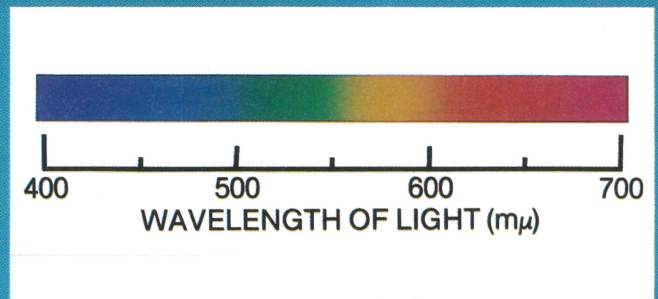


Tekniques

**Meteorology:
From Satellite
to Television
in 44 Minutes**



**Jet Fighters:
Monitoring
Maintenance
and Repair**



**Color:
The Second of Three
Articles on Combining
Color for Effective Displays**

Tekniques

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To submit articles to *TEKniques* or for information on reprinting articles, write to the above address. Changes of address should be sent to the IDG Program Exchange serving your area (see Program Exchange addresses).

* Editor's Note:

IDD Now IDG

The Information Display Division of Tektronix, of which *TEKniques* is a part, has been formally renamed to Information Display Group. You will notice this change in our masthead and throughout the newsletter. Everything else remains the same, including our address, telephone and telex.

Indexes

In this issue are indexes for 116 articles, 148 programming tips and 12 software packages (encompassing 147 programs) published in Volumes 5, 6, 7 of *TEKniques*.

Past indexes may be found as follows:

Volume 4 – *TEKniques* Vol. 4 No. 8
Volume 3 – *TEKniques* Vol. 4 No. 1
Volume 2 – *TEKniques* Vol. 3 No. 1
Volume 1 – *TEKniques* Vol. 2 No. 1

Reader Response

A separate article outlines your likes and dislikes according to your response on the recent survey forms. Thank you for your valuable suggestions.

Keep User Library Catalog

The catalog of program abstracts for the user's library (now the IDG Program Exchange, formerly the Applications Library and 4050 Series Applications Library) should be retained. As descriptions of programs contributed to the library are printed in the *New Abstracts* section of *TEKniques*, clip these pages and add them to your catalog

On the cover:

An F-16 fighter bomber ready for flight. Throughout the world automatic test equipment (ATE) modules built by General Dynamics are used by the U.S. Air Force to test the electronic instrumentation of the F-16 fighter bomber. General Dynamics employs the Tektronix 4052 Desktop Computer to help manage the maintenance of the ATE modules.

A near real-time weather telecast produced by Osaka Asahi Broadcasting depends on the Tektronix 4113A intelligent graphics terminal for the final weather picture.

Viewers may perceive the colors in the visible spectrum differently. Jerry Murch, one of Tektronix's color experts, continues his explanation of why.

binder. You'll have an up-to-date reference of user programs available.

Although the abstracts are added to the catalog at each reprinting, there is no set reprint schedule, and the new catalog copies are only sent to new subscribers or current users who haven't received one. If you don't have a copy of the catalog, contact your local Tektronix office.

IDG Program Exchange


For each program accepted into the Program Exchange, you receive one of the packages in exchange. Remember that each package is comprised of from six to over 20 programs.

Readers who wish to contribute to the IDG Program Exchange for Tektronix Graphics Systems may acquire documentation instructions and forms by writing to:

Tektronix, Inc.
IDG Program Exchange
Mail Stop 63-575
P.O. Box 1000
Wilsonville, OR 97070

Back Issues

Back issues of *TEKniques* Vol. 4 through the current issue are available by writing to the address noted under IDG Program Exchange or contacting your local Tektronix office. Although issues from Vol. 1 through 4 are out of print, the Programming Tips for the 4050 Desktop Computer in those issues are compiled in a booklet which is included in the IDG Program Exchange package "Programming Aids T2," part number 062-5972-01.

Beginning with *TEKniques* Vol. 6, No. 3 (Fall, 1982) coverage was expanded to include all of Tektronix IDG graphics displays, not just the 4050 Series. 

Programming Tips, Product Articles Favorites of *TEKniques* Readers

In 1983 three issues of *TEKniques* included a form for readers to return if they wished to continue to receive the newsletter. We also asked for an evaluation of *TEKniques*. As in past surveys, programming tips were voted the favorite. The results are:

	Very Useful	Useful	Not Useful	No Opinion
Programming Tips	50%	42%	3%	5%
New Product Information	46	47	1	6
Applications Articles	35	55	5	5
Program Exchange	19	60	7	14

Programming Tips

The high interest in programming tips was also indicated by 22% of you asking for *more*. Machine language programming for the 4050 Series was specifically mentioned in quite a few requests. Perhaps these needs can be fulfilled through the two programs in the Program Exchange: 4051 Assembler (Program 11 in *TEKniques* Vol. 7 No. 4 T2) and 4052A/54A Assembler (Program 1 in *TEKniques* Vol. 6 No. 4 T1). The number of tips published depends on space but we'll strive for a good proportion.

Interfacing

A significant 13% requested interfacing ideas or tips. Since interfacing is a collective term, we pose some questions in response to your requests.

Data acquisition systems and software: What type of data samples are you collecting?

Interfacing to other systems: What type of other systems? What are your concerns - hardware, software?

Laser trimming and electronic testing and measuring: Anyone willing to share their application?

Several requests will be met in future issues of *TEKniques*. Upcoming programming tips will cover common interfacing techniques to mainframes, minicomputers and peripherals from the various Tektronix terminals/computers.

A number of application articles included the 4050 desktop computer interfacing with other vendors' equipment, but readers with current systems are encouraged to send in diagrams and suggestions for interfacing.

Past programming tips have also covered a number of interfacing situations. Check

"Data Communications" in the index to programming tips in this issue. For 4050 users, the Programming Tips handbook contains all programming tips published in the first three years of *TEKniques*. Many interfacing situations were described. The publication is

available through the Program Exchange in the package "Programming Aids T2."

Applications and Programs

Readers asked for more information or programs in the areas of business, statistics, education, graphics, CAD, geoscience, mapping, numerical control, project management, and utilities such as host-to-Tek terminal software, 4050 BASIC to CP/M, BASIC to FORTRAN, etc.

The Program Exchange is one vehicle for you to share programs. While the library contains many 4050 programs (including two for 4050 BASIC to FORTRAN conversion), it lacks CP/M programs which run on the local Programmability systems. We invite you to make your programs available to other users. Check the *New Abstracts* section of *TEKniques* for more information on the exchange policy.

Your Tektronix sales office can provide you with information on third party software available for Tektronix terminals/computers. Some of these packages have been described in *TEKniques*.

Prices

Our policy is not to publish prices, however, your local Tektronix sales office maintains an up-to-date price list.

Product Information

In this issue the Tektronix 4100 terminals capabilities and comparison table is in direct response to the 10% who asked for such an overview and more product information. We will continue to do more in-depth articles of Tektronix hardware architecture.

Good News, Bad News

One reader commented, "I have been on-line since issue number 1 and you continue to im-

prove." Another said "I find *TEKniques* a valuable reference source." A new reader said "This is the first *TEKniques* I have read; so far so good." Many others sent in positive comments and we appreciate them.

Of course, not everyone likes the same thing. "More unique applications are needed," from one reader was offset by "Applications are too specific; would like more with broader end user adaptation" from another. Several individuals summed it up with "Applications (or *TEKniques*) are consistently interesting if not useful every time." We'll settle for this.


We took our lumps, too. "They are always two months late," reflects our bulk third class mailing of *TEKniques*. But to send first class is prohibitively expensive. "Indexes! I haven't seen one since Volume 4;" this comment was echoed by others with varying degrees of patience and prompted the indexes you will find in this issue. We'll try to have indexes in the Winter issue of *TEKniques* each year.

"It seems to me that your articles and tips have moved away from the basic 4051/4631 configuration. I suppose this is inevitable as your product line expands and evolves. Oh, well," and "Don't forget about the 4050 Series," indicated the continuing interest and readership of our 4050 users.

Your comments on products have been passed along to the managers concerned who will consider your suggestions in their new product or action plans.

Constructive criticism indicates readers who care and helps us to do a better job. All of your comments will be taken into account in planning future issues of *TEKniques*.

Something for All

The equipment checked on the survey forms and also on the new membership cards returned show that quite a number of you are using the entire line of Tektronix graphics displays, from the 4010 through the 4050, 4100 and 4110 Series. For you, all *TEKniques* articles are probably appropriate. For other users, we realize that not every article will apply. We will attempt, however, to have something for every reader and hope the index in each issue by graphics system enables you to quickly find relevant articles. 

The Effective Use of Color: Perceptual Principles

by Gerald Murch
Tektronix, Inc.
Beaverton, OR

In the previous issue of *TEKniques* we examined the effective use of color from the perspective of the neurophysiology of human vision. From an understanding of some of the features of the color vision mechanisms we could not only derive a number of principles for the proper use of color but gain a feeling for how our visual system functions.

This article will review some of the perceptual aspects of color. That is, we will be concerned with how we experience color. Again, the attempt will be made to derive some principles for the effective use of color that are based on perceptual considerations.

Perception refers to the process of sensory experience. Although this process is most certainly a product of our nervous systems we do not possess enough adequate information about these "higher order" functions to describe perception in physiological terms. Thus, we are forced to rely more on psychological methods and techniques. Of these, the methods comprising the discipline of *psychophysics* are the most valuable. Psychophysics seeks to describe objectively the way in which we experience the physical world around us.

In a word, psychophysical research has shown that practically all perceptual experiences are **nonlinearly** related to the physical event. Figure 1 provides an example. The figure indicates perceived brightness as a function of the intensity of a light. Notice that the brightness increases very rapidly at low intensity levels and then tapers off at higher levels. This means that a very small initial change in intensity produces a relatively large change in perceived brightness. To produce an equally strong perceptual change at a higher intensity level, a much larger physical increase must occur. You've probably noticed this effect with a three way light bulb in which the amount of light gained with each higher level appears to be proportionately less. That is if the bulb produces 50, 100, and 150 watts, switching from 100 to 150 watts does not appear to generate as much of an increase as from 50 to 100 watts. The relation is approximately **logarithmic**. Perceived brightness increases as the logarithm of stimulus intensity.



Although still in its infancy, research into aesthetics of color displays supports the preference of white and yellow for thin lines and text and yellow, white and green for thick lines and panels when displayed on a black background. On a Tektronix 4109 Color Graphics Terminal, these color combinations produce crisp text and a pleasing map.

On a visual display a similar relation exists for the light intensity emitted by the phosphor as a function of beam current. Again, small increases produce rather rapid increases in light intensity while at higher levels only small increases result from an equal voltage increment. The exact function is known as the **gamma** of the display. The ramification of this property of perception and the CRT is a **loss** in the number of discriminable levels of intensity, or gray levels as they are commonly called. For example, if we divide the gray scale into 100 equal increments, a large number of the steps at the higher levels will be indistinguishable from one another. Conversely, at lower levels one "throws away" a number of discriminable steps. In fact, for a display with 100 equal gray level steps about 64 discriminable shades result. Figure 2 shows the uncorrected and firmware corrected gamma of the Tektronix 4115B display. This gamma correction offsets the perceptual insensitivity to changes in light level at high intensities and compensates for the high degree of sensitivity at lower levels. The end result is 100 discriminable shades of gray which vary in perceptually even steps.

This is an example of firmware engineering based on perceptual principles.

The Perception of Achromatic Color¹

When the light source illuminating an object – such as the sun or an incandescent bulb – contains all of the wavelengths to which the human eye is sensitive and the object reflects all those wavelengths equally, the color of the object is **achromatic**. That is, the object appears white, black or some intermediate level of gray. The amount of light reflected largely determines the **lightness** of the object; objects reflecting 80% or more of the light appear white while those reflecting 3% or less appear black. Various levels of gray are represented by intermediate reflectances. Consider, for example, a black, white and gray automobile. Each reflects different amounts of light and, therefore, takes on a specific achromatic color. If the total amount

¹The sections on **The Perception of Achromatic Color** and **The Perception of Chromatic Color** are synthesized from a more extensive chapter by the author entitled "Color Displays and Color Science" in the book *Color and the Computer*, ed. John Durette, (Florence, KY: Van Nostrand Reinhold, 1984).

of light illuminating the car is increased, the lightness stays the same but the *brightness* increases. The white car stays white but becomes much brighter – perhaps even dazzling. Thus, lightness is a property of an object itself while brightness depends upon the amount of light illuminating the object.

Often we are able to distinguish perceptually between lightness (white-black) and brightness (bright-dark); however, under certain conditions the separation of the two is difficult. For instance, increases in lightness are often coupled with increases in brightness. To make matters even more difficult, the two terms are often used interchangeably in colloquial language.

In general, as previously noted, lightness appears to increase as a logarithm of reflectance. As the reflectance of the surface increases, the increase in lightness away from black is initially very rapid – small reflectance changes produce large lightness changes. In fact, most scales locate the middle gray point at a reflectance of 10–25%. The apparent lightness of an object, however, is also largely dependent upon the reflectance values of surrounding objects and the overall level of illumination so that a general scale of lightness is difficult to establish.

An increase or decrease in illumination has little perceptual effect upon the relative lightness of areas of differing lightness on a printed hard copy. As the percentage of light reflected from different areas remains unchanged with variations in illumination, so do the ratios of reflected light. An increase in illumination makes everything appear brighter, but the contrast between elements remains constant. On a hard copy, just as with the cars in the parking lot, it is the ratios

of reflected light that determine lightness.

The situation for a visual display is more complex. As the electrical signal to the display is increased, a change in both lightness and brightness occurs. The images vary from black to white and from dark to bright. The amount of light reflected from areas of different lightness is roughly the same. When the illumination is increased, an equal amount of light is added to all areas of the display. The net result is a reduction in contrast and hence lightness. Conversely, decreasing the illumination increases the contrast as an equal amount of light is removed from all areas.

The amount of light emitted by a display is usually expressed as *luminance*. This is a measure of energy which has been corrected to correspond to the visual system's differential sensitivity to wavelength. The human eye is most sensitive to light in the 555 nm range (a yellowish green) with decreasing sensitivity towards the spectral extremes. The luminance of a display, then, is a measure of combined lightness and brightness. Unfortunately the measure provides only an approximation of the eye's sensitivity to wavelength.

The Perception of Chromatic Color

Objects in our visual environment that reflect or emit distributions of wavelengths in unequal amounts are said to be *chromatic*. Figure 3 shows the distribution of wavelengths reflected by the surface of a ripe tomato illuminated by sunlight. The abscissa of the graph indicates the range of wavelengths to which the human eye is sensitive. The tomato reflects most of the visible light striking it but does so in differing amounts. More long wavelengths (600 nm and above) are reflected than short wavelengths which, in turn, tend

to be absorbed by the surface. It is the preponderance of long wavelengths in the energy distribution that is responsible for the perceptual experience of the tomato's chromatic color and the primary basis upon which we assign the names to color experiences.

Our willingness to say that an object is a particular color derives from the physical attributes of the dominant wavelengths, the intensity of the wavelengths and the number and proportion of reflected waves. The identification also depends upon a multitude of learning variables, such as previous experiences with the object and the association of specific sensations with color names. The sensation is also affected by the context in which the color occurs and by the characteristics of the surrounding area or the colors of other objects. The study of the physical attributes of chromatic objects is always compounded by the experiences of the observer with colors in general; because the perception of color is a subjective or personal experience, many of its aspects can be described only in terms of the subject's report of his or her perceptions. These color sensations vary along the psychological dimensions of hue, lightness, saturation, and brightness.

Hue. The color sensations reported by an observer with normal color vision vary as a function of the wavelength of the stimulus. This holds true for the range of wavelengths falling between approximately 380 and 700 nm. The sensations reported by observers exposed to these various wavelengths are known as *hues*. For the range of wavelengths between 450 and 480 nm, the predominant sensation is blue. Green best characterizes a fairly broad range of wavelengths extending from 500 to 550 nm, while yellow is concentrated in a narrow range around 570 to 580 nm. Above

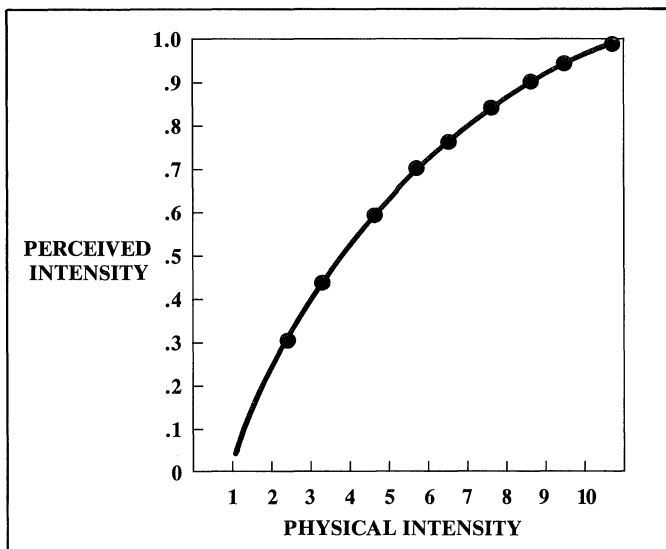


Figure 1. Perceived brightness as a function of the intensity of a light.

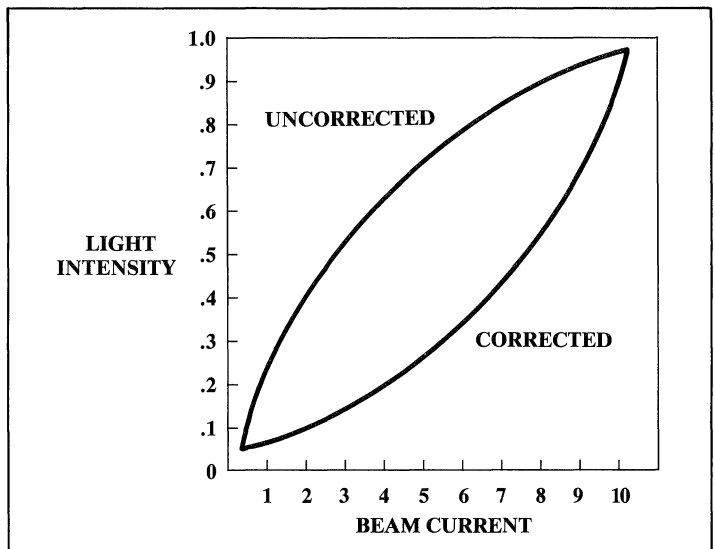


Figure 2. "Gamma" correction as a means of increasing the number of discernable gray scale steps on a display.

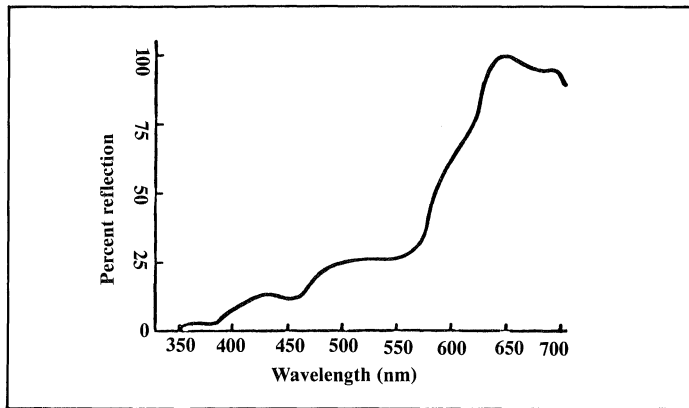


Figure 3. The spectral reflectance from a ripe tomato.

610 nm, most viewers report the sensation of red.

The best or purest colors – defined as those containing no trace of a second color – would indicate pure blue at about 470 nm, pure green at 505 nm, pure yellow at 575 nm and no clear wavelength associated with pure red.

Another way of approaching the relationship between hue perception and wavelength is to establish the amount of increase or decrease in the wavelength of a comparison stimulus that is just perceived as perceptually different than a standard stimulus of fixed wavelength. Figure 4 shows a set of such measurements taken for a single observer. The abscissa of the graph indicates the wavelength of the standard stimulus while the ordinate shows the number of nanometers that the comparison had to be changed in order that a noticeable change in hue could be perceived. Although a considerable amount of variation between observers is usually noted in such experiments on hue discrimination, most observers show a pattern similar to that indicated in Figure 4. That is, they are insensitive, unable to discriminate well, changes in extreme long and short wavelengths. Conversely, at several points in the visual spectrum, discrimination is very good. A change of about 2 nm produces a noticeable shift in hue from a standard set to 430 nm, 480 nm, or 580 nm. Hue discrimination is poorer in the range of 440 to 450 nm and 500 to 540 nm.

Hue, then, is the basic component of color and is primarily responsible for the specific color sensation. While the color names or hues evoked by different portions of the visual spectrum show a close relationship to certain wavelengths, it should be remembered that hue is a psychological variable, and wavelength a physical one. Although all individuals with normal color vision would name a sector of the visual spectrum red, disagreement would occur in deciding which was the reddest red or at what point red becomes orange. These differences probably reflect

varying experiences with color as well as intrinsic differences in the color mechanisms of each individual's visual system.

Saturation. We are seldom presented with a pure monochromatic light source that evokes the sensation of a single hue. Rather, the light reflected or emitted by different objects is multichromatic. That is, it contains a number of different wavelengths such as the energy distribution of the tomato shown in Figure 3.

If we start with a narrow band of wavelengths, we will be able to identify a dominant hue. This dominant hue remains the same even though we increase the width of the band of wavelengths. Increasing the bandwidth causes the sensation to be modified, however; the hue becomes less distinct or clear, and we say then that the hue is less saturated. Saturation is most closely related to the number of wavelengths contributing to a color sensation. The narrower the band of wavelengths (e.g., 510 to 512 nm), the more highly saturated is the resulting color sensation. By the same token, the wider the band of wavelengths, the less saturated will be the resulting color (e.g., 510 to 590 nm).

Conceptually, we can envision a scale of saturation extending from a pure hue such as red through less distinct variants of the hue such as shades of pink to a neutral gray in which no trace of the original hue is noticed. A measure of saturation discrimination can be obtained by starting with a neutral color and determining the amount of a pure hue which must be added to the neutral color in order that the hue be detectable. Figure 5 shows the results of such a study. The abscissa indicates wavelength while the ordinate shows the amount of the pure hue which must be added to the neutral color in order that it could just be recognized. Obviously substantial differences exist in our capacity to detect the presence of color along a scale of saturation with the largest amount of color required for a 570 nm stimulus. This means that such a yellow appears initially to be less

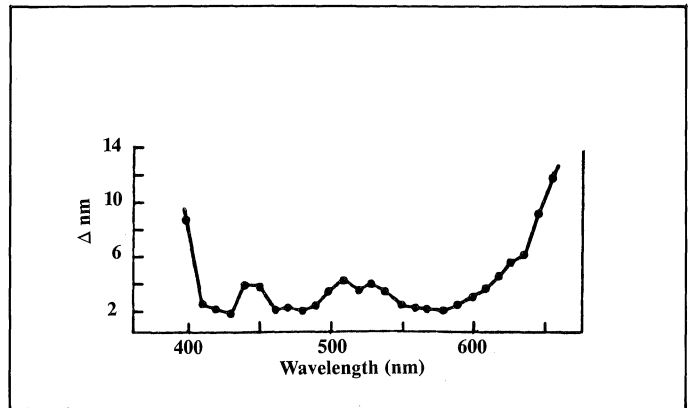


Figure 4. The discriminability of different wavelengths.

saturated than any other pure hue and desaturates quickly as the wavelength distribution is broadened or as neutral colors are mixed with it.

Lightness. Lightness, it will be recalled from the earlier discussion, refers to the gamut of achromatic colors ranging from white through gray to black. By definition, achromatic colors are completely desaturated as no trace of a hue is present. Combining an achromatic color with a specific hue produces a desaturated hue with the level of saturation depending upon the relative amounts of each. The lightness of the combination will depend upon the lightness of the achromatic color. Therefore, combining white with red, for example, produces a desaturated pink which is lighter than the same hue combined with gray or black. Just as with achromatic colors, the lightness of the mixed color will depend upon the reflectance of the surface under consideration: the higher the reflectance, the lighter the color.

As you might anticipate from the discussion of saturation, monochromatic colors do not appear to be equal in lightness. That is, some hues appear lighter than others, even though their reflectances are the same. If observers are presented with a series of monochromatic lights of equal brightness and asked to rate them in terms of lightness, a relationship similar to that shown in Figure 5 results. A monochromatic color with a wavelength of 570 nm appears much lighter than all other wavelengths with the level of lightness decreasing rapidly as the extremes of the visible spectrum are approached. This means that a color made up of yellow combined with an intermediate gray will appear lighter than a blue-green of the same brightness combined with gray.

Brightness. Increasing the level of illumination of both achromatic and chromatic colors produces a qualitative change in appearance along the dimension of dark to bright. As with achromatic colors, the separation of

lightness and brightness often proves difficult as brighter colors invariably appear lighter as well.

Consider the situation in which a series of equal reflectance surfaces, each of which reflects a very narrow band of wavelengths, is illuminated by a broad band light source (i.e., one containing all visible wavelengths). If we start with a very low level of illumination and progressively raise the level we first perceive the surfaces as gray. A further increase in intensity allows dark and desaturated hues to become discernible with those wavelengths in the middle of the spectrum (around 555 nm) visible at lower intensity levels. Thus, as the intensity is raised, a broader and broader range of hues appear with the extreme long and short wavelengths visible only at the higher intensities.

Note that we are using the term brightness to describe the perceptual effect of variations in intensity. A related expression, *luminance*, refers to the measurement of intensity variations in units calculated to reflect the eye's variations in sensitivity to different wavelengths. Unfortunately the luminance measure does not assess perceived brightness of displayed colors particularly well.

It is not surprising that the luminance measure does not accurately characterize brightness relations on a color display as the scale was developed under rather restrictive conditions. Among other things, the colors were produced as small, monochromatic (single wavelength) sources. In studies conducted at Tektronix² observers adjusted the intensity of a white panel until it was perceived to be equal in brightness to a contiguous panel of a specific color such as red. When the colored panels of red, green, blue, yellow, cyan and

magenta were all set to a luminance value of 10 cd/m², the luminance of the white selected to appear equally bright varied substantially. The following table lists *luminance* values which render the brightness of each color equal to a white of 10 cd/m². In other words, panels adjusted to the specified luminance would all appear equally bright.

Table of equal brightness colors

Color	Luminance (cd/m ²)
white	10
yellow	7.6
cyan	7.4
green	7.1
red	4.7
magenta	3.7
blue	2.7

Besides changes in saturation and brightness, increases in intensity of a monochromatic color produces a further modification in appearance. In a now classic study³ subjects were asked to adjust the wavelength of one half of a circular field to match the wavelength shown in the other half. The intensity of the adjustable portion of the field was then lowered by a fixed amount and the observers asked to readjust the wavelength of this field so that the two halves, although differing in brightness, showed the same hue. Such measurements were taken over the range of wavelengths from 450 to 660 nm. Figure 6 shows the result which indicates the amount of change in the wavelength of the variable field required to make both fields match in hue after the luminance of the variable field half was lowered. For example, if both halves of the field had a wavelength of 520 nm, a drop in intensity required a change in the variable field of 20 nm (to 540 nm) in order to make both halves once again appear to

have the same hue. The changes in hue as luminance changes, known as the *Bezold-Brücke Effect*, are often very large, reaching over 30 nm for a deep red. Perhaps of greatest interest, however, is that for three wavelengths, no change in the wavelength of the variable half of the field was required to maintain a match. These three wavelengths were 470, 505, and 572 nm. These numbers should be familiar as they are essentially the same wavelengths judged as the purist blue, green and yellow respectively.

Colors in Context

Colors are subject to contextual effects in which adjacent colors exert an influence on one another: A color on a dark background will appear lighter and brighter than the same color on a light background. Not only is lightness and brightness dependent upon the relative intensity levels of color and background, but hue as well. In fact, the shifts in hue parallel those noted by Purdy in his study of the Bezold-Brücke effect (see Figure 6), including the observation that pure colors remained invariant in hue as background intensity varied.

Work on the appearance of a color seen against a colored background capitalizes on the observer's ability to select narrow bands of wavelength displaying the purist blue, green, yellow and red. These are projected as a circular test target centered in a chromatic surround. The wavelength distribution selected as representing the purist color changes as the surround color is varied – a phenomenon known as *color contrast*. In order to maintain a particular pure hue, the test field is adjusted towards the wavelength of the background color. For example, a pure blue selected against a neutral background is adjusted towards longer wavelength when the background is greenish-yellow. The magnitude of the shift depends on the proximity of the surround to the test field. The largest shift occurs when the borders of the surround and

²Gerald Murch, Micheal Cranford and Paul McManus, "Perceived Brightness and Color Contrast of Visual Displays," *SID Digest* 14 (1983): 168-169.

³D.M. Purdy, "The Bezold-Brücke Phenomenon and Contours for Constant Hue," *American Journal of Psychology* 49 (1937): 313-315.

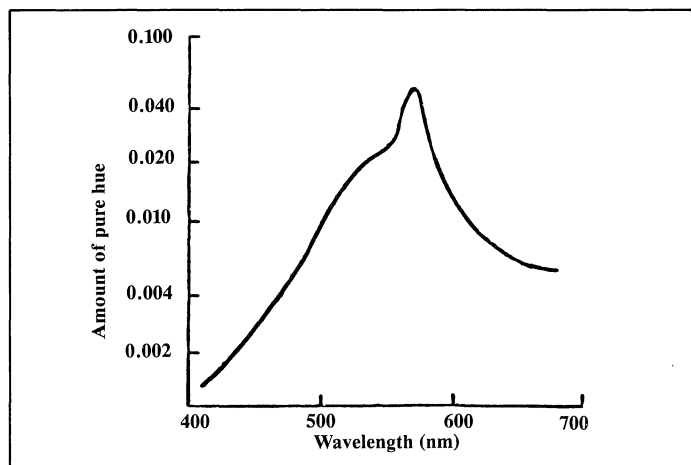


Figure 5. The perceived saturation of different wavelengths.

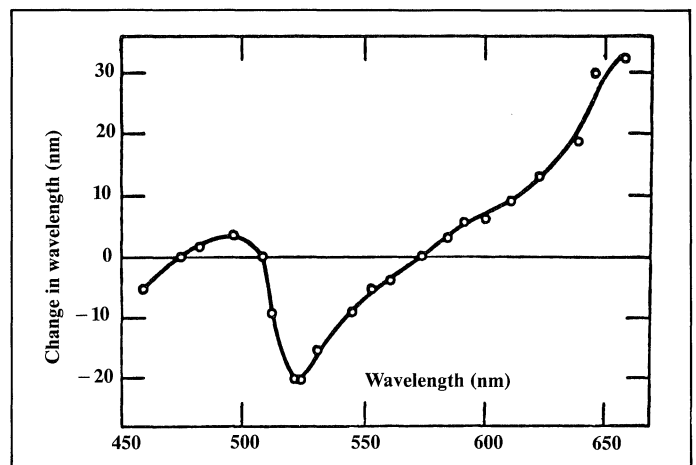


Figure 6. Changes in hue with increasing or decreasing intensity.

the test field touched and decreased steadily as the degree of separation increased.

In color contrast studies the influence of a colored surround upon the perception of a colored test field is observed. If the test field is neutral (i.e., gray) or dark, and is perceived to be colored due to the presence of a colored surround, one speaks of *induced colors*. The general effect of the inducing surround upon the neutral test field is a coloration of the test field in the direction of the hue complementary to the inducing field. For example, a red would induce a green into a neutral gray.

A series of experiments on the factors influencing induced colors have been reported by Jo Ann S. Kinney⁴. Subjects viewed a vertical dark strip imposed on a circular induction field; this surround could be blue, green, yellow, or red. They were required to match the color induced on the dark strip with those shown in the comparison strip. The latter could be varied in hue, brightness, and saturation. Kinney reported that the best induction occurs with a blue inducing field. The actual colors reported depended upon the size of the test field, the purity of the inducing color, and the luminance ratios of the inducing field to the test area. Brightness differences of the inducing field alone produced a wide variety of hues. For example, with a blue surround varying along the brightness dimension, subjects reported colors including canary yellow, antique gold, toast and Indian red.

The size of a colored area has a marked influence upon its perceptual properties. In general, smaller areas become desaturated and often show a shift in hue as well. At the normal viewing distances for displays, maximal color sensitivity is not reached until the size of a colored area exceeds about 3" square (visual angle⁵ of 10°). This creates some problems when text is color coded. Small color differences become indistinguishable. As one might expect, the degree of desaturation and loss of hue discrimination depends upon the actual color. Blues and yellows are particularly susceptible to small area color loss. In fact, characters in these colors should not be made smaller than 20' of arc. Reds and greens can be a bit smaller with 15' representative of a realistic limit. The top row of text in Figure 7 provides some examples. All the colors are the same for all size characters but when viewed from arms length, the smaller ones become desaturated.

⁴Jo Ann Kinney, "Factors Affecting Induced Color," *Vision Research* 2 (1962): 503-525.

⁵Visual angle defines the size of an area on the retina of the eye in terms of the angle subtended by the area:



Best Color Combinations
(N = 16)

Background	Thin Lines and Text	Thick Lines and Panels
	White	Blue (94%) Black (63%) Red (25%)
Black	White (75%) Yellow (63%)	Yellow (69%) White (50%) Green (25%)
Red	Yellow (75%) White (56%) Black (44%)	Black (50%) Yellow (44%) White (44%) Cyan (31%)
Green	Black (100%) Blue (56%) Red (25%)	Black (69%) Red (63%) Blue (31%)
Blue	White (81%) Yellow (50%) Cyan (25%)	Yellow (38%) Magenta (38%) Black (31%) Cyan (31%) White (25%)
Cyan	Blue (69%) Black (56%) Red (37%)	Red (56%) Blue (50%) Black (44%) Magenta (25%)
Magenta	Black (63%) White (56%) Blue (44%)	Blue (50%) Black (44%) Yellow (25%)
Yellow	Red (63%) Blue (63%) Black (56%)	Red (75%) Blue (63%) Black (50%)
Overall Frequency of Selection		
	Black 25%	Black 23%
	White 20%	Blue 19%
	Blue 20%	Red 17%
	Yellow 13%	Yellow 13%
	Red 11%	White 10%
	Cyan 5%	Magenta 7%
	Magenta 4%	Cyan 6.4%
	Green 1%	Green 4%

Worst Color Combinations
(N = 16)

Background	Thin Lines and Text	Thick Lines and Panels
	White	Yellow (100%) Cyan (94%)	Yellow (94%) Cyan (75%)
Black	Blue (87%) Red (37%) Magenta (25%)	Blue (81%) Magenta (31%)
Red	Magenta (81%) Blue (44%) Green and Cyan (25%)	Magenta (69%) Blue (50%) Green (37%) Cyan (25%)
Green	Cyan (81%) Magenta (50%) Yellow (37%)	Cyan (81%) Magenta and Yellow (44%)
Blue	Green (62%) Red and Black (37%)	Green (44%) Red and Black (31%)
Cyan	Green (81%) Yellow (75%) White (31%)	Yellow (69%) Green (62%) White (56%)
Magenta	Green (75%) Red (56%) Cyan (44%)	Cyan (81%) Green (69%) Red (44%)
Yellow	White and Cyan (81%)	White (81%) Cyan (56%) Green (25%)
Overall Frequency of Selection		
	Cyan 24%	Cyan 23%
	Green 18%	Yellow 17%
	Yellow 16%	Green 16%
	Magenta 11%	Magenta 12%
	Red 10%	White 12%
	White 8%	Blue 9%
	Blue 8%	Red 7%
	Black 3%	Black 2%

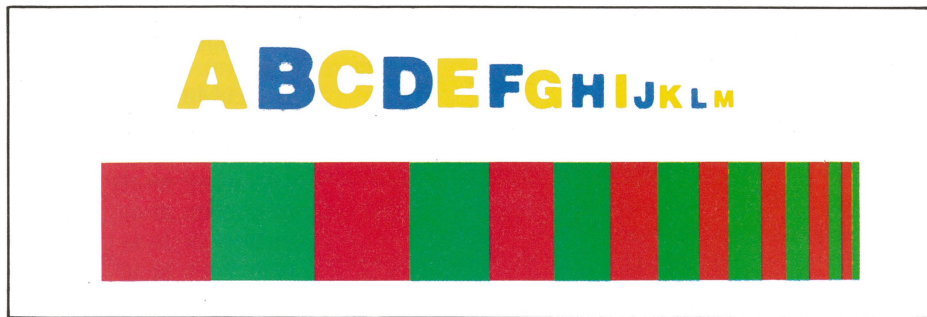


Figure 7. Changes in perceived hue as a function of element size.

The lower portion of Figure 7 illustrates an additional problem with small colored areas on a display. The alternative lines of red and green merge into a mixed yellow as they become smaller and smaller. The eye integrates each component and signals the mixture of the two to the brain. This problem has intensified with the advent of high resolution displays which allow the user to address very small areas of the screen.

High resolution displays introduced another new problem: *misconvergence*. When the display is not properly converged a line written as yellow, for example, comes up with a red and a green fringe on either side. Misconvergence which was simply annoying on the previous generation of medium resolution displays has become a source of potential misinformation on the new generation of high resolution displays. In fact, the convergence specification over the entire active area of the display becomes the effective resolution limit. That is, a 1000 line display is not useable as such unless the convergence specification insures no detectable misconvergence anywhere on the screen. In fact, for the automatic convergence specification of the 4115B the perceptual limit of misconvergence was measured and that limit or .2 mm used as the specification. On other products with fixed convergence, the line number is dictated by the convergence specification.

Individual Characteristics

We have described perception in general terms as it applies to the typical human visual system. Yet, each of us have our own perceptual idiosyncrasies which will impact the way in which we use color on a display. Some users prefer highly saturated colors while others prefer muted tones. It is important to remember that our perception of color tends to change over time. That is, our visual system adapts to color with prolonged viewing. This results in an apparent softening of the colors. As a result there is a tendency to use highly saturated colors to offset the effect or adaptation. The unadapted viewer, however, will see the colors as highly saturated. Additionally, some research has indicated that pure colors are visually fatiguing.

Although we are still a long ways from developing an aesthetics of color displays, we have attempted to compile some information on combinations of colors which go well together and those which do not. The above two tables present data from a study in which we asked people to select the best and worst appearing colors on different backgrounds. Choices were made for both thin lines (two pixels wide) and for larger filled panels. The tables list those combinations preferred or rejected by at least 25% of the 16 subjects. Obviously the sample is small, but represents the start of an understanding of the complex issue on aesthetics.

Using Color Effectively

A consideration of some of the principles of color perception allows the derivation of some perceptual principles for the effective use of color.

Not all colors are equally discernable. Perceptually we need a large change in wavelength to perceive a color difference in some portions of the spectrum and a small one in other portions. In practical terms, the size of the numerical difference between two colors defined in R, G, B or H, L, S tells us little about their relative discriminability.

Luminance does not equal brightness. The photometric scale of luminance does not apply particularly well to color displays. Two equal luminance colors will probably appear to have different brightnesses. The deviations are most extreme for colors towards the ends of the spectrum (red, magenta, blue).

Different hues have inherently different saturation levels. A classic example of the non-linear nature of perception is seen in the fact that pure colors do not appear to have the same level of saturation. Yellow in particular always appears less saturated than other hues.

Lightness and brightness are confounded on a color display but not on printed hard copy. The functional nature of a display does not allow lightness and brightness to be varied independently. This contributes to the difference in overall appearance in colors pro-


duced by emissive and reflective media.

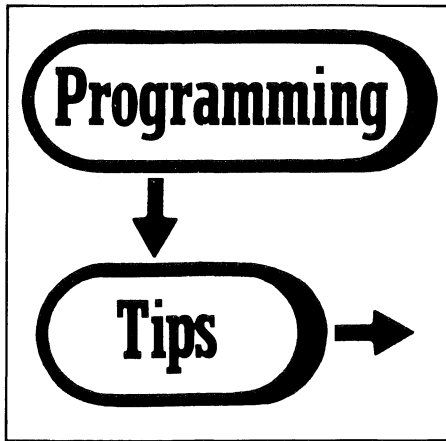
Not all colors are equally readable or legible. Extreme care must be exercised with text color relative to background colors. Besides the loss in hue with reduced size, inadequate contrast frequently results when the background and text color are similar. As a general rule the darker, spectrally extreme colors such as red, blue, magenta, brown etc. make good backgrounds whereas the brighter, spectrum center and desaturated hues produce more legible text.

Hues change with intensity and background color. Our perception of a particular hue is extremely dependent upon the context in which it occurs and its intensity level. Thus in grouping elements on the basis of color one must exercise care that backgrounds or other nearby colors do not change the hue of an element in the group. By restricting the number of colors and being sure that those used are widely separated in the spectrum confusions can be reduced.

Use the stereotypic meaning and salience of color. The eye is attracted to bright saturated colors. This perceptual tendency can be used to draw attention to important elements. Similarly certain colors have stereotypic meanings associated with them: red for warning or danger, yellow for caution, green for advance or positive, cyan for holding back and so on. Meanings can be assigned in a particular application and then maintained throughout a number of displays. For example, use the same background color for related information and use the change in background hue to indicate a change in topic.

Avoid the need for color discrimination of small areas. Hue information is lost for small areas. In general two adjacent lines of a single pixel width will merge to produce a mixture of the two. The human visual system produces much sharper images with achromatic colors. Thus, for fine detail it is wise to use black, white and gray with chromatic color reserved for larger panels and as a means of attracting attention.

Don't overuse color. Perhaps the best advice on the effective use of color is the warning to do so sparingly. The benefits of color as an attention getter, information grouper and value assigner are lost if too many colors are used. With the exception of complex images, simple graphics seldom need more than six colors. Alone the fact that the experience of color is subjective suggests not over-doing it with color. Even if you find a highly colored display to be tasteful, remain assured someone will experience it as garish. 



Automatic Commands on 4170 Boot

by Joel Spinhirne
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Wilsonville, OR

Some users want a command, or more likely, a group of commands in a SUBMIT file, executed automatically each time CP/M-86 is booted. To do this, you must edit the file, CPM.SYS in user area 15 on your boot (CP/M-86 System) disk. This lets you have a CP/M-86 command line executed automatically each time the system is booted, just as if you had typed that line. The command can

be a SUBMIT command referring to a *.SUB file containing a number of commands.

Here is how to do this on the 4170. Before starting the procedure make sure you have a good backup copy of your boot disk. Then, follow these steps (all system prompts are shown in bold):

1. Access user area 15. Type:
A>user 15
2. Start DDT86. Type:
A>ddt86
3. Read in CPM.SYS. (DDT86's prompt is a hyphen.) Type:
-rcpm.sys
4. At location 0A put the length of the command you want executed. Type:
-s0A

DDT86 displays the address of the byte you are entering, shows the current value in hex, and waits for you to enter the new value in hex for that location. Assuming the command is nine characters long, type 09 after the prompt:

```
0E50:000A 00 09
```

DDT86 now prompts you for each subsequent character you want to enter.

5. Enter the hex equivalent for each character in the command you want automatically executed, followed by a null. Assum-

ing the command is SUBMIT GO, type the hex value of each character (DDT86's prompts are shown):

```
0E50:000B 20 53
0E50:000C 20 55
0E50:000D 20 42
0E50:000E 20 4D
0E50:000F 20 49
0E50:0010 20 54
0E50:0011 20 20
0E50:0012 20 47
0E50:0013 20 4F
0E50:0014 20 00
```

6. Indicate you are done entering values by typing a period:
0E50:0015 20 .
7. If you want, take a look at what you have done. Type:
-d
You should see your command displayed at the top of the right column.
8. Write the modified CPM.SYS file to the disk. Type:
-wcpm.sys
9. Exit DDT86. Type:
Ctrl-C

Complete instructions for using DDT86 are in the CP/M-86 Programmer's Guide.

Emulating the NO-SCROLL Key of the DEC VT100® Terminal on the 4100 Series Terminals

by Shell Haffner
Tektronix, Inc.
Chicago, IL

Users familiar with DEC VT100* terminals might wish to emulate the NO-SCROLL key on their 4105, 4107 or 4109 terminal. The operator simply presses this key to stop or start host communication. Using the 4105's nonvolatile macro feature, this key may be emulated.

First, a few nomenclature conventions:

<CNTRL-P> or <CNTRL-S> will mean press the Control key and the "P" or "S" key at the same time.

<ESC> is the Escape key.

<CR> is the RETURN key.

* is the SETUP prompt (shown in bold)

(Place the 4105 in SETUP mode and type:

```
* KEYEXPAND YES
```

```
* NVDEFINE 145 /<CNTRL-P><ESC>
KDG<<A1A0A;D;E8D9C2A;B5B1C1A0
<CNTRL-P>/<CR>
```

```
* NVDEFINE 146 /<CNTRL-P><ESC>
KDG<<A3A0A;B5B1C0A;D;E8D9C1A0
<CNTRL-P>/<CR>
```

```
* NVDEFINE 124 /<CNTRL-S>
<CNTRL-P><ESC>%!0<ESC>KXII
<CNTRL-P>/<CR>
```

```
* NSAVE
```

At this point the Vertical Bar "|" is the NO-SCROLL key. It is programmed to send a DC3 to the host, then expand Macro Number 145. Macro Number 145 reprograms the Vertical Bar to send a DC1 then expand Macro Number 146. Macro Number 146 reprograms the Vertical Bar to its original definition - it will again send a DC3 to the host then expand Number 145. Thus, you can toggle the Vertical Bar between the two definitions.

Macros can be defined only in Tek mode. A keystroke that stops scrolling puts the terminal in Tek mode to permit macro definition. The keystroke that resumes scrolling puts the terminal back in ANSI mode.

If another key is preferred instead of the Vertical Bar, you must make three changes.

Change the last nonvolatile definition key specifier from 124 to the ASCII decimal value of the preferred key. In the first and second key definitions, replace the sequence "G<" with the encoded <INT> parameter identifying the key.

I used this emulation with my 4105 connected to a VAX 11/780 and it worked just fine.

*VT100 is a registered trademark of Digital Equipment Corporation.



Tektronix 4100 Series Graphics Display Terminals Overview

Product	4105	4107	4109	4112B	4113B	4114B	4115B	4116B
Display Type	Color raster	→		B/W raster	Color raster	DVST	Color raster	DVST
Display Size	13"	→	19"	15"	19"	→		25"
Display Area	9.5 × 7"	→	14 × 10.5	10.5 × 7.875	14 × 10.5	→	13.5 × 10.8	18 × 13.5
Display Resolution	480 × 360	640 × 480	→		4096 × 3120	→	1280 × 1024	4096 × 3120
Display Addressability	4096 × 3133	→		4096 × 3127	→	4096 × 3120	4096 × 3277	4096 × 3120
	NOTE: For raster devices, these are the defaults. All raster devices except the 4115B can display a maximum of 4096 × 4096 addressable points. The 4115B maximum addressability is 4.3 × 4.3 billion points (32 bit).							
Displayable Points/Inch	50.5	67.4	45.7	60.9	45.7	292.6	94.8	227.6
Addressable Points/Inch	431.2	→	292.6	390.1	292.6	→	303.4	227.6
Simultaneous Colors (grey)	8	16	→	2 (std) (grey) 8 (opt) (grey)	8 (std) 16 (opt)	N/A	16 (std) 256 (opt)	N/A
Available Colors (grey)	64	64	4096	15	4096	N/A	16.7 million	N/A
Color Definition	HLS only	HLS → RGB → CMY →	→	percentage	HLS RGB CMY	N/A	HLS RGB CMY machine RGB	N/A
	NOTE: For the 4115B, machine RGB must be used to achieve the full range of 16.7 million colors.							
Display Area Display	alphanumeric overlay	→	shared with graphics	refresh	A/N overlay	refresh		
	NOTE: No dialog area/graphics interaction occurs on devices with either an alphanumeric overlay (raster devices) or refresh (DVST devices). Raster devices with a shared display surface can be defined to have a dedicated dialog area surface at the expense of color (or grey) capability.							
Dialog area Characters	30 × 80	32 × 80	→	34 × 80	→	variable	34 × 80 64 × 160	variable
Alphatext Size Display Units	5 × 9	7 × 12	→	7 × 9	→	variable	16 × 30 8 × 15	variable
Alphatext Size Address Units	42.6 × 76.8	44.8 × 76.8	→	44.8 × 57.6	→	variable	51.2 × 96 25.6 × 48	variable
Device Command Set	4010 emulation	→						
	4110 common command set	→						
	no segments	segments	→					
	4010 GIN	4110 GIN	→					
	string precision graphtext only	string and stroke precision graphtext	→					
	4113 command subset	→						
	no blockmode/half duplex	→						
	no user-defined fill patterns	→						
	no views	→						
	no surfaces	→						
	opt. pixel operations	→						
	NOTE: String precision graphtext differs in characteristics between 410x and 411x devices. Stroke precision graphtext characteristics are compatible across all products.							
User RAM	8kb	256kb	256kb	288kb (std) 672kb (max)	800kb (max)	→	288kb (std)	288kb (std)
Graphic Tablet	no	optional	→					
Local Zoom and Pan	no	standard	→		no	standard	no	
Local Peripheral I/F	Centronix	→		Optional 3 port RS-232	→			
		2 RS-232	→					
Local Mass Storage	no	(avail. w/4170)	→					
Locally Programmable	no	(avail. w/4170)	→					

4100 Series

Marine Meteorological Firm Uses Tektronix 4113 Terminals in Japanese Ship Routing and Television Weather Show

Founded in San Francisco in 1952 when the value of applying the science of meteorology to ship routing was just beginning to be recognized, Oceanroutes has become the world's largest private marine meteorological organization. Oceanroutes' worldwide network of offices, regional forecasting centers and computers supports the maritime industry through oceanrouting, forecasting, ocean tow and rig-move strategies and offshore studies services. Recently the Japanese branch, Oceanroutes Japan Ltd., incorporated the Tektronix 4113 Intelligent Graphics Terminals into their network to graphically convey weather information to shipping companies and to a broadcasting firm in Japan.

Oceanrouting

Each month Oceanroutes assists hundreds of departing ships in their passage between the major ports of the world. The route recommended is the optimum route developed for an individual ship on a specific voyage, taking into consideration the ship's cargo load, its trim and draft, and its own distinctive speed and seakeeping characteristics.

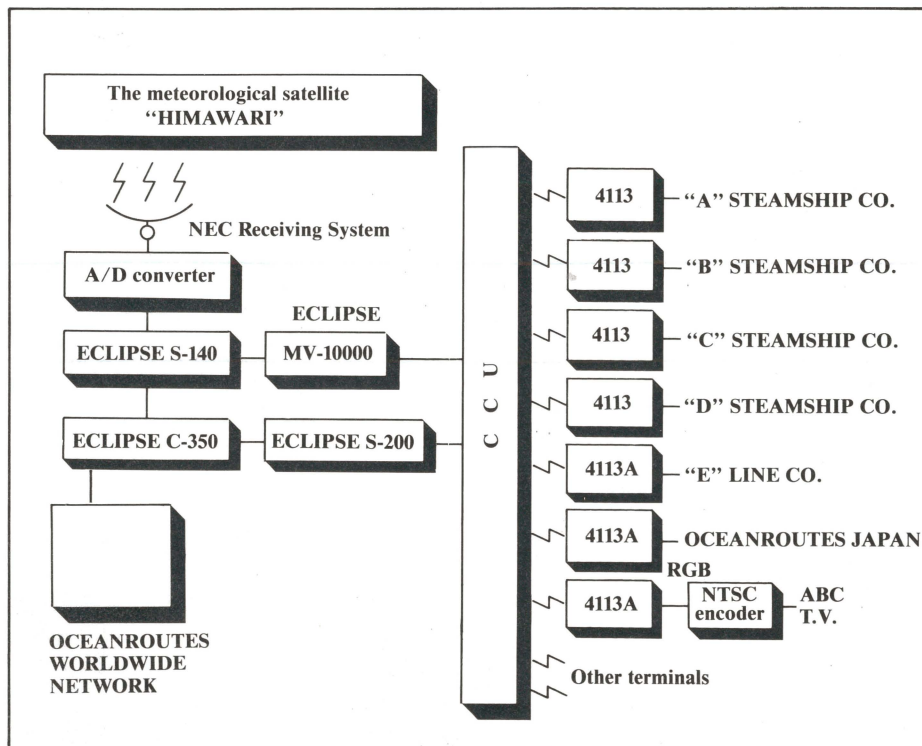
Once underway, the ship is followed by Oceanroutes' tracking program and becomes the responsibility - 24 hours a day - of the on-duty route analysts, backed by experienced oceanographers, master mariners, and senior professional meteorologists.

Supported by unique computer programs and graphic plots, the ship's passage is continuously tracked. Its performance is correlated with the weather, and the result is used to dead reckon the ship's position over the route ahead in light of the prevailing and developing weather.

If unexpected adverse weather prompts a change from the original route, the shipping firm can alert the ship's master in advance and give diversions that will enable him to avoid the worst conditions.

Oceanroutes Japan is using Tektronix 4113 Graphics Systems to present real-time weather information to their shipping clients and to advise the most suitable sailing route.

Prior to incorporating the 4113 terminals into the system, alphanumeric terminals were used. Characters and numbers, however,



The system configuration of Oceanroutes Japan, Ltd. includes Tektronix 4113 Intelligent Graphics Terminals to display weather and ship routing information.

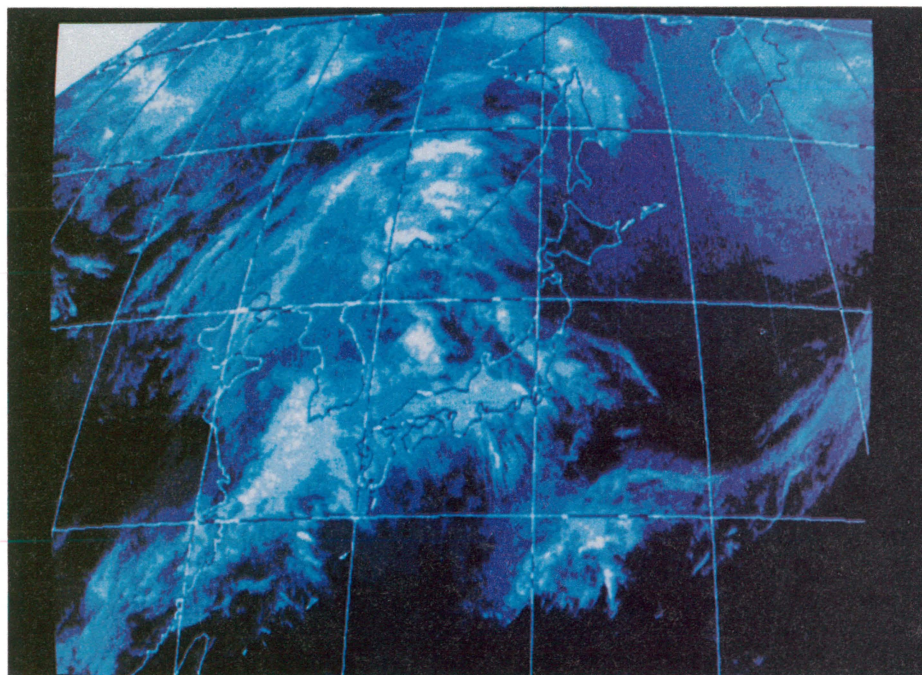



Figure 1. A weather map from the satellite "HIMAWARI" is displayed on the Tektronix 4113A Graphics Display. Host computers add geographic information and display it through the 4113A's pixel operations.

could not portray the inherent complexity of a weather map. Using the high resolution and picture segments function of the 4113 terminal, the map of the sailing sphere, the present sailing point, high and low atmospheric pressure conditions, and the better sailing route are displayed simultaneously. The shipping firm has timely, easily understood information to help them accurately instruct the ship's master so he can take action to minimize cargo damage, lost sailing days and excessive fuel consumption.

Weather Forecasting

Although the shipping and offshore petroleum industries are the major customers for the extensive marine weather knowledge services of Oceanroutes, nonmarine commercial clients also receive low cost, easily accessible weather information. Recently Oceanroutes Japan and Osaka Asahi Broadcasting (ABS) jointly developed a near real-time weather telecast using the Tektronix 4113 Graphics Terminal. The six-minute "Time 6 Weather" program is Oceanroutes Japan's first television weather forecasting in which a computer graphics terminal is used directly.

The analog signal of the picture taken by the weather satellite "HIMAWARI" is converted into digital signals by Oceanroutes' computer system and forwarded to the 4113A. The 4113A then processes additional information from the host computers to add the longitude and latitude lines and the coastlines of Japan, Korea and part of China to the weather picture. After the 4113A does its work, its 60 Hz noninterlaced signal is converted to a 30 Hz interlaced scan for broadcast from the TV station.

With this process, pictures taken by the satellite are broadcast on Osaka's evening "Time 6 Weather" just 44 minutes later. 

Editor's note: We thank Mr. Yoshihiro Morishige at Sony/Tek in Tokyo for bringing this unique application to *TEKniques*' readers. (All photographs courtesy of Oceanroutes Japan Ltd., Tokyo, and Osaka Asahi Broadcasting, Osaka.)

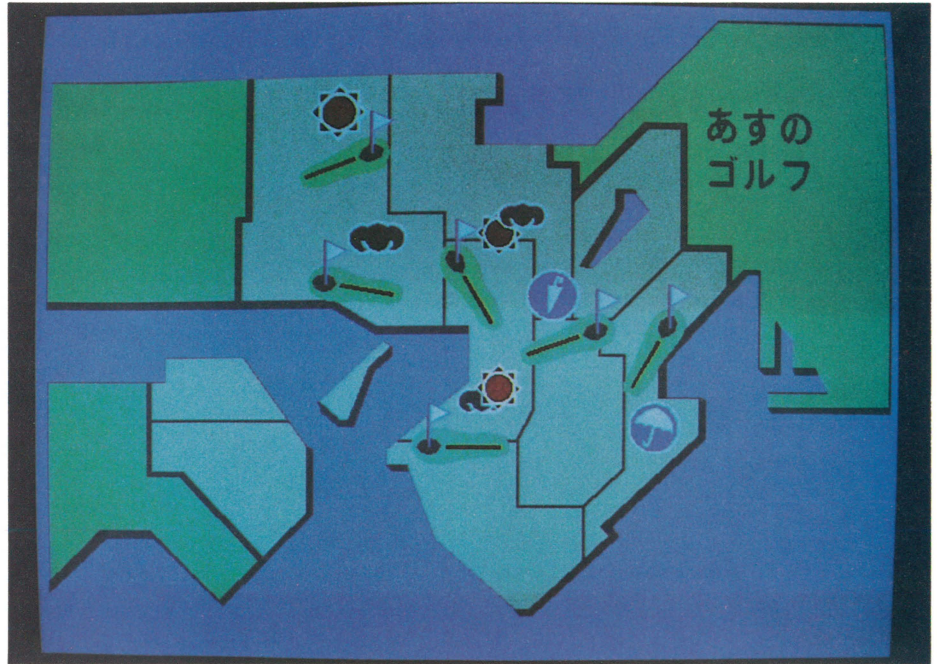


Figure 2. Local weather maps with appropriate symbols indicating tomorrow's weather (and local golf course locations) are portrayed on the 4113A's graphics screen.

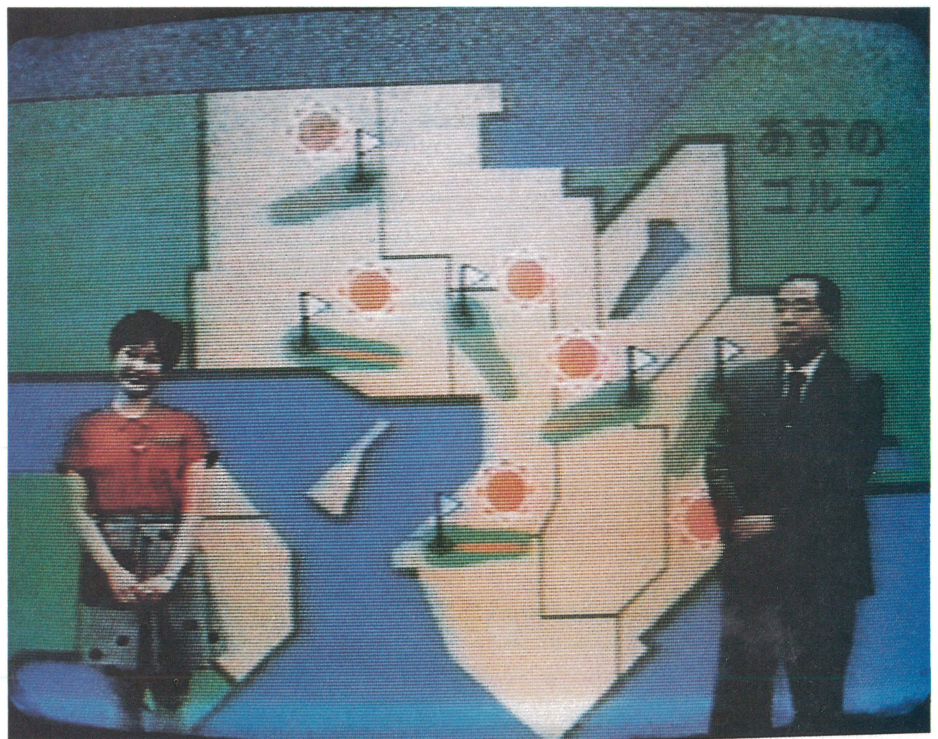


Figure 3. During the "Time 6 Weather" program, newscasters explain the weather as each symbol is redrawn from 4113A picture segment memory and displayed on the 4113A screen.

Computer Aided Design in the Production of Tactual Graphics for Visually Impaired Preschool Children

Jack Massey

Department of Geography
University of Melbourne

Dean is totally blind; he is two and one-half years old. Jordina is four years old and she has very poor partial sight. When Dean and Jordina reach school age it is anticipated that they will be integrated into classrooms of children with normal sight. But their education will not start at that time. It has already started. Just like their sighted peers, Dean and Jordina are read to by their parents and they play educational games. Nevertheless, Dean and Jordina are at a marked disadvantage. Although they can hear words and they can grasp solid objects such as a cube and a sphere, there are very few graphics which they can use to assist their learning of concepts.

Much learning involves the examination of graphics. The graphics which are appropriate for children and adults with severe visual impairment are called tactual graphics. In a typical sequence for the conventional production of a tactual graphic, shapes are cut out of textured wallpaper or sandpaper. The shapes along with string, wire and/or buttons are glued to a heavy card which constitutes the master. A piece of light plastic is then vacuum thermoformed over the master to produce the tactual graphic copy. Finally, braille and low vision print, or both may be added. Because this is a time consuming and, therefore, expensive procedure, very few tactual graphics have been produced. As a result, severely visually impaired persons are restricted in their learning experiences; they are educationally handicapped.

The problem of cost-effective production of tactual graphics is being investigated by a research team of the Department of Geography, University of Melbourne. This research is being supported by the Australian Commonwealth Schools Commission and is oriented to pre-school visually impaired children.

Computer aided design

Research is focused on the development of a method for the production of tactual graphics based on computer aided design. Hardware comprises a Tektronix 4114A computer

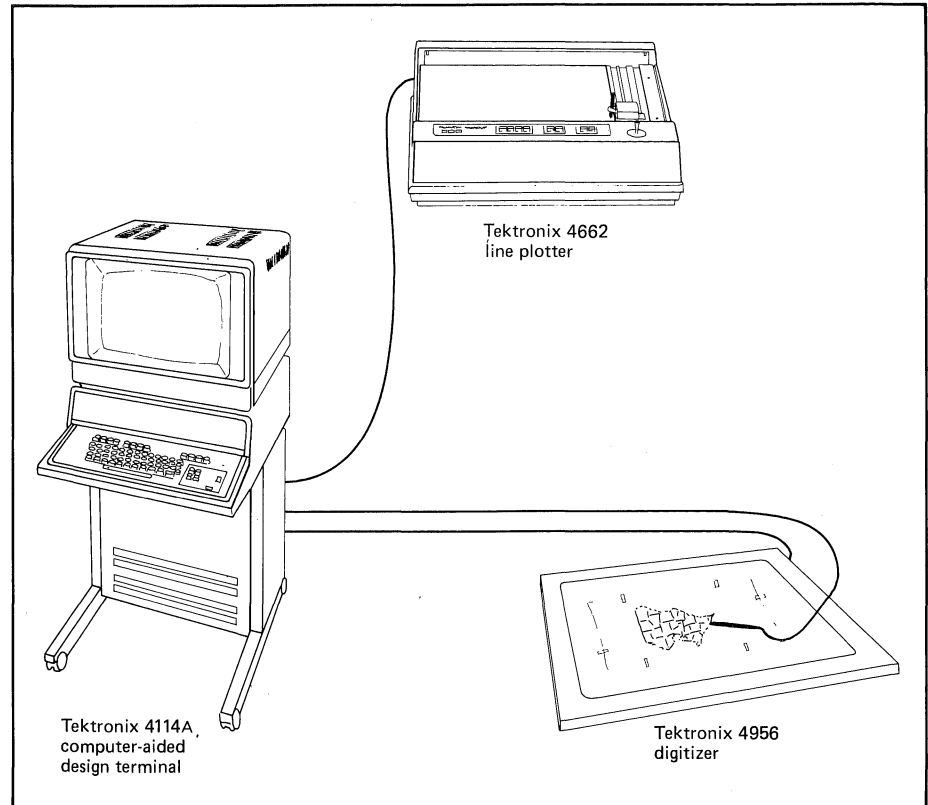


Figure 1. Hardware configuration for the computer aided design of tactual graphics.

graphics terminal, a 4956 digitizing tablet and a 4662 digital plotter (figure 1). The menu-driven software has been written in FORTRAN by Dr. Jack Massey with guidance from Mr. John Poliness. It uses the local programming capability of the 4114A (figure 2) including extensive use of low level terminal interface (LTI) statements. There are approximately 2,500 lines and over 50 subroutines.

The method is applied in three stages. First, graphic primitives are digitized and stored on a floppy disk. In the second stage selected primitives are retrieved from the disk and used to compose the artwork for the tactual graphic. This may be annotated with low vision print and braille or both. Then the artwork and annotations are line-plotted on paper. Finally, in the third stage the artwork and annotations are photocopied onto heat sensitive paper. The paper is passed through a heat bath and the surface of the paper lying directly beneath the artwork and annotations swells to the extent that it can be sensed by the fingers. This is known as stereocopying.

Stage I - Digitizing of Graphic Primitives

There is little knowledge of what constitutes an effective tactual graphic. For example, should the representation of a balloon be the raised outline of a circle or should it be a circle which is filled and raised? There is also the question of perspective, e.g., how do you represent the profile of an animal with four legs? The best way to answer these questions and many others is to produce tactual graphics and present them to visually impaired children in order to gauge their reactions.

Mr. Andrew Turk and Ms. Mary Ainley assisted by Mr. John Falk have designed a number of graphic primitives on the basis of discussions with parents and teachers of visually impaired children. These include animals, fruits, utensils, flowers, trees and geometric forms. Some of the primitives are outlines and others are filled shapes.

The drawing of a graphic primitive is taped to the digitizing tablet and a four button cursor is used to trace the outline, which appears

on the screen of the 4114A. Because the outline may be recorded as a series of "short segments," individual lines may be altered. The software provides for the automatic filling of a digitized polygon. There is also a circle generator and a circle may be filled selectively. Once the graphic primitive is digitized it is stored in a permanent floppy disk file.

Stage II - Composition of the Artwork

Typically, two or more graphic primitives are retrieved from the disk and manipulated to compose the artwork for a tactual graphic. Manipulations include transformation, enlargement, reduction, rotation and duplication. For convenience, segments may be rendered invisible or deleted. There is also a software option for segment classification. Manipulation of segments is facilitated by the ability to list all existing segment numbers and to pick a segment and display its number on the screen of the 4114A.

To compose the artwork for "Flowers, Fish, and Trucks" (figure 3) three graphic primitives were retrieved. Each was duplicated twice. Transformation during duplication allowed for positioning of each primitive. The orientation of each of two of the fish was changed as it was rotated in a clockwise or a counterclockwise direction. Another option allowed duplicates of the truck to be enlarged and reduced.

Each annotation is a segment and as such it may be created at any time during the composition of the artwork. However, because the artwork is the focus of attention, usually it is composed first and then the annotations are added. This was the case with "Flowers, Fish and Trucks." The software option for low vision/braille allows the operator to key in a number, letter, word, phrase or sentence. This appears on the 4114A screen in refresh mode as an alphanumeric character string. The position of the string may be changed by using the thumb wheels. When the low vision annotation is in the desired position, the string is rendered in storage mode, made invisible, and translated in approximately eight seconds into grade two braille. The braille characters appear on the screen in refresh mode and, again, their position may be changed by using the thumb wheels. If low vision print is also desired, the alphanumeric character string may be made visible. Alternatively, if the low vision print is desired, the string is made visible and the braille characters may be deleted or made invisible.

Once the operator is satisfied with the composition of the artwork and the nature and positioning of the annotations, these may be stored in a permanent floppy disk file. When

line-plotted output on paper is required, the artwork and annotations are stored in a temporary floppy disk file and then spooled to the 4662 digital plotter.

Stage III - Stereocopying

Stereocopying is a procedure developed in Japan by Professor Yonezawa of Shinshu University and Matsumoto Oil and Fat Pharmaceutical Company. The hardware and paper are marketed internationally by Minolta. There are two steps in the stereocopying method: photocopying and heat treating.

In the first step the line-plotted artwork and annotations are photocopied onto "microcapsule" paper. The top layer of the paper comprises foam microcapsules which are heat sensitive.

In the second step the microcapsule paper is passed through a heat bath. The black of the artwork and annotations absorbs heat which is transferred to the microcapsules lying directly beneath. These microcapsules swell causing the artwork and annotations to rise thereby producing the tactual graphic.

Three books and a matching game have been produced using this method. Figure 4 shows Dean and his mother examining the book, A to Z. Jordina and her mother are pictured in figure 5 examining the book, Shapes.

Normal Sight is a Problem

The artwork and annotations for the initial tactual graphic are prepared by an operator

with normal sight. In this context normal sight is a problem. The only person who can judge adequately the effectiveness of the tactual graphic is a person with a visual impairment.

It is envisaged that a person with a visual impairment would be part of the production team. The initial tactual graphic is assessed by this person. If it is not satisfactory, then the operator can change the artwork and an-

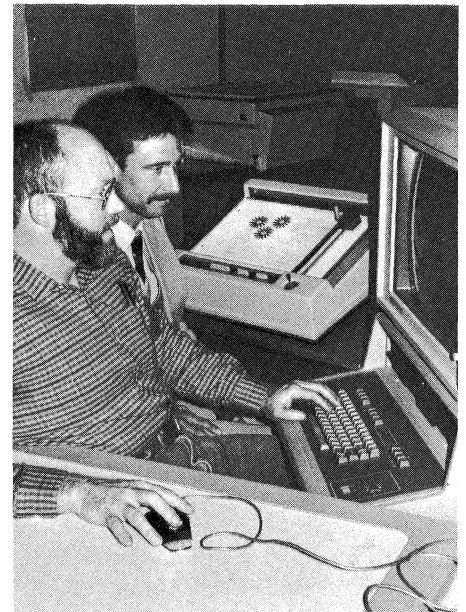


Figure 2. Dr. Jack Massey and Tektronix representative, Mr. Glenn Charlesworth, discussing the computer aided design of tactual graphics.

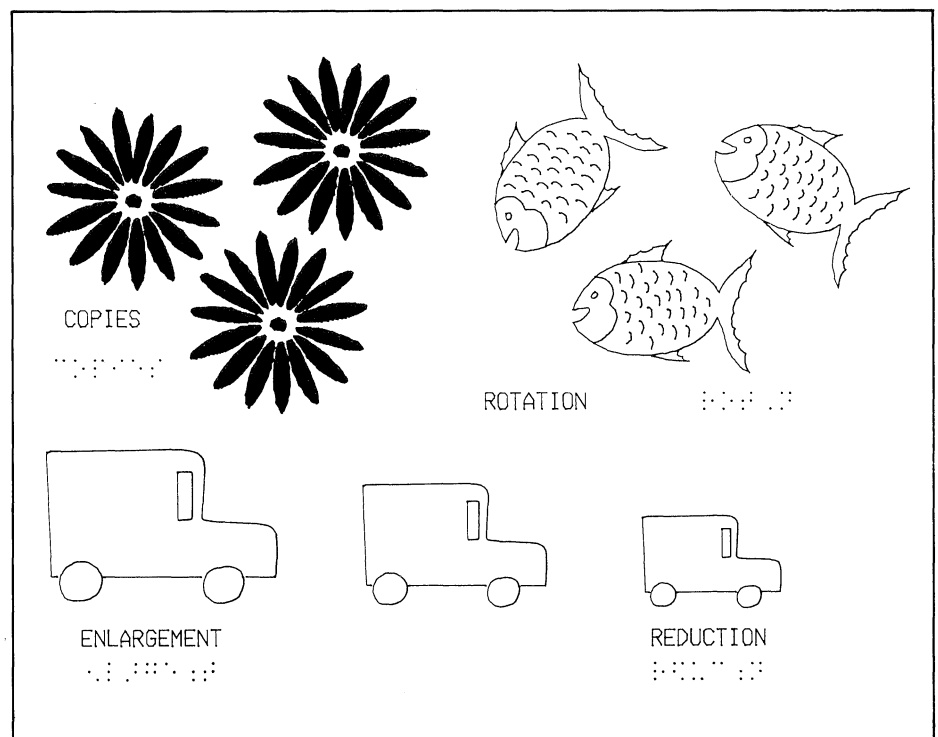


Figure 3. Artwork for "Flowers, Fish and Trucks." NB: Scale of artwork reduced for publication.

notations. This is the real advantage of computer aided design in comparison to conventional methods of production of tactual graphics. Not only is there a dramatic reduction in the cost of composing the artwork and adding annotations, but since these may be retained on the 4114A screen or stored in a file they may be changed at little extra cost to suit the specific needs of the visually impaired. This approach is especially valuable in the production of complex tactual graphics such as mobility maps.

When the tactual graphic is considered satisfactory, several additional copies can be produced by stereocopying. However, if a larger number of copies is needed a more cost-effective technique is employed.

A same size photographic negative of the artwork and annotations is used in the deep etching of a magnesium or a zinc plate. The artwork and annotations are raised features on the metal plate. In addition, the artwork and annotations are printed on heavy paper. After the paper is positioned in register on the metal plate, it is pressed with a heavy roller to emboss the tactual graphic. A production facility of this type has been established at Pentridge Prison in Melbourne with the assistance of the Victorian Government Department of Community Welfare Services.

Future Activities

There are many more persons who have low vision in comparison to the number who are totally blind. It is because of this that the


research team has interpreted the needs of the visually impaired in the broadest sense, i.e., low vision as well as tactual. All the tactual graphics which we have produced can be seen as well as felt.

Currently, our stereocopied tactual graphics are black against a cream background. This has proved effective when presented to partially sighted children. Nevertheless, several parents have stressed the need for color tactual graphics especially for storybooks. It is their opinion that bold color will stimulate the child with low vision to explore the tactual graphic and extend concentration on the learning exercise.

The development of a cost-effective method for the production of color tactual graphics is the next phase of the research program. A necessary aspect of the research is the determination of suitable sets of colors for use with particular types of visual impairment. The ideal configuration is a Tektronix 4115B color graphics terminal, a 4695 color graphics copier and a 4926 hard disk with floppy disk backup. The compatibility of the Tektronix Systems would allow for rapid modification of the existing software to exploit the advantages of color raster technology.

The goal of our research is the widespread availability of tactual graphics. This will be realized when the method we have developed is implemented in a production environment. Directors of several agencies, which serve members of the visually impaired communi-

ty, have already expressed a desire to have their own facility for the computer aided design of tactual graphics. While advanced hardware, such as the 4115B color graphics terminal, is desirable for research, it is unnecessary in a production environment. Consequently, an immediate need is to rewrite existing software for relatively low cost hardware, such as the Tektronix 4109 color graphics terminal, 4957 digitizing tablet, and 4695 color graphics copier.

There will be a marked increase in the number of tactual graphics as a result of continued research into production methods and the availability of software and hardware to agencies which serve the visually impaired. The increase will allow for not only the qualitative evaluation of the use of tactual graphics, but also quantitative psychological testing of tactual sensing. This is an important research direction. It is only through knowledge of how tactual sensing works that the design of tactual graphics will improve. As this happens, we can anticipate a time when visual impairment does not necessarily imply an educational handicap for Dean, Jordina and many many others. 

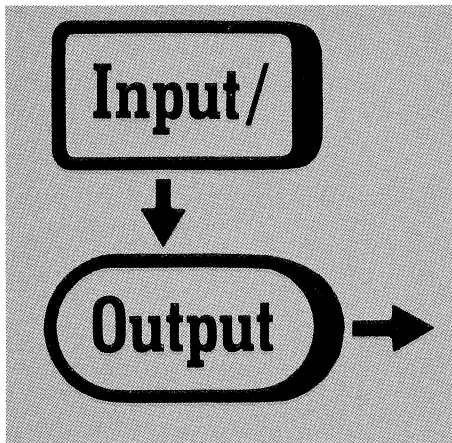
Editor's Note: Dr. Jack Massey, Senior Lecturer, Department of Geography, University of Melbourne, Parkville, Victoria 3052, Australia.



Figure 4. Dean and his mother examining tactual graphics in the book, *A to Z*.



Figure 5. Jordina and her mother examining tactual graphics in the book, *Shapes*.



Ascertaining Cyclical Overlap

In the Input/Output column of *TEKniques* Vol. 7 No. 4, David Walcutt asked for a function to ascertain cyclical overlap.

Michael Lane, Missouri Div. of Health, Jefferson City, MO, has responded with the following:

Lines 1070-1150 of his program can be replaced by:

```
1070 IF 1=(P2<P1)+(P7<P2)
      +(P8<P7)+(P1<P8) THEN 1380
```

This formula can be derived from the fact that if there is no overlap in the times, one time must follow another in orderly progression, and the times of the broadcasts plus the

times in between the broadcasts should equal 24 hours. That is:


$$\begin{aligned} \text{TIME} = & (P2 - P1 + 2400*(P2 < P1)) \\ & + (P8 - P7 + 2400*(P8 < P7)) \\ & + (P7 - P2 + 2400*(P7 < P2)) \\ & + (P1 - P8 + 2400*(P1 < P8)) \end{aligned}$$

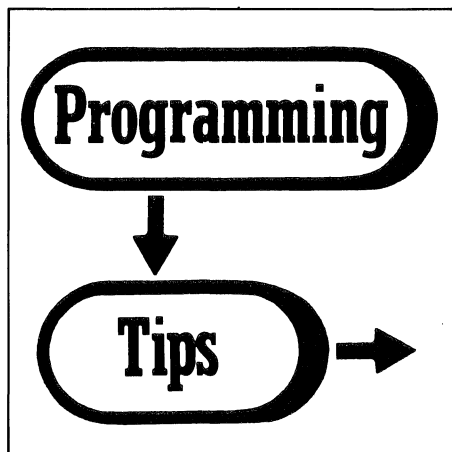
where $2400*(P_x < P_y)$ adjusts for time crossing the 24'th hour.

This simplifies to:

$$\begin{aligned} \text{TIME}/2400 = & (P2 < P1) + (P8 < P7) \\ & + (P7 < P2) + (P1 < P8) \end{aligned}$$

which translates to my line 1070.

Mr. Walcutt need not SIN and COSIN his computer time away. 



```
SUBROUTINE MOVE(X,Y)
COMMON /CP/ XCF,YCF
XCF=X
YCF=Y
RETURN
END
SUBROUTINE DRAW(X,Y)
COMMON /CP/ XCF,YCF
REAL XS(2),YS(2)
XS(1)=XCF
YS(1)=YCF
XS(2)=X
YS(2)=Y
XCF=X
YCF=Y
C * GPL IS THE POLYLINE ROUTINE OF GKS
CALL GPL(2,XS,YS)
RETURN
END
```

Example 1. Unbuffered adapters for MOVE and DRAW.

If the previous example seems intolerably inefficient, consider the next example, which buffers arrays of connected line segments. If the applications programs being converted draw polylines of many connected line segments, as often happens when curves are being approximated by short line segments, this method will greatly reduce the number of calls to GKS.

Note that the "current position" is maintained as the last point stored in the XB, YB arrays. Also a text drawing routine is not shown. It, of course, would flush the buffer (if buffered) and set the "current position" in a manner to match the behavior of the original graphics package. This is often a difficult calculation, and it is wise to carefully examine the applications to make sure it is necessary, since many application programs never make use of the value of the updated cursor position.

There are a few other housekeeping chores to consider in a buffered environment. It is important to make sure that the buffer is properly initialized. An adapter to startup routines (INITT in TCS, PLOTS in CalComp, etc.) assure proper initialization. Be sure to flush the buffer before most calls to GKS routines in the application. Finally, try to make buffer size as "soft" as possible, so that it will be possible to tune performance by adjusting the tradeoff of memory required for buffers versus run-time overhead of calls to GPL.

```
SUBROUTINE MOVE(X,Y)
PARAMETER MAXB=100
COMMON /XYBUF/ N,XB(MAXB),YB(MAXB)
IF(N,GE,1) CALL FLUSHR
N=N+1
XB(N)=X
YB(N)=Y
RETURN
END

SUBROUTINE DRAW(X,Y)
PARAMETER MAXB=100
COMMON /XYBUF/ N,XB(MAXB),YB(MAXB)
IF(N,GE,MAXB) CALL FLUSHR
N=N+1
XB(N)=X
YB(N)=Y
RETURN
END

SUBROUTINE FLUSHR
PARAMETER MAXB=100
COMMON /XYBUF/ N,XB(MAXB),YB(MAXB)
CALL GPL(N,XB,YB)
N=N-1
RETURN
END

BLOCK DATA
PARAMETER MAXB=100
COMMON /XYBUF/ N,XB(MAXB),YB(MAXB)
DATA N/0/
END
```

Example 2. Buffered adapters for MOVE and DRAW.

Buffered or Unbuffered Line Segments when Adapting Software to GKS

by Dave Straayer
Tektronix, Inc.
Wilsonville, OR

TEKniques Vol. 7 No. 3 discussed computer graphics standards, with a close look at GKS (Graphical Kernel System). In *TEKniques* Vol. 7 No. 4, we examined some of the reasons to convert existing software to the GKS standard and three conversion approaches.

The hybrid strategy which modifies the original code as little as possible, makes adapters for commonly used routines, such as graphics primitives. One decision in this approach is whether to buffer or not buffer line segments. Not buffering will result in many calls to GKS, whereas buffering will result in fewer calls. The best illustration of this is the following short code examples:

4110 Local Programmability and 3PPI Devices

by **Brad Powell**
Tektronix, Inc.
Wilsonville, OR

When the optional Three Port Peripheral Interface (3PPI) is installed, three additional physical devices are provided for sending or receiving data on a 4110 Terminal. When running CP/M-86® Local Programmability, these physical devices are assigned to CP/M-86 logical devices through either the DEV (device) command or through the subroutine DEVSET contained in the BDOS.LIB. Once one of the 3PPI ports has been assigned to a

logical device, it is no longer available for use by non-CP/M-86 functions. These include SETUP Mode commands and the DTI calls.

Therefore, be sure to set all the parameters (such as EOF/EOL strings, flagging mode and so forth) before assigning a 3PPI to a CP/M-86 logical device.

CP/M-86 is a registered trademark of Digital Research, Inc.

4110 Local Programmability COPYDISK Command

by **Brad Powell**
Tektronix, Inc.
Wilsonville, OR

As the COPYDISK command executes, it displays text which describes the current operation and disk track number. In doing so, it uses backspaces to alter the line it writes to. These backspaces can fill the Dialog Area Buffer while leaving the cursor viewable, and the system will appear to "hang." Setting the Dialog Area Buffer to a minimum of 110 lines will provide sufficient room for the COPYDISK operation.

Running Software Designed for 4014 Terminal and 4953/54 Tablet on 4110 Terminal with Option 13 or 14 Tablet

by **Scott Nelson**
Tektronix, Inc.
Concord, CA

When using a 4110 Terminal with Option 13 (small tablet) or Option 14 (large tablet) connected to a host that is running software driving a 4014 Terminal with 4953 (small tablet) or 4954 (large tablet), some parameters must be set.

First, find out the strap settings on the 4953/54 interface card and set the 4110 Terminal to the appropriate corresponding settings. The 4110 Command Reference manual illustrates this in the Enable-4953-Tablet-GIN section.

Parameters you should check are: TBSTATUS, REOM, TBHEADERCHARS, XMTDELAY, EOLSTRING, BYPASSCANCELCHAR, and if a stroke function is used with the tablet, TBFILTER.

The following SETUP command parameter settings worked for me:

```
TBSTATUS OUT
REOM 1
TBHEADERCHARS CONTROL
XMTDELAY 50
EOLSTRING CR Enter as /~CR/
BYPASSCANCELCHAR NUL Enter as
CTRL-SHIFT @
TBFILTER 10 0 250
```

Be careful with the TBHEADERCHARS command: 0 = LETTERS and 1 = CONTROL are correct. The BYPASSCANCELCHAR is another command that must be set absolutely correctly for GIN to work. Also helpful is the description of 4953-Tablet-GIN-Report.



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IDG Graphics Systems Workshops

Computer-Aided Drafting Workshops

A comprehensive workshop gives PLOT 10 Computer-Aided Drafting and PLOT 50 2-D Drafting users a jump on productivity. Taught by Tektronix professionals, the one week workshop equips the students with knowledge and skills usually gained only through months of experience. Instruction in optimum use of the Drafting system combined with "hands-on" training tailored to the user's environment accelerates the individual's effectiveness.

Course Objectives/Content:

The workshop consists of lectures and laboratories emphasizing efficient working habits and a working knowledge of all system functions and capabilities. Specific topics which will be covered in the workshop are:

- Reviewing and using all functions
- Generation of quality ink drawings
- Digitizing drawings
- Geometric operations (lines, arcs, line smoothing)
- Note generation and editing
- Workset usage
- Blanking
- Drawing modifications
- Drawing organization
- Uses and creation of symbols
- Configuring equipment

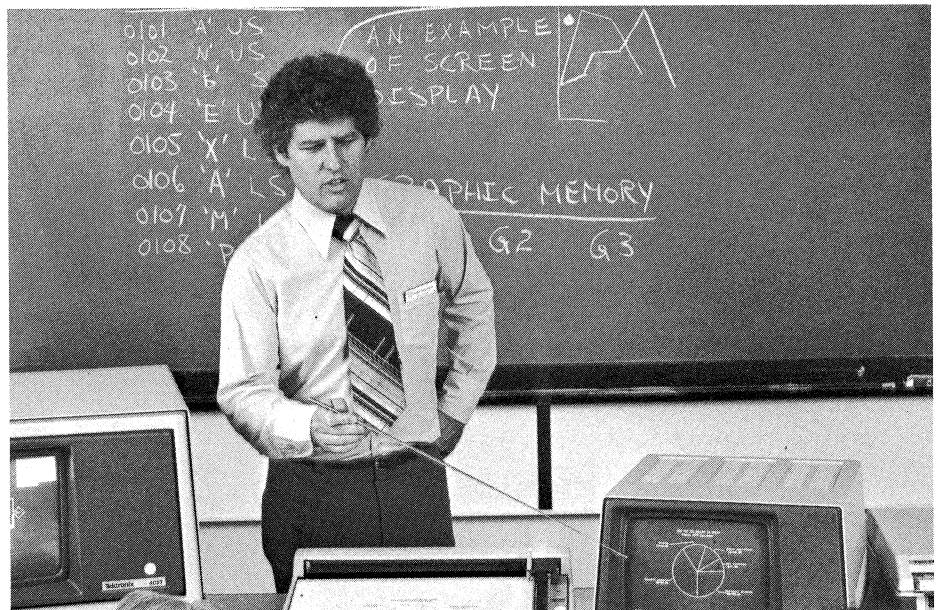
The workshop is not intended to *introduce* the student to drafting.

Enrollment in a workshop is limited to ensure each participant receives the maximum benefit. Workshops will be taking place in the next few months. Classes may also be scheduled at a customer site.

<u>Gaithersburg, MD</u>	<u>Santa Clara, CA</u>
June 11-15	Aug. 13-17
Oct. 1-5	Dec. 3-7

Local Programmability Workshops

Spending one week in a Tektronix workshop getting to know Local Programmability is the equivalent of three to six months of on-the-job education. The Tektronix Local Programmability Workshop is a hands-on course which teaches the FORTRAN programmer the basics of Local Programmability, its capabilities, and support libraries. The student



will understand the operation of Tektronix graphics terminals. Tablet, plotter, copier and disk interaction with Local Programmability and the terminal is thoroughly reviewed. Basic and advanced data communications concepts are taught. The small class size of 12 students allows for individual attention. The schedule for the last half of the year is:

<u>Gaithersburg, MD</u>	<u>Santa Clara, CA</u>
June 18-22	July 16-20
Aug. 13-17	Sep. 10-14
Oct. 8-12	Nov. 5-9
Dec. 3-7	

IGL Workshops

An intensive workshop will give programmers or project managers a familiarity with IGL which will speed them on their way in program development. Instruction in the proper use of IGL routines eliminates the need for experimenting, permitting faster, more effective graphics applications design. Effective training results from keeping class size small and focusing on tasks typical of a user's work. The workshop features hands-on use of the entire Tektronix 4110 Series of graphics terminals, and peripherals such as tablets, plotter and copiers.

Several Summer and Fall workshops have been scheduled.

<u>Gaithersburg, MD</u>	<u>Santa Clara, CA</u>
June 25-29	July 23-27
Aug. 20-24	Nov. 12-16
Oct. 15-19	
Dec. 10-14	

4050 Series Workshops

Tektronix desktop computers are ideal tools for improving operating effectiveness. Although satisfied with the job the Tektronix graphics system is doing now, the user probably isn't aware of all its capabilities and how they can be used to increase efficiency.

To help the user get the most out of the 4050 Desktop Computer, Tektronix provides workshops combining classroom lecture with extensive supervised laboratory sessions. Each day the students will exercise the problem-solving concepts presented using a complete desktop computing system.

The 1984 Schedule follows:

<u>Gaithersburg, MD</u>	<u>Santa Clara, CA</u>
July 30-Aug. 3	Oct. 29-Nov. 2

For additional information regarding these workshops, or to register, please contact:

Tektronix, Inc.
 ATTN: Customer Training Registrar
 Mail Station 63-574
 P.O. Box 1000
 Wilsonville, OR 97070
 (503) 685-3808



4050 Series ROM Pack and Interface Overview

The following is a list of the ROM Packs and Interfaces available for the 4050 Desktop Computer Series. Unless otherwise noted, all are available for the 4051, 4052, 4052A, 4054 and 4054A. 4051XXX order numbers are compatible with the 4051 Desktop Computer. 4052XXX order numbers are compatible with the 4052, 4052A, 4054 and 4054A. To place an order or to receive more information, please contact your local Tektronix office.

Editor ROM Pack

Allows general ASCII file editing of data or programs or text (including FORTRAN, BASIC and COBOL programs) offline. Includes 29 commands such as COPY, INSERT, MOVE, SEARCH and SORT for creating, manipulating and storing ASCII text.

Order 4051R06/4052R06

Signal Processing ROM Pack #1

Adds seven new functions which can be applied to one dimensional data arrays; integration, differentiation (2 and 3 point), fast graphing, locating minimum and maximum, and crossing over a threshold. Functions operate 2-10 times faster than equivalent BASIC routines.

Order 4051R07/4052R07

Signal Processing ROM Pack #2

Extends array handling capabilities by adding commands that perform Fast Fourier Transform (FFT), convolution, correlation, windowing and related utility functions. Functions execute 7-20 times faster than BASIC routines.

Order 4051R08/4052R08

Real Time Clock ROM Pack (Not available for 4051)

Provides five time-related functions for date and timekeeping, elapsed time measurement and a time programmable 4050 BASIC level interrupt. All functions may be executed directly from the keyboard or may be used within a program.

Order 4052R09

Character and Symbol ROM Pack (Not available for 4051)

Generates high resolution stroked characters that can be scaled, rotated and slanted to user's specifications. In addition to the over one-hundred standard characters, users can

construct unique custom symbols. The degree of smoothness is selectable for quick screen previews before final plotter copy. Additional commands extend Dynamic Graphic capabilities of the 4054.

Order 4052R11

Advanced File Manager ROM Pack

Provides easy access to advanced file management offered by the 4909 Multi-User File Management System. Accessible using commands in BASIC, capabilities such as indexed or "keyed" files, variable length records and dynamic file allocation are supported.

Order 4051R10/4052R10

Graphics Enhancement ROM Pack

Adds 65 commands which expand the graphics capability of the 4050 Series. Vectors and dots are drawn very quickly (up to 130 times faster than BASIC). Also provides refresh crosshair cursor, refresh objects (up to 12 vectors), refresh text (up to 15 characters). New data storage format requires 1/8th the memory previously needed for graphics information. Allows graphic transformations, utility routines, music and sound generation.

Order 4051R12/4052R12

GPIB Enhancement ROM Pack

Provides additional and enhanced features for the GPIB. Adds thirty-nine new commands which complement standard GPIB calls, improved polling capability and automated data acquisition functions.

Order 4051R14/4052R14

(Note: Add Opt. 1A for 4052A and 4054A only.)

4050E01 ROM Expander

Permits connecting up to eight ROM Packs to the 4050 Series Desktop Computer. Uses one slot of existing two slot backpack.

Order 4050E01

4051E01 ROM Expander (4051 Only)

Same as 4050E01 except only compatible with 4051.

Order 4051E01

Data Communications Interface

Allows asynchronous, bit serial communications between 4050 Series Desktop Computer

and any external device conforming to EIA RS-232 standard. Ease of use is facilitated by a special overlay and added language commands that make communication parameters and communications programmable.

Order 4051F01/4052F01

Four Slot Backpack (Not available for 4051)

Optional four-slot backpack.

Order 4052F02

Four Slot Backpack with Data Comm. (Not available for 4051)

Optional four-slot backpack with Option 01 Data Communications Interface built-in.

Order 4052F03

Printer Output Interface

Enables 4050 Series system to output alphanumerics to any printer or output device conforming to the RS-232-C or RS-244A Standard for EIA Numerical Machine Control. Data rates are switch-selectable up to 2400 baud with the 4051, and 9600 baud with the 4052 or 4054.

Order 4051F10/4052F10

Extended Memory File Managers (Not available for 4051)

Integrated RAM-based peripheral with command set similar to 4907 File Manager. Provides storage of programs and data files with very fast transfer rates. Includes 4052F03 (Data Comm. Interface and Four Slot Backpack).

Order 4052F27 (256K)
4052F28 (512K)

A-Series Upgrades (4052 or 4054 Only)

Adds A-Series features to the 4052 or 4054. Including enhanced BASIC language with multi-character variable names, structured programming concepts, true subroutines, new graphics commands and others. The GPIB and Data Communication interfaces also offer expanded capabilities.

Order 4052F39 for 4052
4054F39 for 4054





F-16 Fighter Bomber. (Photo courtesy of General Dynamics)

Graphics Computing System Helps Keep Jet Fighters Flying

SAN DIEGO, Calif. - As the weaponry developed in support of our national defense grows increasingly sophisticated, so grows the critical task of maintaining defense equipment in a constant state of readiness. Consequently, many defense suppliers are relying on complex computer-based systems to monitor the maintenance and reliability portions of major defense contracts.

General Dynamics (GD), for example, is using a desktop computer with powerful graphics capabilities to manage the maintenance of automatic test equipment (ATE) modules used in support of the F-16 aircraft. Since installing the graphic computing system in 1980, GD reports that the improved project control afforded by the desktop has resulted in an overall increase in maintenance department productivity, as well as improvements in product quality and customer support.

"We may make the finest avionics test equipment in the world, but if we can't repair and maintain it quickly and properly the U.S. Air Force will certainly look for another supplier," says Jim Pullen, production control and test section head for GD's Electronics Division.

"In addition to analyzing tremendous amounts of information regarding current jobs in progress, parts inventories, and manpower requirements, the Tektronix desktop system provides valuable forecasts concern-

ing parts requirements and reliability, mean time between failure rates and job turnaround times," says Pullen.

"Once analyzed, information is transformed to easy-to-understand charts, graphs and drawings. Graphic presentations have resulted in improved communications aiding our internal productivity and quality as well as our proposals to management and customers."



Analysts at General Dynamics' Electronics Division use a Tektronix 4052 Desktop Computing System with powerful graphics capabilities to manage the maintenance of automatic test equipment (ATE) modules used in support of the F-16 aircraft.

General Dynamics, a Fortune 500 designer and manufacturer of a variety of advanced technical products, is the prime contractor to the U.S. government for the production of the F-16 fighter bomber. Its Electronics Division, located in San Diego, California is responsible for the design, manufacture and maintenance of ATE shop sets used at F-16 maintenance facilities throughout the world.

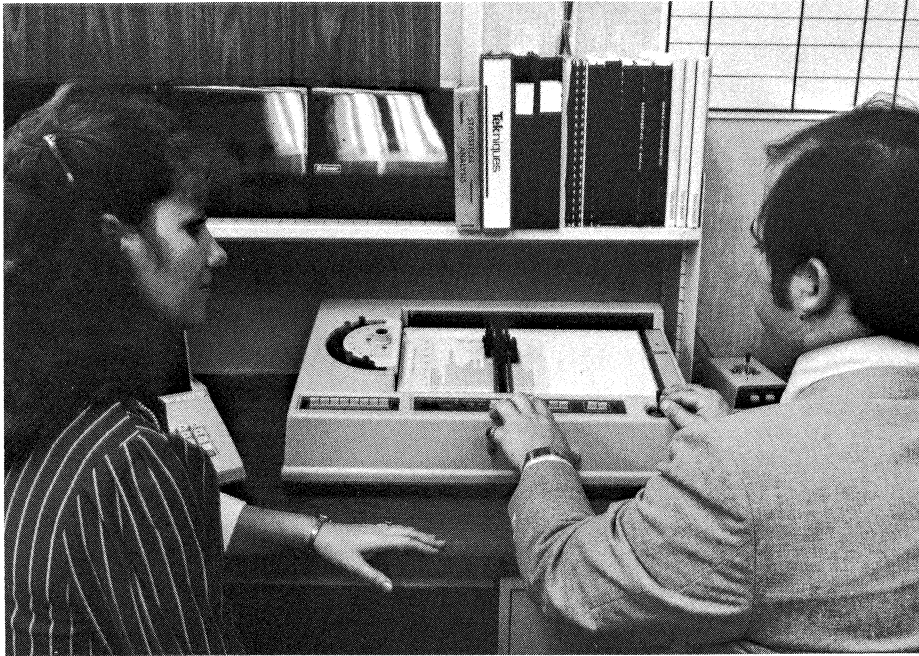
These ATE shop sets are used by Air Force personnel to test advanced on-board electronic instrumentation which controls much of the F-16's flight, maneuvering, radar and ordinance systems. According to Pullen, constant maintenance of the ATE shop sets is becoming increasingly critical in order to maintain the rapid advances in on-board electronic warfare (EW) and electronic counter measure (ECM) systems.

Manual maintenance monitoring proves inefficient, costly

"Maintaining the ATE shop is a tremendously complex operation," says Pullen. "We must monitor part numbers, available stock, qualified suppliers and reordering procedures for thousands of individual parts - from hybrids to resistors to integrated circuits. Additionally, we must track the part requirements and repair progress for individual sets as well as the overall work in progress in the entire maintenance department."

Previous to the addition of the Tektronix gear in 1980, GD monitored much of the repair and maintenance functions manually, relying on a large staff of highly-skilled analysts. These analysts were supported by a large-scale corporate mainframe computer

4050 Series



Once analyzed by the desktop computer, information is transformed to easy-to-understand charts, graphs and drawings with a Tektronix 4662 eight pen plotter. In addition to improving communication among maintenance department personnel, the graphics are used in presentations to General Dynamics' top management and to customers.

used to manage parts order information and a minicomputer which monitors parts inventories for the Electronics Division.

"Shortcomings associated with our manual monitoring system quickly became apparent as the importance of the maintenance operation grew. Timeliness was, of course, the foremost problem we encountered. In one area - parts control - for instance, analysts could only determine the proper ordering frequency, failure rates and most reliable supplier of perhaps 10 to 20 of the most significant parts even with the mainframe and minicomputer systems."

According to Pullen, monitoring even a small amount of parts or projects was a tremendously time-consuming as well as tedious project. It was evident that any solution must speed and simplify maintenance program monitoring, and in so doing link the corporate and divisional computer systems with the special needs of the maintenance department. Additionally, to be most efficient, the solution should be accessible to a variety of users - from secretaries to engineers to programmers.

Tektronix provides friendly solution

GD solved the needs of their ATE maintenance operation through a direct desktop to minicomputer link. At the heart of the maintenance system is a Tektronix 4052 Desktop Computer. The graphic computing system is configured with two Tektronix 4907 Floppy Disk Drives for program and data storage, and a Tektronix 4662 eight-pen plotter for preparation of color charts and graphs. The

desktop is linked to GD's inventory monitoring Texas Instruments TI 990 minicomputer via an RS 232 interface.

"Essentially, we chose the Tektronix computing equipment for its friendly user interface," says Pullen. "Initially, our main concern was to develop a powerful system which could be operated easily by a variety of users."

"To date, our goals have certainly been met. Lesser paid, clerical personnel easily perform data entry and system management operations. Our analyst's maintenance-monitoring work load has been reduced by fifty percent, freeing them to perform more important problem-solving tasks. However, at any time analysts and engineers can draw on the maintenance and repair data base to augment their efforts."

Several Tektronix packaged software tools enhance the wide accessibility of GD's repair and maintenance system. GD uses the PLOT 50 Series Easy Graphing, Business Planning and Statistics programs. These menu-driven packages enable GD personnel to draw down large amounts of numerical maintenance information from the TI minicomputer and reduce it into easy-to-understand graphic information via the desktop computer and pen plotter.

Plans call for the Tektronix to TI network to be expanded to include the corporate order-processing IBM 370 mainframe. Upon completion, Pullen's staff will have direct access to all information regarding the maintenance operation for use in their day-to-day opera-

tions, maintenance forecasts and business planning.

System tracks current work, plans future contracts

Adhering to production schedules and maintenance agreements is certainly important to any contractor. However, General Dynamics must face the critical task of meeting contract goals for an uncompromising defense department.

"We meet with top management every two weeks to discuss our performance on particular contracts," says Pullen. "The desktop has enabled us to make accurate and understandable presentations to management on where we stand on individual projects and where we will be with regards to contract performance several months down the road."

Each ATE module is tracked by the desktop throughout its repair cycle. Using the nature of a particular repair as a basis, Pullen's staff is able to determine expected job completion time, manpower requirements and needed parts for each repair. Constant monitoring of work in progress allows GD to accurately schedule overtime work in particular repair areas, eliminate unnecessary manpower and keep abreast of parts ordering requirements.

Information regarding these individual repair projects is compiled creating a maintenance department data base. In addition to monitoring work in progress, and forecasting future work loads, the data base is invaluable for preparing and documenting new contracts.

"As an example of the system supporting new business efforts, consider for instance, that we are bidding on a contract to supply several ATE modules for a new F-16 maintenance installation," says Pullen.

"In addition to supplying the Air Force with a proposal describing module prices and maintenance costs, we analyze our data base and develop forecasts on the amount of repairs the Air Force can expect during a contract period. These forecasts, which are generally plotted out graphically for use in sales presentations, provide documented justification for our maintenance contracts. Additionally, we will then compare our forecasts with actual maintenance of repair projects to evaluate our contract performance."

Parts control - computer scrutinizes entire operation


Another important maintenance program element to be automated is that of monitoring the wide variety of parts used in the manufacture and repair of the ATE shop sets. Since the addition of the Tektronix gear, GD is able to track the supplier, availability, fre-

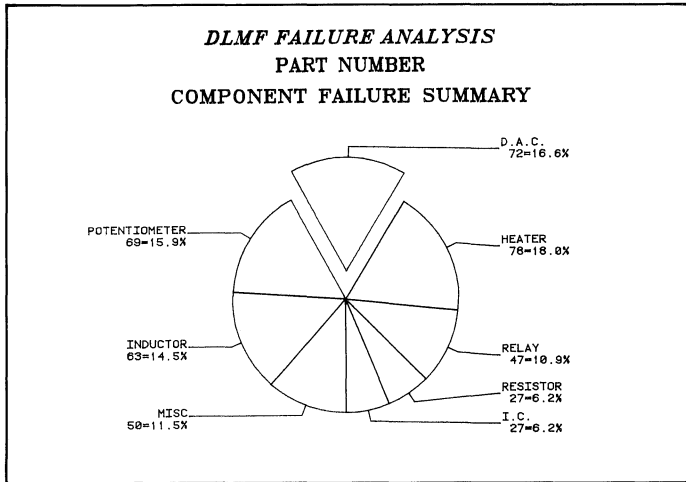
quency of use and failure rate for every part used in the ATE modules.

According to Pullen, by tracking the parts inventory, GD has eliminated several problems which formerly hampered maintenance procedures. Most notably, ATE modules do not sit unrepaired at the Electronics Division through parts unavailability. Furthermore, few, if any parts remain unused in stock for an extensive period of time.

Additionally, GD uses the powerful statistical and graphics capabilities of the Tektronix gear to compare the failure rates, reliability, availability and cost of similar components from a variety of suppliers.

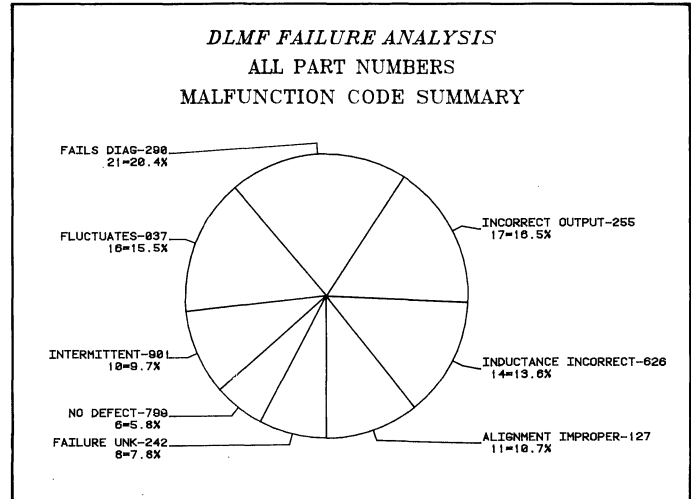
“Such comparisons enable GD to purchase the most reliable products, and also graphically demonstrate to a particular vendor the problems associated with a product,” says Pullen. “These demonstrations often lead to

improved products at the component level, resulting in improved ATE modules for our customers.” 



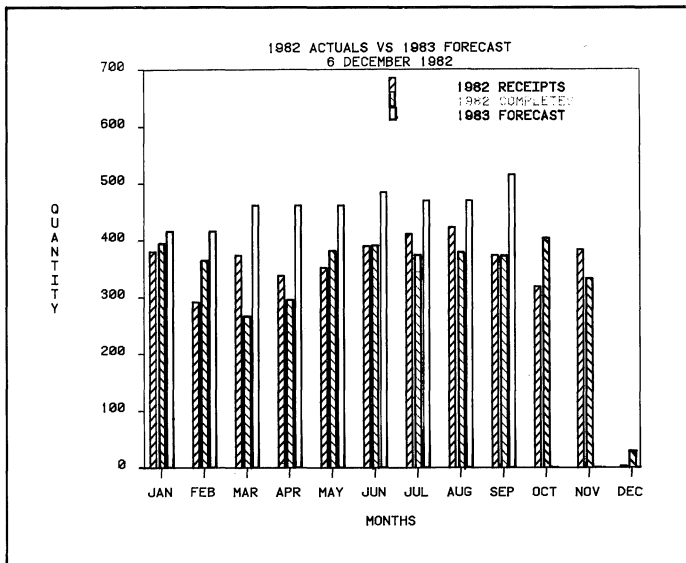
Depot Level Maintenance Facility (DLMF) Failure Analysis Component Failure Summary

This plot describes the number of component failures (and corresponding percentage of total failures) for components of the avionics test equipment (ATE). A major function of this plot is to gauge the reliability of components used in the ATE shop sets. By studying this plot, analysts can determine if particular manufacturers' products are satisfactory and/or if they are manufactured to specification. Additionally, the plot can also be used to determine if the Air Force's component specifications are adequate for particular products.



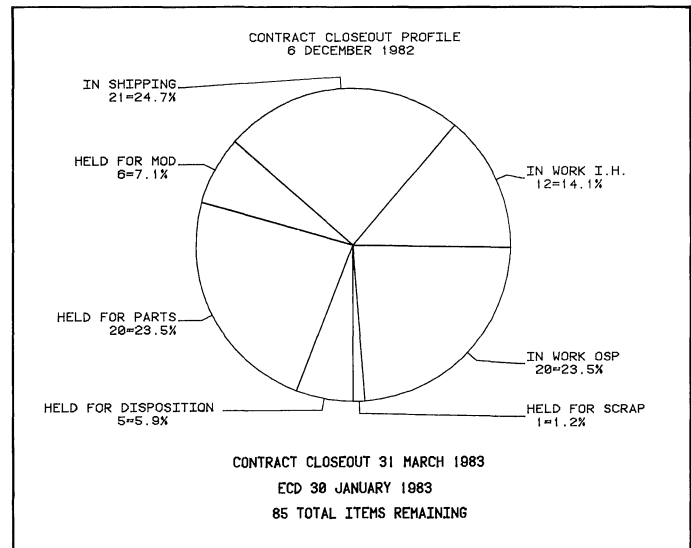
DLMF Failure Analysis Malfunction Code Summary

This chart describes the types of failures (by description, number and code) for all components of the avionics test equipment. This chart is used to monitor the design of ATE shop sets. For instance, if shop sets consistently exhibit incorrect levels of electrical inductance or electrical output, information on these problems will be directed to the design engineering staff and the product will be modified in order to eliminate recurring problems and improve reliability.



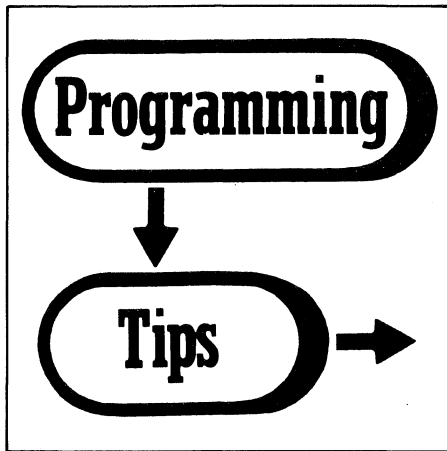
1982 Actuals vs. 1983 Forecast

This plot shows the amount of maintenance jobs received and completed during each month of 1982 plotted out against the amount forecast for each month of 1983. This plot would be used to estimate future contracts, and to gauge manpower requirements.



Contract Closeout Profile

Shows the disposition of maintenance jobs (with regards to completion) at 6 December 1982 - and a contract closing date of 31 March 1983. ECD is estimated date of completion. This chart is developed every two weeks and shows top management exactly where the DLMF stands with regards to contract completion. It also keeps the maintenance division apprised of its most pressing action items.



4956 and 4957 Graphics Tablets and the 4050 Series

by Mark Mehall
Tektronix, Inc.
Wilsonville, OR

The 4957 is the low cost Tektronix graphics tablet introduced in the Winter 1983 issue of *Tekniques*. This article is a comparison of the new 4957 Tablet to the Tektronix 4956 Tablet now in use with many 4050 Series Desktop Computers.

Specifications

The most obvious differences are the sizes available and the interfaces used. Another obvious difference is the price: the 4956 is \$5,670, the 4957 is \$795 (U.S. dollars).

	4957	4956
Physical Size (surface)	16.5" x 15.5"	27.75" x 27.75" (Opt. 43.75" x 55.75")
Digitizing	11.7" x 11.7"	20" x 20" (Opt. 36" x 48")
Interface	RS-232	IEEE-488
Resolution	.001" (programmable)	.005"
Input Device	4 Button Cursor (Opt. 1 button stylus)	Pen (Opt. 4 button cursor)
Digitizing Rate	2 to 90 points per second	3 to 30 points per second
Distance Filter	0-255 points	2 points

Data Collection Mode Differences

The mode and speed of digitizing on the 4956 Tablet is set from the front panel of the controller. The 4957 Tablet is controlled entirely through software commands. The following corresponds the commands of the 4957 Tablet to the front panel button functions of the 4956 Tablet.

Programming Differences

The 4050 Series computers receive information from both tablets through the INPUT

4957 Tablet Command	4956 Tablet Front Panel Button
ESC M 1	POINT
ESC M 2	STREAM SWITCH
ESC M 0	STREAM (proximity)
ESC R b	SLIDE (Rate)
where b=1 2 coordinate pairs per second	(3 to 30 points per second)
b=3 10 coordinate pairs per second	
b=4 30 coordinate pairs per second	
b=5 60 coordinate pairs per second	
b=6 90 coordinate pairs per second	
Note: The 4051 only supports up to 10 coord/sec.	
4052/4054 only supports up to 30 coord/sec.	
4050A series can accept up to 90 coord/sec.	
(in flagging-mode)	
ESC I b	INCREMENT BUTTON
where b=0 to 255	
the distance in resolution elements the cursor must be moved before a coordinate is sent.	
ESC Z (Initialize)	CLEAR (initialize)
Not Supported	ORIGIN (reset origin)

Statement. For the 4956 Tablet the command is typically:

INPUT @ 8:X,Y,Z\$

where 8 is the GPIB address, X and Y vary from 0 to 4000, and Z\$ is the status showing which button or buttons were pressed and whether or not the cursor is on the tablet.

For the 4957 Tablet the command is:

INPUT @ 40:X,Y,F,T,

where 40 is the RS-232 interface address, X and Y vary from 0 to 5080, F is the status showing which button or buttons were pressed and whether or not the cursor is on the tablet, and T indicates the tablet ID number (0 or 1).

The example program illustrates the use of the 4957 Tablet commands and shows how the cursor buttons can control the function of the program.

```

100 REM 4957 TABLET DRIVER PROGRAM FOR 4050 SERIES
110 INIT
120 REM INITIALIZE THE 4050 COMMUNICATIONS INTERFACE (OPTION 1)
130 CALL "CMINIT"
140 REM SET BAUD RATE TO 9600, 7 DATA BITS, 1 STOP BIT AND ODD PARITY
150 CALL "RATE",9600,3,2
160 REM NOTE THAT THE 4051 SHOULD USE:
170 REM CALL "RATE",2400,3,2
180 REM AND THE AUTOBAUD FEATURE OF THE TABLET SHOULD BE ENABLED
190 REM (REFER TO SECTION 5 OF THE 4957 MANUAL)
200 REM RESET THE COMMUNICATIONS INTERFACE BUFFER
210 PRINT @40:30!
220 REM IF USING A 4052A OR 4054A INCLUDE THE FOLLOWING:
230 REM CALL "CMFLAG",1
240 REM THE CMFLAG SETS INPUT FLAGGING FROM THE TABLET
250 REM PRINT A SPACE TO THE TABLET TO SET AUTOBAUD FOR THE 4051
260 PRINT @40:" "
270 REM SEND RESET/CLEAR COMMAND
280 PRINT @40:"EZ"
290 REM WAIT A FRACTION OF A SECOND FOR THE RESET OPERATION
300 CALL "wait",0,2
310 REM SEND SET FORMAT TO ASCII COMMAND
320 PRINT @40:"IQ"
330 REM SET RATE TO 10 COORDINATE PAIRS PER SECOND
340 PRINT @40:"IR3"
350 REM IF USING A 4052A/4054A THE RATE CAN BE SET AT 90 PAIRS/SEC:
360 REM PRINT @40:"IR6"
370 REM SET DATA COLLECTION MODE TO STREAM MODE
380 PRINT @40:"EM0"
390 WINDOW 0,5850,0,5850
400 REM RING BELL
410 PRINT "B"
420 REM SET THE 4050 CHARACTER FONT TO 5 (GRAPHIC)
430 PRINT @32:1815
440 REM READ THE POINTS FROM THE TABLET
450 INPUT @40:X,Y,F,T
460 MOVE X,Y
470 INPUT @40:X,Y,F,T
480 GOSUB F+1 OF 510,550,580,620,660
490 GO TO 470
500 REM NO KEY PRESSED - PRINT CHARACTER (IN REFRESH)
510 MOVE X,Y
520 PRINT @32:24:"!"
530 RETURN
540 REM KEY #1 - DRAW LINE
550 DRAW X,Y
560 RETURN
570 REM KEY #2 - PRINT ASTERISK
580 MOVE X,Y
590 PRINT "*"
600 RETURN
610 REM KEY #3 - PRINT A DOT
620 MOVE X,Y
630 PRINT "."
640 RETURN
650 REM KEY #4 - PRINT X
660 MOVE X,Y
670 PRINT "X"
680 RETURN

```

Quick Directory Using the 4909

by John Romine
U.S. Naval Station
Keyport, WA

Because so many files can reside on a 4909, a file directory can be quite lengthy (even using the short format) when finding a file name.

In response, this short program will output a file name-only directory using a 4909. The output is similar to the short format 4907 directory.

Please note that line 260 selectivity removes a 25 character block of the file name. The 25 could be changed since the 4909 handles file names up to 100 characters long.

```
100 INIT
110 ! 4909 Directory Routine
120 ! Configuration: 4052A/54A, 4909
130 ! Output is similar to the 4907
140 ! command: DIR0 which outputs
150 ! the file name only.
200 !
210 Out=32
220 PAGE @Out:
230 CALL "PUTDSK","DIRECTORY"
240 CALL "EOIBSK"
245 DO
250 CALL "GETDSK",A$ !A$ sets one file
255 !name at a time
260 A$=SEG(A$,21,25) !File name removed
265 ! in 25 character block
270 IF SEARCH(A$,"09AZ",1)<>0 THEN
280 PRINT @Out:A$
285 END IF
290 A1$=SEG(A$,1,3)
300 EXIT IF A1$="EOT"
305 LOOP
310 END
```

Recovering From 4050A Read Tape Errors

by Peter Kellenberger
Tektronix, Inc.
Zug, Switzerland

Several 4050 users have offered solutions to recovering data stored on magnetic tape. With the recent introduction of the 4052R14 Option 1A ROM ("Option to GPIB Enhancement ROM Pack Provides Compatibility with A-Series Systems" - *TEKniques* Vol. 7 No. 1), chances have increased to recover from magnetic tape data loss.

Imagine a situation where one or more arrays of data is written on a file, then during reading you are faced with error message 53 (read error). The problem is how to move the bad tape across the reading head without closing the file or aborting the program. Help

comes from the 4052R14 Option 1A ROM. The following routine shows how it works.

Lines 100 and 110 can be changed to your specific situation. S is the total amount of numbers stored in that file. The loop 170-190 tries to read the data. If at some location of the tape the data cannot be read, error 53 would be generated. Due to lines 140 and 150 this does not happen. The program jumps to lines 200-230 where the address of the first bad number (I1) is stored and another try at line 180 is started. These trials move the tape across the head and the loop 170-190 continues as soon as the data is readable again.

However, the loop counter does not reach S because a certain amount of data is lost. The loop at lines 300-330 corrects for this offset

in array addresses. Finally, all those array elements, which could not be filled with correct data, are set to zero (lines 340-360).

```
100 FIND 2
110 S=1000
120 DIM A(S)
130 C=0
140 CALL "ERRLIST",53:63
150 ON SIZE THEN 200
160 ON EOF (0) THEN 360
170 FOR I=1 TO S
180 READ @33:A(I)
190 NEXT I
200 IF C=1 THEN 230
210 I1=I
220 C=1
230 CALL "RETRY"
300 I2=S-I+1
310 FOR I=S TO I1+I2 STEP -1
320 A(I)=A(I-I2)
330 NEXT I
340 FOR I=I1 TO I1+I2-1
350 A(I)=0
360 NEXT I
370 END
```

Attention! 4052A/54A Assembler Program Users

by Mark Mehall
Tektronix, Inc.
Wilsonville, OR

Customers who have ordered the 4052A/54A Assembler program (Program 1 in package

062-6704-01 described in *TEKniques* Vol. 6 No. 4) should also get the 4051 Assembler (Program 11 in package 062-7456-01 described in *TEKniques* Vol. 7 No. 4). The core of the operating system is similar for all 4050 Series products, and the 4051 Assembler pro-

gram documentation lists common operating system calls and utility routines.

Geometric Shapes Using 4052R11 ROM With 4052 or 4054

by Yvonne Johnson
Control Data Canada, Ltd.
Mississauga, Ontario

Using the Character and Symbol ROM Pack with the 4052 or 4054 Desktop Computer, these subroutines draw shaded circles, lines and arrows or arcs. To locate the cursor for two of the routines, use the thumbwheels on the 4054 or the 4952 Joystick on the 4052.

Shaded Circles

The following example creates and shades a circle at the density of two lines per window unit. The inputs are X and Y (the center of the circle), and R (the radius). Changing the value 0.5 in the two lines in which it appears will change the density.

```
100 REM SHADED CIRCLES
110 MOVE X,Y
120 CALL "CIRCLE",R
130 T7=R-0.5
140 FOR I=-T7 TO T7 STEP 0.5
150 Z=ASN(I/R)
160 Z=COS(Z)*R
170 MOVE X-Z,Y+I
180 DRAW X+Z,Y+I
190 NEXT I
200 RETURN
```

If you'd rather draw the figure in dynamics, replace the first MOVE by an STPOINT and ROPEN. Replace the MOVE and DRAW in the loop by:

```

170 RMOVE -Z,I
175 RDRAW 2*Z,0
180 RMOVE -Z,-I

```

Lines and Arrows

Using the following routine locate the cursor first at the tail of the arrow and enter M. The cursor moves to this point without drawing. Then locate the cursor at the head of the arrow and enter an A to draw the line plus the arrowhead, or enter a J to draw just the arrowhead at this point. Enter any other character to draw a line with the arrowhead. Enter the character E to terminate the subroutine.

```

1 REM ARROWS
100 VISIBILITY 3,0
110 SET DEGREES
120 X0=0
130 Y0=0
140 REM *** SET STROKING VECTOR ***
150 DIM A(2)
160 A(1)=-B
170 A(2)=0
180 REM ** GET THE NEXT LINE POINT **
190 GOSUB 630
200 CURSOR 3
210 X1=X0
220 Y1=Y0
230 POINTER X0,Y0,T$
240 REM *** E ENDS THIS FUNCTION ***
250 IF T$='E' THEN 610
260 X0=INT(X0+0.5)
270 Y0=INT(Y0+0.5)
280 IF T$='M' OR T$='J' THEN 340
290 REM *** DRAW THE LINE PART ***
300 MOVE X1,Y1
310 DRAW X0,Y0
320 IF T$='A' THEN 380
330 GO TO 190
340 MOVE X0,Y0
350 IF T$='J' THEN 380
360 GO TO 190
370 REM *** DRAW THE ARROWHEAD ***
380 X=ABS(X1-X0)
390 Y=ABS(Y1-Y0)
400 R=SQR(X**2+Y**2)
410 IF R=0 THEN 610
420 REM *** CALCULATE THE ROTATION ***
430 D=ASN(Y/R)
440 T6=D
450 IF X0>X1 AND Y0>Y1 THEN 520
460 D=180-T6
470 IF X0<X1 AND Y0>Y1 THEN 520
480 D=T6+180
490 IF X0<X1 AND Y0<Y1 THEN 520
500 D=360-T6
510 REM ** STROKE IN THE ARROWHEAD **
520 DRAW X0,Y0
530 V$='DE'
540 CALL 'LROT',D-30
550 CALL 'STROKE',V$,A
560 MOVE X0,Y0
570 CALL 'LROT',D+30
580 CALL 'STROKE',V$,A
590 CALL 'LROT',0
600 GO TO 190
610 DELETE A
620 RETURN
630 REM *** A RUBBER BAND CURSOR ***
640 STPOINT 3,10,10
650 ROPEN 3
660 RMOVE -2,-2
670 RDRAW 4,0
680 RDRAW 0,4
690 RDRAW -4,0
700 RDRAW 0,-4
710 RDRAW 4,4
720 RMOVE 0,-4
730 RDRAW -4,4
740 RMOVE -0.5,-2
750 RDRAW 5,0
760 RMOVE -2.5,-2.5
770 RDRAW 0,5
780 RMOVE 0,-2.5
790 DRAW X0,Y0
800 RCLOSE
810 RETURN

```

An optional feature included jumps the end points of the line to window grid points. Since data storage doesn't retain all the decimal points, it's usually easier to work on grid crossings.

The arrowhead size varies with the grid size and can be adjusted with the LSIZE command or by changing the values in the array A.

If you are using a 4052 delete statements 100, 190, 200 and 630 through 810 and change statement 330 to read: GOTO 210.

Arcs

This routine could be incorporated into a general drafting package. Using the thumbwheels or a 4952 Joystick, the user specifies any three points on the arc. Although the program draws a small circle at the three points as they are entered, this is for display purposes and may be removed by deleting statements 200-210. Once the third point is entered, the routine draws the arc through the three points.

```

1 REM ARCS
100 INIT
110 PAGE
120 SET DEGREES
130 DIM Z(3,4),Z1(3,4)
140 DATA 1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
150 READ Z
160 REM *** GET 3 POINTS ***
170 FOR I=1 TO 3
180 POINTER Z(I,1),Z(I,2),Z(I,3)
190 IF Z(I,3)='E' THEN 590
200 MOVE Z(I,1),Z(I,2)
210 CALL 'CIRCLE',0,25
220 Z(I,4)=-((Z(I,1)-Z(1,1))2+Z(I,2)-Z(1,2))2)
230 NEXT I
240 REM ** GET CENTER AND RADIUS **
250 Z1=INV(Z)
260 C1=-Z1(1,4)/2
270 C2=-Z1(2,4)/2
280 R=SQR((Z(1,1)-C1)2+Z(1,2)-C2)2)
290 REM *** IS IT >180 DEGREES **
300 B=SQR((Z(1,1)-Z(2,1))2+Z(1,2)-Z(2,2))2)
310 C=SQR((Z(1,1)-Z(3,1))2+Z(1,2)-Z(3,2))2)
320 V=Z(1,1)-C1
330 U=Z(1,2)-C2
340 T=2*ARCTAN(V/U)
350 IF B>C THEN 480
360 A=SQR((Z(2,1)-Z(3,1))2+Z(2,2)-Z(3,2))2)
370 IF A>C THEN 480
380 REM ** < 180 CALCULATE THE ANGLES **
390 B0=ACS((T-B)/T)
400 A0=ACS((T-A)/T)
410 Q=A0+B0
420 REM * CLKWISE OR COUNTER CLKWISE *
430 X=INT((V*COS(Q)-U*SIN(Q))*10000)
440 Y=INT((V*SIN(Q)+U*COS(Q))*10000)
450 IF X=INT((Z(2,1)-C1)*10000) AND Y=INT((Z(2,2)-C2)*10000) THEN 560
460 GO TO 540
470 REM ** THE ARC IS > 180 DEGREES **
480 C0=ACS((T-C)/T)
490 Q=C0-360
500 REM * CLKWISE OR COUNTER CLKWISE *
510 X=INT((V*COS(Q)-U*SIN(Q))*10000)
520 Y=INT((V*SIN(Q)+U*COS(Q))*10000)
530 IF X=INT((Z(3,1)-C1)*10000) AND Y=INT((Z(3,2)-C2)*10000) THEN 560
540 Q=-Q
550 REM *** DRAW THE ARC ***
560 MOVE Z(1,1),Z(1,2)
570 CALL 'ARC1',C1,C2,Q
580 GO TO 170
590 END

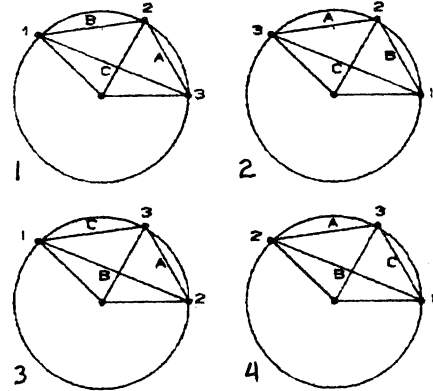
```

The equation for any point on a circle is:

$$X^{**2} + Y^{**2} + DX + EY + F = 0$$

A matrix is established that contains the values X, Y, 1 and $-(X^{**2} + Y^{**2})$ for each of the three given points. The INV command is used to get the values for D, E, and F.

The center point is at $-D/2, -E/2$. The radius is the distance from the center to any of the given points.



Depending on how the points were entered there are four different situations.

If the length from point 1 to 2 or the length from point 2 to 3 is greater than or equal to the length from point 1 to 3 then the arc will be greater than 180 degrees.

In cases 1 and 2 the total rotation is the sum of angle A plus angle B. In cases 3 and 4 it is (360-angle C). The equation for the angle of an isosceles triangle with sides R and base B is:

$$\text{angle} = \text{ACS}((2 * R * R - B * B) / (2 * R * R))$$

The last problem is whether the rotation is clockwise or counterclockwise. For a circle centered on the origin the equation giving the new XY coordinates when a set of coordinates are rotated counterclockwise Q degrees is:

$$X = x * \cos(Q) - y * \sin(Q)$$

$$Y = x * \sin(Q) + y * \cos(Q)$$

Therefore if we subtract the center's coordinates from point 1 and rotate it A (or C) degrees, we will end up at point 2 (or 3) (also minus the center coordinates) if the arc is to be counterclockwise. Otherwise it is clockwise and the angle needs to be negated. In the routine these calculations are all multiplied by 10000 and truncated. This is because the results are only accurate to about 7 places.

The center, the first point, and the angle is known. ARC1 can be used to draw the figure.

4662, 4663 Pseudo Margin

by **Dave Myers**
Tektronix, Inc.
Irvine, CA

How do you maintain a reference margin for subsequent carriage returns when you are printing columns of text on the plotter surface at random locations? Use the alpha rotate command. The alpha rotate command

sets the current pen position as the carriage return reference point. Thus, a "pseudo margin" may be set at any location on the plotter surface by moving to that location, and issuing an alpha rotate command, e.g., `PRINT @1,25:0`.

Alternatives to the above technique might be using image statements to tab to new printing

locations, or using GIN to establish the current pen position, with the use of a subroutine to emulate CR/LFs to that reference point. These methods, however, are not as quick and easy to use as the alpha rotate method.

Interfacing SAS/Graphtm with a 4662 Plotter via 4051 System

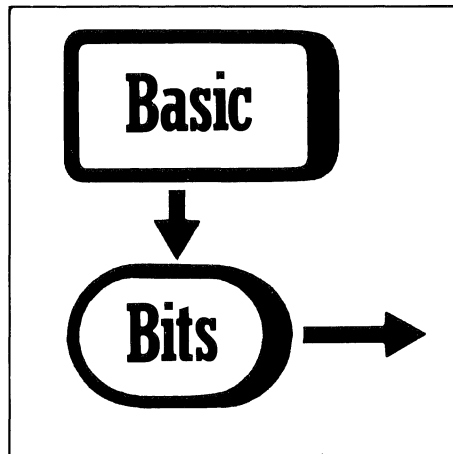
by **Michael Lane**
Missouri Div. of Health
Jefferson City, MO

The following routine interfaces SAS/Graph (under IBM OS, JES2) and a Tektronix 4662 Plotter via a Tektronix 4051 system (GPIB) with a 4051C01 Synchronus Communications Interface.

For the SAS portion, specify DDname FT14F001 as a sysout dataset, and use 'GOPTIONS DEVICE=TEK4662G;' (use NOTERMINAL if you wish). In the BASIC routine, the 4051 emulates some commands

of a Tektronix 4027 terminal. Line 8800 checks for a premature EOF (a JES problem), lines 8810-8820 set up a delay (the 4051 outruns an IBM 4341), line 8830 calls a subroutine to reset certain RMT parameters, and 8840 returns the 4051 to normal functioning (note: the 4051C01 is initialized to its defaults).

```
8600 REM ACCEPT GRAPHICS INPUT
8610 ON EOF (9) THEN 8800
8620 REM EXPLICIT PLOTTER COMMANDS &
      SCREEN OUTPUT
8630 INPUT @59:A$
8640 A$=SEG(A$,3,LEN(A$)-2)
8650 F9=1
8660 IF POS(A$,'!',1)=1 THEN 8710
8670 IF POS(A$,'!BEL',1)=0 THEN 8630
8680 PRINT A$;'G'
8690 INPUT T$
8700 GO TO 8630
8710 T=POS(A$,'/F',7)=7
8720 T$=SEG(A$,12+6*T,LEN(A$)-11-7*T)
8730 PRINT @1,17-5*T:T$
8740 REM IMPLIED PLOTTER COMMANDS
8750 INPUT @59:A$
8760 A$=SEG(A$,3,LEN(A$)-2)
8770 IF A$='/*' THEN 8630
8780 PRINT @1,17:A$
8790 GO TO 8750
8800 IF F9=0 THEN 8630
8810 FOR I=1 TO 1000
8820 NEXT I
8830 GOSUB 1490
8840 GO TO 1040
```



Use Care with 4050 ROM Packs

by **Tim Spiro**
Service Support
Tektronix, Inc.
Beaverton, OR


It is stated in all the manuals but people still do it. Don't insert or pull out your 4050 ROM Pack from a 4050 backpack or ROM Expander unit with the power on. If you do, you can cause a short in the ROM Pack which could damage a delicate component. It may not be apparent at the time, but can show up later as the weakened component is stressed.

Along these same lines, when you are handling any ROM Pack, avoid touching the exposed edge connector - the part extending below the plastic case which plugs into the ROM slot. Static electricity builds up in your body and should you touch the edge connector it could damage internal components if the voltage is high enough. You've all had the experience of crossing a carpet and getting "zapped" by a water fountain or doorknob. That is static electricity at work.

4050 Automatically Adds LF to CR for Remote Terminals

by **Sean Sullivan**
U.S. Forest Service
Happy Camp, CA

`PRINT @37,26:1` changes the normal CR delimiter to CR/LF for output from the 4050 Desktop Computer. In addition to using this feature for listing long programs, which makes it easier on the eyes, I have found another convenient use for it. We use the 4052 as a host for several remote terminals and most of these terminals have to receive

the CR/LF. Instead of changing all the PRINT statements within the program, we simply change this 4050 environmental parameter before running the program. 

IDG Program Exchange

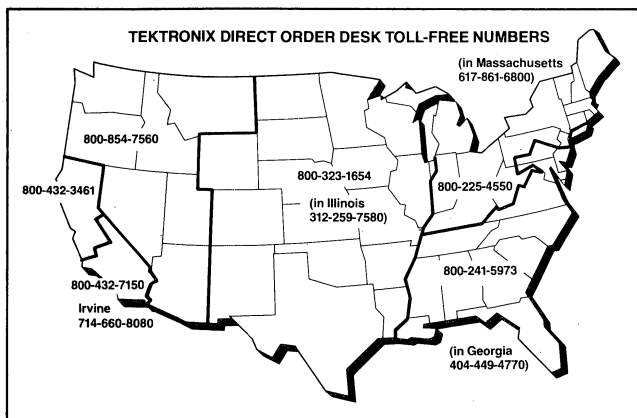
The IDG Program Exchange is a central location of user software for Tektronix Graphics Display Products. As programs are received, they are collected into packages according to the product they support. The packages are available to all users through exchanges for program contributions or for a nominal charge.

Program Contributions

Contribute one program to the Program Exchange and receive the package of your choice in exchange. To receive documentation instructions and forms, contact the Program Exchange serving your area. In the U.S., you may TWX: 910-467-8708 or TLX: 15-1754.

U.S. Orders

Order IDG Program Exchange packages through the toll-free number of Tektronix Central Parts Ordering. The following map delineates the geographical regions and the toll-free number serving each region.



Call the number serving your area and give the customer service representative the nine-digit part number and name of the Program Exchange package you wish. If you have any questions, call your local Tektronix Field Office. The field office has the current prices. Effective July 1, 1984, each Program Exchange package will cost \$95 (U.S. dollars). Manuals, ordered separately, will cost \$15 (U.S. dollars) each. (Note: The minimum acceptable Tektronix order is \$25.00.)

Orders Outside U.S.

To order a copy of the catalog, or to order a package, contact the local Tektronix sales office or the Program Exchange serving your area. See Program Exchange Addresses section of *TEKniques*.

4000 Series Graphics Terminals

The 4010, 4020 and 4100 Series programs are packaged and nomenclated with the appropriate prefix and disk number.

Each package includes media with the source code together with the supporting documentation; listings are not included. Documentation may be purchased separately.

A 4000 Series catalog will be published when a sufficient number of packages are collected.

Package Title	Documentation Part #	Package Part #
4110 LP Program Exchange		
Disk 1.....	062-6955-00	..... 062-6955-01

4115

Package Title	Documentation Part #	Package Part #
VAX/VMS Driver for 4115 DMA (Option 3A)	062-7305-00	..... 062-7305-01
VAX/UNIX (Berkeley) Driver for 4115 DMA (Option 3A).....	067-7327-00	..... 062-7327-01

4050 Series Desktop Computers

The 4050 Series programs included in the IDG Program Exchange prior to September 1981 are packaged and nomenclated by function. Those programs accepted after September 1981 are packaged and nomenclated with the Volume and Number of the corresponding issue of *TEKniques* in which the package was announced.

Each package includes the source code on tape or disk (T=tape; D=disk) together with the supporting documentation; listings are not included. Documentation may be purchased separately.

The IDG Program Exchange catalog contains the abstracts describing the programs in each package along with representative output in most cases. The catalog part number is 062-6343-00.

Package Title	Documentation Part #	Package Part #
Business Aids T1	062-5987-00	..... 062-5987-01
Business Aids T2	062-5988-00	..... 062-5988-01
CAD T1	062-5976-00	..... 062-5976-01
CAD D1	062-5977-00	..... 062-5977-01
Character Generator T1	062-5951-00	..... 062-5951-01
Education/Research T1	062-5982-00	..... 062-5982-01
Education/Research T2	062-5983-00	..... 062-5983-01
Electrical Engineering T1	062-5978-00	..... 062-5978-01
Graphing T1	062-5964-00	..... 062-5964-01
Graphing T2	062-5965-00	..... 062-5965-01
Graphing T3	062-5966-00	..... 062-5966-01
Graphing D1	062-5967-00	..... 062-5967-01
Graphing D2	062-5968-00	..... 062-5968-01
Interfacing T1	062-5984-00	..... 062-5984-01
Mapping T1	062-5980-00	..... 062-5980-01
Mechanical Engineering T1	062-5979-00	..... 062-5979-01
Programming Aids T1	062-5971-00	..... 062-5971-01
Programming Aids T2	062-5972-00	..... 062-5972-01
Project Aids T1	062-5985-00	..... 062-5985-01
Project Aids D1	062-5986-00	..... 062-5986-01
Recreational Plots T1	062-5989-00	..... 062-5989-01
Slidemaker T1	062-5962-00	..... 062-5962-01
Slidemaker D1	062-5963-00	..... 062-5963-01
Text Processing T1	062-5969-00	..... 062-5969-01
Text Processing D1	062-5970-00	..... 062-5970-01
Utilities T1	062-5974-00	..... 062-5974-01
Utilities D1	062-5975-00	..... 062-5975-01
Tekniques Vol. 5 No. 4 T1	062-5981-00	..... 062-5981-01
Tekniques Vol. 6 No. 1 T1	062-6443-00	..... 062-6443-01
Tekniques Vol. 6 No. 1 D1	062-6442-00	..... 062-6442-01
Tekniques Vol. 6 No. 2 D1	062-6515-00	..... 062-6515-01
Tekniques Vol. 6 No. 3 D1	062-6516-00	..... 062-6516-01
Tekniques Vol. 6 No. 3 T1	062-6514-00	..... 062-6514-01
Tekniques Vol. 6 No. 4 T1	062-6704-00	..... 062-6704-01
Tekniques Vol. 7 No. 1 D1	062-6715-00	..... 062-6715-01
Tekniques Vol. 7 No. 3 D1	062-7276-00	..... 062-7276-01
Tekniques Vol. 7 No. 3 T1	062-7275-00	..... 062-7275-01
Tekniques Vol. 7 No. 4 T1	062-7455-00	..... 062-7455-01
Tekniques Vol. 7 No. 4 T2	062-7456-00	..... 062-7456-01
Tekniques Vol. 8 No. 1 T1	062-7611-00	..... 062-7611-01
Tekniques Vol. 8 No. 1 D1	062-7612-00 062-7612-01

Software Support Category C

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New Abstracts Index

4050 Series

In the fall of 1981, like-subject 4050-based programs in the user library were combined on tapes or disks and nomenclated according to the subject and media, e.g., *Programming Aids T1* (T=tape), or *Project Aids D1* (D=disk). Thereafter, as the 4050-based programs came in they were combined on tape or disk regardless of subject and nomenclated with the issue of *TEKniques* in which they were described, e.g., *TEKniques Vol. 5 No. 4 T1*.

As the list of packages grew, it became apparent a subject index for these tapes/disks was needed. The following index, based on the earlier subject nomenclature, covers the 12 4050-based packages (encompassing 147 programs) from *TEKniques Vol. 5 No. 4 T1* through *TEKniques Vol. 7 No. 4 T2*. The name of the program and the package in which it's included are identified under the subject. You may wish to clip this index and insert it at the front of your library catalog.

4050 SERIES

Business Aids

Cu-Sum Fuel Consumption
@Checks

TEKniques
Package Name
Vol. 6 No. 1 T1
Vol. 7 No. 3 T1

CAD

4054 Dynamic Graphics Flowchart Symbols
Data Alignment
Arrowhead Macro
Operator Digitizing on the 4663
Plot Digitized File
Space Manipulator
Plot Digitize
Arrowhead Macro
RDrawing
2-D Drafting Fonts (4 programs)
PICTURE30
Drawing with a Joystick
Tek Digitizer
Four View Draw
3D Shade

Vol. 6 No. 1 T1
Vol. 6 No. 1 T1
Vol. 6 No. 2 D1
Vol. 6 No. 2 D1
Vol. 6 No. 2 D1
Vol. 6 No. 2 D1
Vol. 6 No. 3 T1
Vol. 6 No. 3 T1
Vol. 6 No. 3 T1
Vol. 6 No. 3 D1
Vol. 7 No. 1 D1
Vol. 7 No. 3 T1
Vol. 7 No. 4 T1
Vol. 7 No. 4 T1
Vol. 7 No. 4 T1

Education/Research

Spacetime/Minkowski
Micrograph Measurement
Rank Sum Statistic
Two-Factor Repeated Measure Analysis of Variance
Granulometry
Graphical Linear/Nonlinear Regression Analysis
Two Phase Simplex Method
Exercise Test Evaluation
Moment of Inertia Optimization
FFT of 2048 Real Numbers
IFT of 1024 Complex Numbers
Newton Integration and Plot
Bauer-Reinsch Inversion
Acoustic Noise Graphing
Calculate Expected Mean Squares
Moving Average Interpolation Method for
Determining the Median Lethal Dose
and Its 95% Confidence Limits
Tidal Acceleration-Earthtides
CAI
PLOT 50 4050D02 Enhancements
Polyfit
Interp

Vol. 6 No. 1 D1
Vol. 6 No. 1 T1
Vol. 6 No. 1 T1
Vol. 6 No. 1 T1
Vol. 6 No. 3 T1
Vol. 6 No. 3 T1
Vol. 6 No. 3 T1
Vol. 6 No. 4 T1
Vol. 6 No. 4 T1
Vol. 6 No. 4 T1
Vol. 7 No. 3 T1
Vol. 7 No. 3 T1
Vol. 7 No. 3 D1
Vol. 7 No. 3 D1
Vol. 7 No. 4 T1
Vol. 7 No. 4 T2

Electrical Engineering

Printed Circuit Board Layout
PC Component Mechanical Analysis
Printed Circuit Board Layout

Vol. 6 No. 1 D1
Vol. 6 No. 1 T1
Vol. 6 No. 4 T1

Graphing

General Function Z=F(X,Y) Plot
Stereo Surface
3-D Plot w/wo Hidden Lines
PLOT3D
Pipechart
Contour Plots
Hierarchical Clustering
Nonlinear Mapping
Vertical Plot
Scatter Plot w/Curve Fitting
Pie Chart with Panel Fill
Enhanced Spider Web Chart
Connect the Dots

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Vol. 5 No. 4 T1
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Vol. 5 No. 4 T1
Vol. 5 No. 4 T1
Vol. 5 No. 4 T1
Vol. 5 No. 4 T1
Vol. 5 No. 4 T1
Vol. 6 No. 1 D1
Vol. 6 No. 1 T1
Vol. 6 No. 1 T1
Vol. 6 No. 2 D1

4100 Series

TEKniques Vol. 7 No. 1 carried the first package for the 41XX series of Tektronix terminals. Each 41XX package is nomenclated for the terminal(s) it supports and the environment, e.g., *4110 LP Program Exchange Disk 1* indicates that it runs on a 411X terminal equipped with Local Programmability.

The index following identifies the packages by subject, by the package name and by which issue of *TEKniques* carried its abstract.

Data Chart
SDBAR
Friendly Graphing
PLOT 2D Graphing
64K Data Graphing
Multivariate Bargraph with Enhancements
Modified Data Graphing, Pie Chart and Slidemaker*

Vol. 6 No. 4 T1
Vol. 6 No. 4 T1
Vol. 6 No. 4 T1
Vol. 7 No. 3 T1
Vol. 7 No. 4 T1
Vol. 7 No. 4 T2
Vol. 7 No. 4 T2

Interfacing

4050/TM5000 GPIB Routines
CDC 6500 Mainframe I/F
4050/468 Utility II
49XP IEEE-488 I/F Verification
4050 Data Comm Utility
4050/468 Utility III
Sound Analyzer Interface
7D20/4050A Utility
7912AD/4050A Utility/Demo
GPIB General Device Exerciser
4050/1980 Interface
TM5000 Instrument Checkout

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Vol. 6 No. 1 T1
Vol. 6 No. 1 T1
Vol. 6 No. 3 T1
Vol. 6 No. 3 T1
Vol. 6 No. 4 T1
Vol. 7 No. 3 T1
Vol. 7 No. 4 T1
Vol. 7 No. 4 T1
Vol. 7 No. 4 T2
Vol. 7 No. 4 T2
Vol. 7 No. 4 T2

Mapping

Coordinate Geometry & Utilities
Drill-Log Error Checking
Legend
Aeronautical Miles
Stereonet Plot (Equal Area)
LORAN-C Distance and Time Difference Readings

Vol. 6 No. 1 D1
Vol. 6 No. 3 T1
Vol. 7 No. 3 D1
Vol. 7 No. 4 T1
Vol. 7 No. 4 T2
Vol. 7 No. 4 T2

Mechanical Engineering

Pipe Construction
CAM Draw
Shaft Size
MECH 50

Vol. 6 No. 4 T1
Vol. 7 No. 3 T1
Vol. 7 No. 3 T1
Vol. 7 No. 3 T1

Programming Aids

Tape Menu
FMarker
LHeader
PHeader
Stripper
Crossref
Compsort
4907 FORTRAN to BASIC Converter
Progvarli
Superlist
Super Disk Directory
Simplot-Simpose
ASCII Program Comparison
Numerical Expression Evaluator
Syntax Diagrams
Pretty Page Listings
4052A/4054A Assembler
Flowcharter II
EDITPROG
UDF Key Overlay Generator
Header
Log Axis
4051 Assembler

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Vol. 6 No. 3 T1
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Vol. 6 No. 3 T1
Vol. 6 No. 4 T1
Vol. 6 No. 4 T1
Vol. 7 No. 1 D1
Vol. 7 No. 4 T1
Vol. 7 No. 4 T1
Vol. 7 No. 4 T2
Vol. 7 No. 4 T2

Project Aids

Presentation GANTT Chart
Fund Usage
Manufacturing Sequence Flowcharter
Inventory Control
Production Capacity Forecasting Model
Schedule Chart Display

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Vol. 6 No. 1 T1
Vol. 6 No. 1 T1
Vol. 6 No. 4 T1
Vol. 7 No. 1 D1
Vol. 7 No. 3 T1

	<i>TEKniques</i> Package Name		
Recreational Plots			
Air Defense Game	Vol. 6 No. 1 T1	PLOT 50 Standard Data File Reformat	Vol. 6 No. 2 D1
Computer Poker	Vol. 6 No. 3 T1	Disk Utilities	Vol. 6 No. 2 D1
Slidemaker		4050 Series Clock	Vol. 6 No. 3 T1
Viewgraph	Vol. 6 No. 3 T1	4050-4010 Utilities	Vol. 6 No. 4 T1
Block Letters	Vol. 7 No. 3 T1	4907 Multiple Volume Directory Lister	Vol. 7 No. 1 D1
Text Processing		Local Language Translator	Vol. 7 No. 1 D1
Readnote	Vol. 5 No. 4 T1	DOC1	Vol. 7 No. 1 D1
Writnote	Vol. 5 No. 4 T1	Modified Julian Date Calendar	Vol. 7 No. 3 T1
Reference Index	Vol. 5 No. 4 T1	Calendar Conversion	Vol. 7 No. 3 T1
Word Processor	Vol. 6 No. 1 D1	4695 Color Graphics Copier Driver	Vol. 7 No. 3 T1
Report Writer	Vol. 6 No. 1 D1	Disk Start-Up Utility	Vol. 7 No. 3 D1
Memogenda	Vol. 6 No. 1 D1	4050A Extended Memory Backup/Restore	Vol. 7 No. 4 T1
Texted	Vol. 6 No. 1 T1	BASIC Linker	Vol. 7 No. 4 T2
Label Printer	Vol. 6 No. 1 T1	4100 SERIES	
Text Editor	Vol. 6 No. 2 D1	Interfacing	Described in <i>TEKniques Issue</i>
4050A Tecu	Vol. 6 No. 4 T1	VAX/UNIX (Berkeley Driver for 4115 DMA (Option 3A))	Vol. 7 No. 4
Telex	Vol. 6 No. 4 T1	VAX/VMS Driver for 4115 DMA (Option 3A)	Vol. 7 No. 4
Utilities		Utilities	
Tape Dupe	Vol. 5 No. 4 T1	4110 LP Program Exchange Disk 1	Vol. 7 No. 1
R40 File Maintenance	Vol. 6 No. 1 D1		Vol. 8 No. 1
Disk-to-Tape	Vol. 6 No. 1 D1		
4907 to 4909 File Transfer	Vol. 6 No. 1 T1		

TEKniques Vol. 8 No. 1 D1 Part #062-7612-01

TEKniques Vol. 8 No. 1 D1 package consists of one large program contained on two disks. Because the program uses CALL "EXEC," it can only be used with a Tektronix 4051 Desktop Computer.

Title: The Big Green Sheet for the Tektronix 4051

Author: Dennis L. Miller
California State Senate
Sacramento, CA

Memory Requirement: 32K/4051
Options: 4907 File Manager
Printer

Files: 147 Program
80 ASCII Data
6 Binary Data

Statements: 20,135

The Big Green Sheet is a collection of financial analysis programs through which 4051 Desktop Computer users can build and analyze data.

A financial model may be as simple as a single "green spread sheet" or much more complex involving numerous spread sheets with transfer posting between them. The elementary component is the "green spread sheet." To the system, each "green spread sheet" is a single "model." The model is initially created using the BUILD feature. Other features of the program add headings, labels, data and calculation rules to the model.

One model may be highly flexible requiring many user-entered commands to operate it. Another may be entirely automatic - calculated and printed as it is loaded.

Models are stored on disk and loaded into the \$FINAN program when they are to be processed. The user may direct the loading of a model, or one model may automatically cause a successor model to be loaded.

The \$GRDEMO program assists the user to extract data from one or more models and generate charts or graphs from the data. User-supplied data or special calculations may supplement the data from the models in preparing a graph.

The \$PIE program produces only pie charts.

The \$FINDOC program lists the specifications of a model in a form suitable for documentation. It does not list the data from the model, only the specifications.

The \$EDIT program may be used to write the textural portion of reports, or to make complex modifications to a model.

The \$FORMAT program may be used on the results of the \$EDIT program to produce formatted documents or reports.

The \$LIST program may be used to list a model, edited text, or HELP text.

The \$DUMP program is a specialized version of \$LIST that can list any type of tape or disk file.

The \$HERSHEY program can be used to generate fancy header pages or logos to use with reports or displays.

The \$BACKUP program should be run periodically to insure that the latest versions of data files are duplicated to provide for a recovery in the event the original becomes inaccessible. It also provides for initializing new disks into the system. The system has four disks: Master Program, Master Data, Backup Program, and Backup Data.

The TUTOR provides information to new users, to familiarize them with the equipment and general features of the system.

The HELP feature provides selected information more directly than available through the tutorial. There are two HELP libraries. The SYSTEM library contains general information. The FINAN library contains information of particular interest to FINAN users. The HELP text named "FINAN" is an excellent introduction to the basics of the modeling process. The HELP text is accessible from the Master Menu and the FINAN portion is accessible from the \$FINAN program.

Because the program uses CALL "EXEC," it can only be used with a Tektronix 4051 Desktop Computer.

TEKniques Vol. 8 No. 1 T1 Part #062-7611-01

TEKniques Vol. 8 No. 1 T1 tape consists of seven programs: one Business Aids, one Character Generator, one Education/Research, one Interfacing and three Utility. The Interfacing program must be transferred to a separate tape.

Program 1

Title: PLOT 50 2-D Drafting/TekniCAD Data Exchange Utility

Author: Tektronix, Inc.

Memory Requirement: 4054/64K w/4054D08
41xx Local Programmability
with 4100P30

Peripherals: As required by above systems
Option 1 Data Comm I/F

Files: 3 ASCII Program

Statements: 1934

This program enables the transfer of drawings and symbol libraries between PLOT 50 2-D Drafting (4054D08) and Tektronix's PLOT 10 Computer-Aided Drafting System (4100P30).

Program 2

Title: User Friendly Character Generator

Author: Alfred G. Childers
Jan Combs
Indiana University
Bloomington, IN
Memory Requirement: 32K
Peripherals: Optional-4662/3 Plotter
Files: 1 ASCII Program
1 Binary Data
Statements: 428

This program makes use of Mark Mehall's Character Generator program (program 2 in the Character Generator T1 package) in its entirety. Using the User-Definable Keys for data entry, rather than writing a new program each time the characters are wanted, this program eases the task for users who are not yet proficient at programming.

Program 3

Title: Right Triangle Solutions

Author: LeRoy Nollette
Tektronix, Inc.
Wilsonville, OR
Memory Requirement: 8K
Files: 1 ASCII Program
Statements: 226

Any two factors may be entered and the program will solve for the unknowns. The user is presented with a right triangle with the components identified, i.e., the three sides and the two acute angles by letters. After entering the values for either two of the sides or one of the angles and a side, the program solves for the angle(s) and side(s), and draws the resulting scaled right triangle.

Up to four decimal places for the side values are accepted and will be calculated; for the angles, decimals are rounded to integers.

Program 4

Title: Stock Market Charting

Author: Mark Mehall
Tektronix, Inc.
Wilsonville, OR
Memory Requirement: 16K
Peripherals: Optional-4907 File Manager
Files: 1 ASCII Program
1 Binary Data
Statements: 296

Track your daily stock prices and volumes with this program. Enter the beginning date and the program automatically prompts you with consecutive dates taking into consideration weekends and leap years. Once your data is in, the program displays a graph of the volumes at the bottom of the screen, and above it a graph of the prices, with a curve showing the 20 day moving average of prices. If no volume is entered, the graph of prices will fill the entire screen.

Data may be stored and recalled on tape or disk. Disk files will be automatically created if they don't exist; tape files must be pre-marked.

Using the redimensioning feature of the A-Series, the program permits you to add data. 4051 users and others without A-Series features will have to change a few lines of code to redimension arrays before reading in data and adding to it.

Data may also be listed and changed.

Program 5

Title: Decoder

Author: Bill Vesser
Tektronix, Inc.
Wilsonville, OR
Memory Requirement: 8K
Files: 1 ASCII Program
Statements: 155

Using a table look-up method, this program arranges and prints all possi-

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ble combinations of any five letters you input. The program can be used to decode letter transposition coded words.

The method can be used to generate a series of numeric arrays for combinations of 3, 4, 5, 6, etc. letters.

Program 6

Title: Morse Code Generator

Author: Bill Vesser
Tektronix, Inc.
Wilsonville, OR
Memory Requirement: 8K
Files: 1 ASCII Program
Statements: 111

This small routine converts alphanumeric characters to morse code, using the 4050's bell, or from dots and dashes entered, converts code to alphanumeric characters.

Program 7

Title: 7854/4052A Utility/Demo

Author: John McHugh
Tektronix, Inc.
St. Paul, MN
Memory Requirements: 4052A with
Opt. 24 (64K bytes memory) and
Opt. 27 or 28 (Extended Memory)
Peripherals: 7854 Digital Storage Oscilloscope
4052R07 & R08 Signal Processing ROM Packs
1 GPIB Cable
Optional: 4907 File Manager may be
substituted for Opt. 27 or 28
Files: 1 ASCII Program
18 Binary Program
25 Binary Data
(Files must be transferred to separate tape)

Using a 4052A Desktop Computer as the GPIB controller for a Tektronix 7854 Digital Storage Oscilloscope, this program transfers waveforms, 7854 programs, and messages between the 4052A controller and the 7854 Oscilloscope. A variety of signal processing routines are available.

Functions include:

- Acquire the right or left channel waveform from the 7854.
- Send either the right or left channel waveform data to the 7854.
- Acquire an averaged waveform from the right or left channel (up to 1000 averages).
- Perform signal processing on either the right or left channel waveform data. Any of the following signal processing functions are included: MIN/MAX or HISTOGRAM pulse parameters, Waveform analysis, Integration, Differentiation, Convolution, Correlation, Autocorrelation, and Fast Fourier Transform with cosine taper option.
- Send any 7854 program stored on DC300 tape or Extended Memory (or the 4907) to the 7854.
- Save any program stored in the 7854 onto either DC300 tape or Extended Memory (or the 4907).
- Allow the user to define the ground reference of both channels.
- A talk/listen function that allows the user to communicate with any GPIB instruments on the bus that support Tek Codes and Formats. The talk/listen function also enables the user to send a message to be displayed on the 7854 CRT.
- Define a sequence of User-Defined Functions and let the 7854/4052A run unattended. This function is called SHOW SEQUENCE.

All of the functions are invoked from the User-Definable Keys.

4110 LP Program Exchange Disk 1, Release 1.2 Part #062-6955-01

Author: GSP Engineering
Tektronix, Inc.
Wilsonville, OR

Equipment: 411XA/B with Local Programmability

Memory Required: 256K

The 4110 LP Program Exchange Disk 1 is a collection of utility type programs which extend the power of CP/M-86® as implemented on Tektronix 4110 Series terminals. Although the disk is shipped with the Local Programmability product, it is updated periodically with new programs. Thus, the current release is made available in the Program Exchange.

Program	Function
ATR.CMD	Sets file attributes. Substitutes for CP/M's STAT.
BDOS.LIB	Allows calls to CP/M's Basic Disk Operating System (BDOS) from FORTRAN.
*CHARIO.OBJ	Allows character I/O from FORTRAN.
*COMPARE.CMD	Compares two files, byte-by-byte, and prints the differences.
*DD41LPNI.SYS	Alternate 411X driver (no terminal initialization included).
DRIPO.CMD	DRI assembler list file post-processor.
*DUMP.CMD	Outputs a binary file in hex and ASCII.
EMACS.CMD	Screen-oriented text editor. Substitutes for CP/M's ED.
EXD.CMD	Extracts documentation from a program.
FILCOM.CMD	Does a "smart" compare of two text files and reports line differences between the two.
FILESPLY.CMD	Binary file editor.

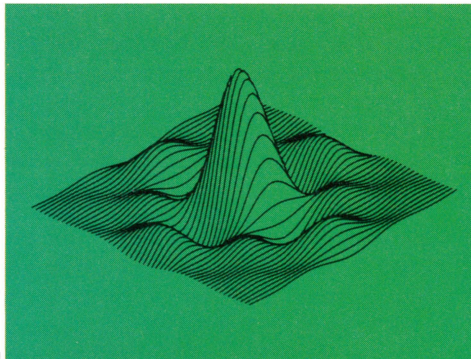
*FIND.CMD	Lists mapping of CP/M drive names to firmware drive names.
*FCOPY.CMD	Performs a fast copy of an entire disk.
GREP.CMD	Searches for strings in text files.
ITS.CMD	Implements system clock. Easier to use than TOD if time setting always desired after loading CP/M.
MEMDRIVE.CMD	Allows memory to be used as though it were a disk drive.
PAT.DAT	Displays color patterns and defines them for use through terminal commands.
QB.CMD	Creates "one-shot" batch files.
SDFC.CMD	Copies files from one disk to another on a single disk system.
*TABLET.OBJ	Provides a FORTRAN-compatible subroutine to directly access the tablet controller.
*TEACH.EM	EMACS tutorial.
TECO.CMD	Character-oriented text editor. Substitutes for CP/M's ED.
TOD.CMD	Implements system clock and reports time of day.

*New since release 1.1

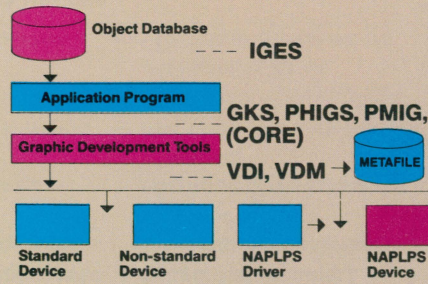
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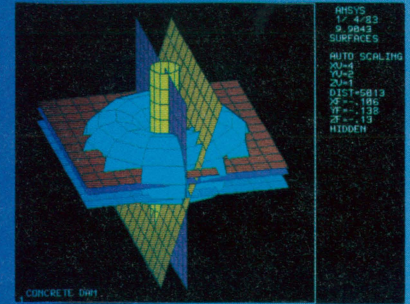
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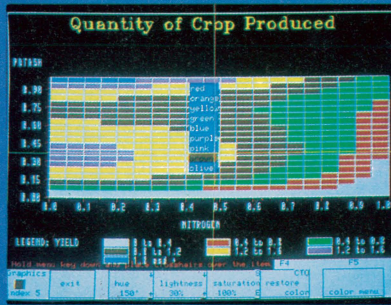
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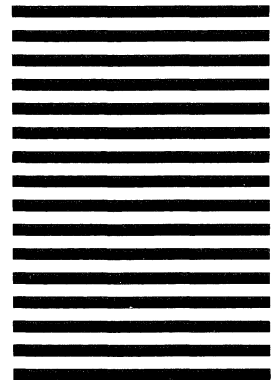
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Customers in the U.S. may order manuals through the Tektronix Central Parts Ordering office serving their area. International customers should contact their local Tektronix distributor.

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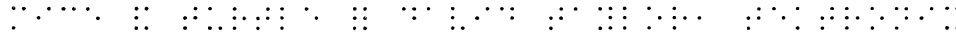
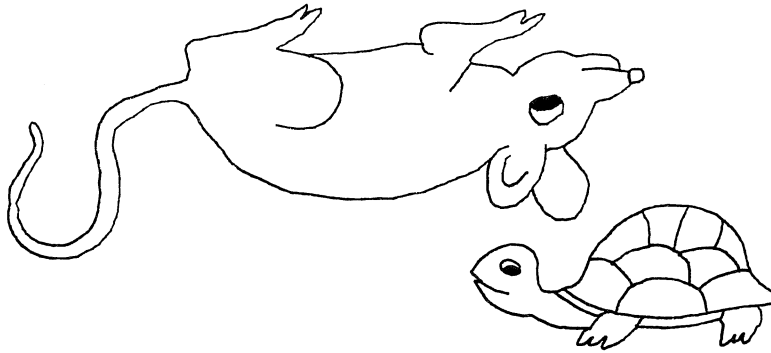
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