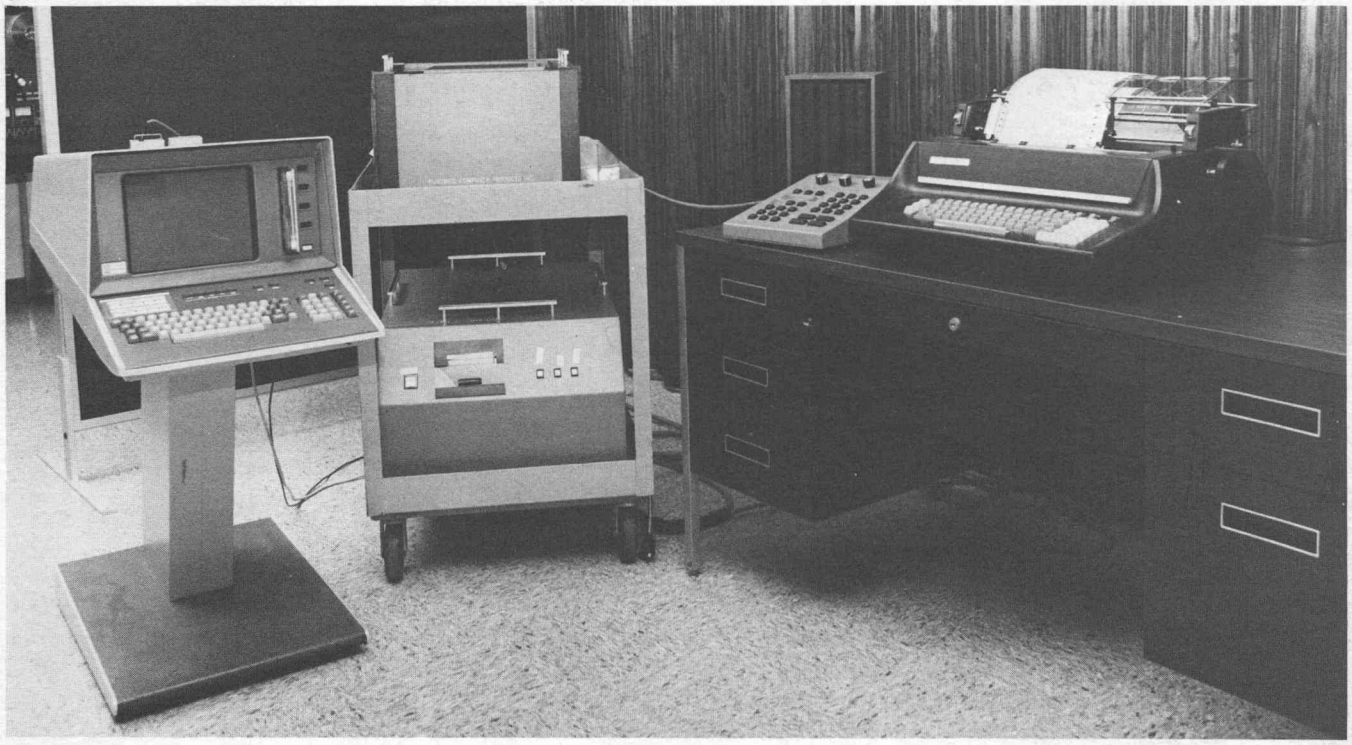
Teknigues

The 4050 Series Applications Library Newsletter June 15, 1979 Vol. 3 No. 4



A 4051 Graphic System (left), a Kurzweil Reading Machine (center), and a Diablo Hyterm Printer (right), open the world of printed communication to the blind. The 4051 connects to the reading machine and the printer simultaneously through a "Y" parallel connector on the RS-232 Option 1 Interface. The Kurzweil Reading Machine includes a computer (bottom shelf of the cart), a scanner (top shelf) a control panel and a speaker (both on the left corner of the desk). (Photograph by Jeff Shyshka and Curt Campbell, Medical Media Production Service, VAMC, Palo Alto, CA.)

4051 + KRM = Computer Access for the Blind

by Gregory L. Goodrich, Richard R. Bennett, J. Kenneth Wiley
Western Blind Rehabilitation Center
Veterans Administration Medical Center
Palo Alto, CA

Historically, blindness has imposed a major limitation on the blind population of the world by severely restricting their ability to obtain information from print and to convey information by print. The statistics and illustrations of the limitations imposed by blindness are almost endless, but you can get some idea the next time you type a letter. Just do it blindfolded!

To be sure, there have been beneficial developments with practical applications, such as braille, electric typewriters, and portable cassette recorders. But such developments are limited by pragmatic considerations. For example, braille is bulky (Webster's Dictionary in braille requires 36 volumes and occupies a twelve-foot long shelf), and braille is read by less than 10% of the blind population. Less than 1% of published books are converted into cassette tapes as talking books; almost no technical material is available on tape. Electric typewriters can be used to communicate with the sighted world, but formatting and error detection are very difficult.

Making Some Progress

Some unique solutions have been developed to aid the visually impaired in the last 10 years. For those who have

In This Issue

some visual capacity (about 80% of the total visually-impaired population of 2.5 million in the United States), specialized optical aids and closed-circuit television have been very helpful. For the remaining 500,000 people, some direct translation reading machines are available. The Optacon (OPtical to TActile CONverter), for example, is a small, battery-operated unit that converts print into a tactile image that can be felt on the reader's index finger. Reading speeds possible with the Optacon vary, but at best are far slower than those possible for a sighted reader.

The expanded development and use of small, inexpensive, and versatile computers offers another potential aid to the visually handicapped. It has become increasingly clear that almost any handicapped person can reduce his/her problems and increase his/her opportunities by learning to interact with computing systems. The tool for the sightless to do just that came about in a very recent development by Dr. Raymond Kurzweil. His device, the Kurzweil Reading Machine (KRM), is a machine that converts printed material into speech. A prototype of this machine was placed at the Western Blind Rehabilitation Center for evaluation as a reading machine for the blind. Researchers immediately began looking at the various areas where this machine's potential could be used.

A 4051 Graphic System and a Diablo Hyterm printer were already in use at the Western Blind Rehabilitation Center. But the 4051's ability to store and retrieve data, and its editing capacity (4051R06 Editor ROM Pack), led researchers to think about linking the 4051 with the KRM. This was a way for blind staff members to gain access to a computing system, the 4051, using the speech capacity of the Kurzweil machine.

Linking the 4051 with the KRM brought immediate impressive results. After a brief introduction to the 4051, one of the center's blind staff members was able to store and retrieve data on the 4051, using the voice of the KRM both as a means for proofing input and for obtaining output (Figure 1). To control text formatting for storage, the Editor ROM Pack was used. To control printer formatting, the Text Formatting software program written by Bruce Clarkson (4050 Series Applications Library #51/00-8018/00) was added to the tape cartridge.

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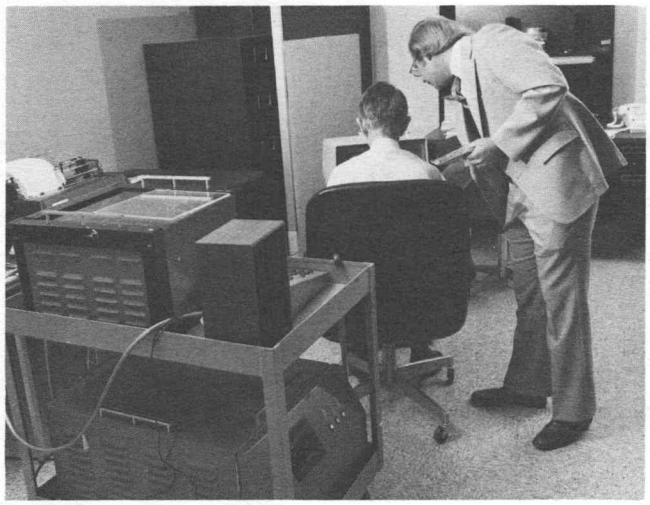


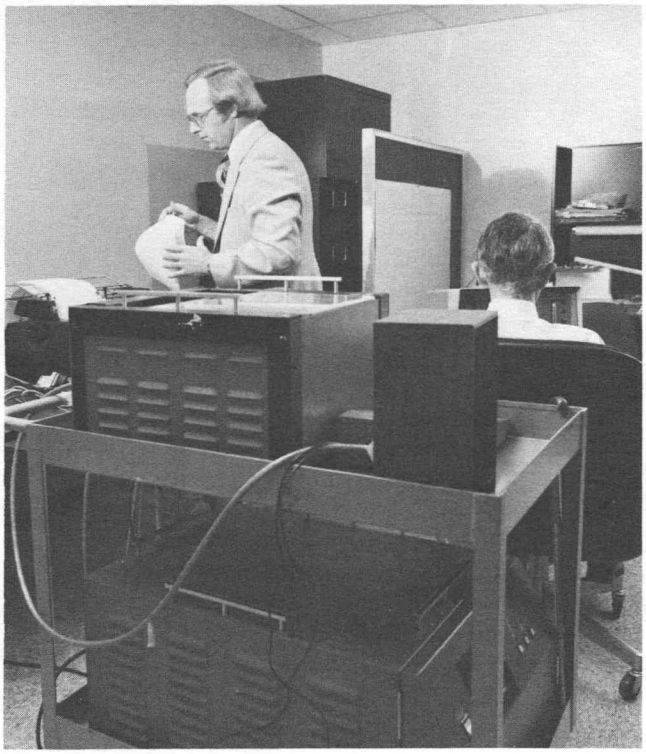


Fig. 1. Richard Bennett (seated) and Greg Goodrich key text into the 4051 using the 4051R06 Editor ROM Pack. The 4051 subsequently transmits the text to the Kurzweil Reading Machine which converts it to speech. This audio aid along with the 4051R06 editing functions enables the operator to edit text, either as he enters it or as he retrieves it from tape. Edited and formatted text is then sent to the Diablo Hyterm Printer. (Photographs by Jeff Shyshka and Curt Campbell, Medical Media Production Service, VAMC, Palo Alto, CA.)

More About the Kurzweil Reading Machine

The Kurzweil Reading Machine was developed by a team of experts in computer software design, systems analysis, linguistics and phonetics, electrical and mechanical engineering, optics, and eduction. They wanted to develop a tool that would allow the blind population to have rapid access to printed and typewritten material. This would increase employment opportunities and personal opportunities for all those with visual handicaps. They reached their goal in 1974, when the first complete print-to-speech reading machine prototype was

completed. Production models will soon be installed in educational, vocational, and rehabilitation centers in cities across the United States.

The KRM uses an optical character recognition system. The printed page to be translated is placed on a glass plate on the top of the machine, much like an office copier. As the machine scans the printed page, the image of each character is converted to an electronic signal, forming an enhanced image in digital form. A small computer in the KRM performs several conversions, then computes the pronunciation of each word. Linguistic rules, exceptions to the rules, and stress contour computations are drawn upon to provide appropriate inflections in the pronunciation process.

The user controls the manner in which the material is read. On the simplest level, the user can speed up or slow down the reading rate, and adjust the tonality of the voice. Thirty-three other controls allow the user to manipulate the machine according to personal needs. The machine can be made to repeat the previous few lines, spell out obscure words, enunciate punctuation and capitalization, or mark certain words for later reference. The position of the scanner can also be controlled. A hand-tracking option is being developed to allow the user to rapidly scan complicated page formats, develop a mental image of the layout, and then proceed to read and follow the printed matter.

To link to the 4051, Kurzweil engineers developed an appropriate software program, and developed an RS-232 input interface to the KRM. No modifications were required for the 4051. However, a "Y" parallel connector (Figure 2) was added to allow simultaneous communcation with the KRM and the printer, and braille markings were added to six keys to facilitate typing on the 4051 keyboard.

The Results

The net effect of the system is to provide three things to a visually impaired person that had not been previously available. The Kurzweil machine provides a means for accessing printed material. Including a 4051 in the system adds the ability to store and retrieve data in a fast and reliable manner, as well as providing an easily-used means for writing and proofing material.

Some practical applications of "talking computers" were demonstrated recently for representatives of the Veterans Administration, Kurzweil Computer Products, Tektronix, and private rehabilitation organizations. Since that demonstration, a number of new applications have occurred; it appears that we have found only the most obvious ones. Access to canned programs, for example, can be obtained by changing the display address from the 4051 graphic screen to the address of the KRM. This provides a voice for the written information, but does not display graphics. The hard copy problem might be solved by adding a braille computer printer and developing a software program which converts Tektronix graphics into a form usable by the braille printer.

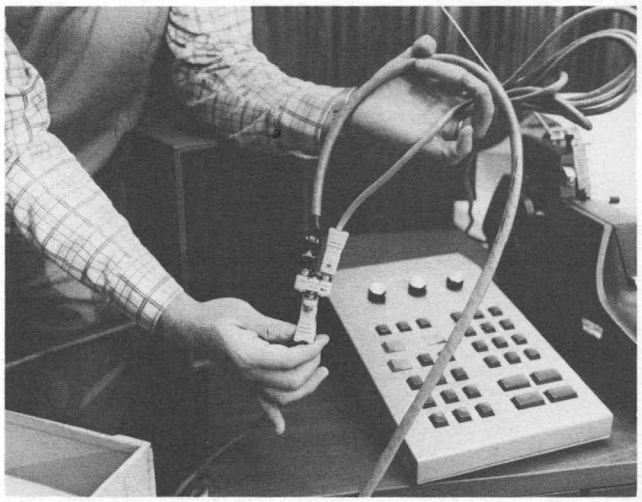


Fig. 2. The "Y" parallel connector interfaces the 4051 to the Kurzweil Reading Machine and Diablo Hyterm Printer simultaneously. The reading machine's control panel lies on the desk behind the connector. (Photograph by Jeff Shyshka and Curt Campbell, Medical Media Production Service, VAMC, Palo Alto, CA.)

Another Option

The ELINFA Digicassette (manufactured by Electronique Linguistique Informatique Appliques in France) is a battery-operated cassette recorder that has an electronic braille keyboard and 12 refreshable braille cells. Each cell contains six mechanically driven pins. Information may be recorded on a cassette tape using the braille keyboard, or retrieved by activating the pins within each of the 12 braille cells. Two ELINFA's can be directly connected to allow a deaf-blind individual to communicate with another braille user. The ELINFA can also be obtained with an RS-232 interface, equipped with an interpreter which translates ASCII to braille and braille to ASCII.

At a recent meeting of the American Association of Workers for the Blind, the ELINFA was demonstrated by a deaf-blind individual. Although the individual had not used his ELINFA to interact with a computer, the 4051 was linked with the ELINFA. Information was exchanged quickly and efficiently through the RS-232 interface.

The applications listed here are relatively few in number. However, they have a tremendous potential for the handicapped by removing the barriers prohibiting access to printed communications and to rapid processing of information. And the ease of 4051 use is accented again by the brief introduction necessary before staff members are able to use it.

Editor's Note. *Dennis Hagemeier, Tektronix Sales Engineer, Santa Clara, observed the demonstration mentioned in the article. At his suggestion Dr. Goodrich and his associates compiled the story for TEKniques.*

The 4054 Brings New Graphics and Alphanumeric Capabilities to the 4050 Series

by Cathy Cramer

With over 13 million addressable points on a 19" screen, the 4054 Graphic Computing System can display more graphic and alphanumeric information than any other desktop computer.

TEKniques Vol. 3 No. 3 introduced the 4052 and 4054, two new desktop systems that join the 4051 to form the 4050 Series family of compatible Graphic Computing Systems. Both the 4052 and 4054 bring major enhancements to the 4050 Series. A fast new bit-slice processor in both systems provides speed increases in computation, graphics, and data communications. The increased performance of the 4052 and 4054 makes them highly responsive, and thus more interactive than other desktop computers. The large memory option (64K) combines with fast processing to make larger or more complex applications more practical than ever before.

The 4054 has all of the features of the 4052, without exception. In addition, the 4054 offers graphics and alphanumeric capabilities never before seen in a desktop computer.

Graphics

The 4054 provides superior high resolution graphics on a 19" DVST display. With its large screen, the 4054 can display more information than any other desktop computer, and with greater precision. Dense, complex images can be displayed using 4096 x 3125 viewable points—over sixteen times the capacity of the already high-resolution 4051 and 4052.

Graphic Input

With the 4054, a full-screen crosshair cursor provides the graphic input capability. The POINTER command activates the crosshair, the same way it activates the blinking arrow cursor on the 4051 and 4052. You can manipulate the crosshair using two new thumbwheels, which come standard, on the far right of the 4054 keyboard: one thumbwheel moves the cursor up or down; the other moves it left or right. Each position of the thumbwheels corresponds to a point on the screen, for easier and quicker positioning of the crosshair to an exact location.

The thumbwheels eliminate the need for a 4952 Option 2 Joystick. But if you prefer the Joystick, you can use it to manipulate the crosshair by simply connecting the Joystick and pressing the SELECT button.

Graphic Displays

Graphic Displays can be generated very quickly on the 4054, for two reasons. First, the new high performance processor cuts down the amount of time spent on computations involved in the display; whether the computations are just conversions of user units to graphic display units, or complex mathematical routines to compute coordinates. Second, the raw speed at which vectors are drawn is faster on the 4054, due to a new vector generator.

The new vector generator draws at a constant rate of 15,000 cm/sec, for consistently crisp and clear vectors. The time required to draw a vector is proportional to its length: the shorter the vector, the faster it draws. You can save considerable drawing time over the 4051 and 4052, whose "constant time" vector generator takes the same amount of time to draw any vector, regardless of length.

All vectors draw faster on the 4054. The longest possible vector, a full-screen diagonal, shows the smallest increase; drawing about 25% faster than on the 4051 or 4052. Short vectors benefit the most from the new vector generator. A 5 cm vector draws about 10 times faster on the 4054, and a 1 cm vector is over 55 times faster. Taking into consideration the time required to compute coordinates and execute graphics commands, you can expect the 4054 to generate graphic displays up to 50% faster than even the 4052, making the 4054 especially suited for applications that are heavily graphics oriented.

Dashed Vectors

As a special graphics feature incorporated into the hardware, the 4054 can generate dotted or dashed vectors in a variety of patterns. A particular pattern can be selected using a new BASIC keyword DASH along with a number from 0 to 255, like this:

```
DASH 1
```

The above command tells the 4054 to draw subsequent vectors with long (about 1.3 cm) dashes. You can enter a DASH command such as this one directly from the keyboard or under program control; and you can change the dash pattern at any time simply by entering a DASH command with a different parameter, or executing DASH 0 or INIT to revert to the default solid line vectors.

The DASH command completely eliminates the need for

BASIC software to generate dotted and dashed vectors. The benefits are many. First, there's the simple convenience of being able to enter one command instead of a software routine. You save program development time, as well as valuable memory space. The 4054 offers 36 unique selectable patterns, for a high degree of flexibility. A BASIC software routine to generate this many patterns could require in excess of 6K of user memory. Also, because the 4054 dashed vectors are handled by hardware, they draw much faster than equivalent software-generated vectors. You save considerable drawing time using the 4054 DASH command instead of custom-written routines (a factor of over 100 times for the Data Graphing example shown in Figure 6).

The unique vector patterns you can select using the DASH command are shown in Figure 1, along with the pattern number for obtaining each one. For example, DASH 85 gives short dashes, and DASH 5 gives long dashes separated by very short dashes. Not shown in the figure are DASH 0 (solid vectors), and DASH 255 ("dark" or invisible vectors).

Dashed vectors can make graphic displays more meaningful, and easier to interpret. You can use different vector patterns to distinguish multiple curves on a graph. Or, you can represent theoretical curves with dashed vectors, and actual data with solid vectors. Hidden lines or tool cut lines are also good candidates to be drawn with dashed rather than solid vectors.

There are many other applications. The example shown in Figure 2 depicts a multiple feedback low pass filter. The lower portion of the display plots both actual and theoretical frequency versus gain curves for the filter. The actual distribution is plotted using the default solid vectors. But the ideal or theoretical curve is plotted using the very short dash vector pattern, selected by the command DASH 85.

A quick note about how the DASH command works: the parameter of the DASH command is the decimal equivalent of an 8-bit representation for a particular pattern. A bit that is off (0) turns the writing beam on, and a bit that is on (1) turns the writing beam off. Each of the eight bits corresponds to .71 graphic display units (GDUs), and the pattern that results is used repeatedly to generate dashed vectors. In theory, this gives you 2^8 or 256 selectable patterns; but because the pattern is placed end-to-end repeatedly when drawing vectors, there are actually 36 unique patterns—probably more than you'll ever need.

A final point about the DASH command is that the 4054 "remembers" what portion of the pattern it is drawing as it ends each vector. So if the next vector begins at the endpoint of the previous one, the pattern simply continues, rather than restarting and destroying the appearance of the graph or design.

Alphanumerics

The 4054 draws all characters with vector strokes, rather than dot patterns as on the 4051 and 4052. Because the stroked characters are continuous, they're extremely clear, and easy to read. The hard copies are excellent. And like the 4052, the 4054 has an expanded set of character fonts, including the new business font with the "slashless" zero (shown in Figure 4).

Character Sizes

The 4054 is the first desktop computer to offer four character sizes. The four sizes, shown in Figure 3, are selectable from the 4054 keyboard or under program control using a new BASIC command CHARSIZE. You can select a character size at any time; just enter the keyword CHAR followed by a digit 1 through 4. Character size 1 is the smallest, with 132 characters per line, and character size 4 is the largest, with 72 characters per line as on the 4051 and 4052.

You'll find the choice of several character sizes has major advantages in both purely alphanumeric applications, and applications that mix alphanumerics with graphics. Some examples are shown in Figures 4 through 6. The smallest character size displays 132 characters per line, making the 4054 the world's first desktop computer that can be used to preview 132-column line printer output with no overwriting or wraparound (Figure 4). The small character size is also convenient for BASIC program development or debugging, because it lets you inspect almost twice as many program statements as you're accustomed to seeing on the 4051 at one time. And the more statements you can examine at once, the easier it is for you to keep track of the flow of your program.

The two-column listings under control of the EDITOR ROM pack are optimized using the 4054's small character size (Figure 5). You can display 60 characters per line in each of the two columns, with no overwriting of the second column by the first, and no wraparound in the second column.

Finally, the most well-known application for multiple character sizes is enhancing graphic displays with text annotations of varying sizes (Figures 2 and 6). Titles, axis labels and numeric values, legends and tables can all be differentiated and highlighted according to their importance or their placement on the page, using the four character sizes. In Figure 6 the overall title is in character size 4, but the footnote under the title is in the small character size 1. X and Y axis labels are made with size 3. The legend in the lower left corner and the numeric values labeled on the X and Y axes are displayed in size 2. Appropriate use of multiple character sizes on graphic displays lets you place the emphasis where needed, and puts the final touch on high-quality presentations. And not to be ignored is the fact that in many instances, the smaller character sizes allow you to display extra text that you couldn't have otherwise fit on the page.

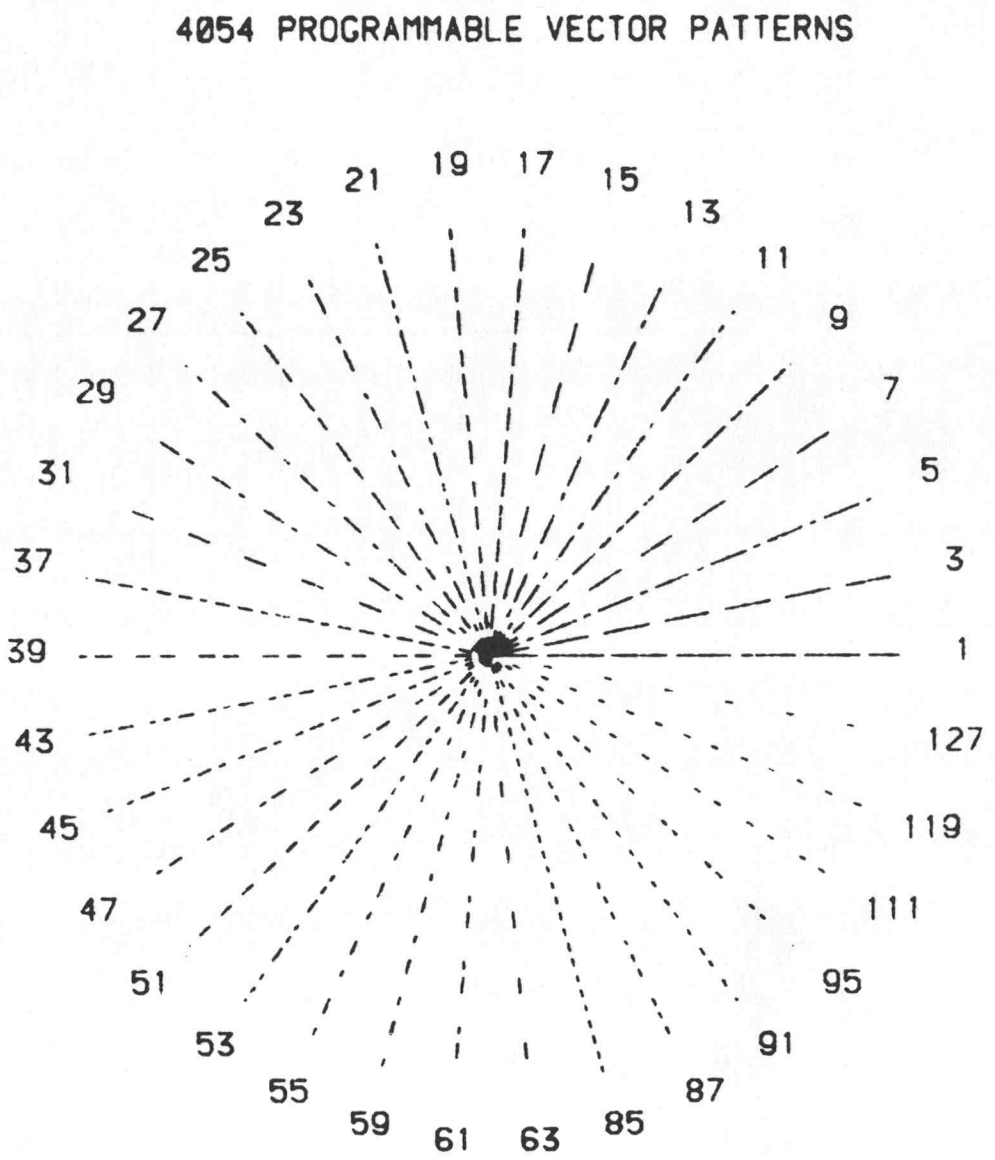


Fig. 1. The 4054 generates dotted and dashed vectors in 36 user-selectable patterns.

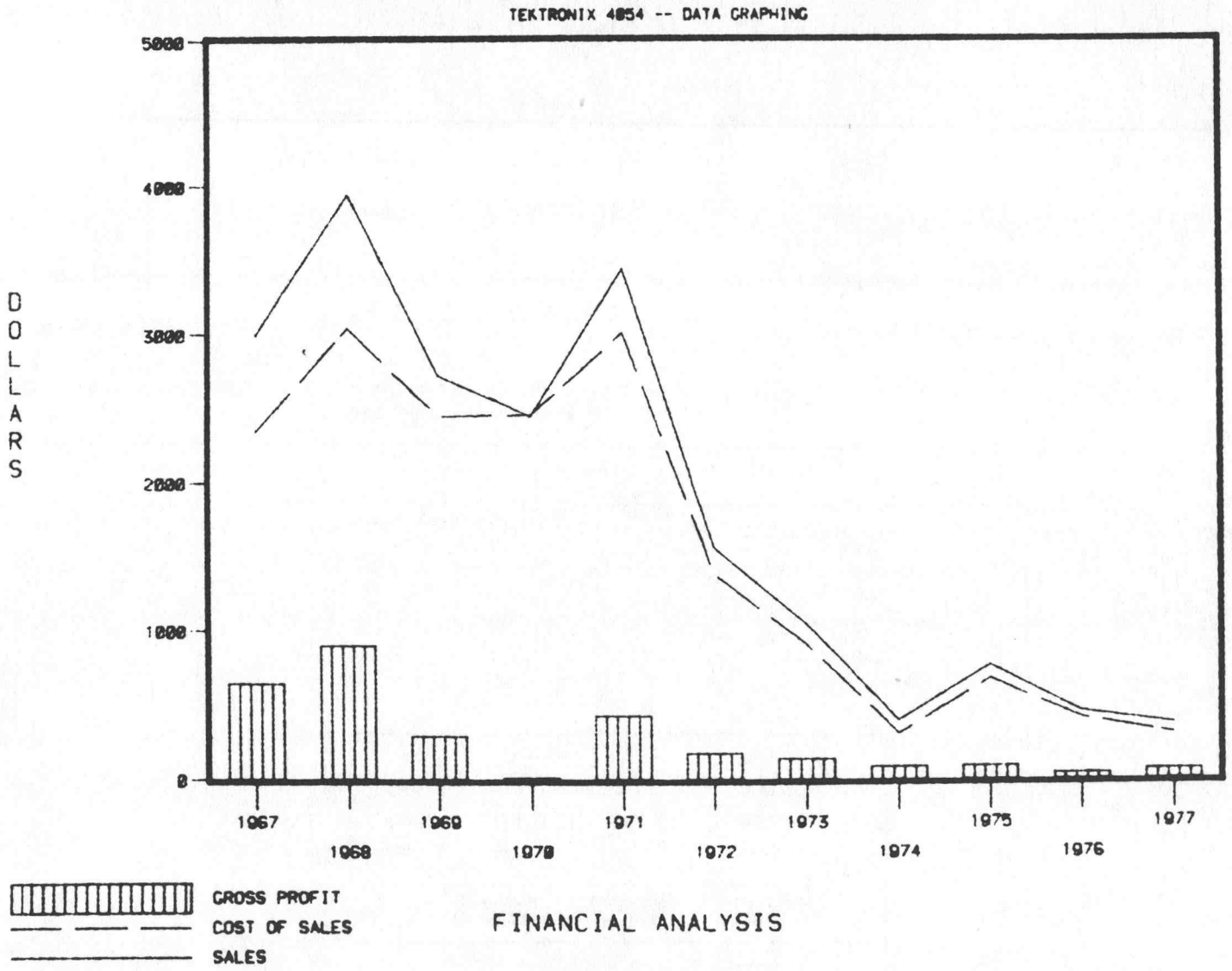


Fig. 2. Dashed vectors help differentiate theoretical curves from actual data.

4054 CHARACTER SIZES

	CHARACTERS PER LINE	LINES DISPLAYED	TOTAL CHARACTERS
CHAR 1	132	64	8448
CHAR 2	118	50	8082
CHAR 3	70	38	3882
CHAR 4	72	35	2520

THIS IS CHARACTER SIZE 1

THIS IS CHARACTER SIZE 2

THIS IS CHARACTER SIZE 3

THIS IS CHARACTER SIZE 4

Fig. 3. The 4054 is the only desktop computer to offer four user-selectable character sizes.

ABC CORPORATION
OPERATING BUDGET
FOR 1978

9/2/78

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
02 SALARIES	67238	67238	68622	76850	79703	79703	80252	80252	83023	83023	83023	83023	931946
05 PAYROLL TAXES	3383	3383	3522	3880	4019	4101	4101	4101	4182	4182	4182	4182	47218
08 GROUP INSURANCE	1930	1930	2003	2305	2368	2388	2388	2388	2449	2449	2449	2449	27436
10 SALES COMMISSION	6846	6846	7824	8802	9780	9780	9780	9780	9780	9780	9780	9780	108558
21 ADVERTISING	488	488	488	2363	2363	2363	2363	2363	2363	2363	2363	2363	22734
22 SALES PROMOTION COLL.	163	163	163	488	488	488	488	488	488	488	488	488	4880
23 TECHNICAL DOCUMENTATION	407	407	407	407	407	407	407	407	407	407	407	407	4884
24 DIRECT MAIL	163	163	163	1121	1121	1121	1121	1121	1121	1121	1121	1121	10578
25 CORPORATE MATERIALS	163	163	163	163	163	163	163	163	163	163	163	163	1956
30 MARKET RESEARCH	81	81	81	81	81	81	81	81	81	81	81	81	972
31 PRINTING SUPPLIES	203	203	203	203	203	203	203	203	203	203	203	203	2436
34 BAD DEBTS	163	163	163	163	163	163	163	163	163	163	163	163	1956
35 COPY MACHINE	346	346	346	346	346	346	346	346	346	346	346	346	4152
36 PREPROD. MATRLS.	1304	1304	1304	1467	1467	1467	1467	1467	1467	1467	1467	1467	17115
37 EQUIP. LEASE & RENTAL	40	40	40	40	40	40	40	40	40	40	40	40	480
38 REPAIRS & MAINT-EQUIP.	121	121	121	121	121	121	121	121	121	121	121	121	1452
39 DEPREC.-OFFICE EQUIP.	407	407	407	407	407	407	407	407	407	407	407	407	4884
41 AMORT. LEASE IMPROV.	40	40	40	40	40	40	40	40	40	40	40	40	480
45 AMORT. NOTE DISCOUNT	235	235	235	235	235	235	235	235	235	235	235	235	2820
46 AMORT. PURCHASED PROD.	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	13392
50 EMPLOYEE RECRUITING	1732	1732	2906	374	2493	374	374	2493	374	374	374	374	13974
51 EMPLOYEE RELATIONS	125	125	125	125	125	125	125	125	125	125	125	125	1500
54 TELEPHONE	6519	6519	6519	6519	6519	6519	6519	6519	6519	6519	6519	6519	78228
56 TRAVEL & LIVING	6600	6600	7334	10046	10535	10535	10698	10698	10698	10698	10698	10698	115838
57 ENTERTAINMENT	563	563	595	628	677	677	677	677	677	677	677	677	7765
59 MOVING EXPENSES	1709	1709	1709	1709	1709	1709	1709	1709	1709	1709	1709	1709	20508
61 OFFICE SUPPIES	733	733	774	814	855	855	855	855	855	855	855	855	9804
62 POSTAGE	1043	1043	1075	1108	1141	1141	1141	1141	1141	1141	1141	1141	13397
63 TERMINAL COSTS	2445	2445	2445	2445	2445	2445	2445	2445	2445	2445	2445	2445	29340
64 COMPUTER TIME	8150	8150	8150	8150	8150	8150	8965	8965	8965	8965	8965	8965	102690
68 LEGAL FEES	4890	4890	4890	4890	4890	4890	4890	4890	4890	4890	4890	4890	58680
69 PROFESSIONAL SERVICES	2445	2445	2445	2445	2445	2445	2445	2445	2445	2445	2445	2445	29340
70 TAXES & LICENSES	326	326	326	326	326	326	326	326	326	326	326	326	3912
71 AMORT. ORGANIZING EXP.	105	105	105	105	105	105	105	105	105	105	105	105	1260
75 BUILDING RENTALS	5990	5990	6357	6723	7090	7090	7090	7090	7090	7090	7090	7090	81780
76 UTILITIES	488	488	488	488	488	488	488	488	488	488	488	488	5868
77 JANITORIAL SERVICE	342	342	342	342	342	342	342	342	342	342	342	342	4104
79 GENERAL INSURANCE	407	407	407	407	407	407	407	407	407	407	407	407	4884
81 INTEREST	5868	5868	5868	5868	5868	5868	5868	5868	5868	5868	5868	5868	70416
** TOTALS **	135317	135317	140273	154112	161243	159206	160733	162882	163666	163666	163666	163666	1863717

DEPARTMENT NAME: ** CORPORATE **
DEPARTMENT CODE:

Fig. 4. The 4054 can be used to preview a page of 132-column line printer output at a glance.

```
LIST
      !1 SET KEY
      !2 GO TO 4480
      !4 GO TO 10000
      !8 PAGE
      !9 GO TO 11000
      !12 GO TO 12000
      !16 PAGE
      !18 GO TO 2000
      !20 GOSUB 4500
      !21 END
      !24 Z=32
      !25 N8=0
      !26 GO TO 3000
      !28 Z=1
      !29 GO TO 3000
      !32 PAGE
      !33 GO TO 12100
      !36 PRINT "LJJJEXAMPLE GRAPHS:"
      !37 GO TO 12000
      !40 GO TO 60
      !42 GO TO 100
      !44 GO TO 12500
      !48 GO TO 13000
      !60 INIT
      !61 SET KEY
      !62 GO TO 100
      !64 GO TO 60
      !68 FIND 3
      !69 CALL "BOLD"
      !72 FIND 4
      !73 CALL "BOLD"
      !76 GO TO 20
      !80 PAGE
      !81 F1=999
      !82 GO TO 4430
      !100 SET CASE
      !110 DATA 120,20.0,2.857,1.87,32,0,0,0,0,10,1,0,0,3,1,0
      !120 READ H,B,A2,H2,W,Z,G,S5,S,H7,P5,P6,N9,N8,F1,L,F9
      !130 DELETE X,Y,N,L$,Z4,B5,C$,N4,D$,D4,L$
      !140 DIM X$(1),A$(36),V$(8),S1(7),W$(16),C$(16)
      !150 A$="JANFEBMARAPRMAYJUNJULAUGSEPOCTNOVDEC"
      !160 DATA 1,1.5,2,2.5,5,7.5,10
      !170 READ S1
      !180 PRINT "L ** FUNCTION KEY DEFINITIONS **J"
      !190 GOSUB 4520
      !200 PRINT "JJJPRESS FUNCTION KEY #9 FOR EXAMPLES"
      !210 PRINT "J                OR"
      !220 PRINT "JPRESS 'RETURN' TO CREATE A GRAPHCC  ";
      !230 INPUT B$
      !240 U$="TEKTRONIX data graphing"
      !250 M$="Time Periods"
      !260 E$="DOLLARS"
      !270 PRINT "LJJHOW MANY VALUES FOR X AXIS:  CC";
      !280 INPUT N
      !290 DIM X(N),L$(N*16)
      !300 X$="N"
      !310 L$=""
      !320 FOR I=1 TO N
      !330 L$=L$&"
      !340 X(I)=I
      !350 NEXT I
      !360 PRINT "J(U)SER-INPUT OR (AH_)AUTO-SEQUENCE LABELS ON X-AXISCC ";
      !370 INPUT X$
      !380 IF X$<>"U" THEN 460
      !390 PRINT "J"
      !400 FOR I=1 TO N
      !410 PRINT "LABEL # ";I;" (________________HHHHHHHHHHHHHHHH)";
      !420 INPUT W$
      !430 L$=REP(W$,I*16-15,LEN(W$))
      !440 NEXT I
      !450 GO TO 1000
      !460 PRINT "JAUTO-SEQUENCING BY (M)MONTHS OR (NH_)NUMBERSCC ";
      !480 INPUT X$
      !490 IF X$<>"M" THEN 600
      !500 PRINT "J STARTING MONTH # (1=JAN, etc.) ? ";
      !510 INPUT M3
      !520 FOR I=1 TO N
      !530 T=M3+(I-1)-INT((M3+(I-1))/12)*12
      !540 T=T+(T=0)*12
      !550 W$=SEG(A$,T*3-2,3)
      !560 L$=REP(W$,I*16-15,3)
      !570 NEXT I
      !580 GO TO 1000
      !590 IF X$<>"N" THEN 790
      !600 P5=1
      !620 P6=1
      !630 PRINT "JENTER STARTING NUMBER (DEFAULT IS= ";P5;") C";
      !640 INPUT B$
      !650 IF B$="" THEN 670
      !660 P5=VAL(B$)
      !670 PRINT "JENTER INCREMENT (DEFAULT IS =";P6;") C";
      !680 INPUT B$
      !690 IF B$="" THEN 710
      !700 P6=VAL(B$)
      !710 B$=" "
      !720 FOR I=1 TO N
      !730 W$=STR(P5)
      !740 FOR K=1 TO 16-LEN(W$)
      !750 W$=W$&B$
      !760 NEXT K
      !770 L$=REP(W$,I*16-15,16)
      !780 P5=P5+P6
      !790 NEXT I
      !1000 N1=1
      !1020 PRINT "JYOU MAY HAVE 1 TO 6 CURVES ON GRAPH"
      !1030 PRINT "ENTER NUMBER (DEFAULT IS =";N1;") C";
      !1040 INPUT B$
      !1050 IF B$="" THEN 1070
      !1060 N1=VAL(B$)
      !1070 IF N1<7 THEN 1100
      !1080 PRINT "JCCLIMIT IS 6 CURVES. TRY AGAIN."
      !1090 GO TO 1000
```

Fig. 5. Two-column listings under control of the EDITOR ROM Pack can display 60 characters in each column with no overwriting or wraparound.

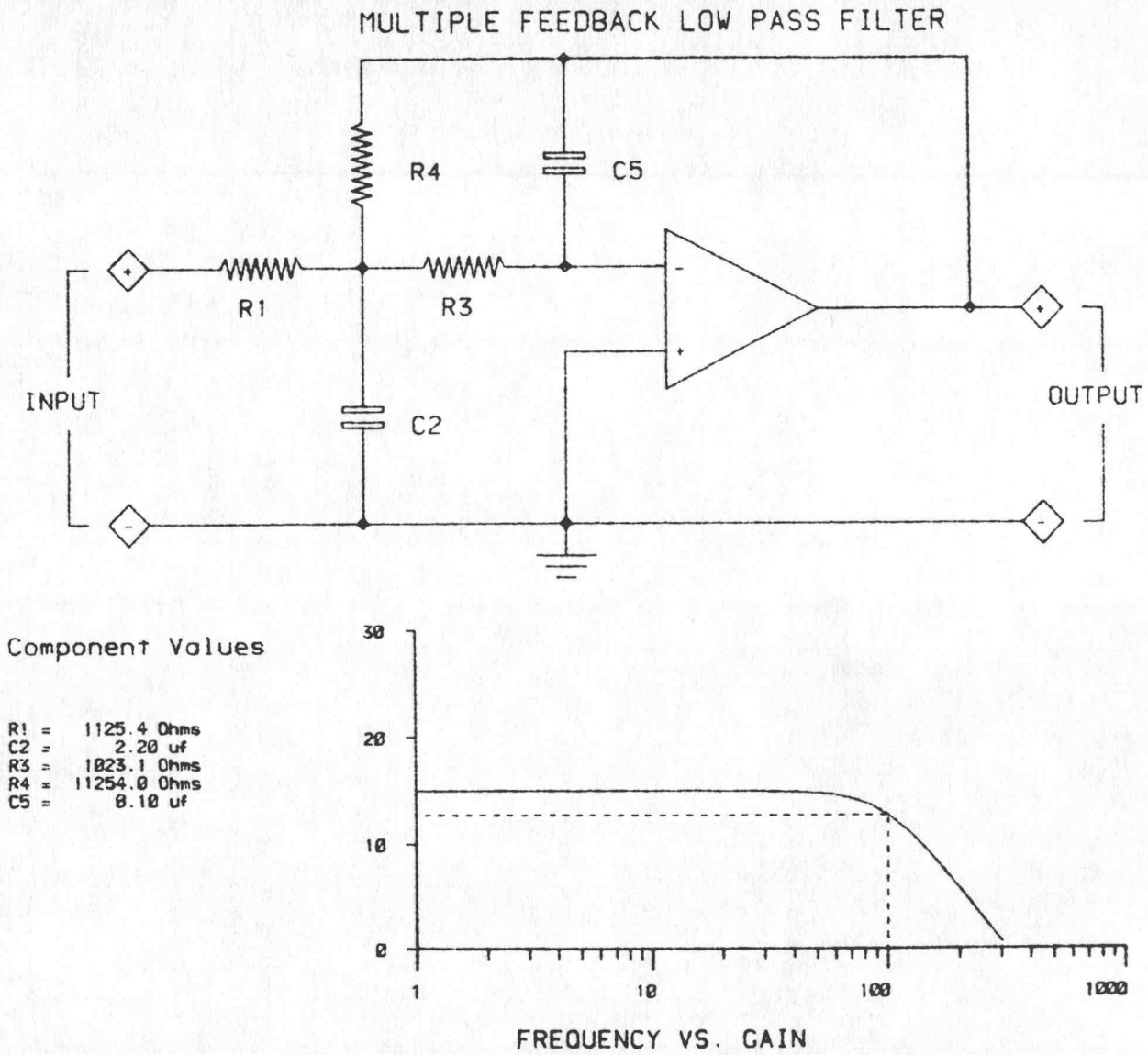


Fig. 6. Multiple character sizes can be used to differentiate or highlight text annotations on a graphic display. (Actual size of display is almost twice the size shown here.)

Automatic Data Handling of Uranium Analysis for the NURE Program

by Stanley T. Kosiewicz
Los Alamos Scientific Laboratory
Los Alamos, NM

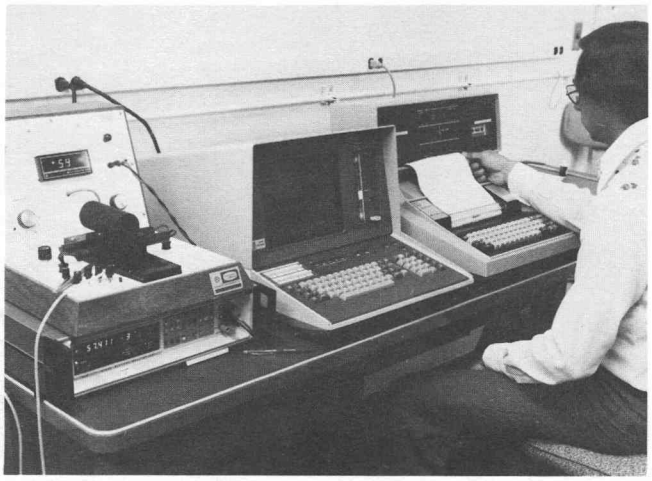


Fig. 1. The Tektronix 4051 Graphic System is the controller in the automated system which analyzes pelleted samples for uranium. A fluorometer modified to include a digital voltmeter (left), and a printer/storage terminal (right) complete the system.

Since 1975, the Los Alamos Scientific Laboratory (LASL) has been participating in the National Uranium Resources Evaluation (NURE) program. In that program, three laboratories are assessing the nation's potential uranium resources. LASL's responsibility area has been the Hydrogeochemical and Stream Sediment Reconnaissance (HSSR) of New Mexico, Colorado, Montana, Wyoming, and Alaska. The other laboratories involved in the program, Oak Ridge Laboratories in the middle west and Savannah River Laboratory for the east and west coast, are performing similar studies.

Evaluting Samples

Scientists collect samples throughout the subject area. In the contiguous United States, a sample is collected every four square miles, while in Alaska a sample is collected for each 10 square mile area. The samples are then sent to the laboratory for analysis. At Los Alamos Scientific Laboratory the pellet fluorometric method determines the quantity of uranium in the sample. The method works like this: Water samples are gathered in the field for testing. These samples are dried under a heat lamp, and the resulting deposit is mixed with a matrix of lithium fluoride with sodium fluoride. This mixture is placed in a platinum cup and fused to make a pellet. Subjecting the pellet to ultraviolet light produces a fluorescence which can be measured by a fluorometer. The amount of fluorescence in the pellet is proportionate to the amount of uranium in the original sample. LASL processes about 38,000 samples per year by this method.

At the start, the analyses were done by hand. Sample readings from a fluorometer were written down on paper. When enough readings had been recorded, a technician processed them using a desktop calculator. The result was usable data on sample concentrations that could then be compared against rejection criteria. Data was later transferred to a host computer for storage. Manual processing of the analytical data for these samples demanded a lot of time and labor. Additional effort was required to check the accuracy of data collected in this manner.

Now an automated system controlled by the 4051 records the data and analyzes the readings quickly and easily, with less chance for error. The system is interactive; instructions to the operator are displayed on the 4051 screen.

The 4051 is interfaced with a fluorometer to obtain readings from the test samples; the interface occurs through a controllable digital voltmeter connected to the 4051 through the GPIB. The digital voltmeter samples the signal generated by the fluorometer upon command from the 4051 Graphic System.

After blanks, controls, standards, and sample pellets are read, the 4051 performs a least squares calculation to make a concentration curve. The uranium concentrations of all pellets read are then tested against all rejection, precision, and diagnostic criteria in the current water analysis laboratory guidelines.* Subsequently, the concentrations and diagnostics (if any) are transmitted over the RS-232 interface to a terminal for printing. If a set of samples has not been rejected, the sample identifications and concentrations are transferred directly to a magnetic tape cassette, where they are available for additional processing. Data are stored on a host computer, and are available to the public for uranium mining research.

Equipment Configuration

The following items, shown in Figure 1, were used to automate the data acquisition and processing.

(1) Fluorometer. A Jarrell Ash 26-000 fluorometer was used, with the meter replaced by a digital voltmeter. Positive output is taken from pin 2 of the DVM, while negative output is taken from pin 10. The fluorometer DVM reads in millivolts.

(2) Digital Voltmeter. The signal from the fluorometer is transmitted to a Fluke 8500 A DVM equipped with an optional IEEE-488 (GPIB) interface. Two DVMs are connected to the 4051. The DVMs are remotely controlled through an address of 1 or 2. The

*A Los Alamos Scientific Laboratory internal document.

instruments are operated in a dc volts mode with a maximum range of 312.5 mV. This range will never be exceeded under any conditions to be encountered in trace uranium analyses of natural waters.

(3) Computing System. The Tektronix 4051 Graphic System, equipped with an RS-232 optional interface and 16K memory, processes the signal from the Fluke DVM. Using the graphic display, the computer asks questions of the technician and also displays the technician's responses entered from the keyboard (Figure 2). The BASIC language computer program is stored on the 4051's internal magnetic tape. The 4051 commands the Fluke DVM to sample the fluorometer signal and subsequently to send the data to the 4051 for processing into concentration data. The data are then sent to a TI 733 terminal, which is used merely as a controllable typewriter and tape recorder.

```
ENTER SAMPLE NUMBER
339299
IS THIS SAMPLE A CONCENTRATE?  1 FOR YES, 0 FOR NO.
0
LOAD FIRST PELLET FOR 339299 HIT RETURN WHEN READY TO READ

****WHAT FLUOROMETER SCALE WAS USED? .01 OR .1?****
.01
 31.729
LOAD SECOND PELLET FOR 339299 RETURN WHEN READY TO READ

 31.785
DO YOU WANT TO REPEAT THIS SAMPLE?
SAMPLE=339299
TO REPEAT TYPE 1. TYPE 0 TO CONTINUE.
```

Fig. 2. The operator interacts with the system through instructions displayed on the 4051 graphic screen.

(4) Hard Copy Terminal. A Texas Instruments 733 ASR terminal prints the concentrations and also records them on a magnetic tape cassette. The terminal is remotely controlled through the RS-232 interface using an address of 40. Upon command from the 4051, the terminal prints the concentrations (Figure 3). Then only acceptable data that are within established analytical guidelines are recorded on the terminal's magnetic tape cassette, again upon command from the 4051. In addition, data from the TI 733 terminal can be sent to the LASL Central Computing Facility over the RS-232, via an acoustic coupler.

A continuing check of field water samples compares the 4051-generated data against that obtained manually with a desktop calculator. Comparisons made on more than 500 samples so far demonstrate excellent agreement between the two methods. Figure 4 displays uranium concentration data from 60 samples processed using a desktop calculator versus data obtained "automatically" using the 4051 system. The barely-visible dashed lines in the graph are the 95% confidence limits.

Conclusions

The automated data acquisition and processing system decreases labor, saves time, and eliminates manual errors in computation. Manual keypunch operations previously required to transmit data to the Central Computing Facility are eliminated resulting in large additional time and labor savings.

```
          TODAY'S DATE IS 10-31-78
BLANK AV. = 0.0280  PPB
  1 PPB CONTROL = 0.51 PPB
1 OPPB STD = 9.97 PPB


     SAMPLE = 339270     U PPB = -0.131
PELLET 1 = -0.136 PELLET 2 = -0.126
 CONCENTRATE NEEDED***


 SAMPLE = 339271     U PPB = 0.112
PELLET 1 = 0.226     PELLET 2 = -0.003


    SAMPLE 339273     U PPB = -0.095
PELLET 1 = 0.027 PELLET 2 = -0.217
 CONCENTRATE NEEDED***


 SAMPLE = 339274    U PPB = 1.155
PELLET 1 = 2.085 PELLET 2 = 0.226
 SAMPLE REJECTED***


 SAMPLE = 339276     U PPB = 1.339
PELLET 1 = 1.429 PELLET 2 = 1.248


 SAMPLE = 114009     U PPB = 15.04
PELLET 1 = 22.32  PELLET 2 = 7.75
 TO BE REPEATED BY P-2****
```

Fig. 3. Computer-analyzed concentrations are printed at the terminal.

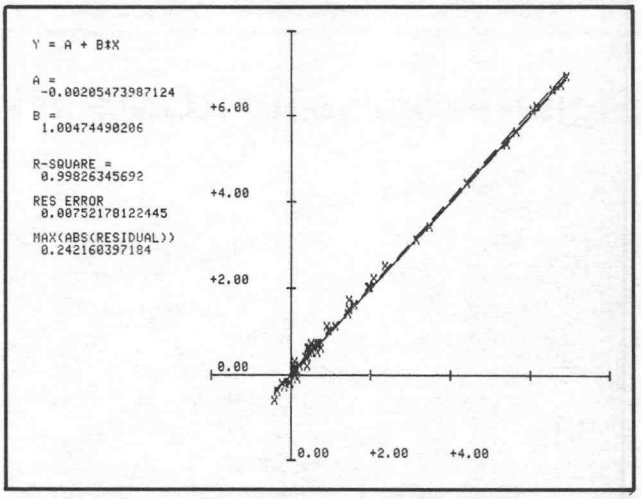


Fig. 4. Uranium concentrations obtained manually for 60 samples demonstrate excellent agreement with those obtained for the same 60 samples through the automated system.

Finally, sample throughput may also increase since the technician operator knows immediately whether a sample or set of samples must be repeated. Operator satisfaction appears to have increased because of the smoothness and simplicity with which they interact with the 4051 Graphic System and the immediate feedback they receive from it.

Acknowledgements: I thank the following people for their assistance in various aspects of this work: W.E. George, W.E. Sandoval, D.A. Sandoval, Jadine Davis, and A. Hues. I also thank E.J. Cokal and W.H. Ashley for selecting and obtaining the equipment used.

Editor's Note: *The work of Stanley T. Kosiewicz and his associates at the University of California, Los Alamos Scientific Laboratory, was brought to TEKniques' attention by Wayne Avila, Tektronix Sales Engineer at Albuquerque. More detailed information on the program is contained in LA-7648-MS Informal Report, UC-51, issued Feburary 1979.*

Register for the PLOT 50 Software Maintenance Newsletter

by Howard Sanders

Are you registered for the PLOT 50 Software Maintenance newsletter? If not, fill out the Product Update Registration card in your 4050 Reference manual or your software manual(s). Registrants will receive the periodic newsletter listing verified PLOT 50 software problems and how to correct or bypass these problems.

PLOT 50 software products are those developed and supported by Tektronix for the 4050 Series and to date include the following packages:

4050A01 PLOT 50: Statistics Vol. 1
4050A02 PLOT 50: Statistics Vol. 2
4050A03 PLOT 50: Statistics Vol. 3
4050A04 PLOT 50: Mathematics Vol. 1
4050A05 PLOT 50: Mathematics Vol. 2
4050A06 PLOT 50: Electrical Engineering Vol. 1
4050A07 PLOT 50: Graph Plot
4050A08 PLOT 50: General Utilities Programs Vol. 1
4050A09 PLOT 50: Business Planning and Analysis Vol. 1
4050A10 PLOT 50: Statistics Vol. 4
4050A13 PLOT 50: Statistics Library
4050A14 PLOT 50: Mathematics Library
4050A15 PLOT 50: Scientific Library

Much of the information in the newsletter is developed from customer comments or reports of software problems. Please send in any comments or reports of errors. Contact your local Tektronix Systems Analyst for help in submitting a Software Performance Report.

NOTE: *4050B01 Modeling and Reporting is supported and updated, but not through the PLOT 50 Software Maintenance Newsletter.*

Signal Processing ROM Pack #1 Speeds Up Numeric Sorting

by Dave Barnard

How could the Signal Processing ROM Pack #1 (4051R07 or 4052R07) possibly improve numeric value sorting, or even relate to such a task? Someone really did ask that question. The answer is that it relates very well, and significantly improves the performance of even the simplest sorting program. Although Signal Processing ROM Pack #1 was designed for waveform, signal, and time-series analysis,* its functions can be applied to **any** one-dimensional array of numeric values. It can also operate on numbers stored in 4050 Series Graphic System memory, for sorting operations.

With a few changes a bubble sort program can take advantage of the power and speed of the Signal Processing ROM Pack #1. The changes are easy to implement and easy to understand. Although more powerful sorting algorithms exist, they won't outrun the simple ROM Pack-enhanced bubble sort until the number of values sorted exceeds 1500 for the 4051, or 2400 for the 4052.

Bubble Sort Program

Let's look at a simple bubble sort program (Figure 1). Each time an inner loop consisting of lines 1110 through 1210 is executed, the numbers in the array are only partially ordered. For badly scrambled numbers, line 1090 will command entry of the loop almost N times, or as many times as there are numbers in the array. And the FOR...NEXT loop must examine N-1 values for each repetition. Therefore, sorting time could be proportional to N*N (N = the number of values to be sorted). Even if all the numbers are in sequence, the FOR...NEXT loop must be executed once; that's N-1 executions of some of the lines in the loop. But, when the quantity of numbers to be sorted is small, the bubble sort is an easy solution that is often fast enough.

However, when sorting only 80 numbers, this routine takes approximately two minutes. The lengthy execution occurs because line 1130 simply compares two neighboring values to determine if they're out of sequence. The limited information provided by this comparison only allows partial re-ordering of the values during each run of the FOR...NEXT loop.

```
LIST1000,1230
1000 REM                ******START OF BUBBLE SORT******
1010 REM VARIABLES:
1020 REM                    **INPUT**
1030 REM      A  - THE LINEAR ARRAY TO BE SORTED INTO
1040 REM           INCREASING ORDER
1050 REM      A0 - THE NUMBER OF ELEMENTS OF A
1060 REM                    **OUTPUT**
1070 REM      A  - THE SORTED ARRAY
1080 A2=INT(A0)+1
1090 IF A2<3 THEN 1220
1100 A3=0
1110 FOR A1=1 TO A2-2
1120 REM CHANGE < TO > FOR SORTING INTO DECREASING ORDER
1130 IF A(A1)<=A(A1+1) THEN 1190
1140 A3=A1+1
1150 REM SWITCH ELEMENTS
1160 A4=A(A1)
1170 A(A1)=A(A3)
1180 A(A3)=A4
1190 NEXT A1
1200 A2=A3
1210 GO TO 1090
1220 RETURN
1230 REM                ******END OF BUBBLE SORT******
```

Fig. 1. Simple Bubble Sort program.

*A previous TEKniques article (Vol. 2 No. 7) described the seven functions that the 4051R07 performs.

But suppose that the entire array could be searched, instead of comparing just two points in the array. The approach would be a more direct, logical series of steps:

1. Examine all the numbers until you find the biggest.

2. Put the biggest number at the end of the array (and save the old end number in the place where you found the biggest one).

3. Narrow your search as though the array is shorter by one number (don't again look at numbers you have sorted).

4. Go back to 1 and repeat until you have to search only one number—you're done.

That's closer to the way people sort numbers. For a collection of numbers (N of them) the process involves searching for the largest (or smallest) number only N-1 times.

Signal Processing ROM Pack #1-Enhanced Bubble Sort

With the "MIN" or "MAX" commands of the Signal Processing ROM Pack #1, you can sort numbers in the way just described. The sort program (Figure 2) replaces the one in Figure 1. Line 1110 determines whether the "MAX" or "MIN" command is used for ascending or descending sorting. The variable A1 always points to the last number in the array of unsorted numbers. The CALL Z$ A,V,I statement finds the largest (or smallest when Z$ = "MIN") number and its location, providing much stronger direction (more information) for the sorting operation. The limits of the search ("MAX" or "MIN" command) are decreased by one each time through the FOR...NEXT loop, by re-dimensioning the array. Only N-1 times through the loop sorts all N of the numbers.

The execution time is still proportional to N*N but only N (approximately) loops occur in BASIC. Searching for the largest number among N numeric values is delegated to the ROM Pack. That is, the loop contained in statements 1110 to 1190 in Figure 1 is replaced by the firmware in Figure 2 (statement 1140) with the resultant increase in speed. The 80 number numeric sort that took two minutes without the ROM Pack Function takes only *five seconds* using the "MAX" command of the ROM Pack.

Enhanced Bubble Sort vs. Quick Sort

For larger sizes of sorting problems a different routine is useful: the Quick sort. Such a routine is contained in the General Utilities Program Vol. 1 (4050A08). The Quick sort conquers the sorting problem by subdividing it which makes the execution time proportional to N $\log_{10}$ N instead of N*N. However, for smaller sorting tasks, the ROM Pack-assisted bubble sort is faster than even the Quick sort. Eventually its proportionality to N*N slows it down and the Quick sort algorithm becomes faster.

The table in Figure 3 compares the measured times for performing sorts on various numbers of values in the 4051. When approximately 1500 numbers are sorted, the Quick sort program from the General Utilities Vol. 1 pulls out in front.

```
LIS1000,1210
1000 REM                 **&&**START OF BUBBLE SORT**&&**
1010 REM  MODIFIED SORT IS DIRECTED BY SPS ROM PACK
1020 REM VARIABLES:
1030 REM                        **INPUT**
1040 REM      A  - THE LINEAR ARRAY TO BE SORTED INTO
1050 REM           INCREASING ORDER
1060 REM      A0 - THE NUMBER OF ELEMENTS OF A
1070 REM                        **OUTPUT**
1080 REM      A  - THE SORTED ARRAY
1090 A2=INT(A0)
1100 REM CHANGE "MAX" TO "MIN" FOR SORTING INTO DECREASING ORDER
1110 Z$="MAX"
1120 FOR A1=A2 TO 2 STEP -1
1130 DIM A(A1)
1140 CALL Z$,A,V,I
1150 A3=A(A1)
1160 A(A1)=V
1170 A(I)=A3
1180 NEXT A1
1190 DIM A(A2)
1200 RETURN
1210 REM              **&&**END OF SORT ROUTINE USING SPS #1**&&**
```

Fig. 2. Bubble Sort program modified to use 4051R07 ROM Pack.

For larger applications a 4052R07 Signal Processing ROM Pack #1 combined with the 4052 or 4054 provides a powerful tool. With the greater speed and larger memory nearly intractable problems become solvable. Figure 3 also compares a 4052R07-assisted bubble sort in the 4052 to a Quick sort in the same machine. The point at which the Quick sort method becomes faster than the simpler sorting program has moved to a new plateau (approximately 2400 points).

Thus, the versatility of the Signal Processing ROM Pack provides a new, easy-to-use, efficient alternative to the simple but slow bubble sort at the one extreme, and the powerful Quick sort algorithm at the other.

This is only one of many applications of the Signal Processing ROM Pack #1 that lies outside the realm of signal processing. We are interested in other applications that transcend the question of whether the data came from a DPO, 7912AD, other instrumentation, or no instrumentation at all. As we find them we'll report them. Let us hear of applications you may have found.

N (Number of Points)	4051 Bubble Sort (seconds)	4051+4051R07 Bubble Sort (seconds)	4052 Bubble Sort (seconds)	4052+4052R07 Bubble Sort (seconds)	4051 Quick Sort (seconds)	4052 Quick Sort (seconds)
50	45	3.1	10	too small	15	2.5
80	120	5.0	24	"	22	4.6
500	too long	90.0	995	14	202	45.0
1000	"	365.0	too long	46	450	85.0
2000	"	1199.0	"	165	990	192.0

Quick Sort Time = 4051R07 Time at N = 1500

Quick Sort Time = 4052R07 Time at N = 2400

Fig. 3. Execution time for sorting methods.

*Editor's Note

Programming Tip Exchange Continues

Have you found a small piece of programming information in the course of your work that you think others might find useful as well? We'd like to hear about it, and publish it for others as a Programming Tip or a Basic Bit. Send it in to the Applications Library. Any one of the following Applications Library Programs will be yours when it's published. Simply jot down a brief description of its function, the code, and your choice of program. Mail the information to the Applications Library address serving you; the addresses can be found at the back of each issue.

51/00-0101/0	51/00-5503/0
51/00-0702/0	51/00-7002/0
51/00-0715/0	51/00-8006/0
51/00-1401/0	51/00-9505/0
51/00-1402/0	51/00-9511/0
51/00-5401/0	51/00-9521/0

***Documentation and listing only.**

Your New Catalog is Here!

You'll notice that this issue of TEKniques is accompanied by a new Applications Library catalog. This catalog contains 40 new programs that have been added to the library since that last catalog. Look through it. Additional copies are available for the asking, from the Applications Library office serving you. The Applications Library staff thanks all of you who contributed to the Library, and made these additional programs available to others.

We're 4050 Series Now

Perhaps you've already noticed that, beginning with the last issue, we changed the name of our newsletter. We're now *TEKniques, the 4050 Series Applications Library Newsletter.* This change represents our support for the entire 4050 Series of Graphic Computing Systems. As more of you begin to use the 4052 and the 4054, we'll be featuring programs, programming tips, and applications articles that feature those devices as well as the 4051.

Program Prices are Changing

Beginning August 1, 1979, prices for Applications Library Programs will be increasing. The increase is the first since the Applications Library began, and represents increased material, labor and distribution costs. The new domestic prices are as follows:

Documentation and Listings	$20 per program
Recording Fee	5 per program
Tape Cartridge	30 per tape

Did You Miss an Issue?

The TEKniques office has copies of all previous issues of TEKniques available, for those of you who are new members or otherwise missed or lost an issue. If you'd like to receive a copy of any previous issue, just drop a line to the Applications Library address serving you. The addresses are located at the back of each TEKniques issue.

Space Shuttle Project Progresses

Bob Wheeler, whose 4051-aided space shuttle project was featured in TEKniques Vol. 3 No. 2, is going places with his project. At the Weber High School Regional Science Fair, Bob's project placed first in two categories: Math and Science Engineering Reporting, and Math and Engineering Projects. In doing so, he captured one of the four expense-paid trips to the General Motors Science and Engineering Fair held in San Antonio, May 7-16.

At San Antonio Bob placed fourth in the Math and Computers competition. As a result he will receive a trip to Jet Propulsion Laboratory at Pasadena in early July. This trip will coincide with the rendezvous of the unmanned spacecraft Voyager 2 and giant planet Jupiter on July 9, which event Bob will be able to observe on the deep space tracking network of JPL.

In addition, Bob will be taking his project on another outing. To commemorate the tenth anniversary of the first manned moon landing on July 21, 1969, NASA will be holding celebrations in two cities: Washington, D.C. and Salt Lake City. Bob has been asked to display his project along with other projects at the Hanson Planetarium in Salt Lake City and to meet with the astronauts who will be on hand for the festivities. Lunar Landers will be on display at the ZCMI Mall.

Programming Tips

More Updates on Flowcharter Program 51/00-8005/1

Shift Rubout NOT Ctrl Rubout

by Chester E. Fox, Jr.
Naval Research Laboratory
Washingtot, D.C.

Line 5080 of the newest version (lines 5170 or 5070 of older versions—see the update in TEKniques Vol. 2 No. 5) contains an error. The code looks okay on paper, however, the last character should be a SHIFT RUBOUT, not CTRL RUBOUT.

```
5080 B$=B$&"_"
```

Ed Note: *Unfortunately, we entered the wrong code when updating our master.*

Control Characters in IMAge Statements

by N.J.J. Ogbourne
Comalco Aluminum (Bell Bay) Limited
George Town, Tasmania

Control characters enclosed in literal string in IMAge statements are not "stripped;" e.g.,:

```
IMAGE "GHIJKL"
```

The following example shows code from the newest version of Flowcharter, along with code which corrects this oversight:

PRESENT CODE:

```
1440 GOSUB 2000
1450 P=POS(L$," ",1)+1
1460 C$=SEG(L$,P,3)
1470 C=(POS(A$,C$,1)+2)/3
1480 IF C<>1 OR POS(L$,"@",P)=0 THEN 1510
```

CHANGE TO:

```
1440 GOSUB 2000
1450 P=POS(L$," ",1)+1
1460 C$=SEG(L$,P,3)
1463 V=1
1470 C=POS(A$,C$,V)
1473 IF C=0 THEN 1478
1475 IF (C+2)/3=INT((C+2)/3) THEN 1478
1476 V=C+1
1477 GO TO 1470
1478 C=(C+2)/3
1480 IF C<>1 OR POS(L$,"@",P)=0 THEN 1510
```

4051 Drives Plotter Through RS-232

by Mark Mehall
Tektronix, Inc.
Chicago

4051-generated plots and drawings can be sent to any remote 4660 Series Plotter or 4010 Series Terminal over the Option 1 RS-232-C Interface. However, graphic data transmitted over the RS-232 Interface must address the Plotter surface coordinates, or the terminal screen coordinates, as binary numbers rather than graphic display units. Each coordinate is represented by a 12-bit binary number.* The 24-bits for the two coordinates are specified by transmitting five appropriate ASCII characters over the Interface; the ASCII value of each character contains a segment of the 24-bit pattern.

The first ASCII character determines the five most significant bits of the Y coordinate (HIY). The second character specifies the two least significant bits of Y and the two least significant bits of X (XLOY). The third ASCII character specifies the five intermediate bits of the Y coordinate (LOY). The last two ASCII characters determine the five most significant bits of X (HIX) and the five intermediate bits of X (LOX), respectively.

Converting GDU to Binary

The following routine reads X, Y, Z data points from magnetic tape, converts them into "equivalent" RS-232-compatible ASCII characters and transmits the ASCII string to the Plotter or terminal in BASIC I/O mode. The data points must be in the following form: Z = 20 or 21 (DRAW or MOVE), X = 0 through 130, and Y = 0 through 100. In this case, the Plotter aspect ratio corresponds to that of the 4010-series terminals (Switch A = 6).

Statement 130 defines the modulus function used to segment the binary coordinates into ASCII characters. Statement 160 initiates the GS control character (ASCII

*Shortened addressing may be used; see page 2-26 of the 4662 Interactive Digital Plotter User's manual.

29) which places the Plotter in Graph Mode. Next, the X and Y data from tape are converted to binary coordinates (statements 230 and 240). Since we're using the COPY setting (Switch A = 6), the Plotter X-axis runs from 0 to 4095 and the Y-axis from 0 to 3124.

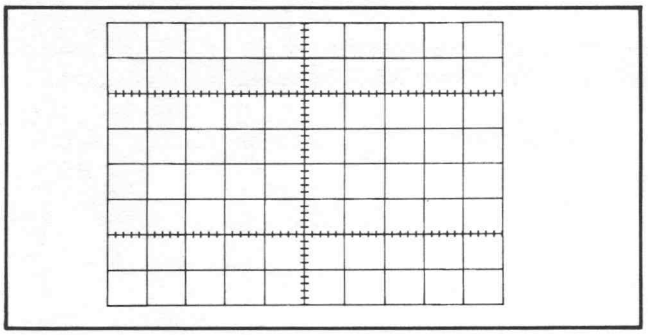
Statement 280 segments the HIY bit pattern. Bits six and seven of each of the five bytes remain fixed; that is, in the HIY byte, bit six is always on, thus, we add 32. The resulting eight-bit pattern is translated into the appropriate ASCII character (statement 290), and added to the outgoing string (statement 300). The other four bytes (XLOY, LOY, HIX and LOX) are segmented, bits six and seven modified, and translated into ASCII characters for transmission over the RS-232 (statements 310 through 540).

Z is now checked to determine whether it's a MOVE or DRAW operation. If it's a DRAW, just the coordinates are sent, since the Plotter assumes a DRAW if no GS control character precedes them. If it's a MOVE, the GS control character is included at the beginning of the string. (Note the first command must include a GS control character to place the Plotter in Graph Mode. Therefore the first string is forced to a MOVE operation in statement 180.)

After the data is transmitted, the string is set to null; the next data is then read from the tape and processed.

```
100 REM FNM IS THE MODULUS FUNCTION
110 REM WHERE MOD(A1,A2)=A1-SGN(X)*IXI*A2
120 REM WHERE X=A1/A2
130 DEF FNM(N)=INT(N-SGN(N/A2)*INT(N/A2)*A2)
140 DIM O$(8)
150 REM SET G$ TO A GS (ADE 29)
160 G$=CHR(29)
170 REM SET O$ (OUTPUT STRING) TO A GS (G$)
180 O$=G$
190 ON EOF (0) THEN 630
200 REM READ THE DATA FROM TAPE
210 INPUT @33:Z,X,Y
220 REM CONVERT TO 0-4095(X) AND 0-3124(Y)
230 X=X/131*4095
240 Y=Y/100*3124
250 REM CALCULATE FIRST CHARACTER
260 REM ICHAR(1)=MOD(KY/128,32)+32 (HIY)
270 A2=32
280 I1=FNM(Y/128)+32
290 I$=CHR(I1)
300 O$=O$&I$
310 REM CALCULATE SECOND CHARACTER (XLOY)
320 REM ICHAR(2)=MOD(KY),4)*4+MOD(KX,4)+96
330 A2=4
340 I2=FNM(Y)*4+FNM(X)+96
350 I$=CHR(I2)
360 O$=O$&I$
370 REM CALCULATE THIRD CHARACTER (LOY)
380 REM ICHAR(3)=MOD(KY/4,32)+96
390 A2=32
400 I3=FNM(Y/4)+96
410 I$=CHR(I3)
420 O$=O$&I$
430 REM CALCULATE FOURTH CHARACTER (HIX)
440 REM ICHAR(4)=MOD(KX/128,32)+32
450 A2=32
460 I4=FNM(X/128)+32
470 I$=CHR(I4)
480 O$=O$&I$
490 REM CALCULATE FIFTH CHARACTER (LOX)
500 REM ICHAR(5)=MOD(KX/4,32)+64
510 A2=32
520 I5=FNM(X/4)+64
530 I$=CHR(I5)
540 O$=O$&I$
550 REM IF Z IS 21 IT'S A MOVE (20 IS A DRAW)
560 IF Z=20 THEN 640
570 REM CHECK IF A MOVE, IF SO INSERT A GS (G$)
580 O$=REP(G$,1,0)
590 REM OUTPUT THE CHARACTER
600 PRINT @40:O$;
610 O$=""
620 GO TO 210
630 PRINT "DONE."
640 END
```

Page 2-25 of the 4662 Interactive Digital Plotter Users manual graphically depicts the binary coordinate values.



4051-size standard graticule.

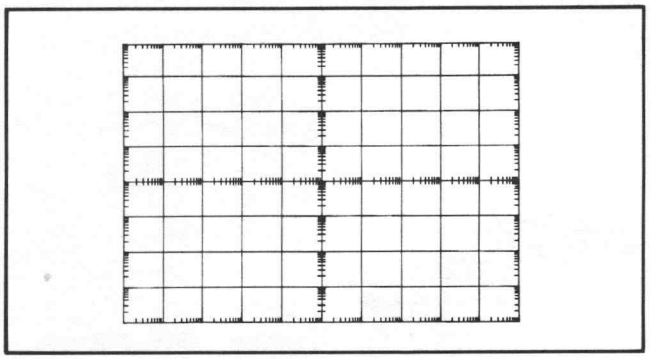
Reproducing Oscilloscope Graticules on the 4051

When you're examining waveform data graphed on the 4051 screen*, it helps to have a reference grid. The following subroutine developed by Nathan Oxhandler of Tektronix, draws oscilloscope-type graticules on the 4051 screen, or on any 4051 GPIB-controllable display device. Five different grids are available: standard, linear-log, log-linear, log-log and plain.

```
1 INIT
2 PAGE
3 GO TO 100
4 GO TO 9000
5 RETURN
100 O=32
110 STOP
8999 REM SUBROUTINE STARTS HERE
9000 PAGE
9010 PRINT "WHICH GRATICULE DO YOU WANT? 0ISTANDARD,1IX LINEAR,Y LOG"
9020 PRINT "2IX LOG,Y LINEAR,3IX LOG,Y LOG,4IPLAIN";I1I@";
9030 INPUT A0
9040 WINDOW 0,100,10,90
9050 VIEWPORT 2.5,127.5,0,100
9060 PAGE @0:
9070 FOR A=0 TO 100 STEP 10
9080 IF A0=0 AND (A=30 OR A=70) THEN 9150
9090 IF A0=1 AND (A=10 OR A=50 OR A=90) THEN 9150
9100 IF A0=0 AND A=50 OR (A0=2 AND (A=0 OR A=50 OR A=100)) THEN 9170
9110 AXIS @0:0,0,A,A
9120 NEXT A
9130 GO TO A0 OF 9190,9190,9190,9140
9140 RETURN
9150 AXIS @0:2,0,A,A
9160 NEXT A
9170 AXIS @0:0.2,A,A
9180 NEXT A
9190 FOR A=0 TO 9
9200 FOR B=2 TO 9
9210 C=10*LGT(B*10^A)
9220 GO TO A0 OF 9270,9230,9270
9230 GO TO A0 OF 9240,9340,9340
9240 NEXT B
9250 NEXT A
9260 RETURN
9270 MOVE @0:0,C
9280 DRAW @0:1,C
9290 MOVE @0:49,C
9300 DRAW @0:51,C
9310 MOVE @0:99,C
9320 DRAW @0:100,C
9330 GO TO 9230
9340 MOVE @0:C,10
9350 DRAW @0:C,11
9360 MOVE @0:C,49
9370 DRAW @0:C,51
9380 MOVE @0:C,89
9390 DRAW @0:C,90
9400 GO TO 9240
```

A subroutine to produce five different 4051-size graticules.

Remember the CTRL Rubout (CHR 13) in statements 9010 and 9020 format only the 4051 Graphic Screen; they are disregarded if sent to any peripheral.



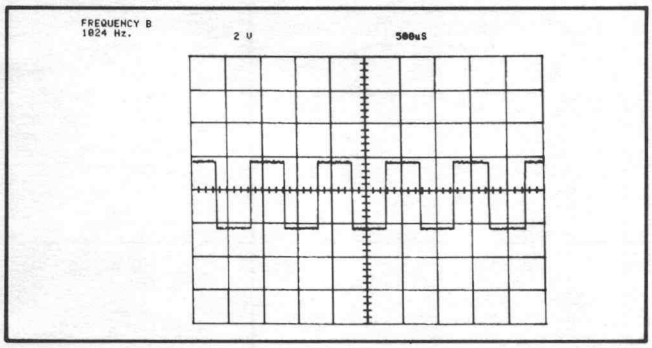
4051-size log-log graticule.

While the above routine draws a 4051 screen-size grid, the following routine offered by Dick Bailey, Tektronix, duplicates the Tektronix 7000 Series Oscilloscope graticule.

```
LIS300,450
300 REM  <DRAW GRATICULE>
305 PAGE
310 VIEWPORT 30,130,10,90
320 WINDOW 0,511,101.4,920.6
330 MOVE 0,101.4
340 DRAW 511,101.4
350 DRAW 511,920.6
360 DRAW 0,920.6
370 DRAW 0,101.4
380 AXIS 10.24,20.48,255,511
390 FOR I=1 TO 9
400 AXIS 0,0,I*51.2,I*102.4+101.4
410 NEXT I
420 VIEWPORT 30,130,0,100
430 WINDOW 0,511,0,1023
440 HOME
450 RETURN
```

A routine to draw the Tektronix 7000 Series graticule.

Incorporate either of these routines into your graphing program and you'll have a quick reference grid for your signals.



The Tektronix 7000 Series graticule.

**See "The 4051/9712AD: An Automatic Waveform Acquisition System," and "New ROM Pack—Adds Fast Graphing and Data Analysis Functions to the 4051," TEKniques Vol. 2 No. 7.*

Don't CALL "MOUNT" With Null String

by Pat Kelley
Tektronix, Inc.

The CALL "MOUNT" command always generates a device status message. A target string variable must be specified in the command to receive this message. Inadvertently, the 4907 File Manager Operator's Manual indicated that to save time the message could be eliminated by specifying a null string rather than a target string variable. To save time, you don't need to look at the message, but it is always generated and must have a target string to receive it.

```
CALL "MOUNT",0,A$
              ↑
              └── Target String
```

Easy Curves

by Howard Sanders
Tektronix, Inc.

You can draw any length of curve ranging from brief arcs to full circles using the following routine. Simply position and digitize the three points of the arc in a **counterclockwise** sequence using the 4952 Option 1 Joystick. The 4051 will draw a smooth curve through these points. The coordinates developed in statement 1000 could be stored in a matrix and saved on tape for future use.

```
100 REM SUBROUTINE TO CALCULATE
110 REM AN ARC FROM THREE POINTS
120 INIT
130 SET DEGREES
140 POINTER X1,Y1,A$
150 MOVE X1,Y1
160 RDRAW 0,0
170 POINTER X2,Y2,B$
180 MOVE X2,Y2
190 RDRAW 0,0
200 POINTER X3,Y3,B$
210 MOVE X3,Y3
220 RDRAW 0,0
230 A1=0
240 B1=0
250 A2=X2-X1
260 B2=Y2-Y1
270 A3=X3-X1
280 B3=Y3-Y1
290 REM  ROTATE POINT 2 UNTIL ON THE Y AXIS
300 IF A2=0 THEN 330
310 D1=ATN(B2/A2)
320 GO TO 340
330 D1=-90
340 D2=90-D1
350 IF D1=0 THEN 380
360 B2=B2/SIN(D1)
370 GO TO 390
380 B2=A2
390 A2=0
400 REM ROTATE 3RD POINT
410 IF A3=0 THEN 440
420 D3=ATN(B3/A3)
430 GO TO 450
440 D3=-90
450 C3=B3/SIN(D3)
460 D3=D3+D2
470 B3=SIN(D3)*C3
480 A3=COS(D3)*C3
500 REM CALCULATE THE RADIUS OF THE ARC
510 K=B2/2
520 H=(A3*A3+B3*B3-2*K*B3)/(2*A3)
530 R=SQR(H*H+K*K)
540 REM   SET THE CENTER OF ARC TO 0,0
550 A1=A1-H
560 B1=B1-K
570 A2=A2-H
580 B2=B2-K
590 A3=A3-H
600 B3=B3-K
610 REM  FIND THE CENTER OF THE ARC
620 C1=-A1
630 C2=-B1
640 D4=ATN(C2/C1)
650 D5=C2/SIN(D4)
660 D6=D4-D2
670 C1=COS(D6)*D5
680 C2=SIN(D6)*D5
690 E1=C1+X1
700 E2=C2+Y1
710 REM   BEGINING AND END ANGLES OF ARC
720 Z1=ATN((Y1-E2)/(X1-E1))
730 Z2=ATN((Y3-E2)/(X3-E1))
740 Z1=INT(Z1)
750 Z2=INT(Z2)
760 IF Y1-E2>0 AND X1-E1<0 THEN 800
770 IF Y1-E2<0 AND X1-E1<0 THEN 820
780 IF Y1-E2<0 AND X1-E1>0 THEN 840
790 GO TO 850
800 Z1=Z1+180
810 GO TO 850
820 Z1=Z1+180
830 GO TO 850
840 Z1=360+Z1
850 IF Y3-E2>0 AND X3-E1<0 THEN 890
860 IF Y3-E2<0 AND X3-E1<0 THEN 910
870 IF Y3-E2<0 AND X3-E1>0 THEN 930
880 GO TO 940
890 Z2=Z2+180
900 GO TO 940
910 Z2=Z2+180
920 GO TO 940
930 Z2=360+Z2
940 IF Z1>Z2 THEN 960
950 GO TO 970
960 Z1=Z1-360
970 REM DRAW THE ARC
980 MOVE X1,Y1
990 FOR I=Z1 TO Z2 STEP 2
1000 DRAW E1+COS(I)*R,E2+SIN(I)*R
1010 NEXT I
1020 DRAW X3,Y3
```

The possibility that any of the three points digitized will be identical is extremely remote. Hence, to save code error checks have been omitted. However, if it should occur, a size dimension error will be generated.

Specifying Optimum Number of Directory Chains in Disc Format

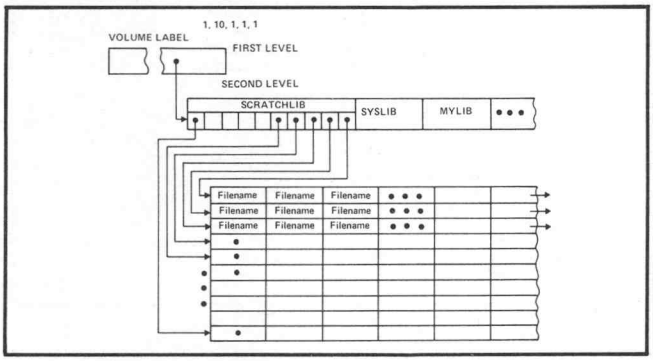
by Jack Gilmore
Tektronix, Inc.

The five digit sequence at the end of CALL "FORMAT" and CALL "FFRMT" commands controls how the file directory is stored on the disc and affects the access time to a file name. Five storage levels are possible on a disc with no limit to the number of libraries or files on each level (other than disc space).[1]

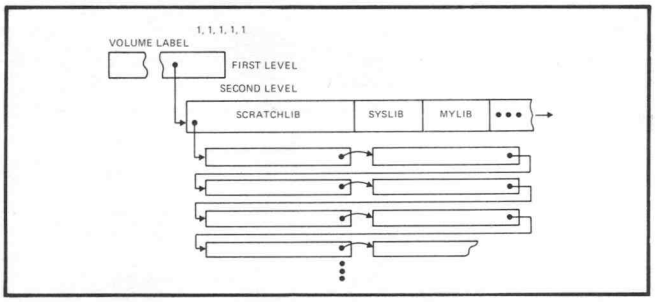
Each level may have one to ten "chains." A chain is a sequential listing of library and file names. If there is more than one chain on a level, hashing decides in which chain the name is placed. Therefore, access time to a file is decreased as the number of chains are increased since the File Manager is routed through the proper chain and doesn't have to search all names on that level.

The five digits at the end of the two format commands specify the number of chains at each level. And the number of directory chains at each level should be determined by the number of library names or file names expected at each level. A general rule of thumb is to divide the number of file names at each level by five to arrive at the appropriate number of chains for that level.[2] For example, a disc with mostly two level names such as heavy use of SCRATCHLIB with over 50 file names should be formatted with these five digits as "1,10,1,1,1" rather than "1,1,1,1,1." On the average, one fifth as many disc reads would be required to access a particular file in the first example.

A diagram of the two chaining structures with 50 files in SCRATCHLIB follows. In the first example, the proper sector is accessed immediately by hashing the file name to determine which chain to follow.[3] The second example may require reading 10 sectors to find the right name.



Example 1. Chaining routes when the last five digits in CALL "FORMAT" or CALL "FFRMT" are 1,10,1,1,1.



Example 2. Chaining route when the last five digits in CALL "FORMAT" or CALL "FFRMT" are 1,1,1,1,1.

---

[1] The fifth storage level may contain only file names.

[2] Maximum number of chains per level is 10.

[3] Five library or file names fit into one sector of disc space.

Basic Bits

RETURN Recovers Memory

by Pat Kelley
Tektronix, Inc.

Branching out of a FOR/NEXT loop in a subroutine will not limit memory, provided the subroutine is exited through a RETURN statement. When the RETURN command is executed, the 26 bytes of memory dynamically allocated to keep track of a FOR/NEXT loop will be freed. The following example illustrates the recovery of memory.

```
LIST
100 INIT
110 PRINT MEMORY
120 GOSUB 500
130 PRINT MEMORY
140 END
500 G=0
510 FOR I=1 TO 10
520 G=G+1
530 IF G=5 THEN 550
540 NEXT I
550 PRINT MEMORY
560 RETURN

RUN
 30505
 30473
 30505
```

Notice that the six bytes allocated to store the return address are also freed.

4050 Series Applications Library Program Abstracts

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Documentation and program listings of each program are available for a nominal charge. Programs will be put on tape for a small recording fee per program plus the charge for the tape cartridge. One tape will hold several programs. (The program material contained herein is supplied without warranty or representation of any kind. Tektronix, Inc. assumes no reponsibility and shall have no liability, consequential or otherwise, of any kind arising from the use of this program material or any part thereof.)

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Program contributions or orders outside the U.S. must be processed through the local Tektronix sales office or sent to one of the Libraries serving your area. See Library Addresses section.

ABSTRACT NUMBER: 51/00-1604/0

Title: **Analysis Of A Proving Ring Calibration**
Author: Colin MacKenzie
National Research Council
Ottawa, Ontario, CANADA
Memory Requirement: 32K
Peripherals: 4631 Hard Copy Unit
4662 Plotter
4051R05 Binary ROM Pack
Statements: 654
Files: 2 Binary Program
1 Binary Data

The program takes data obtained during calibration of a proving ring (applied load, initial zero reading, reading at load, final zero reading and temperature, taken in increments of approximately ten percent of capacity load in three independent runs of ten loadings) and derives an analytical expression for the calibration as a second degree polynominal in load, relating load to deflection for the standard temperature of 23°C. From this expression, calibration tables, relating deflection in divisions to load in pounds-force and newtons, are computed.

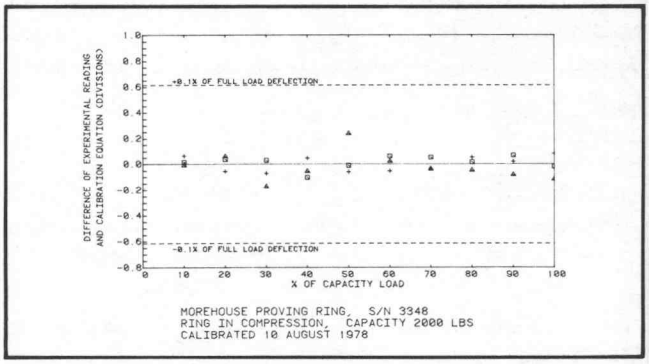
Also produced by this program are:

1. A graph of the difference of experimental readings and calibration equation versus percent of capacity load.

2. A calibration information page which could be included along with the calibration tables and graph in a report of the calibration.

3. The following tables:

   a. Input data
   b. Corrected and average deflections
   c. Experimental calibration factor
   d. Experimental deviations
   e. Fitted deflection compared with average observed deflection
   f. Observed deflection minus fitted deflection
   g. Deviations from average and standard deviations
   h. Mean temperature, sum of squares of deviations, standard deviations and uncertainties

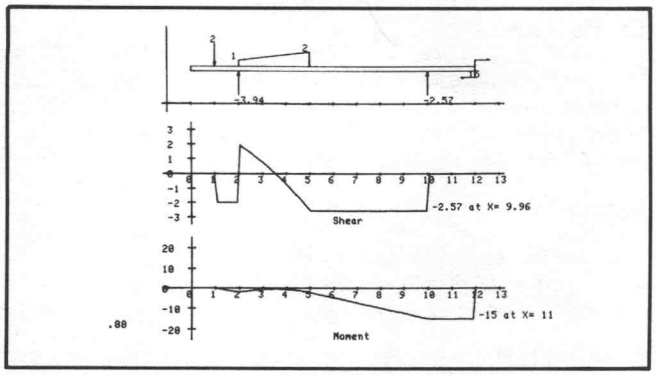


ABSTRACT NUMBER: 51/00-1605/0

Title: **Shear and Moment Diagrams for Determinate Beams**
Author: David Q. Fletcher
University of the Pacific
Stockton, CA
Memory Requirement: 24K
Peripherals: Optional—4631 Hard Copy Unit
Statements: 237
Files: 1 ASCII Program

The program accepts beam loading information in the form of magnitudes and locations of concentrated loads, distributed loads (uniform or linearly varying) and concentrated moments. It computes reactions and then displays a beam loading diagram and plots moment and shear diagrams. Any statically determinate beam can be

analyzed. In addition the magnitude and location of the absolute maximum values of shear and moment are given.



ABSTRACT NUMBER: 51/00-4002/0

Title: **Blood Pressure Evaluation and Patient Data with Statistical Analysis**
Memory Requirement: 32K
Peripherals: Optional—4051R05 Binary Loader
Optional—4631 Hard Copy Unit
Files: 1 Program (ASCII or Binary)
1 Patient Data Tape (dedicated)
1 Stat 4 Data Tape

Although this program was custom designed for a particular hospital, it serves as a pattern for other medical users. The graphically-aided data entry for blood pressure readings and TcP02 readings is unique. It's user-oriented with all data entry initiated through User-Definable Keys.

The user keys in patient data:

Name	Sex
Record Number	Diabetic
Age	Smoker
PVES #	Standard Blood Pressure

Next a diagram of the lower torso guides blood pressure and TcP02 readings. These readings and the ratio of normal blood pressure to actual are displayed on the screen.

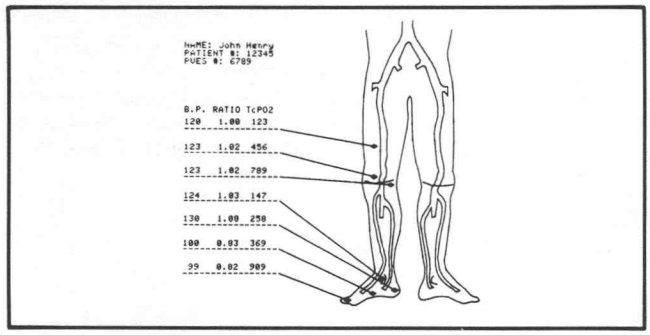
Then the patient's history is keyed in:

Influencing Drugs
Pertinent Laboratory Data
Operative Procedures
Outcome of Operative Procedures
Doppler Flow
Pre or Post

The program combines all of the data into one string and writes it to a patient data tape. Data for up to 240 patients may reside on one tape. A routine will select two data items from each patient file and write these items to another data tape in a format for use with Statistics Volume 4. In this case, the Linear Regression program analyzed sets of data.

The first file on the patient data tape contains the number of full data files on the tape, and an index into the files by patient record number.

Although no routines for data correction or special searching are provided, with the index already in place, it would be relatively simple to insert.



ABSTRACT NUMBER: 51/00-5405/0

Title: **Polarized Light**
Author: Pilwon Kang
Hood College
Frederick, MD
Memory Requirement: 8K
Peripherals: Optional—4631 Hard Copy Unit
Statements: 384
Files: 3 ASCII Program

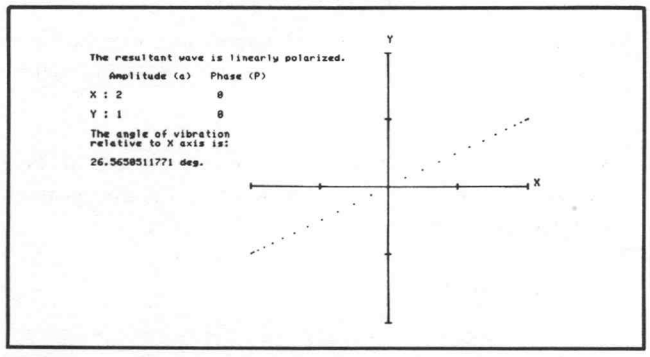
The program performs some of the fundamental calculations frequently encountered in the analysis of polarized light. The program is written in three parts, to fit into 8K of memory.

File 1—Plots the vibration pattern of light, when you specify the nature of polarization.

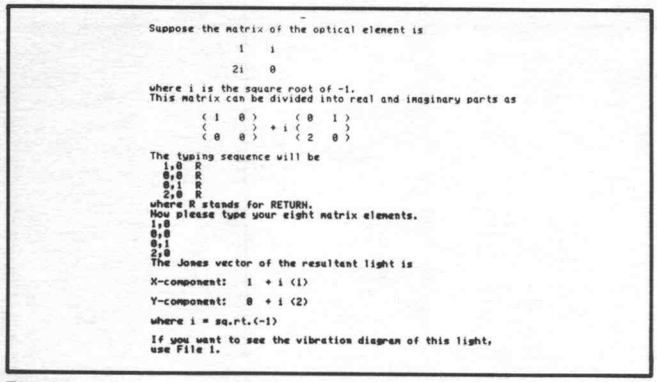
File 2—Calculates the parameters of the resultant light if polarized light is passed through a specified optical element.

File 3—Obtains the following:

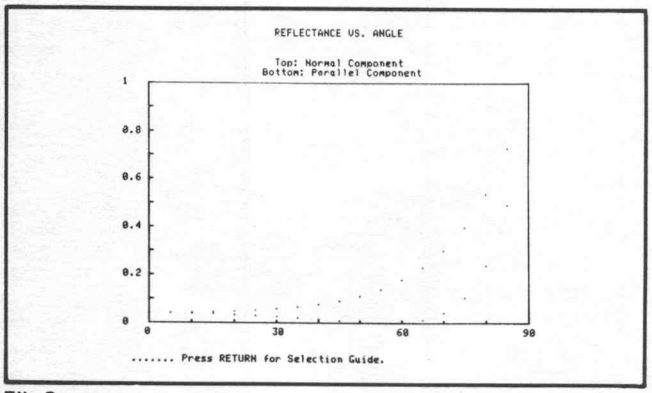
1. The values of the reflection coefficient and reflectance.
2. The Jones matrix of the reflected light.
3. A plot of the reflectance as a function of the angle of incidence.



File 1



File 2



File 3

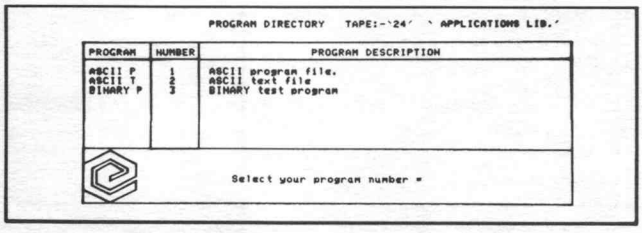
ABSTRACT NUMBER: 51/00-8026/0

Title: **Tape Directory**
Author: Nick Ogbourne
Comalco Aluminium Ltd.
Tasmania, Australia
Memory Requirement: 8K
Peripherals: None
Statements: 92
Files: 1 ASCII Program
1 ASCII Text

The program, located as the first ASCII program file on a tape, operates using the AUTOLOAD, provides a tape 'directory', multipage if necessary, and controls access to, and execution of any required program files.

An 'index' is maintained in file 2 (ASCII) which provides file number, program name and program description to the 'directory' program.

It is not necessary to specify to the directory the type of the program (ASCII or Binary). Programs not required to be accessed by the directory, data files and text files may be recorded in file 2, providing a rapid means of 'TLIST'ing a tape.

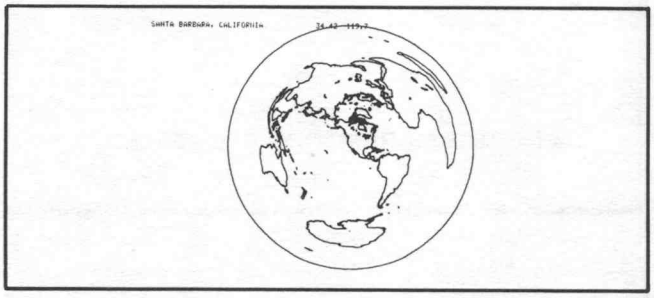


ABSTRACT NUMBER: 51/00-9532/0

Title: **Azimuthal Equidistant Projection**
Author: W. Tobler
University of California
Memory Requirement: 16K
Peripherals: 4631 Hard Copy Unit or
4661 Plotter
Statements: 318
Files: 1 ASCII Program
1 Binary Data

The program draws maps of the world centered at any origin. Great circle distances and azimuths to all places are correct from the map center. The image of the geographic graticule and/or the world coastal outlines (included on tape) can be plotted.

If the map is drawn on the plotter the program can also label places on the map, and prepares a small legend identifying the center of the map. The North and South poles are identified with N and S.

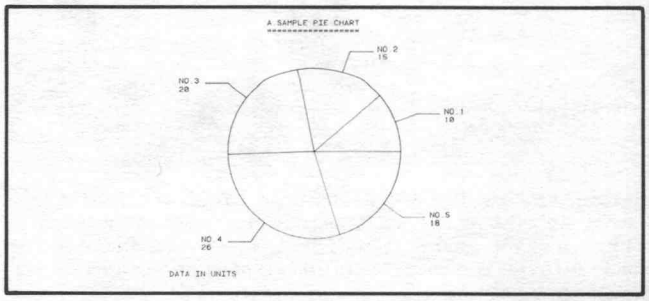


ABSTRACT NUMBER: 51/00-9533/0

Title: **Pie Chart Routine**
Author: Herman D'Hondt
Tektronix Australia
Memory Requirement: 8K
Peripherals: Optional—4631 Hard Copy Unit
Optional—4662 Plotter
Statements: 171
Files: 1 ASCII Program

The program will draw a pie chart diagram of data entered from the keyboard or from tape. The output shows a title, a subtitle and the pie chart with label and data values for each pie. Output may be to the 4631 Hard Copy Unit or to the 4662 Plotter.

Data values may be added or edited, using the User-Definable Keys.



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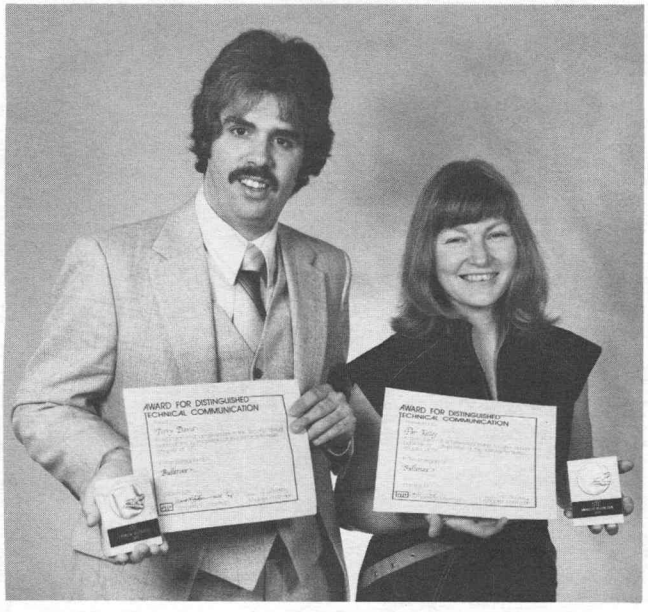

Pictured here are Pat Kelley, Managing Editor, and Terry Davis, Editor, with the Awards of Distinction they received on behalf of TEKniques. The awards resulted from a communications contest sponsored by the Willamette Valley Chapter of the Society for Technical Communication.

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