of the Society for Information Display, February, 1964.

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COLOR OUTPUT GENERATION SYSTEM

by James H. Dinwiddie and Robert C. Mullens

ABSTRACT

The computing industry's development of visual display hardware, including printers, cathode ray devices and plotters has presented a unique problem to the user of such equipments. In addition to being familiar with the idiosyncracies of these display devices, the user must be a capable computer programmer to gather and convert the data to be displayed.

The general purpose Color Output Generation System (COGS) is a research vehicle for exploring the future development of general purpose programming languages for display devices. COGS enables the user to quickly specify display equipment and to easily and efficiently specify the acquisition and format of the data to be represented. Scaling, framing and data conversions are handled within the system and need not be considered by the user.

COGS can be a highly efficient short cut in the complex field of data representation. Most advanced techniques of graphic representation have been incorporated into the system which has been designed and implemented exclusively by Datatrol Corporation for the National Military Command System Support Center. Displays have been programmed for the NMCSSC full color system and the on-line printer. It is anticipated that displays for plotters and cathode ray devices can be handled with equal ease.

Introduction

An examination of the development of data display hardware over the past few years indicates the greatest strides have been made quite recently. It is this introduction of more advanced, programmable display equipments that has led to the design and implementation of the Color Output Generation System (COGS), a multi phase independent computer system oriented to the problems of visual data presentation.

Even though sophisticated systems are coming to the fore, one must consider the current standards in data representation, the printer and the plotter. Considerable effort has been expended towards reducing data to tabular form for printers and plotting complex curves on plotters. Combinations of data representation on either device are usually considered too difficult for the average application and as a result, are rarely done. Speed and accuracy of plotters have not improved greatly until recently and the versatility of either of these display devices is limited. Cathode ray tubes and electrostatic devices are now being developed and used. The problems associated with these are usually low quality and expense of print in the case of hard copy devices, and buffer and flicker limitations in the case of the regenerative CRT.

The common characteristics of display hardware appear to be matrix size and character size or sizes. A basic and addressable X/Y matrix is present in all display devices while other features such as character and/or symbol printing, changing font, color specification, and drawing capability are characteristic of the individual unit.

The full color display system located at the National Military Command System Support Center (NMCSSC)[1] is a photo type process with on-line slide-making capabilities. The system has all the common characteristics of display devices except that changeable character or symbol size is not allowed. Characteristics in addition to the previously mentioned features are the retention and filing of display results and a photographic overlay capability.

A cursory examination of some of the programming samples for versatile and flexible display equipments indicates that while each function is apparently simple, the combination of functions and the application of data can be extremely difficult. Many times the combination of graphic artist, experienced computer programmer, and operations research analyst is needed to display data effectively. Since the availability of such an individual is unlikely and communication among a team of such individuals is often difficult, a standard, effective and practical language for specification and use is desirable. COGS is a first attempt at creating such a language. It is a research vehicle for the testing of the current language and the development and testing of additional functions. The system is implemented on the Control Data 1604 computer. It is, by no means, the final answer to quick display problems. However, it appears to satisfy the majority of the current definable problems.

System Description

Several major considerations must be made in the design and implementation of any general purpose system. Foremost is the scope of possibilities. As applied to COGS, this may be illustrated by studying the different characteristics of the many display devices. Only basic parameters (size) are considered by the code generation and operation phases. The idiosyncracies of the object display device are applied in the output converter/driver routines. (We shall explain more completely in the ensuing paragraphs.)

A second primary concern encountered in such an undertaking is that of data definition. This classic problem has itself been the subject of many dissertations, so at this time we shall just mention that in implementing COBS, an existing technique was employed. The Core Data Set Description (CDSD) method, developed at the NMCSSC, was selected and has proven to provide a satisfactory means of symbolic representation.

The third, and often ignored, problem is operating speed. Because this system was to be implemented using a compiler language, optimum code could not be expected. To compensate for this COGS was divided into logical phases (see Fig. 1) with considerable retention of interim data. Portions of the system can be repeated in the event of malfunctions and the division by logical func-

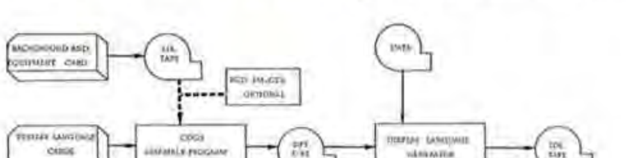


Figure 1. COGS DATA FLOW

tion enables batch processing by type and availability. While not implemented, real-time aspects have been discussed.

Phase I (the COGS Assembly Program) converts and establishes definitions of equipment, layouts, data and data indices. These values are input by the user and where applicable all references to X/Y coordinates are scaled to the pseudo display matrix which is the heart of the system. Program steps, written in a symbolic assembly language are converted to binary sequence steps. These definitions and sequence steps combine to form a complete procedure to be sent to the second phase. Up to this point, the procedure is independent of all data values and will be available in assembled form for any data within the confines of the CDSD definitions supplied initially.

The Display Language Generator is the operate/generate phase (Phase II) of COGS. It has the task of acquiring the referenced data and applying it where requested in the procedure sequence steps. This phase has cognizance only of the pseudo display matrix and, therefore, must be capable of exercising any of the various features of the many display devices. The output from Phase II is the Intermediate Display Language (IDL) code which is generated as a result of the combined definitions, data, and sequence steps. IDL is a generalized code which encompasses the various functions of display devices such as generate character, connect two points, select color, etc.

The third phase must be capable of converting the IDL code to a form acceptable by the object device. It is therefore necessary to have a separate Phase III program for each piece of available display equipment. Likewise, it is necessary only to re-write this portion in the event of equipment changes, as it is the only part of COGS which is based on a given display device.

Data

File descriptions are a major problem in any general purpose programming language. COGS has the capability of handling input data in nearly any describable form. The input data is referenced symbolically and the associated data description is used to input and extract the appropriate fields. Several definitions of data descriptors will be helpful in understanding further usage in COGS context. These definitions are:

- **Item** A computer word or sub-word field.
- **Entry** A group of items with the same subscript within a table.
- **Table** A group of entries with either a serial or parallel entry structure.
- **Block** A memory map of one or more tables for transfer to or from magnetic tape.
- **Index** A range of entry/item subscripts with a fixed increment between entries.
- **Identifier** A symbolic name or tag of an Item, Table, or Block.

As illustrated in Fig. 2, an item such as ABCDE is only a sub-word field of each three word entry in table WXYZ. The remaining bits of each three word entry may be other than item fields or may have no significance. Fig. 3 shows a block of three tables.

Normally, a user of this type of data desires to sum all data of a similar

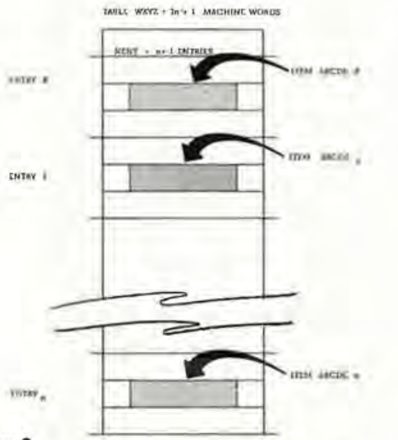


Figure 2

type, cumulate similar data or have a series of data represent coordinate points on a map or graph. In order to work with an entire group of similar things such as all items with the same name found in a table, an index is necessary. An index is more commonly specified with a starting value, an incremental value, and a terminal value. If one desired to acquire every other item instead of every item, it would be necessary to increase the increment value by one. If one desired to acquire only the first half of a list of items, he would reduce the terminal value or last subscript value by one half. Fig. 4 illustrates three examples of indexing over a possible thirteen items. In the first and third examples, seven items each would be acquired or manipulated while in the second example, only four items would be acquired for use. The method of acquiring or working with all of a series of data by identifying and indexing in one reference is a major short cut in programming the display of data.

The desire to represent all of a group of data on a display has led to the data bank concept. Just as an accumulator is a storage receptacle for arithmetic operations in a computer, so a data bank is used for operation in the process of display generation. The difference is that while an accumulator represents one result, a bank will contain the results of the same operation on a series of similar data. The bank concept was developed primarily for use as a central storage receptacle for all of the data to be represented on a display. A data bank might contain all of the occurrences of an action over a period of time and another bank might contain the values for time. A generator which is concerned with generating code to graph the line representing the coordinate points of these banks would have all the data at hand. Ranges of values, minimums, maximums, increments and labeling can be easily determined and subsequent code can be quickly generated.

The current COGS implementation has four programmable data banks, W, X, Y, and Z. Banks W and Z are used as auxiliary banks for holding a series of temporary data, interim calculations or for test data purposes. Banks X and Y can be used in a similar fashion, but their primary purpose is for containing the X and Y data corresponding to the X and Y axes of a graph for containing geographic coordinates of points on a map. Fig. 5 shows how X data and Y data could be represented in their respective banks and if the command were to draw, as illustrated, the results would be presented on the display device.

Bank storage becomes especially useful when sufficient operators are available for manipulation. Many cases arise when a user desires to set a minimum or maximum value rather than let the system find it. Minimum, maximum functions are available which can either set or locate the respective value. A cumulate function can execute successive accumulation in a bank and can place the final result in a temporary storage for subsequent use. Full suppression capability with zeros or range is available for testing and adjusting the data in the banks. These functions, together with the arithmetic operators which can designate a bank address as either an operand or a result, provide a comprehensive data manipulation language useful in itself.

Layouts

One of the major considerations in the graphic representation of data is the layout or design of the areas on which the data is to be displayed. As an example, a header line on a printed tabulation of data would first be identified by location and area on the printer page. The contents of this area could be a title line or might be information carried in the data itself. The method of first defining a field and then using it is a logical process used in graphic display, independent of the type of field involved. The technique of describing a field by its location, area, type and particulars is called background definition.

The method of designing a layout for a given display is primarily affected by two factors, equipment and background characteristics. Minimum character size and spacing considerations must be made to fit titling and labeling into the total layout area. Some consideration should also be given to the accuracy of the display device. For example, a printer is only accurate to one part in one hundred twenty parts along the X axis. Color characteristics, line drawing capabilities, and symbol availabilities should all be evaluated before attempting a graphic display. A given display can usually be made more effective by making full use of the available equipment features. In addition, some display equipments have overlay characteristics such as pre-printed paper, maps for plotters, or photographic overlays as in the case of the NMCSSC full color system. Information about these overlays, in the form of background descriptions, must be communicated to the display generator.

After considering data and equipment features, a typical technique for establishing the graphic display is to sketch a proposed layout. As the sketch gains approval, various layout fields become clearly defined as to type, area, and location. Eventually, the proposed display will be clearly defined in the form of background definitions. Up to this point, the techniques used in the display of data are similar. Using conventional programming systems, a programmer starts implementing a given display busying himself with data unpacking, coordinate conversions and scaling, print and symbol codes, and general flow design. The average time for the completion of a given display will vary from two weeks to as much as two months dependent on the availability of some of the above factors.

Application

Within the COGS system are a series of five background field definitions which are adequate for defining nearly any display problem. A user of the system merely describes the layout in terms of the equipment used. The descriptor fields in the system are designed so that as a proposed display is defined, it is also logically described. Overlays, if used, are described and used in the same fashion as a background field. The programmer then references these fields and instructs the system to generate code for placing data into these background fields. These instructions are in the form PRINT, DRAW, PLOT, BAR and TAB. They may be considered as corresponding to the five background field definitions PRINT, GRAPH, MAP, BAR CHART and TABULAR respectively.

Printing is essential in the preparation of nearly all forms of data display. Whether used for a simple title or date of for a descriptive legend, one finds this capability invaluable. We have provided two basic types of Print background fields; the horizontal field and the vertical field. To describe such a field to the system, one supplies the following information: X and Y origins, X and Y lengths, (where the matrix is considered to be quadrant I). This portion of the field description is common to all background field types and is termed "field location". Unique to the Print field are the horizontal/vertical indicator and the number of lines (columns) allowed in the field. Printing is accomplished in this field by specifying in the instruction the line number and whether the desired string is to be centered or left or right justified. (See Fig. 6.) In addition to Hollerith character strings, special symbols, as described in the equipment definition, may be placed in a Print field by designating the line number, a reference to the symbol code and the character offset from the beginning of the field. Thus, for those devices where a programming distinction exists between characters and symbols, the two may be intermixed in the same line of print. (Fig. 7 illustrates an example of a legend for a scattergraph.)

The presentation of data in graphic form is one of the most frequently used applications of a display device. It is an application which normally requires a great deal of programming effort aimed at determining minimum and maximum data values; axis labeling, including increment determination and finally drawing the lines which represent the data. By detailed definition of the background description, the system is able to take care of this "dirty work" for the user. With X and Y data in their respective banks, issuance of a single DRW (Draw) instruction with arguments giving color and symbol codes sets the process in motion. If not preset by the user, maximum and minimum values are determined and fed into a general purpose labeling routine which combines this information with the detailed background description to produce optimized increment labels. If not pre-printed, the axes could be drawn as defined. Variables are set which correlate data values and matrix units. Obviously this entire process is only accomplished during the initial DRW on a given pair of axes. All that remains is the point-to-point connection with each point corresponding to the values of each related X/Y entry. This line will be drawn in the designated color using the input symbol code.

Closely akin to DRW is the introduction PLT (Plot). These are the only two major operations that are not restricted to a single background field type as either may be applied to both graph and map fields. Internally the two are identical with the obvious exception of point connection for DRW. When used with a map, longitude should be converted to floating point values ranging from 0 to 360, corresponding to degrees East of Greenwich. Latitude should be represented in like manner with the South Pole equal to 0 and the North

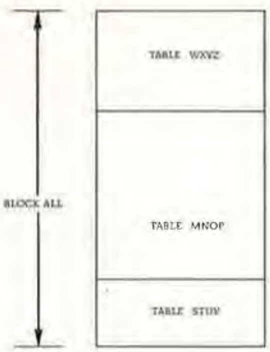


Figure 3

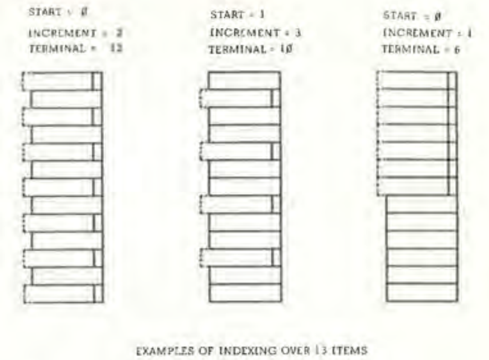


Figure 4

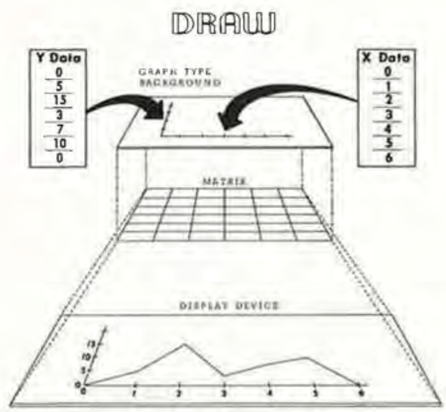


Figure 5.

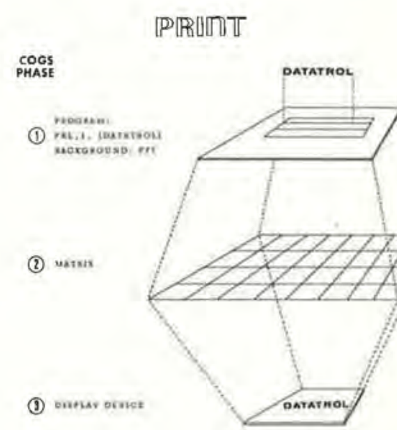


Figure 6

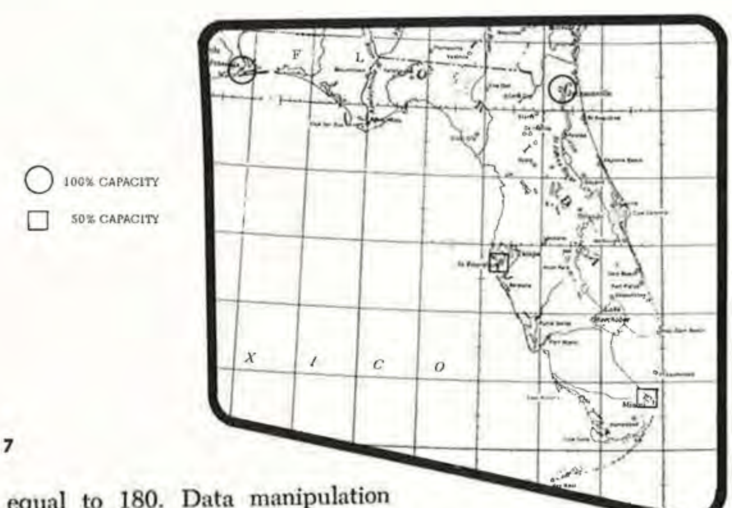
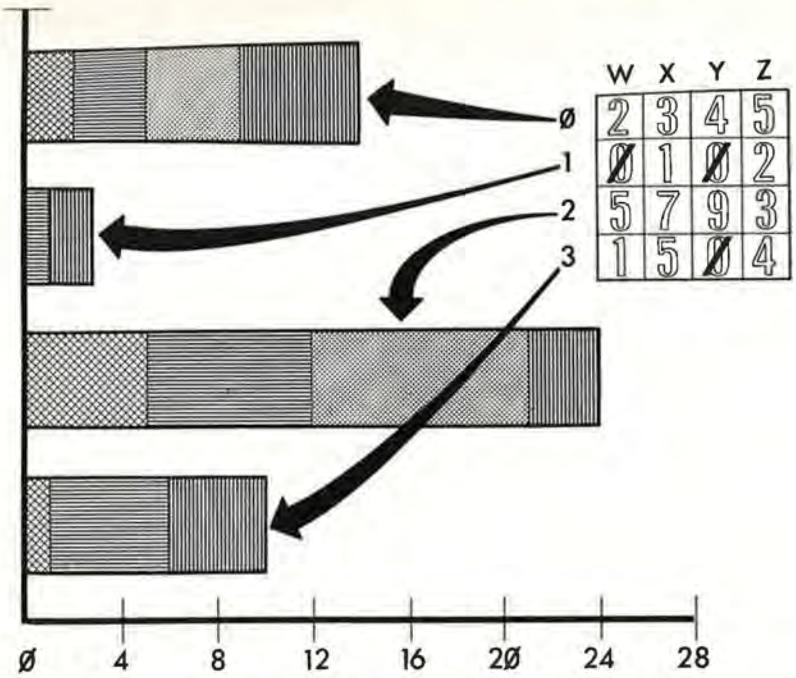


Figure 7

Pole equal to 180. Data manipulation instructions provide assure ease of conversion. The system now is concerned only with X (longitude) and Y (latitude) data values. The labeling process described in the preceding paragraph is omitted when the object background field is of the map type. Currently im-



BAR CHART

Figure 8

plemented are the Lambert Conformal Conic and the Mercator Projections. Provisions have been made to include other types as required by adding the necessary mapping formulas[2].

Bar charting is a desirable form of data presentation when comparisons or quick look references are the object of the display. COGS permits up to four data values in the composition of each bar. These four values would be found in the data banks, with the total number of bars equal to the number of entries in the banks, subject to the limitations of the background definition. When more than one bank is used, a separate color may be associated with each, thus yielding a segmented bar. If only the total of the values is desired, then one would request the same color for all banks. (See Fig. 8.) Much of the support for a finished chart is handled by the system, using the information contained in the background definition. If the bars are defined as horizontal, labeling of the X axis is accomplished; if vertical, the Y axis will receive the labels. As with all field types, the field location is described and similar to a graph type, the axis description is present. Only the horizontal/vertical indicator and the maximum number of bars are required to complete this description.

Finally we have the Tabular background field. This type of presentation is frequently used where an installation has been accustomed to the output format of a printer and desires a similar end product with the new display device. This is not to suggest that such a format is archaic; to the contrary, many applications can best be presented in tabular form. To define such a background, one must supply only the maximum number of columns in addition to the standard field location. Parameters to include with the Tabulate (TAB) instruction supply the data banks to be used and the optional requests for column and/or row totals. Each data bank requested will occupy a separate column with a row for each bank entry. Column separation and perimeter lines will be drawn if not present in preprinted form.

We are confident that through the use of these five principal functions coupled with the various data manipulation and general setup instructions, one can, with minimum effort, program a display in whatever format is best suited to the problem.

Conclusion

The COGS system is a solution to this problem of computer driven data display where the equipment involved requires rather elaborate programming. Significant progress has been made in simplifying the approach to such problems. The establishment of well defined, logical steps provides a standard plan of attack whereby one may be assured that consideration has been given to all necessary phases of problem solution. As in all equipment independent programming languages, one who possesses knowledge of the language has a broad control of all equipments upon which that language has been implemented. A further advantage is gained with COGS through the relationship of language to application. Unlike existing programming languages, COGS is designed to handle display procedures only, thus allowing instructions which are meaningful to the user of such a system. By keeping the language independent of the object display device as well as the computer, the user need not be concerned with the intricacies of either equipment. Object hardware definitions can be effected initially by someone acquainted with the system. Thereafter, these definitions are at the call of all users.

Implementation of COGS indicates a reduction of approximately seventy-five percent in the number of program statements required to perform the same display using the JOVIAL language. A far greater reduction was made in the man-hours necessary to achieve completion of the task. (This is not intended as a criticism of JOVIAL, rather an illustration of what can be achieved through use of a job related language.)

Again, may we emphasize the role of COGS. It was and is intended as a research vehicle to determine the feasibility of this approach to the problem. No attempt will be made here to claim any total elimination of the problem. Initial usage of the system has turned up areas where improvement is desirable. Indeed, had it not been so, the project would have fallen short of its goal. Such modifications were anticipated and the system was written in a form conducive to alteration. The language developed might be classed between symbolic assembly languages and compilers. Internally, the resemblance is to the latter while the external coding has features of both.

The general technique of definition of input/output language in syntax directed compilers seems to be a natural step for the future development of a display language. Real time implementation is another area where displays are becoming more desirable. The COGS lore could be employed to great advantage in preparing a system for such on line applications. Information retrieval systems could be enhanced by the inclusion of a method for quick graphic study of data files. The future appears unlimited for the development and implementation of computer systems designed to provide visual representation of data in the desired context.

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EDITORIAL ADVISORY BOARD

A technical Society journal is always a difficult publication for which to provide meaningful editorial material. Within an interdisciplinary field such as information display may be found specialists ranging from psychologists to electronc engineers, psychophysicists, equipment designers, systems analysts, optical and solid-state physicists and engineers. Obviously, there must be an underlying thread of common interest in such a diverse assemblage of disciplines, yet there is also a basic difference in academic training, problem approach, and terminology.

In order to establish and maintain a dynamic editorial policy, a distinguished team of consultants has been brought together to form the Editorial Advisory Board for **Information Display**, the Official Journal of the **Society for Information Display.** By means of this Board, the SID will be assured of continuing review at the highest professional level of papers to be published and areas to be covered.

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Staff Assistant to the Special Assistant for Intelligence and Reconnaissance, Director of Defense Research and Engineering, Department of Defense, Dr. Davis has been active in government service throughout her professional career.

From July, 1957 – March, 1958, she was consultant to the Office of Naval Research and responsible the development of criteria for selection of computers for command and control systems.

From March, 1958 – Sept., 1961, she headed the Operations Research Div. of the David Taylor Model Basin and was responsible for the entire analysis and programming effort in support of numerous Naval command, control and surveillance systems.

Dr. Davis has been a consultant to the Navy in the areas of intelligence, operations, and weather analysis; a consultant to the Joint Staff Command and Control Development Group, to the U.S. Intelligence Bureau, and to several other government agencies.

She currently serves as Chairman of SID's Honors and Awards Committee.

William R. Aiken

From 1948-195 Mr. Aiken was associated with the University of California Radiation Laboratory in Berkeley in the development of controls for nuclear accelerators, the development of the Chromatron color TV tube, and the instrumentation for Operation Greenhouse in the Marshall Islands.

From 1953-1962 he was Director of Research at Kaiser Aircraft and Electronics, responsible for development of the thin CRT, solid-state switching, and special aircraft instrumentation.

At present, he is an independent consultant to industrial firms and utilizing his experience in patent and corporate law, government contracts, financing, sales, and the preparation of proposals and brochures.

Mr. Aiken has authored numerous papers on CRT's, display tubes, 3-D data display, and display technology. Among his patents: Kaiser-Aiken CRT, Basic Solid-State TV Screen Switching Method, Audio Expressor, Constant Contrast TV Control, and Changeable Message Sign.

He is Councilman and Vice Mayor of Los Altos Hills, California.

Dr. A. M. Zarem

President of Electro - Optical Systems, Inc., Pasadena, Dr. Zarem has received three degrees in electrical engineering: BSEE in 1939 from Illinois Institute of Technology, M.S. one year later from California Institute of Technology, and Ph.D. (Magna Cum Laude) from Cal Tech in 1943.

Dr. Zarem worked for Allis-Chalmers Manufacturing Co. (1943-1945), served as group leader on the Manhattan Project for Cal Tech (1945), headed the Basic Research Electronics Section at Naval Ordnance Test Station (1945-1948), managed Stanford Research Institute's Southern California Division (1948-1955) and taught a course in solar energy at UCLA (1955).

He has authored numerous articles on physics, electrical engineering, atmospheric pollution, area development, and the impact of technology. His inventions include an "Automatic Oscillograph with a Memory" and the Navy's "Zarem Camera". His professional society activities include AIEE and IRE, Association for Applied Solar Energy and AIAA.

REPORT CARD

NAME 801 Data Display System

ADDRESS c/o Telemetrics, Inc.
2830 South Fairview Street
Santa Ana, California

PHONE (714) 546-4500

SUBJECT	COMMENTS	GRADE
Reading	Reads and accepts digital inputs in parallel form at a selected or programmed up-date rate.	A
Writing	Most flexible in its class; uses beam-pencil to write 12 "pages" or levels of information each with 12 lines of data at 32 characters per line.	A
Arithmetic	Memorizes and handles large masses of any kind of data (does not really perform computations as such).	A+
English	Uses real language, not wiggly lines; very easy to see, analyze, or filter processed data.	A+
History	Repeats itself every 16 milliseconds; uses own buffer memory to up-date data.	A
Science	Performs well in any area of investigation, industrial research, experimentation, or process control.	A

ELECTIVES

SUBJECT	COMMENTS	GRADE
Art	Draws maps, charts, graphs, curves, etc.	A
Shorthand	Abbreviates as required by the programming.	A
Economics	Considerably less expensive to operate and maintain than a family of strip-chart recorders.	A+

PERSONAL

Work Effort - Capable of very hard real-time work when asked; applies own buffer memory and character generation memory to reduce the work load on any computer by a factor of 20,000; will work in an off-line situation.

Cooperation - Plays well with the Telemetrics 670 Data Processing System, but will also play with any general purpose computer when so instructed; will not interfere with the playing of permanent read-out devices.

Application - Shows strong tendency to replace as many as 4,608 conventional single-character read-out devices at one time; is also capable of one or more remote displays.

Overall Work Habits - Very reliable; always turns in neat, readable work, is very attentive to instructions; changes its values and data very easily.

Appearance - Very neat, as may be expected from an off-the-shelf item; occupies only 23"x 32" of floor space.

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ID Readout

Business Notes and News

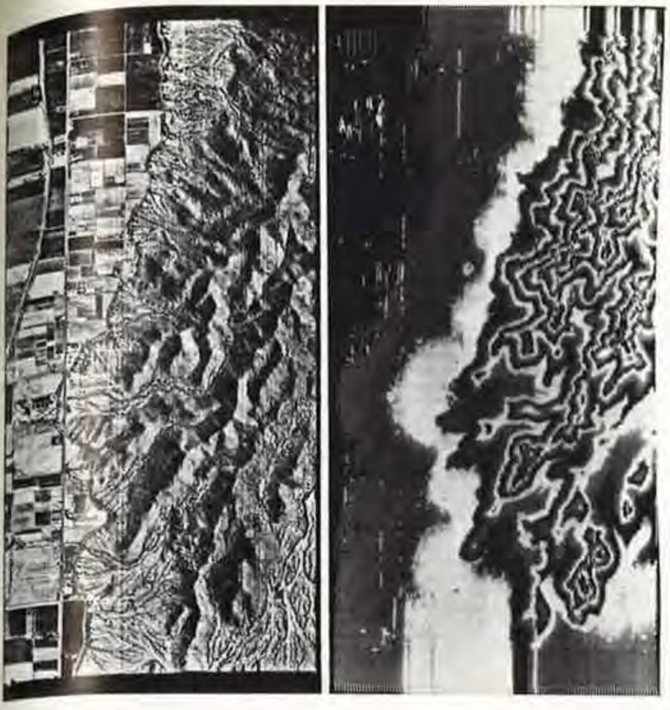
Rand Corp. has licensed Data Equipment Co., subsidiary of Bolt, Beranek and Newman, Inc., to produce a new digital computer and graphic input system on a non-exclusive production and marketing basis for the new man-machine communication device. The Rand tablet, reportedly the first such digital graphical system, permits the operator to write or plot input information for digital computers directly on an integral screen. The 10" x 10" surface can accommodate 1 million input points. . . The Bunker-Ramo Corp. is adding eight computers to its nation-wide financial service network which includes 650 Teleregister quotation boards and over 1000 Telequote III interrogation devices throughout the nation, in addition to master computers at the firm's $5 million Manhattan center. More than 8000 stocks, bonds and commodity items are processed by the network, including New York, American, and Pacific Coast Stock Exchanges. . . Lear Siegler Inc. has been awarded a $1.6 million follow-on contract by NASA/Marshall SFC for equipment, including interfaces for aural and visual system, to be integrated with other facilities at the Center's liquid hydrogen test stand. . . Raytheon Co. has purchased for an undisclosed amount the BIAX and MicroBIAX lines in acquiring the computer memory business of Philco's Aeronutronic Div. . . Discon Corp. has purchased the Digital Electronics and Engineering Dept. at MacLeod Instrument Corp., Ft. Lauderdale, Fla. MacLeod, an Aerosonic Corp. subsidiary, will hereafter concentrate on development and manufacture of aircraft flight instruments . . . Belock Instrument Corp. reports record sales of $19.7 million, net profit of $642,672, or 58c/share, for the fiscal year ending Oct. 31, 1964. Sales were up 23% from the previous high in 1963, and net profits rose 158%. The 1963 earnings were 22c/share.

Technical Meetings

The Third National Inter-Service Data Exchange Program (IDEP) Conference will be conducted in Albuquerque, N.M., Mar. 16-18, under sponsorship of the IDEP Contractor Advisory Board, in conjunction with the Army, Navy and Air Force IDEP offices. It is designed as a working conference dedicated to the development and advancement of data interchange. . . The Washington, D.C., chapter of the Association for Computing Machinery will conduct the Fifth Technical Symposium April 15, with the theme, "New Horizons in Computomation – 1965", and the 800 registrants may select either of two programs, "Technitopics" or "Computopics", dependent upon interest. Maurice F. Ronayne is general chairman, and conference registrar is Richard Litsinger, Computer Concepts, Inc., Silver Spring, Md. . . Final plans are under way for Interdata 65, the International Federation for Information Processing Congress Exhibition May 24-27, at New York's Hilton Hotel.

Automatic Map Compilation System

A new Army automatic photomapper, under development by The Bunker-Ramo Corp., will cut average compilation time of topographic stereo models from the present 25 hours



to only 45 minutes. It is being developed under a $992,000 contract with the Army Engineer Geodesy, Intelligence and Mapping R&D Agency, Ft. Belvoir, Va. A typical pair of outputs is shown above. Using stereo pairs of aerial photos, the system produces an orthophoto (left) in which image elements appear in correct map relationship with photo distortion removed, and (right) an altitude chart which shows successive 10-meter contour lines as the boundaries between grey-level changes. The equipment is intended to be mounted in air transportable shelters making it feasible to transport it rapidly to a theatre of operations and set it up for use. It will be able to compile maps from a wide variety of photographic inputs including convergent and panoramic photography. Compilations from vertical photography should be accomplished in about 45 minutes per model — faster for simple areas — to a vertical accuracy comparable to that obtained with precise manually-operated stereo map compilation instruments.

$7.4 Million Operational Display System

Sanders Associates, Inc., has been awarded a $7.4 million contract for the operational display system to be used in the automatic prelaunch checkout of the *Saturn* V launch vehicle for the *Apollo* program. The sum includes design, manufacture and installation of seven complete operational display systems. Each is comprised of four major subsystems, including a data processor, monitor and control display consoles, interface logic and refresh memories, and data conversion equipment that provides hard copy, slide reference and closed-circuit TV capabilities. The number of display consoles per system can vary from two to twenty, with a total of 54 currently specified by NASA. Four of the display systems will be installed at the Merritt Island Launch Area, and three will be employed at NASA/Huntsville.

$140,000 in Electronic Tube Contracts

Government contracts totaling in excess of $140,000 have been awarded Du Mont Laboratories divisions of Fairchild Camera and Instrument Corp. by DSA's Electronics Supply Center, and the US Coast Guard Supply Center. The USCG contract, in excess of $87,000, is for Loran systems. The DSA contracts, in excess of $53,000, are for CRTs. Production for both contracts will be at Du Mont's Electronic Tube Division plant in Clifton, N.J.

Large, Shock-Proofed, Rectangular CRTs

Electronic Tube Div. of General Atronics Corp. has been awarded a $147,000 contract for a quantity of six-gun special-purpose CRTs. The large-screen tubes will be shock-proofed for use in an unspecified military environment, the firm announced. Total backlog for General Atronics is now at an all-time high of $4.5 million.

Scan Converter Tube Magnetic Shield

A new minimal retentivity, permanently annealed Netic Co-Netic magnetic shield for commercial available scan converter tubes is offered by Magnetic Shield Div., Perfection Mica Co. The firm reports effective shielding of the tube enables it and other magnetically sensitive components to be placed very close together, making possible more compact assemblies.

Tape-Lite Applications Development Kit

An applications development kit, containing sample materials and a power supply for investigating design applications of the flexible electroluminescent light source called Tape-Lite has been made available by Sylvania Electric Products Inc., a subsidiary of General Tel & Tel. Tape-Lite provides medium-level illumination and operates on the principle of electro-luminescence, which creates light by the excitation of phosphors in an electrical field. Tape-Lite is 1/32-in. thick, 1-in. wide, and available in lengths to 150 ft.

Solid-State Elapsed-Time Indicator

Logitek, Inc., has developed a digital count-up/count-down clock, designated to meet military and industrial requirements for precise elapsed-time indication and synchronous command of remote equipment in missile and satellite control centers, data logging systems, computer complexes, and similar applications.

Radar Picture Readable in Ambient Light

A small plan position indicator display that is said to produce a clearly readable radar picture under all ambient light levels, even sunlight, is being offered by the Marconi Co. Ltd. The manufacturer reports that the picture, about 200 times brighter than that obtained by scan conversion, can be viewed by air traffic controllers in the brilliant lighting of a control tower, and is also suitable for ship's bridges. The prototype "Distance from Threshold Indicator", announced in 1962, has been on trial at two London airports and is operating satisfactorily after more than 13,000 hours of continuous use, Marconi reports.

Computerized Preparation, Revision, Speeded

A new IBM development, termed "Administrative Terminal System", permits a typist to communicate with a computer to speed the preparation and revision of ordinary text material ranging from legal briefs to technical manuscripts. It enables a user to enter information into a computer in text form, without regard to format. While the text is stored in the computer, he can edit and revise it by typing words or sentences, then retrieve the updated version in printed form. The computer can accept information entered at many remote keyboards, store it for later recall, align margins, and number pages automatically when it prints final copy. Keyboards are linked to the system by communications lines. Up to 40 ATS keyboard terminals can be used simultaneously with a single computer, each terminal handling a different project, or several terminals working on the same project. ATS was developed at IBM's Advanced Systems Development Div. Laboratory, Los Gatos, Calif.

FIFTH NATIONAL SYMPOSIUM

Society for Information Display

February 25-26, 1965

The Fifth National Symposium of the Society for Information Display will offer 16 technical papers, three addresses by authorities in the field, numerous exhibits, and the organization's annual business meeting.

All exhibits and sessions are scheduled at the Miramar Hotel, Santa Monica, where registration and exhibition viewing will begin from 3 to 9 p.m., Wednesday, Feb. 24.

The technical program is scheduled throughout the following two days.

Keynote address for the Symposium will be delivered Thursday at 10 a.m. by Capt. Harry C. Mason, USN, Commanding Officer, U.S. Navy Electronics Laboratory, San Diego, California. His topic is: "Evolution of Information Display (From the Military Viewpoint)."

The annual banquet, beginning at 6:30 p.m. Thursday, will feature an address at 8 p.m. by Dr. Egon Loebner, Research Specialist, Hewlett-Packard Associates, Palo Alto, California.

He will speak on: "The Role of the Interdisciplinarian in Display 'Technology."

A luncheon, beginning at noon Friday, will feature an address at 1 p.m. by James Robertson, Vice President and General Manager, Television Station KCET, an educational station in Los Angeles. His topic is: "Television's Third Dimension."

Symposium Officials

R. E. Bernberg, Litton Industries, is general chairman of the Symposium, assisted by co-chairman Louis M. Seeberger, also of Litton and President of the host Los Angeles Chapter of the Society.

Chairman of the technical program is E. A. Ulbrich, North American Aviation Space & Information Systems Division. Papers chairman is Rudolph L. Kuehn, Giannini Controls.

Edward Ries, The Whittaker Corp., is exhibits chairman, coordinating this activity with Frank Masters, exposition manager for Trade Associates, Inc., Washington, D.C.

Arrangements for Symposium facilities are handled by Aram Jarahian, Informatics, Inc.; Phillip Parker, ITT United States Defense, Space Group, is finance chairman; and Wendell F. Miller, Intertechnical Corp., is publicity chairman.

The annual business meeting will follow a noon luncheon Thursday, at which national election results will be announced.

Activities on both Thursday and Friday will begin at 8 a.m. with a speakers' breakfast, registration, and opening of exhibits at that time each day.

TECHNICAL PROGRAM

Thursday

10:00 a.m.—Keynote address.

10:40 a.m.—Coffee break.

10:55 a.m.—First Technical Session: "Developments in Group Displays": Papers to be delivered are:

"Advances in Techniques for Large, Dynamic Display Devices", Frances R.

Darne, Bureau of Ships, Department of the Navy.

"Small Screens for Group Display", R. E. Packer, The Bunker-Ramo Corporation.

"Solid State Light Valve Study", Edward J. Calucci, Rome Air Development Center, USAF, New York.

11:55 a.m.—Summary and announcements.

Noon—Luncheon followed by annual business meeting.

2 p.m.—Second Technical Session: "Displays in Simulation": Papers to be delivered are:

"An Evaluation of Orbital Rendezvous Display through Simulation", James E. Holthaus and Thomas E. Spink, Westinghouse Electric Corp.

"Information System Model for Business and Industry", James J. Connelly, ITT Data and Information Systems Division.

2:50 p.m.—Coffee break.

3:10 p.m.—Papers continued:

"A Comparison of Three Display Systems in a Docking and Satellite Inspection Simulation", B. L. Berry, North American Aviation, Space & Information Systems Division.

"Unbuffered Display System for High-Speed Inquiry-Response Applications", S. Singer, IBM Data Systems Division, and E. T. Kozol, IBM General Products Division.

4 p.m. — Summary, announcements, and exhibits.

5 p.m.—Social hour.

6:30 p.m.—Banquet.

8 p.m.—Banquet address.

Friday

9 a.m.—Third Technical Session: "Developments in Components and Systems": Papers to be presented are:

"General Purpose Display", H. Roth and S. Sherr, Sperry Gyroscope Co.

"The Multimode Tonotron, A. Versatile Display Storage Tube", Phillip P. Damon, Hughes Aircraft Co.

10 a.m.—Coffee Break.

10:30 a.m.—Papers continued:

"A Display Screen with Controlled Electroluminescence", Herman Graff and Richard Martel, Librascope Division, General Precision, Inc.

"A Modular Electroluminescent Crossed Grid Display for Graphical Data," J. Hallett and H. Gregozek, Sylvania Electric Products, Inc.

"An Electroluminescent Hover Display for V/STOL and Space Vehicles," J. G. Fellinger, Lear Siegler, Inc.

11:55 a.m.—Summary and announcements.

Noon—Luncheon.

1 p.m.—Luncheon address.

2 p.m.—Fourth Technical Session: "Displays in the Post-1970 Era": Papers to be presented include:

"Information Displays — A New Vista in Retailing", Norman H. Gaber, Battelle Memorial Institute, and Charles G. Dew, Ohio Bell Telephone Co.

"The Role of Film Based Display Systems in the Post 1970 Era", H. R. Luxenberg and A. F. Reichardt, The Bunker-Ramo Corporation.

2:50 p.m.—Coffee break.

3:10 p.m.—Papers continued:

"Technologies for 1970 Era Tactical Display Systems", L. C. Hobbs, Hobbs Associates.

"Information Display in a Vehicular Traffic Control System of the Post 1970 Era", Edith Bairdain, ITT Data and Information Systems Division.

4 p.m.—Summary and announcements.

5 p.m.—Exhibits close.

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ID Products

19-Inch Rear Window CRT

Availability has been announced of a 19-in. rear-window cathode-ray tube suitable for aerial reconnaissance, radar navigation and other readout applications.

It was designed by Sylvania for simultaneous photographic reproduction of the image appearing on the screen, or for optical projection of overlay information on the face of the tube. It also features highly sensitive character writing deflection plates to produce numbers and letters.

For information write to the Industrial and Military CRT Dept., Electronic Tube Division, Sylvania Electric Products Inc., Seneca Falls, N.Y.

Circle Reader Service Card No. 61

Large Screen CR Indicator

ITI Electronics, Inc. has introduced a cathode-ray indicator (Type IT-277) intended for applications which require a high-resolution, bright display. It is particularly suited for response curve tracing and matching where its stability and resolution permit fractional db measurements.

The 17-in. magnetic deflection CRT utilizes a bonded faceplate and filter for halo suppression and contrast improvement; all standard phosphors are available. Deflection sensitivity of 1 mv/in. is standard for both axes.

Contact Clarence A. Slaterbeck, Gen. Sls. Mgr., ITI Electronics, Inc., Clifton, N.J.

Circle Reader Service Card No. 62

Transistorized Display Driver

A transistorized display driver with lamp control circuitry that permits current signals as low as 1 milliamp to switch the incandescent lamps of a display on and off is now available. Signal decoder circuitry is an optional part of the compact module.

The driver is available in three series models: TPD-10 series provides decimal readout from decimal input signals; TPD-20 series provides decimal readout from 4-wire binary coded decimal input signals; and the TPD-30 series provides decimal readout from 8-wire binary-coded decimal input signals.

For complete details, contact TEC-LITE, Transistor Electronics, P.O. Box 6191, Minneapolis, Minn. 55424.

Circle Reader Service Card No. 63

Display Systems Brochure

LTV Military Electronics Division has recently published a capabilities and display equipment brochure entitled "LTV Data Display Systems".

The new brochure describes in detail operation of the multicolor LTV data display system, as well as applications, inputs, interfaces, readouts, other fundamental and peripheral equipment and services.

Complete information is available by writing LTV Military Electronics Division, Marketing Department, P.O. Box 6118, Dallas, Tex.

Circle Reader Service Card No. 64

Segmented Bar Readout

A segmented bar-type digital readout announced by Tung-Sol Electric Inc. offers 1:5.8 ratio of number height-to-depth-of-readout case. Overall case size is 1.000 in. ±0.10 in. in height, 0.400 in. ±0.010 in. in width per digit and 2.32 in. max, in depth, while number size is 0.4 in. high and 0.24 in. wide.

The readout, designated the DT-897C, also has a mean-time-to-failure rating of 4600 hours, based on a 0.01 probability of failure in a group of 40 lamps.

For information contact Tung-Sol Electric Inc., One Summer Avenue, Newark 4, N.J.

Circle Reader Service Card No. 65

Rapid-Setting Switch

The Digiswitch series 600 is a rapid-setting thumbwheel switch for input of alphanumeric or other multi-position information. Each module's setting wheel has up to 40 positions, yet all positions are readily available to the operator in no more than four wheel actuations. Selection speed equals that of a push-button or slide-bar switch while retaining inline visual readout.

It converts directly from dial setting to coded electrical outputs, and output capabilities are extensive.

Contact Jack Jordan, Digitran Co., 855 South Arroyo Parkway, Pasadena, Calif.

Circle Reader Service Card No. 66

Dual Gun Storage System

A solid-state, standard, dual-gun electrostatic storage tube system has been introduced, which permits simultaneous writing and continuous reading of information.

Called the 223 Electrostore, it is so designed that one gun writes information on a storage screen element while the screen is being read by another gun. Erasure can be performed gradually at a controlled rate, or quickly in a small fraction of a second.

Controlled erasure, used with a radar-to-television conversion system, would permit target trails of a moving target to appear on the TV screen for speed and direction estimates.

Write Robert Gallagher, Image Instruments Inc., 2300 Washington St., Newton Lower Falls 62, Mass.

Circle Reader Service Card No. 67

Electrostatic Deflection CRT

A new series of large diameter cathode-ray tubes having electrostatic focus and deflection has been announced in diameters of 12, 16 and 19 inches.

The new tubes overcome many of the display limitations inherent in magnetically deflected CRTs, including large line-width, severe astigmatism, and deflection focusing. Pattern distortion and excessive demands on video and deflection amplifiers are materially reduced.

Write Electronic Tube Division, Du Mont Laboratories, divisions of Fairchild Camera and Instrument Corp., Clifton, N.J.

Circle Reader Service Card No. 68

Projection Oscilloscope

A new projection oscilloscope is available which can display dynamic wave forms, computer data readout, or any symbol that can be generated on a standard oscilloscope.

It can be used for either front or rear-screen projection for pictures from 28 in. up to 12 ft. wide. Separate inputs are afforded for the X, Y, and Z axes, ranging from 0.1 to 100.0 v with 100,000 ohm input impedance.

Write Dalto Electronics Corp., Norwood, N.J.

Circle Reader Service Card No. 69

Colored and Imbedded Lamps

Series of miniature lamps for information display devices featuring standard, unbased lamps completely imbedded in colored silicone rubber are now available from Master Dynamics.

Lamps are available in the T-¾, T-1, and T-1¾ types, using several manufacturer's lamps, in a variety of Mil-Spec colors for immediate delivery. For technical bulletin #3000, contact Art Graver, Sales Manager, Master Dynamics, 165 San Lazaro, Sunnyvale, Calif., or phone 408-245-9040.

Circle Reader Service Card No. 70

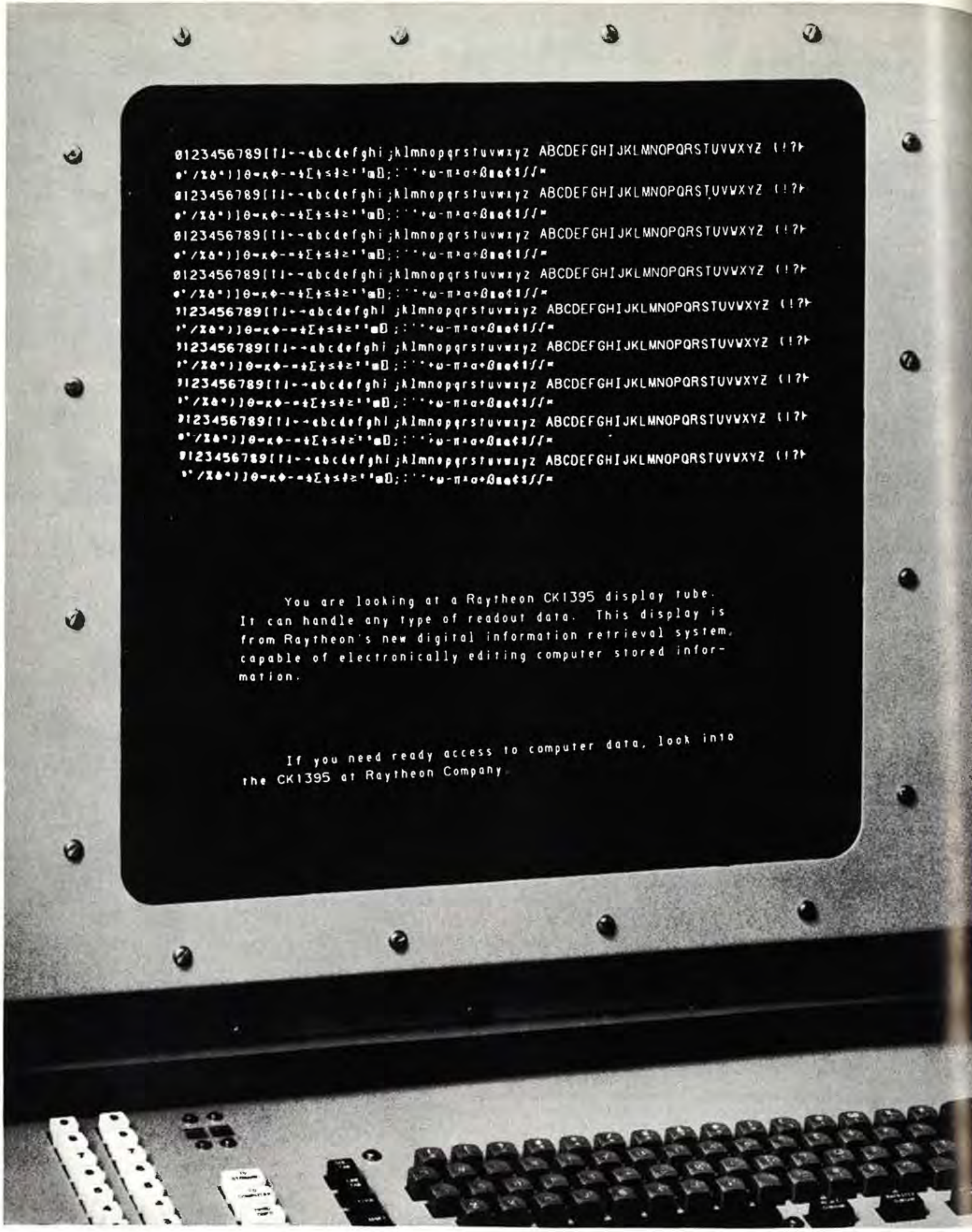
Magnet Pincushion Corrector

A compact permanent magnet pincushion corrector which removes geometrical distortions over an entire Cathode-Ray Tube surface without auxiliary power supply or control circuitry.

The stabilized magnet material from which it is fabricated has exceptional temperature and shock stability.

Write Syntronic Instruments, Inc., 100 Industrial Road. Addison, Ill.

Circle Reader Service Card No. 71



For complete information please write Raytheon Company, Components Division, Industrial Components Operation, Dept. 2011, Lexington, Massachusetts 02173.

RAYTHEON

Circle Reader Service Card No. 29

ID Products

Numeric Indicator Unit

New unit Model NC-4 can display 14 characters: 1 through 0, +, —, all off, all on. Numbers are formed on 27-lamp array, five across and seven high, with lamp sizes, ranging from 0.5 to 40 watts, available in five standard sizes.

Numercom indicators, designed for computer-output applications, are used in computer-controlled industrial plants, annunciator, traffic-control, scoreboard, and silent-paging systems, and other applications where instant information changes are required. Additional information is available from John S. Burton, Chief Engineer, Bloomingdale Instruments, 141 Oregon St., El Segundo, California, Phone (213) 772-2444.

Circle Reader Service Card No. 72

TV Sync Generator

Smallest yet available television sync generator has height of only 1¾ inches with a width of 8½ inches and length of 9¼ inches. Weight is 4 pounds. Featuring a self-contained solid-state regulated power supply, the new micrologic sync generator is used to produce standard EIA Synchronizing, blanking, and drive signals. The binary counter circuitry utilizes the micrologic elements, and the FR-2 has AFC circuitry with an optional provision for a crystal controlled oscillator.

Write Electro-Visual Department, Du Mont Laboratories, Clifton, New Jersey.

Circle Reader Service Card No. 73

New Exposure Photometer

Street Laboratory of Applied Physics has developed a new Type 80 exposure photometer of compact design, high accuracy, employing an entirely new type of photosensitive cell which is completely linear throughout its range. The photometer is available through Traid Corp.

Features, in addition to linear scale, include eight-position range selector, all solid-state electronics, 15,000:1 intensity range, built-in battery check and zero adjustment, high stability, and reading of reflected, incident, infrared, ground glass illumination.

Write Robert W. King, Manager, Photo Instrument Division, Traid Corp., P.O. Box 648, Encino, Calif. 91317.

Circle Reader Service Card No. 74

Solid State Oscilloscope

Monitor oscilloscope, Model KM702, is fully solid-state except for the cathode-ray tube; as a result it dissipates very little heat.

It offers 7-kilocycle full-screen undistorted deflection capability and 100 millivolt - per - centimeter input sensitivity. Oscilliscope sells for $1980 and is available from stock.

Contact Bo Jameson, Inst. Prod. Mgr., ITT Industrial Prod., 15191 Bledsoe, San Fernando, Calif.

Circle Reader Service Card No. 75

On The Move

Peter James has been appointed VP/Management Systems, The William C. Allen Corp. and **Rear Adm. John A. Fitzgerald,** USN-Ret., has been promoted from mgr., market research and business development, to VP/Admin., for the firm.

Raytheon Co. has appointed **Alan F. Dixon** mgr. of engrg. for its semiconductor operation at Mountain View, Cal.

The Bunker-Ramo Corp. has created a new General Engineering Laboratory and appointed **Scott G. Hasler,** director.

D. T. Jarvis has been named mgr. of mktg. for Advanced Scientific Instruments div. of Electro-Mechanical Research, Inc.

James N. Cast has been named Chief, Computer Development, for Telemetrics, Inc.

Electronic Tube div., General Atronics Corp., has named four new sls. representatives. The appointees are **Gawler-Knoop Co.,** Roseland, N.J.; **Glen M. Hathaway Electronics, Inc.,** Arlington, Mass.; **Kelly-Schmitz-Winkeler Associates,** Kansas City, Mo.; and **Sheridan Associates,** Cincinnati, O.

Hugh E. Webber has joined Sanders Associates, Inc., to fill the newly-created post of corporate director of research and techniques.

The Bunker-Ramo Corp. Defense Systems div. has opened a regional office in Dayton, O., with **J. J. Hooper** as midwest regional mgr. in charge of the office. Additionally, **James P. Boyle** has been named mktg. staff asst. for the firm's Industrial and Business Systems div.

General Dynamics Corp. has announced establishment of Stromberg-Carlson Corp., a consolidation of Dynamics' Stromberg-Carlson div., and the United States Instrument Corp. **Dause L. Bibby,** formerly pres. of the Stromberg-Carlson div., will continue as pres. of the new firm. **William A. Rockwood,** pres., USI, will be VP/mktg. and admin., and **John L. Lombardo** will be VP/engrg. and mfg.

David F. Sweeney has been elected VP/engrg., of Anelex Corp.

Frank M. Knox remains chairman of the reincorporated Knox International, which recently moved to new corporate headquarters at 70 Nassau St., Princeton, N.J., and incorporated in that state. The 33-year-old consultant firm was formerly known as The Frank M. Knox Corp., Intl., located in New York.

Thomas C. Rowan has been named VP of System Development Corp. As mgr. of the firm's Advanced Systems Div. he directs data processing activity.

G. A. Thayer has been appointed Coordinator of Personnel Development and Employment at Sylvania Electronic Systems. **B. W. Stryker** is mgr. of Personnel Administration for the division.

ID Authors

Dr. Raymond E. Bernberg

With Litton since June, 1964, Dr. Bernberg has been engaged in the fields of industrial psychology, human factors and systems engineering for the past 15 years. Previously, he was with Bissett-Berman Corp., RCA Data Systems Div. and North American. He is chairman of SID's Fifth National Symposium.

Royal Akin

Director of Engineering of Gamma Scientific, Inc., Mr. Akin has been engaged in design and development of electronic and electro-optical instruments for over 20 years. Prior to joining Gamma Scientific, he was a staff member at the Naval Electronics Laboratory, San Diego. Earlier work was with the Visibility Laboratory, Scripps Institution of Oceanography, and in the research laboratories at Bendix Corp. and RCA. Since 1962, he has been engaged in R&D of photometric and radiometric devices.

Robert C. Mullins (left)

A Senior Systems Analyst with a background of five years in programming displays, Mr. Mullins has been with Datatrol for the past three years. He was associated with the Department of Defense for seven years as an electronic engineer engaged in diagnostics and display generation. He studied at Omaha University and the University of Virginia. He is a member of SID.

James H. Dinwiddie (right)

A Systems Analyst currently engaged in a study of advanced programming techniques for computer assisted displays, Mr. Dinwiddie has been with the Datatrol Corporation since 1962. He has studied at the University of Maryland and was associated with the Department of Defense for seven years. He is a member of SID.

ID Advertisers

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Melbourne, Florida
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Data Products
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Sylvania Electronic Tubes
Div., Sylvania Electronic Products, Inc.
Seneca Falls, New York

INFORMATION

- **PROGRAM**
- **TRANSMIT**
- **DISPLAY**

United Aircraft Corporate Systems Center is producing a variety of data handling and display equipment.

***COMPIX* is a magnetic tape driven plotter which has unique pictorial capabilities for image processing, tone shading, and contour plotting. Alpha-numeric symbols of any size and type may be used to annotate curves and images. *COMPIX* is driven by medium to large scale digital computers, and produces fifty 12 x 18 inch plots per hour regardless of complexity.**

COMPIX

Display Transmission Generator

Facsimile Converter

United Aircraft Corporate Systems Center

United Aircraft

Circle Reader Service Card No. 37

If you really care what your data-display dollar is buying...

Take a cold, hard look at Milgo's New 30"x 30" Vertical-plotting X-Y Recorder.

Compare it for speed. Repeatability. Accuracy. Reliability. Plot visibility. Add-on flexibility. Versatility. Quality. Floor space. Delivery time.

The Milgo solid-state 4021D X-Y Recorder accepts on-line digital inputs from any digital computer; off-line inputs from magnetic tape, punched paper tape, punched cards, a manual keyboard or an analog source. The pen/printer draws lines, curves, and point-plots; it symbol prints with a 50 character symbol printer. Pen and symbol printer interchange electronically in milliseconds. The pen/printer has a slew of 30 ips, with a continuous writing speed of 20 ips. The pen/printer point-plots in either pen or symbol mode at 500 ppm. It prints a random selection alpha-numeric character at 300 per minute. The plotting surface is evenly back-lighted by a variable powerstat control. Plots are clearly visible for 10 feet or more. The complete unit only occupies a 50 by 18 inch floor space. The 4021D was developed and is produced to military standards of quality and

reliability. It is rugged and of modular construction. Installed and operating, it has the lowest feature-for-feature price tag of any 30 by 30 inch plotter available to industrial and commercial users.

Take a cold, hard look, for instance, at the symbol printer and its integral pen and inking system.* The complete unit is 1/3 to 1/4 smaller than competitive units. It has no dangling umbilical cord. Pens are low-mass, jewel-bearing suspended, solenoid actuated. Capillary action prevents spilling at any slew speed or acceleration, and the ink reserve can be filled without disassembly. Ink supply is indicated visually. The arm, only 1 1/4 inches wide, is servo-motor driven at both top and bottom. It is ball-bearing mounted on stainless steel rails, precision ground to within 0.004 inch. It allows accelerations of 400 ips^2 in both X and Y; provides static accuracy within ±0.05% of full scale, and repeatability of ±0.02%.

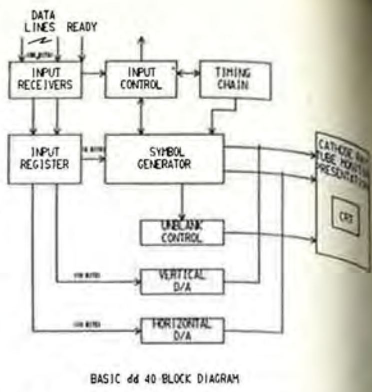
Milgo offers analog and/or digital recorders in vertical or horizontal models with plotting surfaces up to 45 x 60 inches. If you need to know what your "data-display dollar" can buy, call Tom Thorsen,

Marketing Department, at Milgo Electronic Corporation, 7620 N.W. 36th Avenue, Miami, Florida 33147. Phone: 305 691-1220. TWX: 305 696-4489.

*U. S. Patent No. 3,120,214.

milgo

Circle Reader Service Card No. 38



Actual display drawn by dd 40 of its own block diagram.

fast, flexible, functional - - - - dd 40

Designed for effective application to a wide range of display requirements, the dd 40 is a modular digitally driven CRT system offering high-speed performance at low cost. The basic system includes interface logic, symbol generator, display control logic and a 19-inch CRT monitor. Available options include:

- Vector and/or line drawing capability
- Tabular (typewriter-like) page format
- Parallel remote monitor(s)
- Buffer memory (for off-line display repetition)
- Camera recorder (for high speed data recording)
- Light pen, trackball, keyboard/function keys

fast

3,900 characters at a flicker-free rate (40 cps)
Approximately four-times the speed/capacity ratio of most display systems.

flexible

Varied character generation — many type fonts, straight and curved strokes, horizontal and vertical orientation, dim or bright symbols.
Capability of adding parallel "slave" units at low cost.
Ability to add a camera recorder, for permanent record of any display.

functional

Command and Control—Impact Prediction and Range Safety — Systems Simulation — Language Translation —Missile Systems Checkout and Monitoring.

DATA DISPLAY INCORPORATED
1820 COMO AVENUE • SAINT PAUL 8, MINNESOTA

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