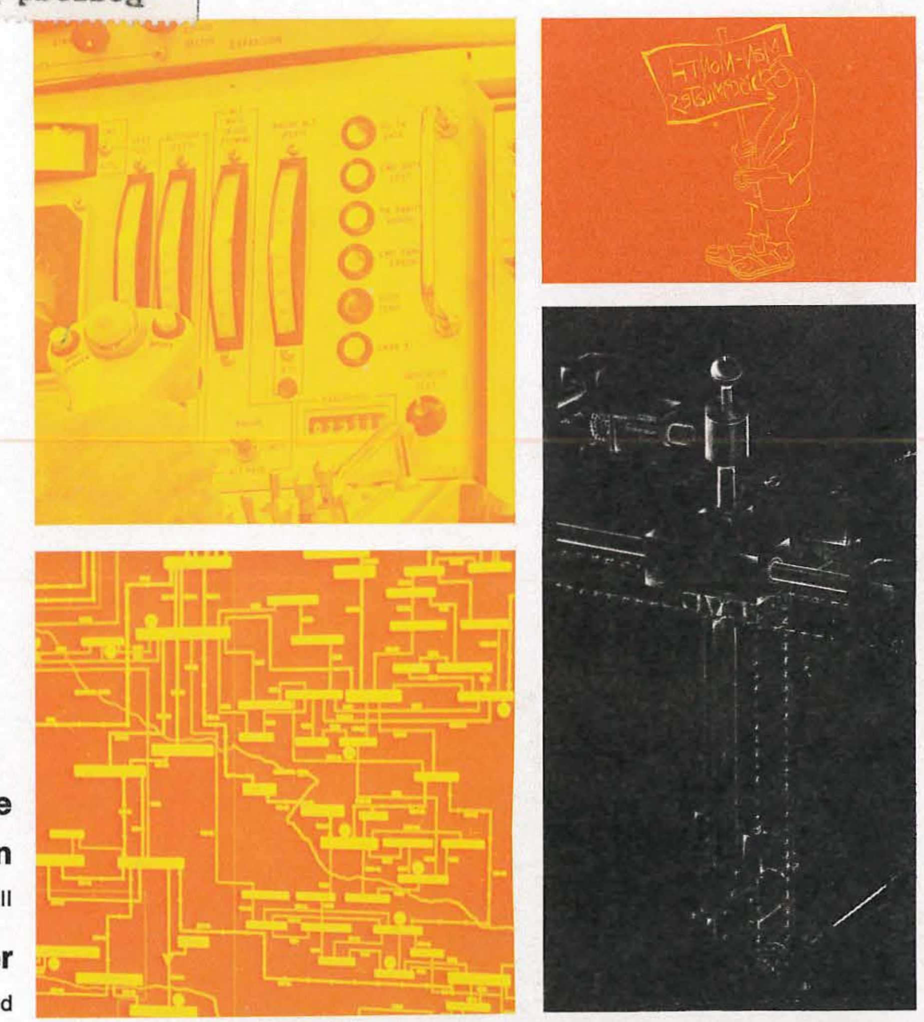
SID JOURNAL

The Official Journal of the Society For Information Display



TACTILE

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ENT'S MESSAGE PRESIDENT'S ME

A Commencement and Anniversary

The Society for Information Display evolved from a Display Course held ten years ago this month; SID was chartered in the early part of 1963. The Society approaches its tenth anniversary with a sense of accomplishment and strength in many areas—yet with the realization that some quality improvements, additional areas of involvement and a broader base of Membership from the display community remain as a challenge to be fulfilled.

During the past year, the Society has initiated the SID Journal with SID being responsible for complete editorial control. The Society is pleased with this beginning and is initiating plans to increase the SID JOURNAL'S value to readers and advertisers. The quarterly PROCEEDINGS OF THE SID has very effectively utilized guest editors for several of this year's issues. Sales of SID Publications, now being accomplished from the SID office, is providing expanded services to libraries and individuals; the response to a large library brochure mailing has been excellent.

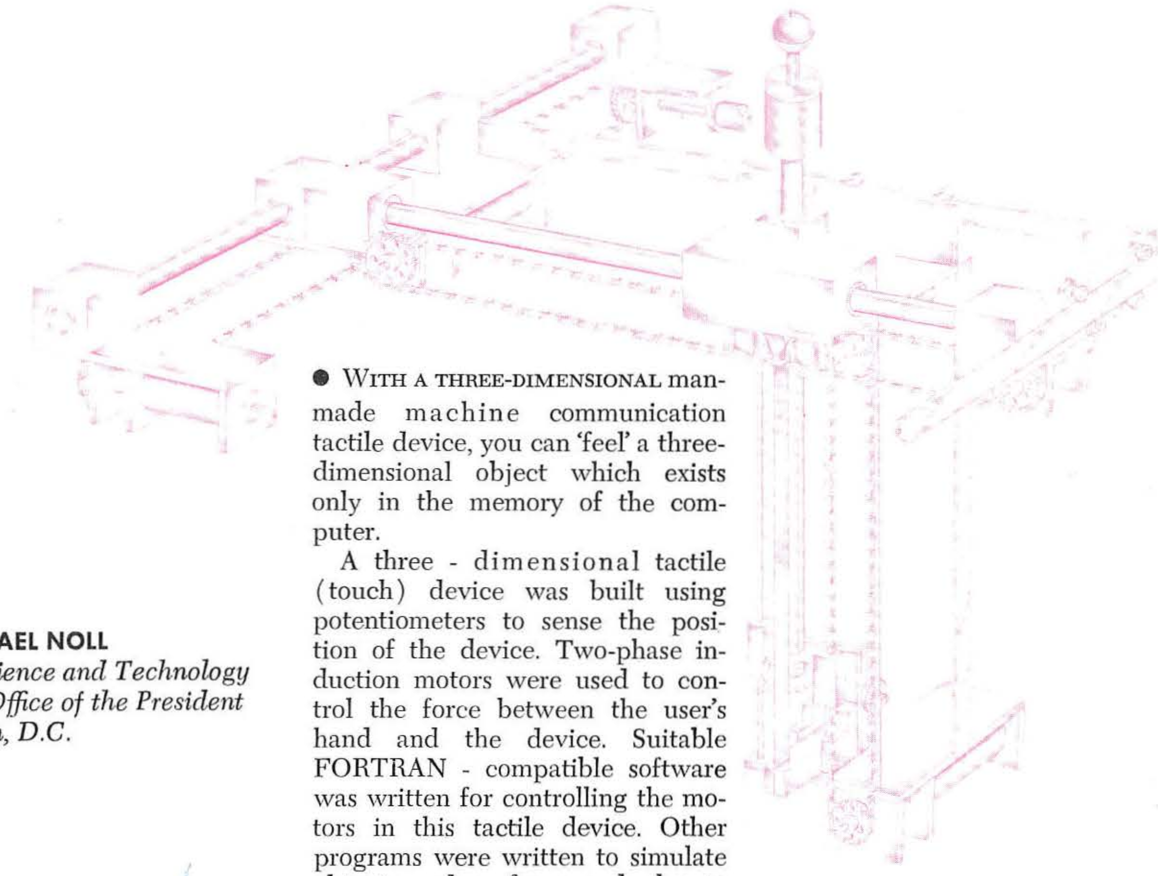
The 1972 SID International Symposium followed the continuing trend of improving quality with exceptional technical content and exhibits; over 800 attended from throughout the world. The 175-page Digest of the symposium's technical papers provides an up-to-date overview of the Information Display field; many full length papers will appear in future issues of the PROCEEDINGS OF THE SID.

My local chapter in San Diego will host SID's one-day Technical Meeting, "Display Update '73" on Friday, December 8, 1972. If you are interested in presenting a paper, let us know. Provide the title on the Membership Reply Card. San Diego is beautiful in December, so plan to come.

As outgoing SID President, it is a pleasure to report that the Society is financially healthy and Membership has increased slightly each of the past two years, in spite of the economic conditions. There is considerable activity at the chapter level and in the several SID committees. The Society achieved non-profit postal privileges—no small task, and automated its membership records—trust you weren't lost in the changeover.

I wish to convey my thanks to the Members for their support during the past two years and for the continuing enthusiasm I know will be provided to Dr. Carlo Crocetti, SID's newly elected President, as he launches into SID's second decade.

Phillip Damon
Past President



MAN-MACHINE TACTILE COMMUICATION

By A. MICHAEL NOLL
Office of Science and Technology
Executive Office of the President
Washington, D.C.

Man, using a simple tactile device, can feel and identify shapes and objects existing only in the memory of a computer. Possible applications are cited.

● WITH A THREE-DIMENSIONAL man-made machine communication tactile device, you can 'feel' a three-dimensional object which exists only in the memory of the computer.

A three-dimensional tactile (touch) device was built using potentiometers to sense the position of the device. Two-phase induction motors were used to control the force between the user's hand and the device. Suitable FORTRAN-compatible software was written for controlling the motors in this tactile device. Other programs were written to simulate objects and surfaces and also to position the tactile device at a specified point.

Results thus far suggest that tactile man-machine communication is useful for "depicting" surfaces and objects which would be virtually impossible to display visually. Man-machine tactile communication also has potential as a practical scheme for computer "graphics" for the blind. In addition, the non-blind have here a possible scheme for a better and totally different "feel" for computer graphics.

By A. MICHAEL NOLL

Introductory Remarks

ALTHOUGH ONE CAN JUSTIFY a negative impression towards using stereoscopy for most displays of scientific and technological data, stereoscopy sems to become more important in those fields which rely more heavily on graphical presentations, such as architecture and design.[1] However, even stereoscopic presentations sometimes do not seem sufficient for many man-machine communication applications in these fields. As an example, the designer needs a computer-controlled "something" to help him mold shapes or forms using his hands and the sensation of touch. Thus, the temptation grows to explore the potential of new sensory modalities as new communication channels between man and machine in applications where graphical communication would not be sufficient or appropriate. Perhaps the feeling that computer graphics has been given too much emphasis in its role as a form of man-machine communication is justified. The blind, for example, have learned how to develop and exploit all sorts of non-visual communication abilities so that they can live most effectively in an otherwise visually-oriented world.

The above-stated possible needs of the designer for tactile communication coupled with the experience gained in investigating and designing a three-dimensional input device for use in man-machine communication indicate that the tactile communication channel would perhaps be suitable as a new form of man-machine communication.[2] The three-dimensional input device helped the user specify the location of a point in a three-dimensional space in cartesian coordinates. If this device could be controlled by the computer so its resistance to motion could be varied, then the user would, in effect, be able to probe, by feel, the contents of a three-dimensional space. This probe would be only a single point and would be akin to poking around with a stick. It would hopefully be a significant test of the possible usefulness of a new man-machine communication channel. This tactile device could be used to augment the stereoscopic display for such tasks as latching on to a line or object in three dimensions. It could also be used in psychological investigations of interactions between the human tactile and visual communication channels. A tactile communication facility opens the door to a totally new man-machine communication channel.

Design of A Three-Dimensional Tactile Device

A COMPUTER HELPING AN individual feel some object which existed only in the memory of the computer could justifiably seem to be a "far-out" idea. One might imagine a computer-controlled, three-dimension, electromagnetic field with a hand-held ball suspended in the field as one possible implementation. But this is too esoteric. A down-to-earth hardware design is required to realistically evaluate man-machine tactile communication. Since a three-dimensional input device had already been designed and constructed, "simply" controlling the device so that the computer could vary the feel of the device, or even lock it in certain positions, seemed to be the best approach to the design of a tactile device.

What is envisioned thus far is a device consisting of a stick, free to move in three dimensions. The stick is constructed in the image of the three-dimensional input device so that motion in three dimensions has been mechanically separated. This device is shown in Fig. 1. Chains and sprocket drives of potentiometers would be used to sense the position of the stick-like portion of the device held by the user. The device might be requested to resist motion for those applications in which the user is bumping into the surface of an object. In other applications, the device might be requested to assist motion to overcome its own inertia and friction so as to move as freely as possible.

Clearly the source of force control of the device would therefore have to be able both to resist motion and to assist motion. A motor with an electrically-reversible direction of rotation meets these requirements. Three such motors connected to their own sprockets would supply the assistance or resistance to motion of the device. A linear force of about twelve pounds would be the required maximum force to simulate bumping into a fairly rigid object. Linear bearings would be used to minimize friction. More details about the final design of this tactile device form the remainder of the material in this section.

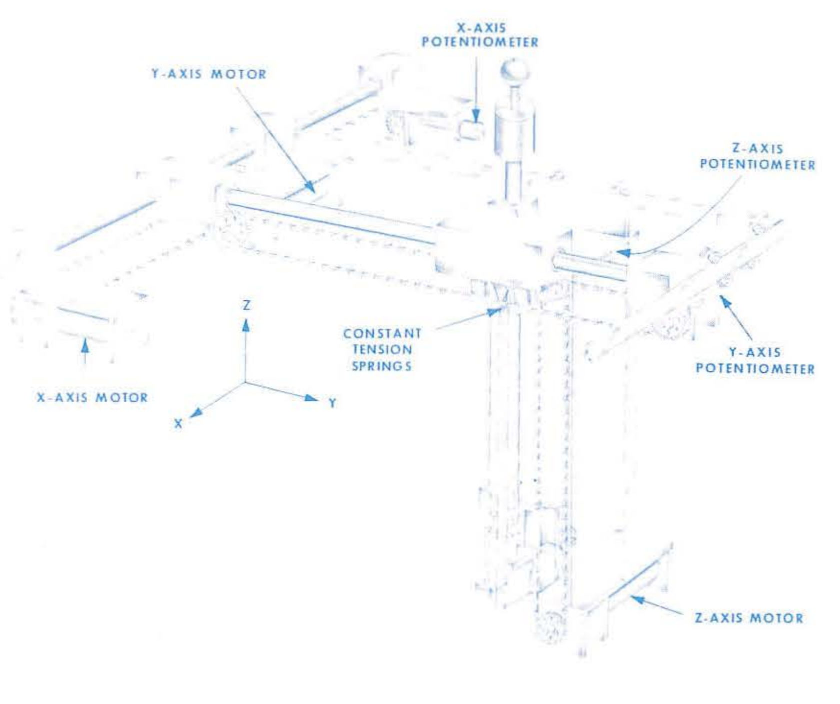
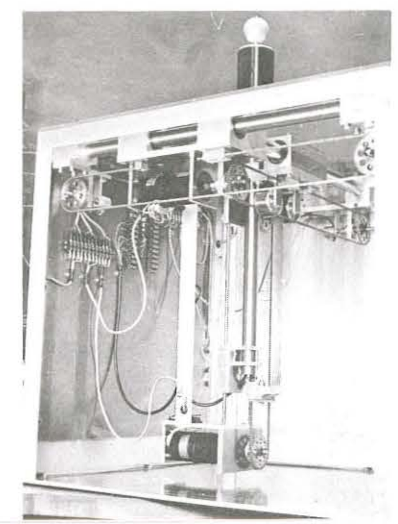


Fig. 1. Sketch of tactile device. The ball at the top of the vertical shaft can be moved within a 10-inch cubical space. The position of the ball is sensed by potentiometers while the force required to move the ball is controlled by motors.

The mechanical design requirement was imposed that the vertical shaft when fully extended would not deflect more than 0.015 inches in any direction under a maximum force of 12 pounds. A defection of 0.01 inches was determined experimentally to be just noticeable to the human hand so that this deflection requirement was most reasonable in these subjective terms.



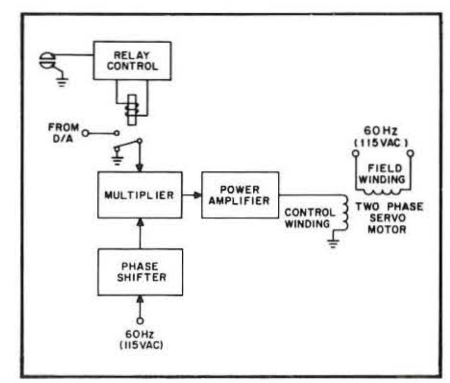


Fig. 2. Photograph of three-dimensional tactile device.

Fig. 3. Block diagram of motor control electronics. Separate phase shifters, multipliers, and power amplifiers are used for each of the three motors. The ball at the top of the tactile device has been split in half so that the user's fingers bridge the gap between the two halves and cause the relay control to operate. Thus, the user must be holding the ball for the motors to be energized.

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Equations for the maximum deflection of supported beams and cantilevers were used to calculate the theoretical deflections for the device when fully extended.[3-4] This theoretical analysis indicated that the shafts forming the major structural members of the device would have to be about 1 inch in diameter to meet the maximum-deflection requirement. A photograph of the interior of the device is shown in Fig. 2.

Two-phase 60-Hz 10-watt induction motors were used to supply the forces needed to control the tactile device. The direct-current outputs from three digital-to-analog converters used to control the motors are converted to 60-Hz voltages at phases of either +90 degrees or −90 degrees depending upon the desired directions of rotation. This dc to ac conversion is accomplished by multiplying the dc voltages by 60-Hz ac voltages which have been shifted 90 degrees relative to the field winding voltages, as shown in Fig. 3. The signs of the dc voltages are retained in the multiplications so that the directions of rotation of the motors can be controlled also. Power amplifiers produce the final voltages for input to the control winding of the motors.

The ball at the top of the vertical stick has been split into two electrically-isolated halves, with the bottom half at ground potential. The upper half of the ball is connected so that when the user's fingers bridge the gap between the two halves of the ball, relays connect the inputs to the multipliers to the output from the digital-to-analog converters. This serves as a "dead-man" safety mechanism to prevent possible injury to either the user or the device, due possibly to some programming error.

Programming and Experience in Using the Tactile Device

THE SOFTWARE REQUIRED for the tactile device must simply input the position of the device and output signals to control the motors. Since the position of the device is indicated by three potentiometers, a subroutine for inputting the value of a knob or potentiometer is called three times to input the values of the three potentiometers. The motor output is accomplished by a subroutine for simply outputting three numbers to the three digital-to-analog converters which control the three motors. Thus, the guiding philosophy of FORTRAN-callable subroutines for use in FORTRAN programs for real-time interactive man-machine tactile communication was preserved, and all the program described below were written in FORTRAN using these two subroutines for communication to and from the tactile device.

One of the simplest and perhaps most basic shapes is the sphere. The tactile device was programmed to simulate a rubbery sphere suspended in space. The three-dimensional coordinates, X, Y, and Z, of the position of the tactile device were inputted to the computer which then expressed these coordinates relative to the center of the sphere. The radius R of the position of the tactile device was then computed from these coordinates. If this radius were greater than or equal to the specified radius of the sphere (R_{SPHERE}) zero force was outputted to the motors, and the device could be moved freely. If this radius were less than the radius of the sphere, forces for the three motors were computed such that the resultant force F was proportional to the square of the distance moved into the sphere until the maximum force (F_{MAX}) was attained. The square of the distance was used since this choice gives a force with a nice feel.

Second Basic Shape

A SECOND BASIC SHAPE is the cube. The program for simulating a cube was a little more involved than that for the sphere program because to compute the force the program had to know along which axis the cube was approached. The cube was suspended in the three-dimensional space such that its faces were parallel to the three axis of movement of the tactile device. Thus, it was necessary to output a non-zero force to only one of the motors to simulate bumping into a face of the cube, while zero force was outputted to the other two motors.

The cube was simulated by first inputting the three-dimensional coordinates of the tactile device. These coordinates were then expressed relative to the center of the cube. If the tactile device were outside the cube, zero force was outputted to the three motors, and the computer determined along which axis the cube was being approached. As soon as a face of the cube was entered, a force proportional to the square of the distance moved into the face was calculated until the maximum force was attained. The width of this square-law force region was variable so that the sponginess of the cube could be varied.

Users Felt Their Way Around

THE TACTILE DEVICE was programmed to simulate an object with a cubical exterior and a spherical interior. The cube and the sphere algorithms were used for these shapes. A cylindrical hole at the top of the cube allowed the user to enter the spherical interior. However, once the interior was entered through this hole, the hole was closed, and the user had to exit through a cylindrical hole in the side of the sphere. However, once the interior was exited through this hole, the hole was closed, and the user could re-enter the interior only through the hole at the top of the cube.

The cube program was modified to present a stereoscopic display of the edges of the cube and a dot representing the position of the tactile device. This was done to disprove the hypothesis that the user's "feel" of the cube would be strengthened if the user could simultaneously "see" both the cube and the position of the tactile device. Most users looked at the stereoscopic display as they "felt" the cube. But, after a short time they abandoned the display and simply felt their way around the cube by feeling the edges, falling off the edges, and sliding along the faces. Thus one quickly concludes that stereoscopic display is not necessary as an adjunct to man-machine tactile communication.

Identifying the Shapes

USERS WERE ASKED TO IDENTIFY the sphere or cube by feel alone and without being told what objects were available in the repertoire. Most users had difficulties in correctly identifying the spongy sphere although they quickly identified the cube. The major source of difficulty with the sphere was that the users nearly always slid off the surface since the sphere had a convex surface when felt from the outside. This difficulty did not occur with the sphere-within-a-cube since the inside of the sphere was a concave surface. Most users were able to explore the sphere-within-a-cube and correctly identify it along with the one-way cylindrical spaces joining the outside and inside.

Residual magnetism in the motors and leakage in the multipliers produced rotational resistance in the motors. This rotational resistance was increased by the gear train and, together with bearing friction, produced enough friction that nearly a half pound of force was required to move the tactile device. This was most bothersome to the users. Friction manifests itself in the differential equation governing motion of the device as a term proportional to velocity in a direction opposing motion. To overcome this friction, the first differences of the position of the device were computed and used as an approximation to the three-dimensional velocity of the device. These first differences were then multiplied by suitable experimentally determined constants, and the results were outputted to the motors in directions to assist movement of the device. These consants were the same for all three axes which was expected since the friction theoretically should be independent of direction. This velocity-dependent movement assist greatly increased the ease with which the device could be moved about.

Control of the Tactile Device

IN SOME APPLICATIONS, the tactile device might be required to remain at a specified fixed location in one or more of the three dimensions. If the user attempts to move the device, a restoring force must be applied to attempt to return the device to the desired position. The determination of this restoration force is a control problem. Although considerable information is available concerning the optimal control of some device, most of this information is theoretical and avoids practical problems.[5-6] Hence, a common-sense control law, combining optimal bang-bang control and linear control, was used as described below.

Control Law

If u represents the error in position of the device and $\dot{u}$ the velocity of the device to the origin of the $(u, \dot{u})$ plane. When approaching the origin, the device has an energy $c_1\dot{u}^2 + c_2u^2$. If a linear damped control law is used in a region near the origin such that $c_1\dot{u}^2 + c_2u^2 < E_{max}$, then the energy must decrease until finally the device stabilizes at the origin. Thus, a control law was programmed which applies optimal bang-bang switching if the state $(u, \dot{u})$ of the device is outside an elliptical region centered about the origin. If the state is inside this elliptical region, the motor control is $f = -k_1u - k_2\dot{u}$. With this procedure k_1 could be made large to give a large restoration force while the energy constraint could be chosen to insure that $|f| \leq N$ so that saturation would not occur. This control procedure was programmed with the time delay correction, but the best performance was achieved by removing the delay correction. The computer plotted the state space of the device defined by u and $\dot{u}$ so c_1 and c_2 could be easily determined by varying two knobs to produce a good trajectory to the origin. If the user moves the device, his hand feels a linear restoring force. No chatter or oscillation is present.

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Future Possible Applications

THE WORK THUS FAR completed indicates that man using a conceptually simple tactile device can feel and identify shapes and objects existing only in the memory of a computer. Furthermore, the tactile device can be positioned by the computer to remain at a prescribed point. This demonstrates that the computer can be programmed to restrain the tactile device so that it can be freely moved by man over only a prescribed three-dimensional path or surface. These might seem to be meager results for extrapolating all sorts of possible future applications for tactile communication, in addition to predicting vastly more elaborate tactile communication devices. However, past experience strongly implies that science and technology have a startling ability to develop whole new fields with such unbelievable speed and in such completely unexpected ways that even the wildest extrapolations and predictions based upon present results usually seem conservative in a few years.

'Like Blind Man'

The tactile device presently constructed is concerned with computer control of the force felt at only one point within a three-dimensional space. This situation is similar to a blind person exploring and poking around three-dimensional shapes and objects with the tip of a hand-held pencil. It is most tempting to drop the pencil and grasp the object or feel the shape with one's complete hand and the tips of five human fingers. This would be possible with a computer-controlled tactile device which consisted of individual force control mechanisms for each finger and electronic or mechanical "things" for each finger tip in addition to mechanisms for controlling the overall motion of the complete hand. With such a future tactile device man could grasp objects and feel the surface texture of objects which existed only as equations or arrays of numbers in the memory of the computer.

The present and future devices for obtaining tactile communication from the computer could be augmented using a three-dimensional helmet-type display similar to that presently being used for computer-generated displays.[7] A mechanical linkage attached to the helmet senses the position of the helmet, and if the position has changed the computer recalculates the steroscopic display on the face of the two tubes. The display on the two tubes is seen by the user through half-silvered mirrors so that the external environment is also visible. In this way, the user might conceivably place his hand in the mechanism that is used for the tactile communication with the computer, and at the same time see both his hand and the computer-generated display. As an example, the user might see a computer-generated three-dimensional cube superimposed on a physical table. He could then move his hand towards the cube, feel the cube, grasp the cube through the force feedback from the tactile device, and even lift the cube from the table and feel its weight.

But what practical uses would there be for a system as elaborate as the preceding, or for that matter what possible uses would there even be for the simple man-machine tactile device described in this paper? One important use was mentioned before: namely, aiding and augmenting the "feel" of conventional man-machine communication through computer graphics so that when one latches onto an object in a display he also physically feels the latching on. Many psychological experiments come to mind that might investigate deliberately introduced clashes and offsets between the tactile and visual communication channels or the ability of a subject to identify objects by feel alone.

Hand-and-Fingers

A tactile communication device involving both the hand and the fingers would be an extremely useful design tool. With it one would be able to investigate the reaction of subjects to three-dimensional shapes and objects which could be simulated on the computer, for instance, a new design for a telephone handset. The manual dexterity of different individuals in performing assembly tasks could be scientifically investigated with computer-simulated objects, thereby resulting in an optimization of the design of an object from both an aesthetic and a functional viewpoint.

Aid to Handicapped

Perhaps the most humanistic use for a tactile communication device is as an aid for the handicapped in communicating with computers. A segment of humanity exists for whom the term "computer graphics" and all the comments about the desirability of man-machine graphical communication are completely meaningless — namely, the blind. With a tactile communication channel the blind would be able to feel the shape of graphs and other curves and surfaces and even objects. As a simple example, a blind person might hold the present tactile device while the device would be constrained by the computer so that it could be freely moved only along a prescribed three-dimensional surface or curve. If humans gifted with sight are able to identify shapes and objects by feel alone using the present tactile device, then the blind with their highly developed sense of touch and tactile memory abilities should perform significantly better.

Could 'Feel' Textiles

Perhaps the second most humanistic use for tactile communication is for communication from man to man and possibly, but not necessarily, involving computers as some form of intermediary. For this application, two humans located at two physically separate locations each with a tactile device would communicate with each other using the tactile devices and a communications network to link together the two devices. As a possible practical application a purchaser of cloth located in New York City could feel the texture of cloth produced by a textile manufacturer in Tokyo without physically transporting any cloth anywhere. A man-to-man tactile communication facility could certainly be augmented and coupled with facilities for the transmission of sound and images. Thus, the senses of vision, hearing, and touch would have been extended over great physical distances, and "teleportation" in one sense would be closer to reality.

Future Directions of Research

A two-dimensional tactile device has been constructed by experimenters at the University of North Carolina.[8] They used their device to demonstrate that force output from the computer can help students better "visualize" concepts in elementary electromagnetic fields. The tactile device described in this paper applies reasonably large forces in three dimensions and could be used to further study the usefulness of tactile communication as an educational tool. The usefulness of man-machine tactile communication as an aid to the blind must likewise be evaluated through carefully-controlled experiments using sighted subjects as a control group. Similarly, tactile communication must be evaluated for its usefulness in supplementing three-dimensional man-machine graphical communication. A unique opportunity exists here to evaluate the effectiveness of computer graphics for man-machine communication now that an alternative form of man-machine communication has been created using the tactile device.

Psychological intersensory conflict experiments introducing deliberate distortions of the visual field have been conducted in the past.[9] With the tactile device it would become possible to introduce independent distortions between the visual channel and the tactile channel. The tactile device using a three-dimensional force-measuring mechanism to determine the force exerted by the user's hand in moving the device might be used in investigations of motor skills involving hand movement. Thus, the tactile device could easily be the common tool in a host of new areas of investigations by perceptual and motor-skill psychologists.

In the hardware area, the design and implementation of a new tactile device embodying control of the five fingers through hydraulic mechanisms would allow the user to grasp and feel objects by program control. This ability would be most useful to designers. Such a device could be used to evaluate newly designed objects by simulating the physical feel and shape of the objects.

a. Further Thoughts on Tactile Communication

THE GRAPHICAL REPRESENTATION of complicated surfaces and solid objects has always been extremely difficult even using stereoscopic techniques. Grid lines could be drawn along the surface at regular intervals or dots could be scattered at random on the surface. Either way a considerable number of points would be required to represent adequately a surface with fine or complicated details, and large numbers of points create display problems in terms of flicker and interactive problems in terms of computation time. If one portion of the surface hides another portion then yet other problems arise in terms of the suitable graphical representation of the hidden surface. A stereoscopic display of the complete surface including the hidden portion is sometimes reasonably suitable, and the depth perceptive abilities of the viewer help him to separate in depth the different portions of the surface.

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All these problems are completely circumvented when tactile communication is used to represent surfaces and objects, since the computer has to be concerned only with the position of the tactile device which is a single point in three-dimensional space. However, with a visual display the computer has to be concerned with the complete surface in all its fine and global details. With tactile communication the computer need only determine whether the tactile device is or is not "touching" the surface. The computer in effect can be concerned with all the fine details of the surface since it does not have to be concerned simultaneously with the global aspects of the surface also. Thus, tactile communication is most suitable for representing complicated surfaces and objects which would be far too detailed to represent graphically.

Man-machine tactile communication therefore emerges not as a supplement for computer-generated visual displays but primarily as an entirely-new man-machine communication medium or channel of vast importance for its own unique abilities to represent surfaces and objects. The tactile channel is a competitor to the visual channel, and this situation is something new to the field of computer science.

Epilogue

In 1932, Aldous Huxley wrote in *Brave New World* of a future entertainment medium which he called "An All-Super-Singing, Synthetic-Talking, Coloured, Stereo-

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about the author

A. Michael Noll, Ph.D. (E.E.) is on the staff of the Office of Science and Technology of the Executive Office of the President, Washington, D.C., a post he came to from ten years with Bell Telephone Labs, Murray Hill (N.J.). There, he was early concerned with computer simulations and investigations of short-time spectrum analysis and the cepstrum method for vocal pitch determination. His interests also included computer-generated 3-dimensional displays of data, application of computer technology to the visual arts and psychological investigations of human reactions to pseudo-random patterns. At the time he left Bell Labs in 1971 he was exploring more effective forms of man-machine communication, including real-time 3-dimensional computer graphics and tactile communication. He has been widely published and his "computer art" has been exhibited throughout the world and shown on network television. He holds four patents in automatic speech production. He is the recipient of numerous degrees and honors. He is a native of New Jersey.

800 at S. F. Symposium Hear 60 Papers Given

Remember when displays used to be the peripherals of a COMPUTER? Now many information experts consider the computer to be a peripheral of DISPLAYS.

Over 800 professionals in the field of Information Display attended the 1972 International Symposium and Exhibition held by SID at the Jack Tar Hotel in San Francisco June 6-8. At this highly successful annual meeting, over 60 papers describing the latest in Display Technology, Applications and Human Factors considerations were presented. In addition to US authors, specialists from Germany, Japan, England, and Australia presented papers on their technology.

The Symposium was formally opened by Herb Hendrickson of Philco WDL, General Chairman of SID 72 and J. H. Becker, Xerox, Program Chairman SID 72.

A short, efficiently-run annual business meeting was conducted by the incoming SID President, Dr. Carlo Crocetti, of RADC, followed by the Honor and Awards presentations. To round out this opening session, Herb Hendrickson presented an award for the Best Paper presented at the 1971 SID Symposium. Nine authors from Xerox collaborated on this award-winning paper.

For the keynote address, a man familiar to most SID members, Dr. H. R. Luxenberg, of California State University, Chico, discussed "The Impact of Information Display on Society." In a provocative talk interrupted from the floor for questions and discussion, Luxenberg defined information display in an all-encompassing definition as "any system, device, item or medium, by or through which information from any source may be or is being presented." And, from Archie Bunker to Marshall McLuhan, this impact on Society is overwhelming.

In the technical sessions, seven papers on Plasma Display, and eleven on Liquid Crystal Displays were presented. Other featured topics were: Solid State Display Technology, Display Consoles, Software for Display Terminals, CRT Devices, Display and Processors, Driving and Access Circuitry, Visual Phenomena and Unique Peripheral Equipment.

Because of the large number of papers presented at the three-day meeting, simultaneous sessions were held. Luckily, the two lecture rooms were adjacent, to make it easy to attend the lecture which most interested one in each of the sessions.

A number of well-attended and interesting informal discussions were held on two nights. "Numeric Displays; Which and Why," moderated by Alan Sobel, Zenith; "Image Storage in Display Terminals," with Bernie Lechner, RCA Labs; and "Developments in Large Scale Information Processing and Display Systems," moderated by P. Reimers, Library of Congress, were held Tuesday night.

The following evening, Eric Swarthe, National Bureau of Standards, chaired a session on "Interactive Cable TV; Can it Meet the Challenge?" E. Sutherland, Trans-A-File Systems Co., moderated a session on "Interfacing with Human Factors"; and Anthony Debons, University of Pittsburgh, led a discussion on "Need for Information Presentation Theory to Evaluate Role and Purpose of Displays in Man Machine Systems." Each of the moderators was ably supported by a panel of experts.

The exhibits, located adjacent to the meeting rooms, were well attended. The SID booth, manned by Violet Puff, National Office Manager and a number of volunteer SID members, was kept busy signing up and personally welcoming over 200 new members to SID at the Symposium.

A tremendous amount of valuable information was produced and disseminated at this three-day meeting. A list of all papers presented is published in the centerfold of the May-June issue of SID JOURNAL. Full-length versions of many of the papers will be published in future issues of the Sid Proceedings and SID JOURNAL. Authors are encouraged to contact the Publications Chairman at the SID National Office to make arrangements for publishing their papers.

(The 1972 Digest of Technical Papers has been published and can be purchased from the SID National Office. The Digest contains two-page abstracts of the papers presented. The price of the 72 Digest is $10.00 to members, $15.00 to non-members).

It is difficult to personally acknowledge everyone who contributed to the huge success of the 72 Symposium. To all of those who worked so hard, SID expresses sincere thanks and the hope that many of you will continue to help in future Symposiums.

The next SID Technical meeting will be held in San Diego, California, December 8, 1972. An announcement on this meeting is included elsewhere in this issue.

Make your plans now to attend the next annual International Symposium and Exhibition, SID 73, to be held at the Statler Hilton Hotel, New York City, May 15-17, 1973—

H. BJELLAND, Editor

200-Plus New Members Joined SID at S.F.

Well in excess of 200 new members joined the Society for Information Display during, or as a result of, the 1972 International Symposium. The final total of new members attributable to event may exceed 250, according to SID National Office Manager Violet Puff. Largest previous new-member sign-up took place at the 1971 Symposium, and was just over 100. Dr. Carlo P. Crocetti, new President of SID, expressed strong satisfaction and commented that the sign-up "certainly demonstrates enthusiasm and growth and shows that the Society for Information Display is fulfilling a long-felt need."

KEYNOTE SPEAKER

H. R. Luxenberg, Professor of Computer Science, California State University, Chico. Topic of Dr. Luxenberg's address was "The Impact of Information Display on Society".

SID 1972-73 Officers

The following officers were elected for the year 1972-73 at the June International Symposium of the Society for Information Display.

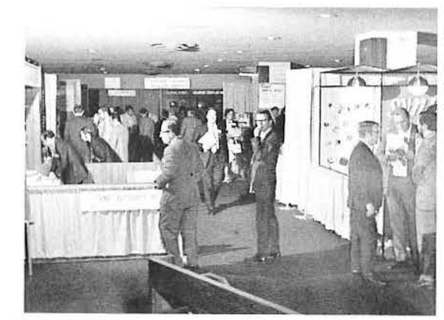
Dr. Carlo P. Crocetti, President, Rome Air Force Development Ctr, Griffiss AFB, New York; Robert C. Klein, Vice Pres., Kollsman Instrument Corp., Syosett, New York; Erwin A. Ulbrich, Secretary, McDonnell-Douglas / Astro, Huntington Beach, Ca.; Robert C. Knepper, Treasurer, Hughes Aircraft Co., Fullerton, Ca.

Directors: New England Chapter, Daniel Enxing; Los Angeles Chapter, Thomas V. Curran; Delaware Valley Chapter, Bernard J. Lechner.

Regional Directors: Central: Marlin Noffke, Sam Yanagisawa. Northeast: Daniel Enxing, Bernard Lechner, Sol Sherr. Southeast: John Edgbert, Stewart Finley. Western: Thomas Curran, Harold Field, James Wurtz. Director at Large: Phillip Damon.

Violet Puff is National Office Manager of SID with headquarters at 654 No. Sepulveda Blvd., Los Angeles.

SID members were queried: (a) are you in favor of a membership directory available to members only? (b) If such a directory were published, would you desire that your name be included? *Both questions were answered "yes" by a substantial majority of members.* A further question (c) Would you purchase such a directory at $2.00? *was answered "yes" by a very narrow margin.*



Herb Hendrickson, left, presenting the award for the outstanding paper at the 1971 SID Symposium. Receiving the award are: L to R W. E. Haas, G. A. Dir and J. H. Becker. A total of 9 authors contributed to this prize winning paper. Authors not pictured are: J. J. Wysocki, R. W. Madrid, J. E. Adams, L. B. Leder, B. Mechlowitz and F. D. Saera. All 9 authors are with the Xerox Corp.

Phil Damon, second from right, congratulates the newly elected SID President, Dr. Carlo Crocetti. Looking on (L to R) are new elected officers: Robert Knepper —Treasurer, Edwin Ulbrich—Secretary, and Robert Klein, Vice President.

Admiring the inagural issue of the new SID Journal, May-June 1972, are Bob Klein, Dr. Crocetti, Robert Black, Publisher, Phil Damon and Harley Bjelland, SID Journal Editor.

Phil Damon (right) SID President 1970-1972, receives a gavel in appreciation of his outstanding service to SID from Dr. Carlo Crocetti, incoming SID President.

A view of a few of the booths in the busy exhibitor area adjacent to the lecture rooms.

Dr. Anthony Debons, Chairman of the SID Honors and Awards Committee, presents an award to Sol Sherr for 'Outstanding Achievement in Literature'.

Recipient of the award for Fellow of the Society is Pierce Siglin, U.S.A.E. Com. Presenting the award is Phil Damon.

The 1972 Digest of Technical Papers being admired by (L to R) Bob Klein, Dr. Crocetti, Lew Winner, Digest Editor, Symposium Consultant and Exhibit Manager and Phil Damon. The Digest can be purchased from the SID National Office.

people POWER

Don't look now, but Section 13, Page 12,105, column C, paragraph 66, line 1 of the 1966 Civil Rights Act may be sneaking up on you.

By HARLEY L. BJELLAND

Hughes Aircraft Co.

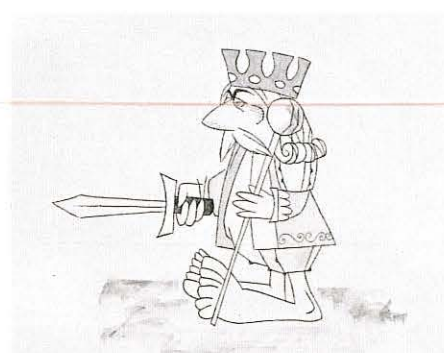
Culver City, California

● The word *Man*-Month now has been officially outlawed by the U.S. government and declared to be "highly discriminatory". According to the 1966 Civil Rights Act, Section 13, page 12,105, column C, paragraph 66, line 1, employers(ees) are forbidden to discriminate against (or for) women. *Man*-Month is clearly discriminatory, offensive and must be eliminated. Woman-Month is equally discriminatory, so a new, universal, innocuous, neuter word must be found to be applied in scheduling and estimating Manpower (that word's gotta go, too).

The Man-Month, or one man working for one month, has been extremely useful in business and industry to estimate the work required to accomplish a specific task, to plan and monitor work schedules, to keep track of expenditures, whether the project be to edit and print a magazine or to design and build a supersonic jet. However, with the government-legislated equality of the sexes, a Man-Month could just as well be a woman working for one month. Since progress is inevitable, we must change our vocabularies and eliminate such highly offensive and discriminatory words.

In a comprehensive search for a new, sexless unit of power, a number of possibilities come to mind. People-Month is the first obvious one, Person-Month another. However, neither of these has any class. But, wait! Maybe we should be bold in this age of rapid changes and examine the total problem of people power in business. (I will use people power only as a working term until I further develop my thesis.)

First, let's start with the basic unit of time, the month. Actually, the month is a quite meaningless, uneven and useless unit of time. It was derived only to chop our year into a dozen, nearly equal parts. (The unit "dozen" is another useless unit that was dictated, legend has it, by King Zunk of England in 1302, some claim in 1203, who was proud of his 12 toes. Thank God for the later Vice Admiral Horatio Glutz Dewey who, blessed with 10 toes, gave us our digital system —also our Dewey Decimal System.)



A much more logical unit of time is the lunar phase or moon phase. There are, however, three types of lunar phases or lunar months: the synodic of 29.531 days; the anomalistic of 27.555 days, and the draconic of 27.212. However, this minor detail can be worked out later and the user has the option of choosing whichever he prefers. The draconic is preferred by computer programmers, the synodic by abacus operators, the anomalistic, because of the repetitive 555, is preferred by calculator operators.

Scientists have proved that a man, much like a woman, is on a 28-day cycle. This also lends further credence to the equality of man and woman. I have verified this cycle personally—by recording my predominant mood for a period of 28 days and found that, during the next 28-day cycle, my moods were repeated with astonishing accuracy. If I were depressed on the 11th day of the first 28-day cycle, I was also depressed on the 11th day of the second 28-day cycle. The reader is urged to verify this cycle. (This cycle is not valid for children under the age of 12. Some of them seem to be capable of a continuous period of 28 days of meanness. This is also true with a limited number of adults.)

SOCIAL IMPLICATIONS — Contrary to public opinion, engineers do indeed respond to the social issues of our time. This response, sometimes explosive, is illustrated by the effect that outlawing 'Man-month' had on the author of People Power.

A moon phase is also helpful as a quick schedule check. When you leave work at night, just check to see if the moon is in it ¼, ½, ¾ or full phase and you can tell if you are behind or on schedule. (Notice, I didn't say ahead, since I could not find any record of this occurring in all of the annals of business.)

So what more logical unit of time could be used than a lunar phase? Let's call it a LUPH (LUnar PHase) for short (pronounced loof). (LUPH is also only a working term that must be displaced later in the article by a less euphonious word, since loof is too close to loaf. Do *not* use the pronounciation "luff", since this nautical term suggests an aimless flapping of sails.)

Next the *man* part of the Man-Month must be dealt with. It seems that, for so many of the gigantic projects under way (and things are getting still bigger), a unit person performing a unit function is much too small. A larger unit is needed. A number of possibilities to describe a group of white-collar workers are: assembly, congregation, outfit, tribe, mob, crowd, horde, host, bunch, mass, lump, batch and throng. As a worker, I personally feel the last is the most descriptive. Throng has a musical, pleasant sound to it, and should dynamically describe a dynamic group of dynamic white-collar workers. I therefore propose that "throng" be adopted for this unit. I further define a throng as, roughly, a third of a building full of white-collar workers, regardless of size. A throng can be easily expressed in larger and smaller groups by using the microthrong (one millionth of a throng, which is the power contained in the knuckle of the left ring finger) to a megathrong (a million throngs, which is the Mohammendan unit of people required to move a small, rocky mountain). This is much preferred to the typical methods of subdivision used such as: 11 throngs = 1 mob; 17 mobs = 1 horde, and 24 hordes = 1 host.

So now we end up with a luphthrong (or a throngluph), both of which are thoroughly unwieldy and cacophonious terms. Fortunately, a synonym for moon, or lune, can be obtained from the ancient Xerfot language. The synonym is "XaP", which, when translated to the American language becomes "drip". Dropping the "r" in the interest of brevity and sound, the new, universal term becomes "dipthrong".

A dipthrong then combines the outlawed manpower and womanpower into one socially acceptable, governmentally permissible, euphonious, neuter unit of People Power. Again, as a point of reference, a microdipthrong is equivalent to a sneeze, a megadipthrong can move a small, rocky mountain in a fortnit.

Next we must deal with the factory workers. A horde, a bunch, a heap, a mob, a swad and host loom as possibilities. Personally, at first, I preferred to use the word "crowd". However, when I discussed this with my coworkers, most of them interpreted the unit of crowd as being a trio because of the ancient Alsatian Indian saying, "An accumulation of three personnel constitutes a crowd."

After considerable cogitation, knuckle-cracking, some sleep and much discussion, I would suggest that the word "herd" would be ideal. However, since the unit "herdluph" (or luphherd) is unwieldy and nonmusical, we can turn this time to the ancient Maesopian tongue for a synonym for moon or lune. The word is "Zbtp", which, when phonetically translated to the American tongue, becomes "ship".

The universal time-power of factory labor then becomes shipherd (not to be confused with a sheep keeper). A shipherd is a factory full of people, regardless of size. To give you a point of reference, a micro-shipherd is the power required to snap closed the jaws of a 6-inch pliers, and megashipherd can move three, medium-sized sandy mountains.

You will note that throughout this dissertation I have assiduously avoided equating the number of people (or warm bodies as some in the trade would call it) with the new, universal units. This is in accordance with Parkinson's Law, which, slightly paraphased, states, "The number of workers and the quantity of work are not related to each other at all. The rise in the total of those employed is the same whether the quantity of the work were to increase, diminish or even disappear." This is why we must deal in throngs and herds rather than the quantity of white-collar or factory workers. People come and go, but factories

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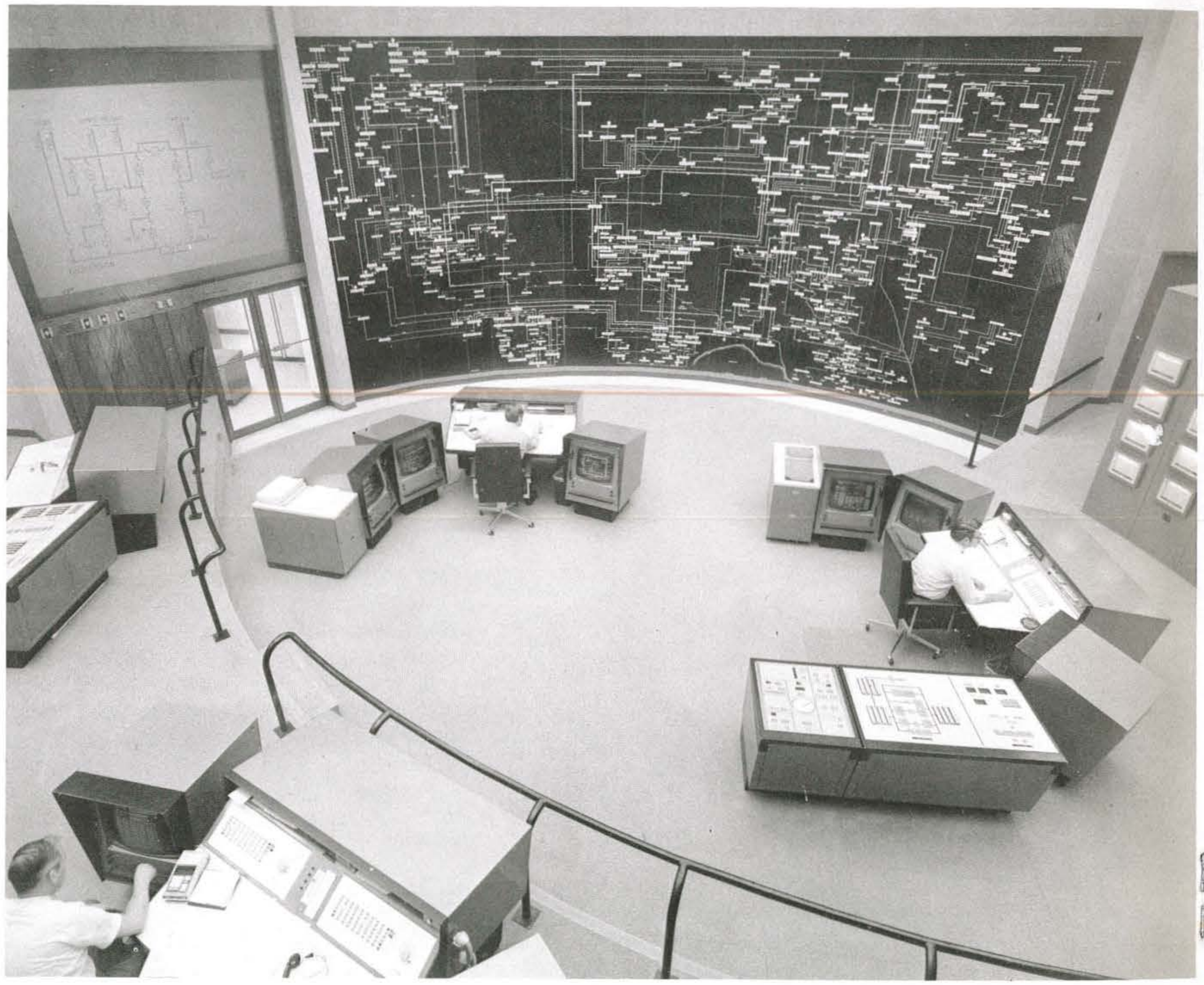
CONTROL CENTER

By JOHN E. BRAUN and
H. GORDON STEWART

At An Electrical Power Interconnection Control Center



Visual display is crucial. The intent is to furnish information which can be quickly understood and aid the operator in making optimal decisions quickly.

● THIS PAPER DESCRIBES the graphic display system which controls the Digital TVs associated with the computer/telecommunications real-time system installed at the Pennsylvania-New Jersey-Maryland (PJM) Interconnection Control Center. Figures 1 through 6 depict the facility at which the subject graphic system is being utilized. This system has been used effectively for more than a year for monitoring, controlling, and evaluating an interconnected network of electric utility companies. Design concepts and general considerations are reviewed.

Photo at Left — Within the Control Center, the Control Room facilities are manned around the clock by a crew of three power system dispatchers.

Introduction

THE INTRINSIC VALUE of any tool is in its adaptation to the task and the operator's skill in its use. The adaptation of a computer/telecommunications real-time system for controlling, monitoring, and simulating large complex systems such as an electrical power system has been well proven. This fact is attested to by the electric power industry's widespread use of these computing devices today. However, the complexity of the required real-time systems and the enormity of the task that these systems are addressing requires that special attention be placed on the man-machine interface. The design of a viable graphic display system will provide the power system operating personnel the means of applying the tool with the skill required.

The Digital TV (DTV) is one means of providing the required man-machine communications. It provides a display capability that facilitates rapid presentation of alphanumeric and graphic information. When combined with a light pen, it provides an equally rapid and flexible means of modifying computer information.

Graphic Display Considerations

THE GRAPHIC DISPLAY system should be designed to give operating personnel the best overall view of system conditions as well as the ability to examine selected areas of the system in detail. The displays may be in the form of preformatted messages, diagrams or tabular information programmed to occur under specified conditions. On occasion, the operator may desire specific information to be displayed such as selected line loadings, station generation and the like. It may also be desirable not only to display information from the computer system, but also to use the same display devices to input information into the computer. Whatever the needs, the information must readily be available, easy to assimilate and practical to use. The DTV is a device which permits these criteria to be satisfied.

Essentially, the DTV serves as the operator's window through which he can observe and control the power system. The basic information which is vital to the operation of the power system is formulated using the real-time system and is presented to the operator in a visual form by the display system. The operator interacts with the graphic system to acknowledge and monitor the information displayed. When required, he may

By JOHN S. BRAUN
and H. GORDON STEWART

modify the information within the computer system by the use of a light pen. This device, when held to the face of the DTV and energized, causes the computer to respond to the request and initiate the desired action. Requests for specific displays are also made in this fashion. Thus, it can be generalized that the DTV with light pen capabilities provides:

- a computer system output device that provides a means for rapidly displaying easily discernible information.
- a computer system input device which permits through use of the light pen the facility for changing system parameters and additionally a means of interrogating the real-time system.

Display Design

Design of the visual display is crucial since the intent is to furnish information which can be quickly comprehended and thus aid the operator in making optimal decisions as quickly as possible. This dictates that the most effective format for display information must be utilized. A DTV with color capability provides the opportunity for rapid assimilation especially for displays of high density. The use of different colors aids greatly in reducing the time required for the operator to differentiate between the dynamically changing information and the regular background information.

It is helpful to design a system using a limited number of formats in order to increase operator's familiarity with the display system. Generally, data and vital electric system values can be displayed in tabular form or in graphic diagrams. The real-time system, however, also generates messages which inform the operator about conditions on the system. These English text messages require a special treatment so as to present them rapidly in a readily understood manner and to provide a means of holding a ready reference for those which require further operator referral. Eight basic display formats were devised to meet these criteria at the PJM installation. All data, diagrams, tabular displays, system performance information, and console displays can be categorized into one of these eight basic formats.

The following briefly summarizes these formats. Pictures of typical displays in each format category are contained in the Appendix.

Display Categories

1. *Null Displays*
   Null Displays are designed to contain a fixed format of information, sometimes referred to as background information, and dynamically changing foreground data which is refreshed with each scan cycle of the real-time system. Either one or two of these displays can be assigned to the same screen simultaneously. Typical displays include: Individual PJM company generations; PJM tie line flows; hydro station generation; individual company frequencies.

2. *Fixed Displays*
   This type of display contains a fixed format of information that is based upon unchanging values at the time of the display request. Typical displays include: Control parameters, alarm messages; telemeter-failure values; cost signal alarms.

3. *Area Diagrams*
   Area diagrams show selected load-generation areas as background information and include in the associated foreground dynamically changing information such as flows on tie lines external to the area, total generation within area, interchange for the area, and frequencies for all areas. In order to facilitate area diagram selection, each diagram is provided with special area selection buttons which, when energized by the light pen, will switch the display to another desired area.

4. *Bar Charts*
   Bar chart displays are designed to show dynamically changing values and their relation to preselected limits. The bars change color and/or are overlayed with slashes as different percentages of the limit are reached. Arrows are used to indicate both power flow direction and its trend. For value changes greater than a selected percentage of total value, the bar is flashed. Telemeter failures are indicated by cross-hatching the bar. Individual bar limits may be modified by use of the special call-up buttons at the bottom of the display. Typical displays include: Actual line loadings; contingency line loadings; station generation; system frequencies; system reserve.

5. *Scanable System Diagram*
   This display is a diagram of major facilities of the PJM Interconnection transmision system, comprised of approximately 400 lines and busses. To display the entire system diagram would require 12 full DTV screens arranged in a 3x4 matrix. However, by making the diagram scanable, that is, permitting the operator to pan the display with his DTV screen, he can select that portion of the system diagram he wishes to monitor. By using his light pen, he may select direction of diagram motion and stopping point. When the diagram is not in motion the flows on the lines are updated at the system real-time scan rate with their directions indicated by arrows.

6. *Fixed Substation and System Diagram*
   These displays are designed to contain a fixed picture of substation equipment layout or a selected transmission system such as the 500 Kv transmission system and include dynamically changing information pertaining to line flows and breaker positions. Initially, changes in breaker positions will be updated by use of the light pens.

7. *Message Monitor*
   These displays are designed to present operations messages in a "roller" fashion. That is, as messages are generated by the system, they are inserted at the bottom of the screen. Once a message appears on the bottom line, it travels up the screen at the rate of one line per second until it reaches either the top of the screen or a previous line of text. If the screen is full, all messages being displayed move upward to make room for any fresh information entering at the bottom. Messages can be "held" by the dispatcher through the use of the light pen. Touching a line of text with the light pen changes its color from white to green and holds it when it reaches the top of the screen until later released by the operator. Typical displays of text traffic would be: Actual and contingency overload messages; telemeter failure notices; major electric equipment status changes; computer/telecommunications facility status changes.

8. *Consoles*
   Console displays are designed to represent several different types of digital pushbutton consoles for inputting special messages and numeric data into the computer system. Typical displays would be: Load-frequency Control Console; Load-Scheduler's Console; Hourly Readings Console; Scheduled Transmission Outage Console and Display Configurator Console.

Operator Display Requests

In order to facilitate ease in requesting displays and reduce as much as practical the need to use a table look-up approach for identifying often requested displays, a set of call-up buttons is maintained across the top line of all screens. When a button is energized with a light pen, the display on the screen changes to that which has been assigned to the button.

Another approach which has been used to minimize the inconvenience of the table look-up technique is the development of the Display Configurator Console. This special console provides the ability to assign selected display functions to any DTV. When a display is requested to appear on the DTV where the console is active, the console is replaced by the display and retained in readiness to be restored. When the requsted display is no longer needed, it is released through the use of one of the top line call-up buttons and the console reappears. In this way any digital TV can readily serve to call up displays, present the displays and revert back to a console with a minimum of effort on the part of the operator.

The ability to call for a detailed display from a more generalized overall display is presently being implemented. This technique is intended to aid in requesting related substation layout displays when viewing the overall system diagram display. The function will be activated by touching the light pen to

By JOHN S. BRAUN
and H. GORDON STEWART

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and H. GORDON STEWART

the desired substation bus on the system diagram. This will cause the substation layout display to appear on that screen.

Equipment and Configuration

THE NUMBER AND LOCATION of the DTVs is important to the effectiveness of the system. The screens must be readily visible, close enough to permit ease of light pen use and yet not placed so that distracting screen activity would interfere with other dispatching functions.

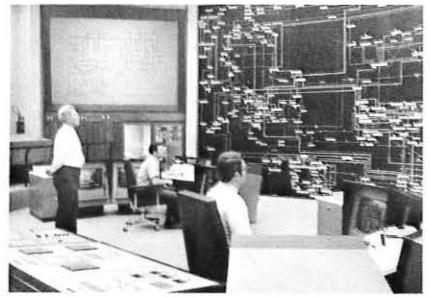
PJM at present utilizes eight 22-inch DTVs. These DTVs have four color capability—red, green, blue and white. Three dispatching positions are provided for coordinating the operation of the PJM Interconnection. A Transmission dispatching position and a Generation dispatching position are each provided with three DTVs. The Supervisor dispatching position is provided with two DTVs.

The DTVs are provided with a full alphanumeric character set and 23 special characters used in formatting the special graphic displays. The display is formed by elements of 48 character rows with 72 characters per row. An 8x10 dot matrix is used to define a character. The design of the special characters is such that those depicting lines or portion of lines extend the bit positions to the extreme edge of the character field. This permits creating continuous lines by butting the characters together on the screen. This is highly desirable when developing graphic displays of the nature used at the PJM installation.

General Program Design Considerations

Priority Assignment

The multi-tasking environment of the computer system allows priority arrangement of tasks. Another design feature of this particular computer system is the instantaneous response to input/output (I/O) interrupts. These two characteristics are used to assure rapid response for all DTV transactions.



The various computer controlled graphic devices are oriented in such a way as to present the dispather with a complete picture of system conditions.

The Control Room incorporates new concepts in dispatching aids in the form of an automated system diagram of the Interconnection, a large screen rear-projection display to show selected substation equipment arrangements, digital televisions to display messages and diagrams concerning system conditions and strip chart recorders to display pertinent electric system quantities.

The generation dispatcher is seen viewing the digital television that permits computer information to be displayed. The dispatcher is using a "light pen," similar to a small flashlight which when held to the face of the digital television permits changing the information in the computer memory to reflect up-to-the-minute conditions.

By assigning the highest priority task area for the display functions, the system is permitted to handle requests immediately. The addition of a light pen request processor to the computer interrupt handling routines permits instantaneous sensing of any light pen input which is immediately transferred to the display task area where it is processed. The task area is on a 100 milisecond scan cycle for request handling. A transaction will therefore be processed with an average delay of 50 miliseconds.

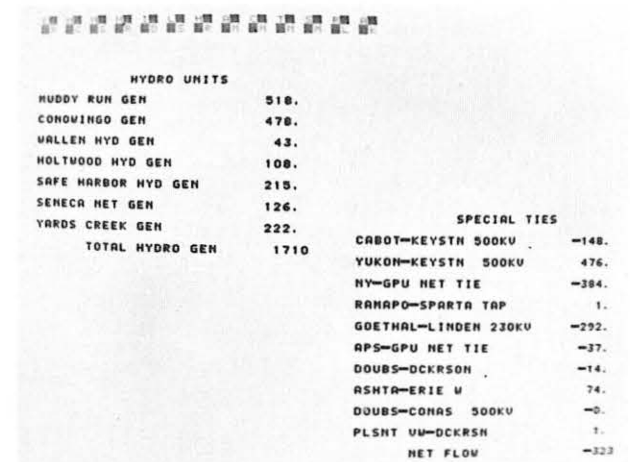
Graphic Display Program Features

BASED ON THE PERFORMANCE requirements for individual display programs, they are designed and implemented by system programmers using a "building block" approach. Each display program consists of up to four basic sections or blocks which are each designed to handle specialized performance functions. These four basic sections comprise the general display routine. Within these blocks, the programs are coded to follow logical paths based on conditions which caused system control entry at that point. It is a system programming requirement that display programs be designed in such a way that they can be easily expanded to handle similar displays of the same basic format category. The blocks or entry points are explained below:

1. *Initialization*

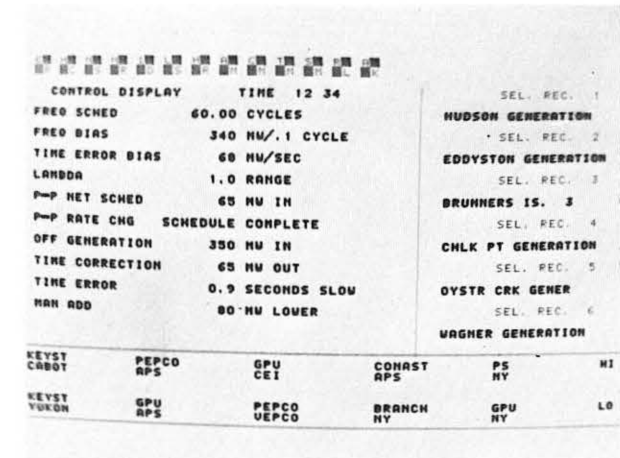
The initialization entry point is entered the first time a TV program is loaded in response to a request for that particular program. This permits the program to take care of preliminary processing such as extracting a display background from files on disk and having it routed to the proper DTV screen. After normal initialization and upon returning control, the program also notifies the Master Controller of its characteristics which will be valid until the next time the program is dispatched. (A TV program may change its own characteristics any time it is running by simply setting a few characteristic indicator bits by which it communicates with the controller.)

APPENDIX



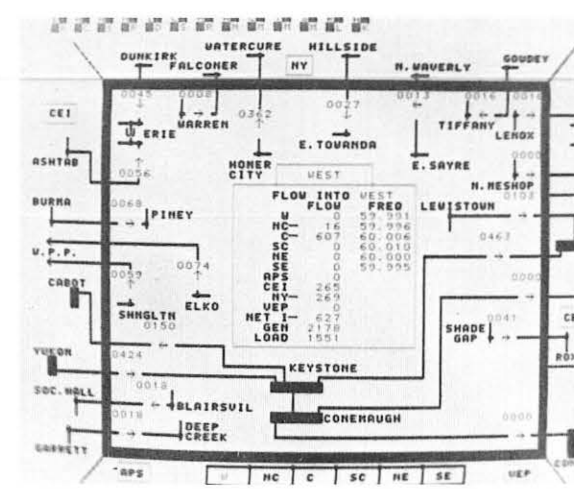
Null Display*

A split screen type display of tabular system information. The foreground values are updated with each scan cycle of the real-time system.



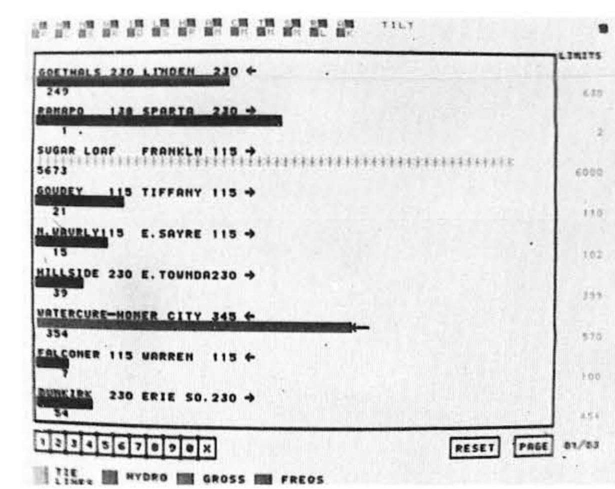
Fixed Display

The values exhibited in this display reflect system conditions at the time of the display request. There is no automatic update of the values in this display.



Area Diagram

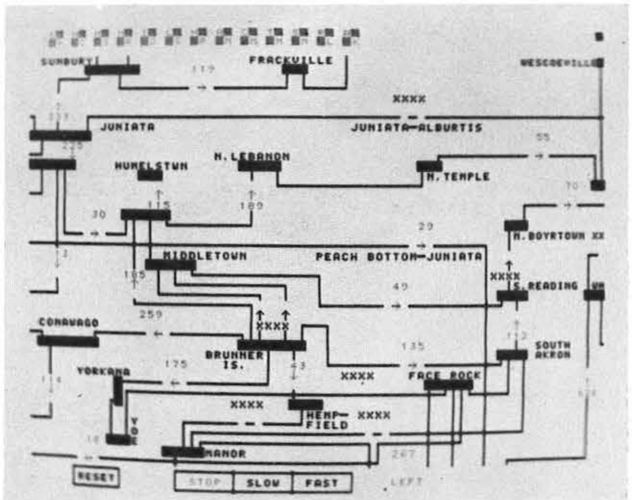
A graphical presentation of a complex geographical section of the transmission network. This style of displays facilitates rapid assimilation of system conditions.



Bar Charts

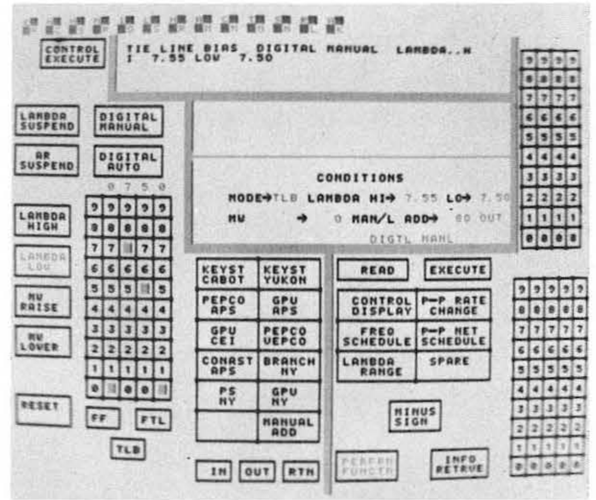
The relationship between a dynamically changing value and its selected limit is vividly projected in this type of display. This approach makes the operator more aware of changing conditions and portrays status clearly.

* For purposes for clear reprint quality, the display illustrations are shown in reverse of their true appearance. Normally, the screen is black with light or colored characters.



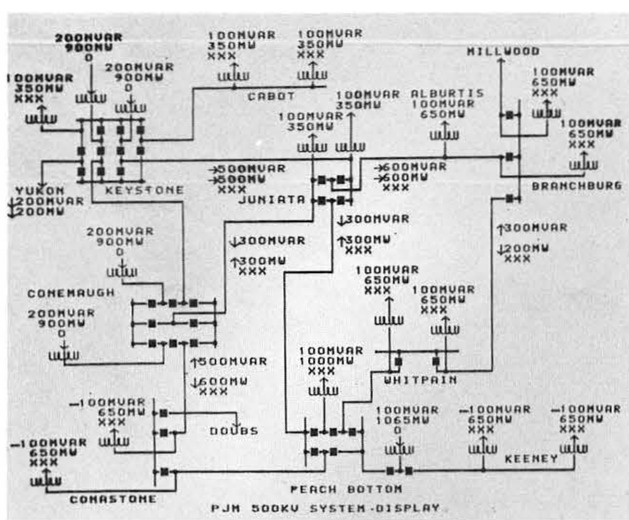
Scanable System Diagram

This type of display permits selected monitoring of any portion of transmission system. When the display is locked in position, the dynamic information is updated at the real-time system scan rate.



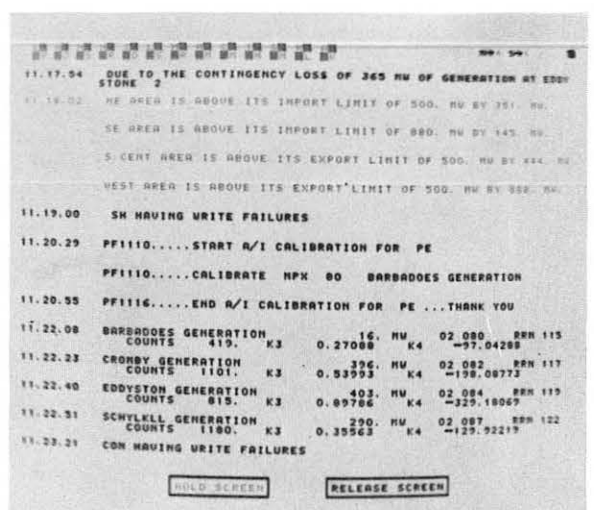
Consoles

The console displays allow the operator to input information to the system through the use of the light pen on the special buttons and numeric input matrices.



Fixed System Diagram

In a fixed system diagram, the operator is permitted to modify breaker positions through use of the light pen. These changes become a permanent part of the display until they are later modified.



Message Monitor

The message monitor display functions as an operations message teletypewriter. Message traffic can be "locked" on the screen or released for "free flow" by use of the buttons at the bottom of the display.

2. *Time/Data*

   The time/data entry point to a DTV program specifies the point in the program where entry is to be made upon the expiration of a predetermined time span, the availabilty of some item of system data, or both. For instance, if a program specifies to the Master Controller that it wishes to be redispatched after a given elapsed time, the Master Controller will monitor time until the program is due to run at which point it will dispatch the routine at its time/data entry point. Additionally, if a program notifies the Master Controller that it wants to be redispatched upon receipt of some item of data, the same entry point will be used upon receipt of that data.

3. *Light Pen*

   The light pen entry point to a DTV routine is where entry is made if a light pen interrupt is received from the DTV on which the program is active. In the event the program has specified to the Master Controller that it does not wish to be receptive to light pen interrupts (For example, a fixed data display program), the light pen entry point is ignored, and any light pen hits on the screen are discarded.

4. *Special Request*

   The Master Controller activates a DTV program at its special request entry point when a request enters the system for a display program termination, erase function, hard copy function, and, in certain cases, upon availability of special system data.

Master Controller

THE FUNCTION OF THE Master Controller is to allocate the resources available to the DTV task area among the various DTV programs that are operational. Essentially, this involves loading and executing a large variety of specialized DTV programs based on their operational characteristics and in response to requests issued to the Master Controller from these pro-

By JOHN S. BRAUN
and H. GORDON STEWART

grams as they are executed. These operational characteristics can be described as the following considerations: Is the TV display program dependent upon or receptive to data; are light pen inputs involved; is timer-controlled recycling required; are special processing requests involved; or are there combinations of any of these?

The Master Controller is furthur responsible for seeing to it that the CPU facilities are made available to other system tasks with great enough frequency to assure proper handling of other system functions. In a multi-tasking environment such as the one in consideration, the CPU facilities are allocated to lower priority task areas while the higher priority DTV task area awaits the completion of its I/O. Thus, if at the end of the Master Controller cycle, there have been I/O operations during the cycle, it is assumed that the CPU resources were made available to other tasks permitting them to run, and the Master Controller immediately recycles. If, on the other hand there have been none, the Master Controller makes processing time available to other tasks by entering a timer-controlled wait state of 100 miliseconds duration.

In this system which has multiple devices, the displays on various screens may each be controlled by different programs. To make most efficient use of the task area available for DTV program processing, the programs are loaded into transient storage areas, permitted to execute, then overlayed by other programs as they are also loaded and executed. This storage utilization and management is also done under the supervision of the Master Controller.

Hardware/Software Interface

In order to interface user-written display routines with the DTVs, a group of routines containing the necessary I/O instructions is required. These standardized routines handle the transfer of data between storage buffers and individual DTV screens (WRITE/READ operations) and process

light pen interrupts. This group of I/O control programs comprises the access method of hardware/software interface.

Miscellaneous System Features

Several system features were included which enhance or simplify operator use of the system:

1. *Slaving*

   In order to permit a display which is assigned to one particular screen to be displayed at other set locations, the system feature known as "slaving" was developed. By maintaining relevant status information, the Master Controller "slaves" any DTV in the system to any other set forming a "master/slave" pair. When any information is transmitted to the "master" screen, it is immediately duplicated on the "slave" set.

2. *Heartbeat*

   In order to provide a rapid system failure alarm, the "heart-

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NEW PRODUCTS

SID SID SID SID

Converts Drawings To Digitized Form

A new semi-automatic graphic terminal, the MetriGraphic, said to combine "the latest in I.C. design" with a rotary encoding system to result in a direct output to an ASR-33 teletype, punch card machine, magnetic tape or automatic digital drafting system has been introduced by the H. Dell Foster Company. The MetriGraphic, a 36" x 42" unit, also provides a real-time measurement capability useful in land planning and similar projects. All data is digitized and scaled for controlled readout.

Primary function of MetriGraphic is to convert graphs, charts, maps, design drawings, civil engineering drawings, weather maps, printed circuit artwork or anything graphic to digital form. As the optical cursor is manually moved over the surface of a chart, digitizing is accomplished instantaneously and a resulting signal fed directly into a digital recorder or any I/O device.

Typical applications include generation of N/C tapes, picking tops off oil well logs, recording map coordinates, measuring land masses in real time, measuring of garment patterns, routing highways or pipelines, designing piping layouts or any similar function.

Circle #101 on Readers Service Card

Picture Monitors

Three new monochrome TV picture monitors are now available to complement Tektronix 650-Series Color Monitors, firm says. The 631 and 632 units are similar in size (10½ inches high by 19 inches wide). Both use a 15-inch diagonal kinescope featuring D6500° K phosphor (W9300° K is optional). The 632 is more measurement oriented, since it has display shift, calibrated brightness and contrast and A-B input mode. The 633 is a larger monitor (14 inches by 19 inches) with a 20-inch diagonal kinescope featuring the same phosphors and general performance characteristics of the 631 and 632. Display shift, calibrated brightness and contrast and A-B input mode are featured.

All units can be switched from 525/60 to 625/50. The 632 automatically performs this function; the 631 and 633 require an internal strap change. All the monitors are 19-inch convertible rack-to-cabinet or vice versa.

Circle #102 on Readers Service Card

Please Pass the SID

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

Motorola Modularized CRT Display

A new Motorola CRT display called "Totalscope II," employs quick-change plug-in modules to perform a wide variety of functions.

Motorola Government Electronics Division developed the versatile, low-cost display, which allows a user to select specific capabilities meeting his requirements and literally build a display from the ground up. The display, which weighs less than 120 pounds including an optional keyboard and all power supplies, can be recommended for use in any type of installation—either fixed or mobile.

Circle #103 on Readers Service Card

Museum of Media

The Museum of the Media was organized in 1967 to utilize multimedia environments to create a more effective method for group communication. The Museum is "experienced and articulate in the imaginative use of all media tools to bring about such an end; be it educational, aesthic or economic." The Museum says it has complete in-house capability for engineering, design, production, installation and maintenance of media information systems. Success of any project depends upon the effectiveness with which its aims and methods are communicated to the public.

Museum utilizes a systems approach in the design of media installations. Programs are easily reproducible. Museum provides drawings, models' cost estimates, blueprints, specifications, inspection, supervision, pre-assembling and testing.

Circle #104 on Readers Service Card

new products

Digital Spotmeter

Photo Research announces the new multi-purpose Spectra® Digital Spotmeter™. The solid-state electronic package is housed in the optical head to provide a completely self-contained system. With only one lens the new Spotmeter can be focussed to make precise measurements at distances from 2 inches to infinity. Lens permits measurements of spots as small as 0.010 inches in diameter with no accessory lenses. Photo Research says device has widest focusing range known for a photometric instrument, that it "measures light as the eye sees it."

Controls are on the back with a 3½-digit digital readout ranging from 0.01 to 10,000 foot-lamberts full-scale. No mirrors or fiber optics are used in the advanced "see-through" optical system. Spotmeter is said to be free from unwanted polarization effects.

Circle #105 on Readers Service Card

Burroughs Panel

New Burroughs Panaplex II panel display with eight 0.7″ characters (compared to previously announced 0.25″ and 0.4″ characters) can be comfortably viewed from distances of up to 35 feet. The 0.7″ character is useful in point-of-sale and sophisticated instrument or control applications where one or more people may be reading the display. The character format is 7-segment structured to provide a character 0.7″ high x 0.37″ wide. The wide character stroke provides a highly uniform bright character displayed against a black, non-reflective background.

New unit, the BRO8751 Panaplex II panel, contains eight digits of display interconnected within a common envelope. Only 24 connections are required to address the eight character positions and decimal point. "Inexpensive, unique" Burroughs connection scheme permits wide variety of vertical, horizontal, and angled mounting configurations. Unit is 5.4″ wide, 1.6″ high, and only 0.25″ thick (not including tubulation). The BRO8751 operates at low power and is compatible with standard T^2L and DTL integrated circuits.

Circle #106 on Readers Service Card

Algebraic Programs

Algebraic programming now available as new feature on the 600 Series Programmable Calculators by Wang Laboratories, Inc. Instead of using a standard machine language, Wang 600 calculators now solve problems directly with algebra, using symbols such as parentheses, up-arrows for exponentials, and alphabetic variables. The Formula Programming Pack, as the new system is named, can also handle subscripts and "do" loops for complex matrix manipulations.

Circle #107 on Readers Service Card

New Low-Wattage Lamp Standards

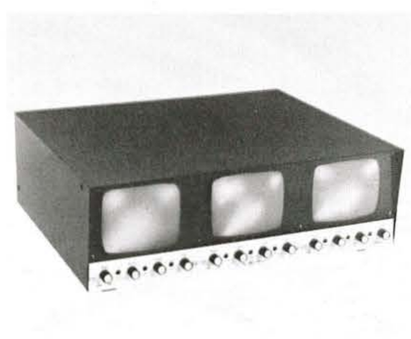
To meet requirements for lower wattage radio-metric standards, Optronic Laboratories recently set up 200-watt and 45-watt tungsten-halogen lamps as standards of both total and spectral irradiance. New standards, which operate at 6.50 amperes dc, are calibrated in watt/cm^2nm over the wavelength region of 250 to 2500 nm and for total irradiance in watts/cm^2, supplement the 1000-watt and one solar constant standards which have been available for a number of years.

In many applications, 1000-watt and one solar constant standards produce too much energy to calibrate very sensitive radiometers and spectro-radiometers.

Circle #108 on Readers Service Card

Two New Monitors By SC Electronics

SC Electronics announces two monochrome monitors. The first is the Setchell Carlson Triple Five, said to be smallest American-made 5″ monochrome monitor on market. It's designed for monitoring three video sources in minimum space. "Professional quality" monitors, mounted side-by-side, occupy space of 5¼″ vertically, with 14″ depth front to back. Has 540-line horizontal resolution, plug-in circuit modules, built-in protection against current fluctuations, says maker.



Second unit is Setchell Carlson 10″ monitor. Model 10M915 said to be "only professional quality 10″ monitor currently available," and said to provide 13% more viewing space than 9″ monitors. Moderately priced. Horizontal resolution of 640 lines "or better", front-located controls.

Circle #109 on Readers Service Card

Graphic Display System Control Center

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beat" feature was incorporated. The "heartbeat" is a single character with all character dots lit white forming a solid white square occupying one character position. It is displayed at the top right hand corner of each DTV set in the system and alternates on-off with a flash rate of three seconds. In the event of a computer system failure, the "heartbeat" ceases flashing, thereby notifying the operations personnel that the system has failed.

3. *Top Line*
   Certain types of display operations require either hardware or program support such as requests to erase a screen, hard copy requests or termination requests for a display program. These functions are supported by providing special call-up buttons across the top line of each set and allowing them to be activated via light pens. If an operator wishes to erase the information displayed on the screen, he aims his light pen at the erase "button" and triggers the pen. The Master Controller supports the functions of these buttons and will interrupt the request and activates the pertinent program at the special request entry point indicating to it that an erase was requested. Similarly, a termination request causes entry to the appropriate display program at the special request entry point with an indication of the termination request. A hard copy request is routed by the Master Controller to a special hard copy program which reads the characters from the screen and transfers them to a program which prints out the screen in hard copy form on a printing device. There are also top line buttons dedicated to frequently used displays. There are supported by the Master Controller in an appropriate fashion.

Inter-active Environment

The inter-active functions of the display system are best explained by examining a typical operational display program. One of those which uses most of the system flexibilities is the Load-Frequency Control Console. The display background is a specially designed control console consisting of buttons for the inputting to the system of special messages and numeric data.

After being entered at the initialization entry point, the console display program retrieves the character strings necessary to describe the basic console display from disk and routes them to the DTV screen for which the console display had been requested. At this point, the display routine indicates to the Master Controller that it is to be only light pen receptive and relinquishes control of the CPU awaiting operator use of the console.

The Master Controller can now use the storage area that was occupied by the console display to run other display programs until such time as a light pen interrupt is received from the console screen. When such an interrupt is received, the console routine is again loaded and entered this time at the light pen entry point. The Master Controller also passes to the routine the X-Y coordinates of the light pen position. The console program uses these coordinates to determine what is being done with the light pen (which button is being depressed). Assuming that the human operator is setting up a console message, the various pushbutton escutcheons are made to change color on the screen to indicate to the user program recognition of the light pen requests. Each light pen input generates similar systems responses through the above described interface chain until such time as the operator has his message completely assembled. At this point, he activates the message processing sequence by pointing his light pen at the "READ" button and triggering it, causing a different processing sequence. Since he has indicated the message is now completely assembled, the contents of that message are passed internally to a console message editing program. Pending complete editing of the message contents, the console display program relinquishes control back to the Master Controller after indicating that it will no longer be receptive for light pen inputs. Instead, it now requests a time/data receptive condition. In this state, the program indicates that upon receipt of data from the console message editing program it wishes to be re-entered. Additionally, it has indicated that if such data does not return within a given time span it wishes to be redispatched. In the meantime, light pen interrupts on the face of the screen are to be ignored.

Upon receipt of the data from the console message editing routines, the Master Controller activates the console display program at the time/data entry point. The program takes the character strings which comprise the incoming data and displays these characters in the proper place on the console display. The program then indicates to the controller that it is again light pen receptive, and once more returns control of the CPU facilities. The console is now ready for a new message sequence.

Conclusion

The use of graphic devices with light pen capability is rapidly emerging as the best method of supporting man-machine interface requirements. Careful consideration of the design characteristics of the overall graphic system will result in a system which is able to rapidly convey easily understandable information. A workable system of this nature will provide the interaction capability required by a sophisticated real-time computer/telecommunications environment.

Acknowledgement

The authors wish to acknowledge Mr. A. Gartenhaus (Applied Programming Services) who designed the software system which is described in this paper. ●

GOOD WORD FOR THE DAY: OMPHALOSKEPSIS—Meditation while staring fixedly at one's navel as an aid toward inducing a mystical trance. Contemplation of one's navel is ideal preparation before writing or reading a technical proposal.

PEOPLE POWER

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and buildings stay.

Next comes the group known as management. (With the forbidden word "man" in it, that word will have to go, too.) I suggest "mismanagement" as an alternative since the "mis", short for Miss or Mrs., combines both sexes in one, easy-to-say, meaningful word.

The mismanagement group always works a minimum of a 12-hour day (in accordance with Murphy's Law), so we also must find a new unit to set mismanagement apart from the throngs and herds.

Mobs, hordes, bunches and lumps are all much too undignified to be accepted by this group. After a thorough study of all the possible words, I would like to propose "Set", as derived from Society Set, not to be confused with Tennis or Number Set. A Set then includes an entire group of company executives, at one physical location, whether the plant is a one-room garage or a 50-story building. A Subset, for example, could be the executives in charge of a throng or herd; an Upset is the group of executives located at the higher levels of mismanagement (or higher levels in a building). Further subdivisions are limited only by the imagination (and stomach) of the user.

For the units of time, because of their extremely long working hours, we must seek longer units. Era, spell and season are a trifle too long; moment, period, round, shake and twinkling are too short. I suggest "trice" as being both melodious and of useful length. Much can be accomplished in a trice.

The trice-set then becomes the unit of executive power. Again, for a point of reference, a microtrice is the executive power required to supervise a throng or a herd while constructing one item, be it a safety pin or an apartment building. A megatrice is the time required to supervise a throng or a herd while building one item, be it a safety pin or an apartment building, again in accordance with Parkinson's Law. For this reason, the use of the microtriceset and megatriceset is discouraged. Furthermore, they should be used only when required by Government Regulation 142.69.05, paragraph (c), Line 5639.

Also, to ease accounting calculations, I propose a standard set of charges, industry wide, for people power. According to my dartboard and abacus, a dipthrong costs exactly 150,000 farthings (a musical sound), a shipherd and a triceset (as well as a microtrice and megatrice) cost approximately $69,109.32. (The use of dollars and farthings will aid in keeping track of costs to see who really spends the money.) These standardized figures should be of considerable help in future work to eliminate this nonsense of competitive bidding, which wastes so much of the industry's people power.

Once the above units are adopted throughout industry, much more time will be left for working. Computers can be programmed to break down the gross figures obtained by mismanagement from their dartboard throws during planning sessions. Virtually any budget can be justified this way, and the computer can break the total dollar value down into dipthrongs, shipherds and tricesets, then further down into clerks, janitors, vice presidents, etc. Charts, graphs, curves, people-power loading, milestones, tables and PERT charts also can be plotted by the computer from those total figures to satisfy all of those, both high and low, who make a living shuffling paper from one pile to another.

Databank

Stay on schedule with these aids proposed by Mr. Bjelland:

1. "Farmer's Almanac", Alsatian Edition, 1910. Information on moon phases and scheduling philosophy, especially influence of weather.
2. "Tiptoe through the Tulips", a record by Tiny Tim—to help you whistle while you work.
3. "1972 Playboy Calendar", especially the months of January, April and June. An excellent reference for general scheduling and for those who declare men and women are equal. ●

Harley L. Bjelland, Staff Engineer, Hughes Aircraft Co., designs controls and displays for aircraft applications. Harley holds a B.S.E.E. from the Milwaukee School of Engineering and has been awarded two patents. These sterling credentials and the fact that Mr. Bjelland believes all proposal writers should have a B.S. degree may or may not have anything to do with his article.

Activities SID SID SID

CALENDAR OF COMING EVENTS

1972 Oct. 3-5	The USA-Japan Computer Conference, AFIPS Tokyo, Japan
Dec. 5-7	Fall Joint Computer Conference Anaheim, California
Dec. 8	5th Annual SID Technical Conference, "SID UPDATE '73" San Diego, California
1973 May 1-3	Spring Joint Computer Conference Philadelphia, Pennsylvania
May 15-17	14th International SID Symposium Statler-Hilton Hotel New York City
Fall	6th Annual SID Technical Conference
Dec. 4-6	Fall Joint Computer Conference San Francisco, California
1974 Apr. 23-25	Spring Joint Computer Conference Chicago, Illinois
May 21-23	15th International SID Symposium Town & Country Hotel San Diego, California
Fall	7th Annual SID Technical Conference
Nov. 19-21	Fall Joint Computer Conference Anaheim, California

Late Notes on SID Chapter Meetings

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

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

New England Chapter

Topic: Panel Discussion—Character & Symbol Generation Techniques for CRT's
Panel: Representatives from M.I.T. (Intrex); Adage, Inc.; Raytheon Co., and Computek

Topic: Holographic Storage of Information
Speaker: Dr. Wilber C. Stewart, RCA Labs.

Delaware Valley Chapter

Topic: Secrets of Color and Visual Effects
Speaker: Charles Halsted, Staff Consultant, American Electronic Labs

Mid Atlantic Chapter

Topic: Plasma Display Panels
Speaker: Dr. Roger L. Johnson, Coordinated Science Lab, U. of Illinois

Topic: Annual Dinner Meeting—Ladies' Day—Harrison House, Glen Cove
Speaker: Dolphin Productions showing their films responsible for the Emmy Award for "Outstanding Achievement in Engineering Development."

Washington D.C. Chapter

Topic: Automated Radar Terminal System (Arts III)
Speakers: Jim Nelson and Lee Du Boise of Univac

Los Angeles Chapter

Topic: Closed Circuit TV System for Navy's LHA Ship
Presented by: Litton, Data Systems Division

Topic: Automated Radar Terminal System El Toro Marine Air Station
Speaker: Mr. Mike Wandrich, Chief of Facility, FAA

San Diego Chapter

Topic: Reuben H. Fleet Space Theater
Speaker: James Crooks, VP for Engr, San Diego Hall of Science

Bay Area

Topic: Non-Visual Displays
Speaker: Dr. John Hill, Stanford Reasearch Institute

Topic: Spring Function-Election of New Officers
Host: Novitiate Winery, Los Gatos

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