Tekniques

The 4050 Series Applications Library Newsletter March 15, 1980 Vol. 4. No. 2

Whether it's trolling, start-stop fishing, or auxilliary power for a sailboat, each requires a different motor-propeller combination. And Shakespeare of Arkansas, Inc. employs the 4051 to optimize the motor-propeller design and fit.

Electric Outboard Motors Optimized Through Intelligence of 4051

by Les Weaver
Shakespeare of Arkansas, Inc.
Fayetteville, AR
with Patricia Kelley
TEKniques Staff

Improving the paddle for those who would move a boat is the objective of Shakespeare of Arkansas, Inc. In this case the paddle is an electric outboard motor and propeller, and matching the propeller to the motor is the key to optimum performance.

From the Water Up

Propeller design is a balance among several variables of form including blade number, diameter, pitch, area distribution, foil, skew, and others, with consideration for material strength. A propeller which provides maximum thrust for the available shaft power is a design objective. The propellers in Figure 1 illustrate differences in design for varying shaft power.

Motor design is a similar balance among several variables in the conversion of the D.C. power to mechanical shaft power, within available energy levels provided by the familiar lead-acid battery.

Propellers tend to be more efficient in converting shaft power to thrust at low shaft speeds, whereas motors tend to be more efficient in converting D.C. power to shaft power at high shaft speeds. This is the principle trade-off in combining motors and propellers.

Shakespeare's electric outboard motors use fractional horsepower permanent magnet motors with housings designed especially for submerged operation.

A range of motor sizes is included in our product line to permit the boat owner to suit his needs exactly. A motor may be used for primary propulsion for canoes and light boats, it may be used as a "trolling" motor or start-stop as a fishing motor, and as auxiliary power for sailboats, party barges and small craft of all types.

A different performance level for each application has in the past been provided by modifying the motor design to drive a propeller at selected points over a wide range of its thrust/speed curve. As the need developed in the market for more efficient motor-propeller combinations at higher levels of performance, it became necessary to deal with motor and propeller designs independently and with greater flexibility.

Designing the System

The 4051 Graphic System is the hub of Shakespeare's product development system.

Tekniques

In This Issue

TEKniques, the 4050 Series Applications Library Newsletter, is published by the Information Display Division of Tektronix, Inc., Group 451, P.O. Box 500, Beaverton, Oregon 97077. It is distributed to TEKTRONIX 4050 Series users and members of the 4050 Series Applications Library.

Publishing Manager	Mark Mehall
Managing Editor	Patricia Kelley
Editor	Terence Davis
Technical Editor	Dan Taylor
Graphic Design	John Ellis
Circulation	Rory Gugliotta

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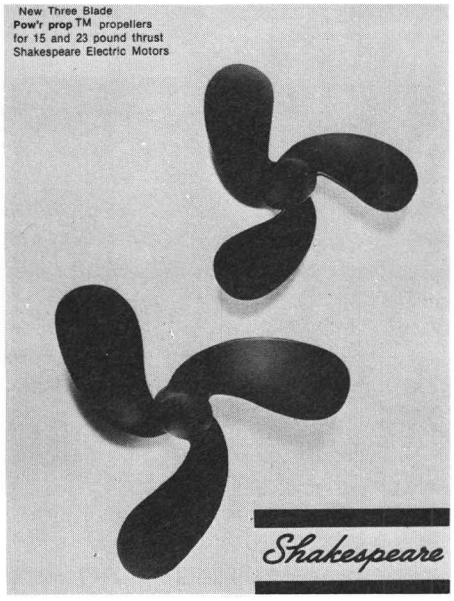


Fig. 1.

In order to benchmark the state of the technology in electric outboard motors, the 4051 has been configured for data acquisition using the RS-232 Option 1 Interface with an Esterline-Angus PD-2064. Sensor signals representing the variables of the outboard motor during operation in a test tank are logged through the PD-2064 into the 4051 as data files, called performance "profiles". Several variables such as voltages, current, thrust, RPM, temperatures, and so on, may be observed graphically in comparison with any other variable, including time during the duration of a test. These profiles may include up to fifteen recorded variables as a time log of any duration.

Permanent files on mag tape permit future analysis in comparison with performance profiles of other outboard motors. Multicolor graphs and transparencies are directly available from the 4662 Digital Plotter.

A similar arrangement for the 4051 in the data acquisition mode is used to evaluate permanent magnet motors on a dynamometer. Exercising a motor on the dyno allows Shakespeare engineers to determine optimum load points for motors of various designs.

A third application in data acquisition is used to determine the load characteristics of propellers back in the test tank using a motor whose performance has been calibrated on the dyno. Overlays of plots of prop load lines with motor load lines permit a quick balance to be struck in selecting appropriate motor-propeller combinations for production.

But, the real forte of the 4051 in Shakespeare's product development is its usefulness in the design and machining of propellers. Coupled with Facit paper tape equipment on the GPIB we are able to cut complex blade geometry directly in metal from the mathematical equations of blade form under numerical control. The equations of blade form completely define the surfaces of the blade. The program, called NCPROP, required interactive interpretation of equations with graphics for rapid development of functions for chord length, blade thickness, skew, etc.

An equation used to define the blade element hydrofoil function was obtained using the 4662 to digitize the shape of a scaled air foil taken from an NACA Technical Bulletin (Figure 2). The shape was then quickly and accurately approximated by adjusting the coefficients of a polynomial modifier on the n-leaf rose equation using graphic iteration on the screen.

Cutting tool motions are computed and stored on mag tape as an isometric presentation of the prop and associated tool positions appear on the screen. The instructions are computed in the format of a production 3-axis N/C milling machine with the cutting pattern and feed rates distributed for maximum accuracy and metal removal rate. "If the picture looks good" the mag tape instructions are transferred over the GPIB to paper tape which is then read and verified.

Approximately 10,000 cutting tool motions on each face of each blade provide a 6-inch diameter prop ready for polishing and test. Families of propellers with singular varia-

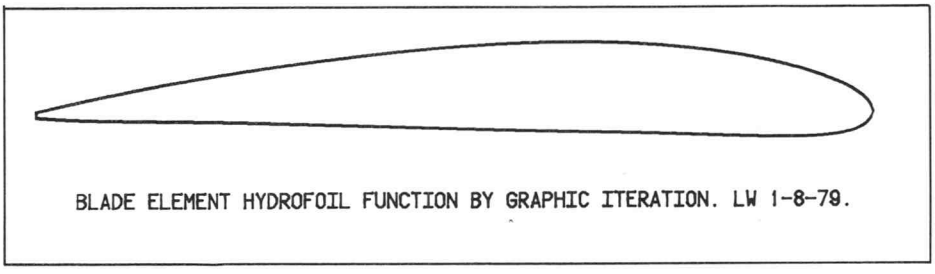


Fig. 2.

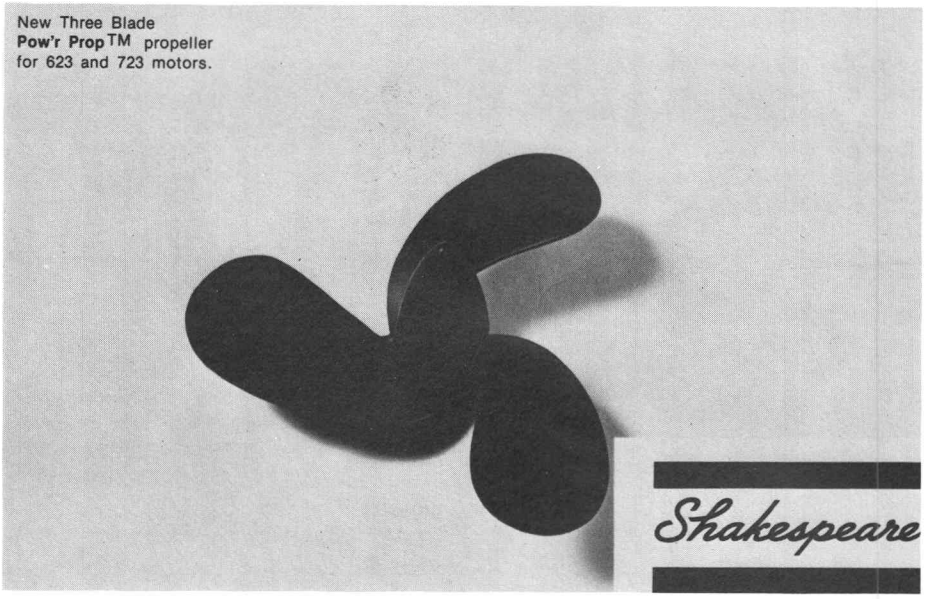
tion have been evaluated for effects of blade geometry on performance. A given geometry may of course be duplicated as often as necessary for field test. A propeller selected for production is traced in steel to provide injection molding dies for production quantities.

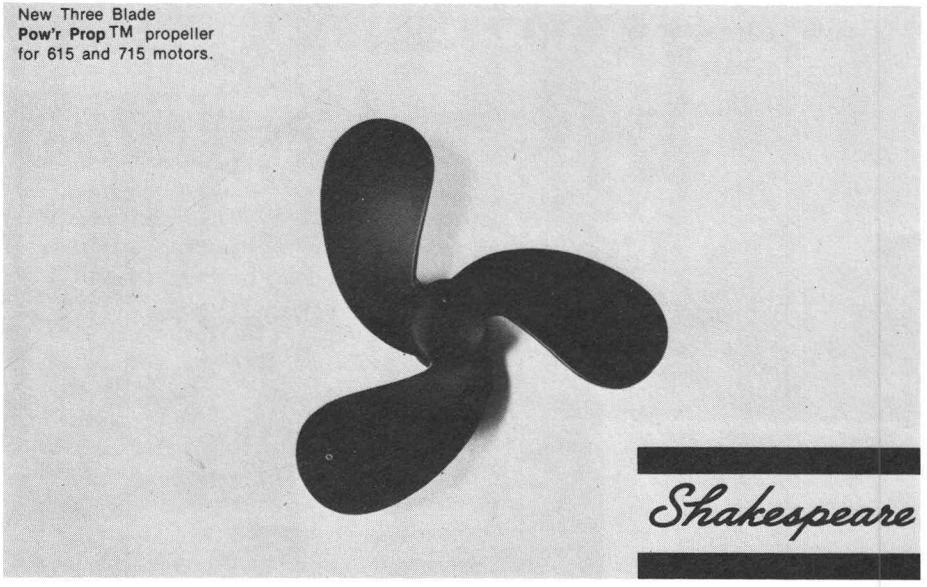
The Result

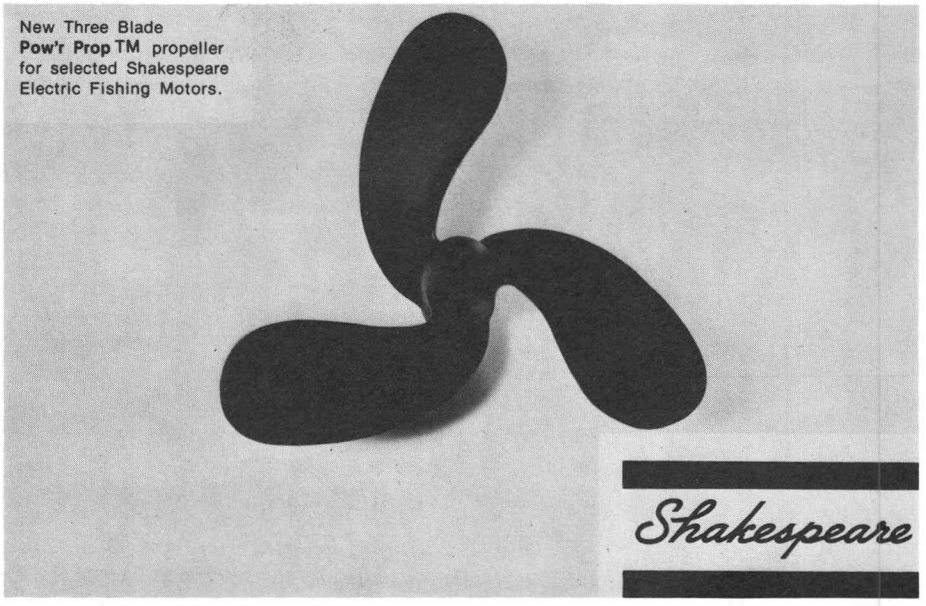
Shakespeare engineers have set out to build the best electric outboard motors possible with today's technology. Thanks to the application of the Tektronix 4051 Graphic System in their development program, each outboard motor in Shakespeare's line is being offered as a balanced propulsion system with optimum performance. The two new high performance models 615 and 623 with matching three blade propellers introduced this year are the direct result of this application.

Editor's Note:

The enthusiasm of Dave Watts, Tektronix Sales Engineer in Oklahoma City, for Shakespeare's unique application prompted TEKniques to contact Les Weaver, Engineering Manager at Shakespeare. Les graciously agreed to tell us how they're using the 4051. (All photographs courtesy of Shakespeare, Inc.)







A sampling of the variety of propellers designed by Shakespeare for their motors.

SUCCESSFUL BUSINESS SCHEDULING WITH THE 4051

by G. W. Allman and J. H. Bottom

American Enka Company
Enka, NC

American Enka is a nationally recognized manufacturer of man-made yarns and fibers, with a manufacturing lineage that goes back almost to the birth of the synthetic fibers industry. The company was started in 1929 by Algemene Kunstzigde Unie N.V. (AKU) of Holland, one of the world's first and largest man-made fiber and yarn producers. Enka's first product was rayon; fiber and yarn products now include nylon, polyester, rayon, and polypropylene fibrillated film.

Enka has grown from its beginnings in Enka, North Carolina, to occupy three manufacturing sites in the Southern Appalachian Region. Others include the Lowland site in the TVA lakes region, near Knoxville in east Tennessee, and the Clemson site in the foothills of northwest South Carolina. Like many companies that locate away from the big-city beaten path, these pastoral settings belie the nature of the business conducted at these sites. And like all companies entering the 80's, Amerinca Enka's business environment requires better data, faster decisions, and more efficiency throughout the development of company projects. To reach those ends, American Enka is relying on the 4051 Graphic System and a scheduling software package supplied by the Sheppard Software Company.

The 4051-based scheduling system has considerably improved the planning and scheduling of projects at American Enka. The system, with its purchased software package, has been used on plant construction projects, new heavy equipment installations, and the like, since April, 1979. It has promoted timely completion of company projects, as well as a fast method of project planning and control. But to best understand the nature of these improvements, some background is helpful.

The Nature of the Problem

Today's business environment demands more efficient engineering and construction, along with more accurate cost and time control throughout all project activities, if a company is to survive and grow. It was determined that the planning and scheduling of resources was a prime area to increase project efficiency, provided that the control could be accomplished in a timely and economical manner.

Investigation into the most well-known methods of scheduling, such as PERT, GANTT, and CPM, revealed deficiencies in all of them. For example, the GANTT Chart or Bar Chart indicates work activities, shown on a time frame annotated with starts, stops, and activity durations. But they don't clearly show the critical path, or the dependency of one activity on the completion of another. CPM and PERT systems do indicate this dependency and critical path, but don't display the activity on a time-frame that can be readily understood without additional calculations.

The best chart for projects usually undertaken by the average-sized company would combine all of the desirable features of the three classic system types. This would provide a chart that shows the critical path, dependency, start times, duration, completion times, and float times of each activity. And the information should be presented on a linear time-frame, so that the overall project situation can be seen without getting into the details of each activity.

Looking For a Solution

American Enka Company, through its Systems Engineering Organization, investigated the packages offered by many software suppliers. The goal was to find a suitable package that would be compatible with any of American Enka's existing computer hardware systems, and could be obtained at a reasonable cost. The package that was settled on is called "Event Scheduling System", written by Leland C. Sheppard of the Sheppard Software Company, located in Sunnyvale, CA.

This software package runs on a TEKTRONIX 4050 Series Graphic Computing System, such as the 4051 Graphic

Systems already in use at American Enka*. Among the options supported by the package is chart output on a plotter. The menu contains 11 functions, as shown in Table 1. A well-written users manual guides the operator through all functions. The graphic display and computing power of the 4050 Series System combines with the scheduling software to provide a total system that is efficient and easy to use.

Table 1

Function #	Description
1	Start
2	Utilities
3	Data Entry
4	Edit
5	Schedule
6	Optimize
7	Renumber
8	Chart
9	Report
10	GANTT Chart
11	Minichart

In addition to plotting the schedules in chart form, with all of the previously-noted desirable features, the system has some other useful abilities. It will print full event and activity reports, showing early start, early finish, late start, late finish, duration, critical path, and maximum duration times. These are computed by the 4050 Series System, and can be listed in any desired order. Activity lists can be output by craft, discipline, or any other listing specified by a two-letter code.

The system's normal display is a network diagram (or diagrams), but GANTT Charts and Minicharts can also be prepared. The Minichart is a network diagram drawn at one-eighth of full scale, without activity descriptions. In this way, the Minichart gives a quick overview of the project working schedule.

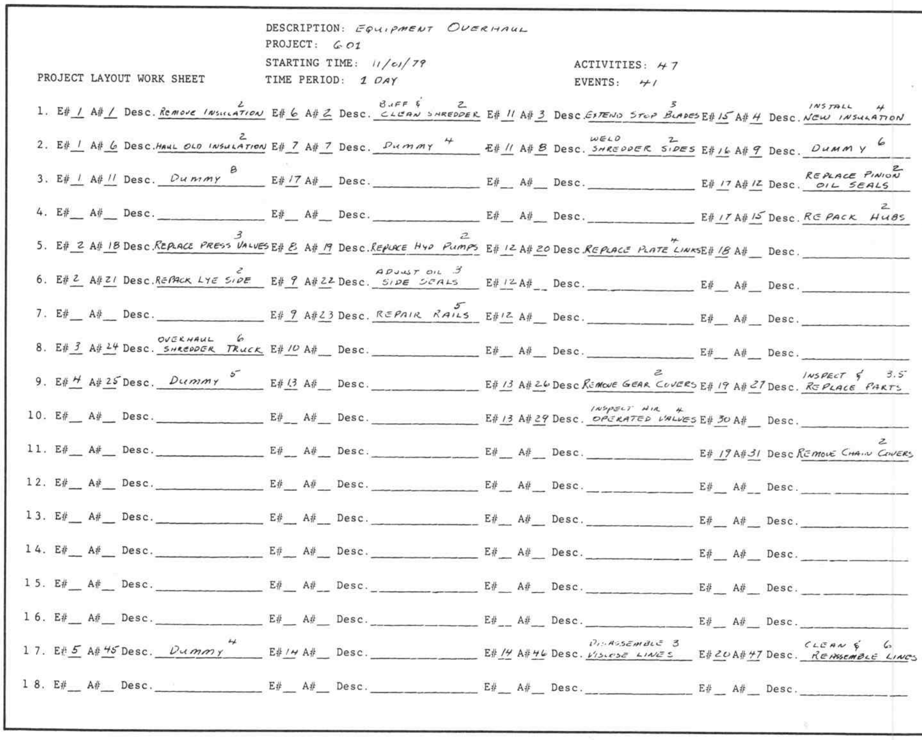
The Editor and Scheduling functions are the most-used parts of the program. When changes occur in equipment delivery times or activity durations, it is a simple matter to enter the changes, reschedule, and print an updated chart. With the Editor and the Scheduling system, changes can be accomplished in minutes, as compared with hours of manual effort.

***One 4051, used in research chemistry at American Enka, resulted in CHROMPLOT, a Chromatic Data Acquisition and Plotting program that was contributed to the library by Leonard H. Ponder. This program, #51/00-5204/0, is listed in the scientific section of your library catalog.**

Running the System

The system is straightforward. The scheduler starts by listing all activities from left to right across a page in chronological order, as shown in Figure 1. Activity durations are entered above each activity. Figure 2 is an example of a one-page activity worksheet, with craft codes added.

Next, event numbers are added sequentially, top to bottom, through the entire project list. Activity numbers are then added sequentially, left to right across the page, through the same project list. Then each activity, with its numbering information, is copied item by item to provide an input sheet. This is followed by establishing the project number, the project start date or time (along with the time interval to be used—months, weeks, days, or hours), and a brief description of the project.

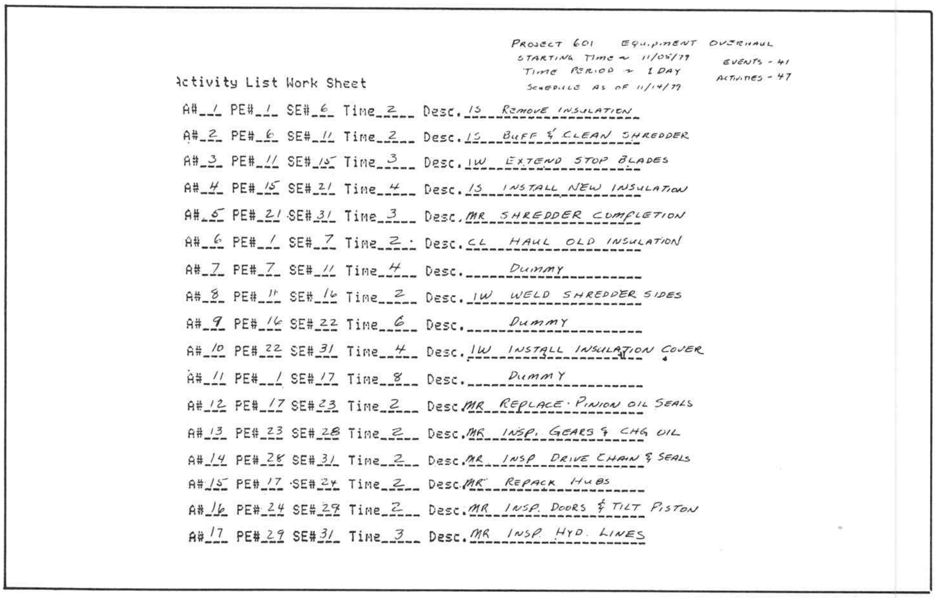


PROJECT LAYOUT WORK SHEET

DESCRIPTION: EQUIPMENT OVERHAUL
PROJECT: 601
STARTING TIME: 11/01/79
TIME PERIOD: 1 DAY
ACTIVITIES: 47
EVENTS: 41

1.	E# 1 A# 1 Desc. Remove Insulation (2)	E# 6 A# 2 Desc. Buff & Clean Shredder (2)	E# 11 A# 3 Desc. Extend Stop Blades (3)	E# 15 A# 4 Desc. Install New Insulation (4)
2.	E# 1 A# 6 Desc. Haul Old Insulation (2)	E# 7 A# 7 Desc. Dummy (4)	E# 11 A# 8 Desc. Weld Shredder Sides (2)	E# 16 A# 9 Desc. Dummy (6)
3.	E# 1 A# 11 Desc. Dummy (8)	E# 17 A#__ Desc.____	E#__ A#__ Desc.____	E# 17 A# 12 Desc. Replace Pinion Oil Seals (2)
4.	E#__ A#__ Desc.____	E#__ A#__ Desc.____	E#__ A#__ Desc.____	E# 17 A# 15 Desc. Re Pack Hubs (2)
5.	E# 2 A# 18 Desc. Replace Press Valves (3)	E# 8 A# 19 Desc. Replace Hyd Pumps (2)	E# 12 A# 20 Desc. Replace Plate Links (4)	E# 18 A#__ Desc.____
6.	E# 2 A# 21 Desc. Repack Lye Side (2)	E# 9 A# 22 Desc. Adjust Oil Side Seals (3)	E# 12 A#__ Desc.____	E#__ A#__ Desc.____
7.	E#__ A#__ Desc.____	E# 9 A# 23 Desc. Repair Rails (5)	E# 12 A#__ Desc.____	E#__ A#__ Desc.____
8.	E# 3 A# 24 Desc. Overhaul Shredder Truck (6)	E# 10 A#__ Desc.____	E#__ A#__ Desc.____	E#__ A#__ Desc.____
9.	E# 4 A# 25 Desc. Dummy (5)	E# 13 A#__ Desc.____	E# 13 A# 26 Desc. Remove Gear Covers (2)	E# 19 A# 27 Desc. Inspect & Replace Parts (3.5)
10.	E#__ A#__ Desc.____	E#__ A#__ Desc.____	E# 13 A# 29 Desc. Inspect Air Operated Valves (4)	E# 30 A#__ Desc.____
11.	E#__ A#__ Desc.____	E#__ A#__ Desc.____	E#__ A#__ Desc.____	E# 19 A# 31 Desc. Remove Chain Covers (2)
12.	E#__ A#__ Desc.____	E#__ A#__ Desc.____	E#__ A#__ Desc.____	E#__ A#__ Desc.____
13.	E#__ A#__ Desc.____	E#__ A#__ Desc.____	E#__ A#__ Desc.____	E#__ A#__ Desc.____
14.	E#__ A#__ Desc.____	E#__ A#__ Desc.____	E#__ A#__ Desc.____	E#__ A#__ Desc.____
15.	E#__ A#__ Desc.____	E#__ A#__ Desc.____	E#__ A#__ Desc.____	E#__ A#__ Desc.____
16.	E#__ A#__ Desc.____	E#__ A#__ Desc.____	E#__ A#__ Desc.____	E#__ A#__ Desc.____
17.	E# 5 A# 45 Desc. Dummy (4)	E# 14 A#__ Desc.____	E# 14 A# 46 Desc. Disassemble Viscose Lines (3)	E# 20 A# 47 Desc. Clean & Reassemble Lines (6)
18.	E#__ A#__ Desc.____	E#__ A#__ Desc.____	E#__ A#__ Desc.____	E#__ A#__ Desc.____

Fig. 1. Project layout worksheet including activity descriptions and durations.



ctivity List Work Sheet

PROJECT 601 EQUIPMENT OVERHAUL
STARTING TIME ~ 11/05/79
TIME PERIOD ~ 1 DAY
SCHEDULE AS OF 11/14/79
EVENTS - 41
ACTIVITIES - 47

A#	PE#	SE#	Time	Desc.
1	1	6	2	IS REMOVE INSULATION
2	6	11	2	IS BUFF & CLEAN SHREDDER
3	11	15	3	IW EXTEND STOP BLADES
4	15	21	4	IS INSTALL NEW INSULATION
5	21	31	3	MR SHREDDER COMPLETION
6	1	7	2	CL HAUL OLD INSULATION
7	7	11	4	DUMMY
8	11	16	2	IW WELD SHREDDER SIDES
9	16	22	6	DUMMY
10	22	31	4	IW INSTALL INSULATION COVER
11	1	17	8	DUMMY
12	17	23	2	MR REPLACE PINION OIL SEALS
13	23	28	2	MR INSP. GEARS & CHG OIL
14	28	31	2	MR INSP DRIVE CHAIN & SEALS
15	17	24	2	MR REPACK HUBS
16	24	29	2	MR INSP. DOORS & TILT PISTON
17	29	31	3	MR INSP. HYD. LINES

Fig. 2. An activity worksheet from the project layout listing information to be typed into the computer. Note the craft codes added to the left of each description:

IS — Insulations *IW — Iron Workers*
MR — Millwrights *CL — Common Laborer*

These last items, and the data from the input sheet, are typed into the 4051 using the Data Entry function of the program. That is the last step of the program's input requirements. Then, from the keyboard, the 4051 is asked to schedule the project, report the input list, provide a chart, give full or partial output, or any combination of the above functions. Figure 3 is a typical plotted schedule output resulting from scheduling system operation.

Updating a schedule is even simpler, using a hard copy list of the input information such as shown in Figure 4. The operator just calls on the Editing function to make changes, usually with just a few keystrokes. After the project edit is completed, rescheduling, charting and reporting will provide new, up-to-date network diagrams and reports.

Putting the Schedules to Work

The Central Engineering Department of American Enka began using this scheduling technique in April, 1979. Since that time, they have scheduled projects ranging from 10 to 166 activities.

These projects are the management responsibility of 11 project engineers and project managers. They must ensure that project scopes are properly defined and estimated, that money is appropriated to do the project, and that construction is completed on a predicted schedule. These responsibilities require close communication with upper management, so that decisions to cancel, change, or continue are administered in a timely manner.

In the past, it has been difficult to communicate the schedule and the details of a large project. But the graphic display of each project scheduled through the 4051 system provides a communication tool that has not been available before. Impractical projects can be screened early in their planning stages, thus saving much engineering effort. Management can look at alternative possibilities by asking "what if" questions of project managers. The impact of program changes, or reversals of thought on a project, can be seen in a matter of minutes rather than days. A planning meeting can adjourn for lunch, and convene again with an entirely new schedule in report and chart form to illustrate a new approach to the problem at hand.

Looking at Results

The "Event Scheduling System", based in the 4050 Series Graphic Computing System, has produced results that surpassed our original expectations. Communications have improved because of the scheduling technique; the publishing of the charts serves as a universal reference. Company management, engineering management, and construction personnel all focus on the same documents, and use them for work control as well.

The time and cost required to run through one project scheduling activity will vary, depending on the size and complexity of the project. But as a rule of thumb, American Enka Company experience is showing that two hours of time on the scheduling system accomplishes the work of ten hours of manual scheduling time. And the results are cleaner and much more useable.

With everyone using these same documents as an information source, many disagreements about priorities and the timing of resources simply disappear. Manpower planners can support requests for additional personnel by backing them up with a summation of data. Plant management and engineering personnel have a document that identifies the timing of all work within their area, allowing them to manage with a broader perspective. This highly productive tool for communication and work trend monitoring is the product of combining computing power and graphics, in the 4050 Series Graphic Computing System, with the software package called "Event Scheduling System". This combination is helping to make each day at American Enka Company a more productive one.

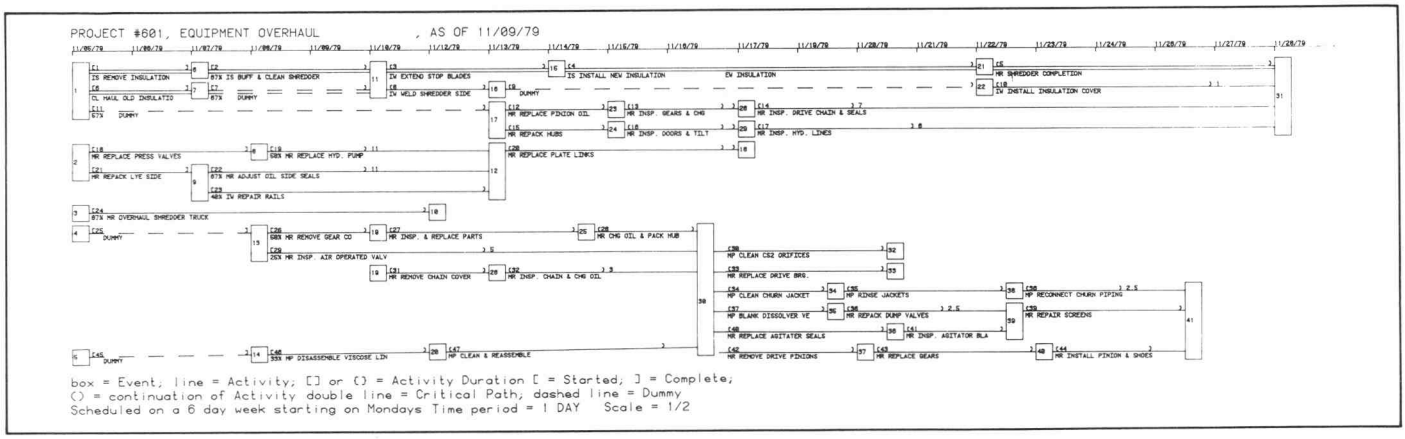
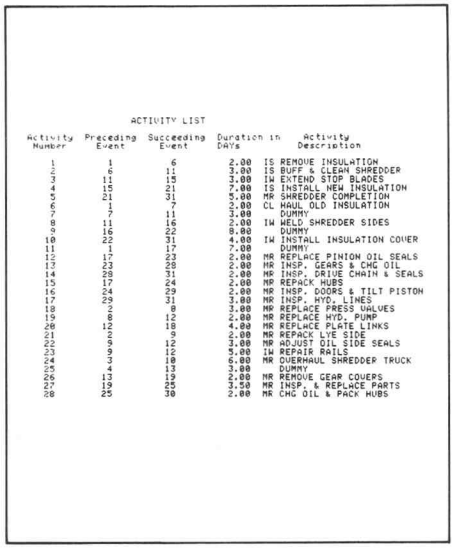


Fig. 3. Scheduled by the 4051 and output on the 4662 Plotter.



ACTIVITY LIST

Activity Number	Preceding Event	Succeeding Event	Duration in DAYs	Activity Description
1	1	6	2.00	IS REMOVE INSULATION
2	6	11	3.00	IS BUFF & CLEAN SHREDDER
3	11	15	3.00	IW EXTEND STOP BLADES
4	15	21	7.00	IS INSTALL NEW INSULATION
5	21	31	5.00	MR SHREDDER COMPLETION
6	1	7	2.00	CL HAUL OLD INSULATION
7	7	11	3.00	DUMMY
8	11	16	2.00	IW WELD SHREDDER SIDES
9	16	22	8.00	DUMMY
10	22	31	4.00	IW INSTALL INSULATION COVER
11	1	17	7.00	DUMMY
12	17	23	2.00	MR REPLACE PINION OIL SEALS
13	23	28	2.00	MR INSP. GEARS & CHG OIL
14	28	31	2.00	MR INSP. DRIVE CHAIN & SEALS
15	17	24	2.00	MR REPACK HUBS
16	24	29	2.00	MR INSP. DOORS & TILT PISTON
17	29	31	3.00	MR INSP. HYD. LINES
18	2	8	3.00	MR REPLACE PRESS VALVES
19	8	12	2.00	MR REPLACE HYD. PUMP
20	12	18	4.00	MR REPLACE PLATE LINKS
21	2	9	2.00	MR REPACK LYE SIDE
22	9	12	3.00	MR ADJUST OIL SIDE SEALS
23	9	12	5.00	IW REPAIR RAILS
24	3	10	6.00	MR OVERHAUL SHREDDER TRUCK
25	4	13	3.00	DUMMY
26	13	19	2.00	MR REMOVE GEAR COVERS
27	19	25	3.50	MR INSP. & REPLACE PARTS
28	25	30	2.00	MR CHG OIL & PACK HUBS

Fig. 4. Printout of the input list used when updating schedules.

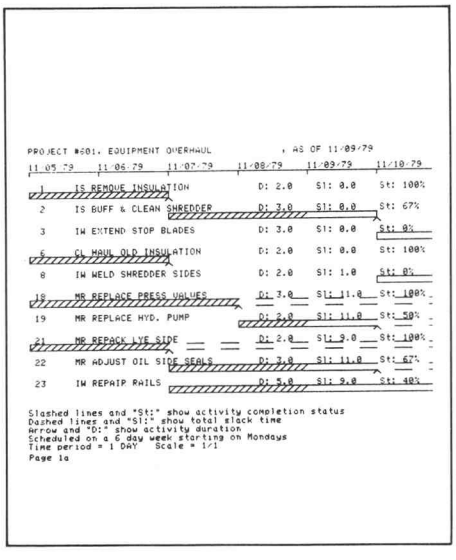


Fig. 5. One page of a Gantt Chart printout.

PLOT 50 Easy Graphing Flexible Data Display

by Patricia Kelley
TEKniques Staff

with Howard Mozeico
Tektronix, Inc.
Wilsonville, OR

Line graphs, bar charts, bar and line graphs, scatter plots, pie charts: however you want to present your data, Plot 50 Easy Graphing Vol. 1 will do it. This newest 4050 Series software package is not only packed with graphing routines but it's easy to use. In fact, someone unfamiliar with computers can enter and graph their data after limited instruction in 4050 System keyboard use.

Easy Graphing allows you to display one to six variables, with a choice of six line types, six symbol types and six bar shadings. You can specify bar width, normal, logarithmic or arbitrary axes scaling, tic mark spacing and labeling, legends and their positioning, and axes and graph titles. X-axis or Y-axis grids are also available. Easy Graphing will automatically calculate pie chart segment percentages and label them; a segment may be exploded. Extended functions allow you to manipulate your data, update and generate repetitive graphs and input/output PLOT 50 Standard Files.

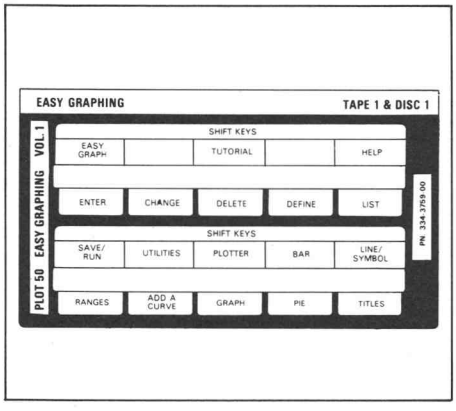
PLOT 50 Easy Graphing is the second PLOT 50 Standard File compatible software package (PLOT 50 Standard Files were discussed in TEKniques Vol. 4 No. 1). This means that data used in BPA-2*, the first PLOT 50 Standard File compatible package, can readily be communicated to Easy Graphing on tape or disc and vice versa using the special UTILITIES programs accompanying each package.

PLOT 50 Easy Graphing is a 4050 BASIC language implementation of the TEKTRONIX PLOT 10 Easy Graphing, a FORTRAN package. Therefore, users of the minicomputer and mainframe PLOT 10 Easy Graphing software will be able to run PLOT 50 Easy Graphing after a quick look at syntax requirements. The commands are almost identical.

Although PLOT 50 Easy Graphing runs on all 4050 Series Systems (minimum 32K memory), it is optimized for the 4052/4054 Graphic Systems. Their larger memories and bit-slice processors can efficiently process the many routines of Easy Graphing. And, Easy Graphing is based on the 4907 File Manager. The program resides on the disc and your data is stored on the disc. Plots may be directed to the 4662 or 4663 Digital Plotters; listings may be sent to the 4641 or 4642 Printers.

A Look at Easy Graphing's Components

What makes this package so versatile but easy to use? The answer lies in Easy Graphing's command processor and in the unique resources invoked by the User-Definable Keys.

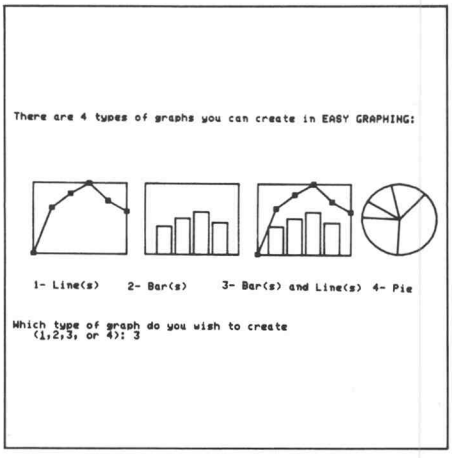


Easy Graphing Command Processor

The flexibility and versatility of Easy Graphing is due to its command processor. It allows you to use simple commands which describe complex tasks, commands such as ENTER, CHANGE, GRAPH and so on. You simply type in a command and its parameters and Easy Graphing accomplishes the task for you, i.e., "processes your command". We'll discuss Easy Graphing's command language in more detail later.

EASY GRAPH Resource

However, you don't need to know any Easy Graphing commands or even much about the 4050 System in order to enter data and display a graph. Just press User-Definable Key 11 and EASY GRAPH takes you through a question and answer session, producing a quality graph according to your specifications.



Although the full feature set of Easy Graphing isn't available within the EASY GRAPH resource, your choices are ample to produce quality graphs of varying design:

- 4 graph types
- 6 curves
- 6 bar types
- 6 line types
- 6 symbol types
- 6 legends
- numeric or monthly X-axis tic labels
- X-axis and Y-axis titling
- main title and subtitle

***BPA-2 was described in TEKniques Vol. 3 No. 5.**

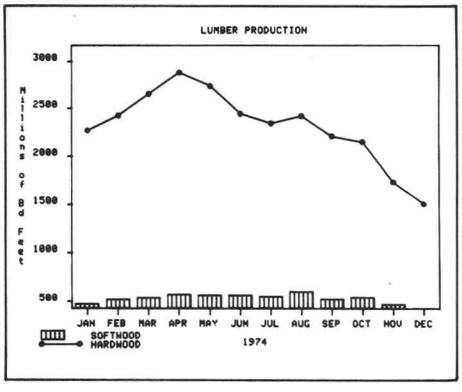
And after each question and answer, Easy Graphing prints the Easy Graphing command which accomplishes that task.

```
What would you like to label curve 1: SOFTWOOD
Enter the vertical value for SOFTWOOD
which corresponds to the horizontal value of:
JAN                 468
FEB                 510
MAR                 534
APR                 570
MAY                 561
JUN                 560
JUL                 540
AUG                 601
SEP                 523
OCT                 540
NOV                 465
DEC                 424
The EASY GRAPHING command corresponding to your previous
response is:
ENTER Y1 468 510 534 570 561 560 540 601 523 540 465 424

Press RETURN to continue...
```

```
Which line type do you want for HARDWOOD

                  1_____    2_____    3_____
  (1,2,3,4,5,6)?1
                  4_____    5_____    6_____

The EASY GRAPHING command corresponding to your previous
response is: LINE 2 1

Press RETURN to continue...


Which symbol do you want on the line
                                  1 △  2 □  3 ◇
  (1,2,3,4,5,6): 5 RETURN - No symbol
                                  4 ☆  5 ○  6 ▽

The EASY GRAPHING command corresponding to your previous
response is: SYMBOL 2 5

Press RETURN to continue...
```

This familiarizes you with the Easy Graphing command language and how it's used.

Once you've entered your data and defined your graph, you can also save it and run it later.



TUTORIAL Resource

Press User-Definable Key 13 and the TUTORIAL tells you what you need to know in order to use the command processor. Its four-phase structure is aimed at many levels of users and may be entered at any of the phases. If you're not familiar with graphs, the *review of graphing concepts* phase acquaints you with the terminology of graphs. *Conventions in Easy Graphing* discusses the syntax of Easy Graphing commands and their parameters, how to enter a command, and how to correct mistakes.

```
For example, one of the commands is GRAPH.
An illustration of a command is:

GRAPH Year UK Gmny Fra Japn USA
                or
GRAPH,Year,UK,Gmny,Fra,Japn,USA
```

The third phase, *Easy Graphing commands you need to know*, acquaints you with two commands which allow you to enter data and graph it: ENTER and GRAPH. This phase of the tutorial also introduces a few other Easy Graphing commands.

Other available help lists resources outside of the tutorial and describes how they are accessed. One of these resources is EASY GRAPH which has already been discussed. Discussions of the other resources follow.

HELP Resource

The HELP resource reduces the need to refer to the manual or reference card. A menu of Easy Graphing commands as well as several general subjects can be obtained by pressing the HELP User-Definable Key 15 or by typing in the Easy Graphing command: HELP.

```
                HELP is available on the following topics:

HELP                            CHARTS
   TUTORIAL KEY                    TYPES
   EASY GRAPH KEY                     PIE
   LIST                                  EXPLODE
   USER KEYS                             PVALUE
DATA                                  BAR
   INPUT                              SCATTER
      ENTER                           CURVE
      ATTACH                             ADD
      DEFINE or FUNCTION                 GRAPH
   EDITING                                  LINE
      CHANGE                                SYMBOL
      DELETE                                GRID
COMMAND FILES                                  XGRID
   RUN                                         YGRID
   SAVE                            LABELS
   KEYBOARD                           TITLE
   PAUSE                                 DATE or SUBTITLE
   CONTINUE                           AXIS
   BELL                                  TICS
   PRINT                                    XTICS
OUTPUT DEVICES                              YTICS
   HCO or HARDCOPY                       XTITLE
   PLOTTER or PERIPHERAL                 YTITLE
FILE INTERFACING                         XLABEL
   UTILITIES                             YLABEL
STARTING or QUITTING                  LEGEND
   RESTART                         RANGE or SCALE
   BYE                                XRANGE
                                      YRANGE
Enter a topic (e.g. TITLE): PIE       LOG
                                         XLOG
                                         YLOG
```

From the menu you can choose the command in which you're interested, e.g., PIE; its purpose, syntax and an example will be displayed.

```
PIE                                   command abbreviation: PI

One of the types of charts available in EASY GRAPHING is a pie chart.
To generate a pie chart, use the PIE command.

Syntax: PIE Name "Label1" "Label2" ...
Displays a pie chart of named variable, including assigned segment
labels, and percentage labels. The first label entered is assigned to
the first segment of the pie, the second label to the second segment,
and so on. Each label must be enclosed in a pair of single or a pair
of double quotes.

Syntax: PIE Name
Displays an unlabeled pie chart.

Syntax: PIE
Re-displays last pie chart, including any new specifications
since it was last displayed.

Other commands used to alter a pie chart are EXPLODE and PVALUE.
EXPLODE causes separation of one section from the rest of the pie.
PVALUE deletes or restores percentage labels from a pie.
e.g.
ENTER X 2 6 3 1
PIE X
produces a chart similar to the one
at the right. The ENTER command
details the values of the pie
segments. The pie is drawn with the
first value starting at 6 o'clock
and proceeds counterclockwise.

You may now enter any Easy Graphing command, or press any User Key.
```

If you choose a general subject, it will be defined and the pertinent Easy Graphing command included:

```
LABELS

EASY GRAPHING permits the following types of labels:

 - title and/or subtitle centered at the top of the graph or
   pie chart
 - X and Y axis titles, centered under the X-axis or
   alongside the Y-axis
 - X and Y-axis tic marks
 - legends, one for each curve, positioned where you want it.

For more information, type HELP followed by TITLE,
AXIS or LEGEND.

You may now enter any Easy Graphing command, or press any
User Key.
```

If you know what subject or command with which you want help, you can type in HELP followed by the term, e.g., HELP PIE. This would result in the same display as Figure 5 but faster since you bypass the HELP menu.

User-Definable Key Syntax Resource

User-Definable Keys 1 through 10 and 16 through 20 provide you with the syntax of often used commands. For example, pressing User-Definable Key 9, PIE, produces the following syntax help:

```
PIE[] Name ["Label"...]
   Displays a pie chart with optional labels.  Paired single
   quotes may be substituted for the double quotes; e.g., 'Label'
PIE[]
   Redisplays the current pie chart.
```

(Compare this with the *full* HELP PIE message shown under *HELP Resource* above.)

After reading the syntax instructions, you can type in the command.

LIST Resource

The Easy Graphing command LIST prints a summary of all variables in memory and parameters of the last graph displayed. You may also request a LIST of all elements within your variables.

```
NAME  TYPE       MIN              MAX              COUNT
CLAK  Long       12               30                   5
LINC  Long       -7.5             3                    5
YEAR  Short      1958             1962                 5

LEGEND  30,00
YRANGE  -10,50

CURVE  XVAR  YVAR  SYMBOL  BAR  LINE
  1    YEAR  CLAK     4          1
  2    YEAR  LINC     5          1
```

```
                  CLAK             LINC
1                 30               -7.5
2                 25               1
3                 12               -0.5
4                 18               3
5                 21               -2.3
TOTAL             106              -6.3
```

Thus, you have a choice of several entry points into Easy Graphing:

- EASY GRAPH—prompts for data and graph parameters and produces quality graphs
- TUTORIAL—instructs in graphing concepts, Easy Graphing syntax, Easy Graphing commands, and help available
- HELP—defines purpose and syntax of Easy Graphing commands
- User-Definable Key Syntax Help—provides immediate syntax instructions on often used Easy Graphing commands
- LIST command—displays your variables, graph parameters and variables' elements
- Easy Graphing Command Language—simple commands which invoke complex tasks

If you are inexperienced in computers or command language, use EASY GRAPH to quickly produce quality graphs. When you are ready to advance, the TUTORIAL will show you how to use Easy Graphing command language.

If you're familiar with graphing and command language, phase 2 of the TUTORIAL (syntax) and the HELP Files will give you the ground rules of Easy Graphing command language.

If you've used PLOT 10 Easy Graphing, simply check syntax rules and go directly into the Easy Graphing commands.

To Be Continued

In the next issue of TEKniques, we'll take a closer look at Easy Graphing commands and what they accomplish. For a sneak preview, however, here are the 41 Easy Graphing commands, listed according to function:

LIST OF EASY GRAPHING COMMANDS

- Data entry and manipulation

  ATTACH
  CHANGE
  DEFINE
  DELETE
  ENTER

- Output device specification

  PERIPHERAL
  PLOTTER
  HCOPY (hardcopy)

- Graphing

  ADD
  GRAPH
  LIST (summarizes current graph)
  PIE

- Graph formatting

  BAR
  EXPLODE
  LINE
  PVALUE
  SYMBOL
  XGRID
  XLABEL
  XLOG
  XRANGE
  XTICS
  YGRID
  YLABEL
  YLOG
  YRANGE
  YTICS

- Titling

  DATE
  LEGEND
  TITLE
  XTITLE
  YTITLE

- Command files

  BELL
  CONTINUE
  KEYBOARD
  PAUSE
  PRINT
  RUN
  SAVE

- Exit

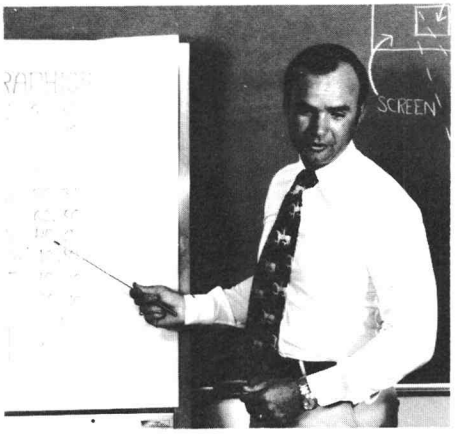
  BYE
  RESTART

Graphic Systems Workshops Available

You're probably already satisfied with the job your 4050 Series Graphic Computing System is doing for you. But you may not be familiar with all of the capabilities of your system, or how these capabilities can best be used to help you get the most out of desktop graphic computing. To help you get that maximum benefit from your Graphic Computing System, Tektronix is now providing week-long workshops for thorough customer training.

The workshops teach the application of BASIC and graphics concepts. Integrating and using TEKTRONIX 4050 Series Graphic Computing Systems with their associated peripheral devices is emphasized. The full range of Graphic Computing System equipment is available in the workshops.

Each workshop is a combination of lectures and exercises, focusing on development of a working knowledge of system capabilities. Laboratory sessions complement and reinforce the lecture information, by leading you through the development of a series of practical examples. Upon completion, you'll have the skills necessary to apply all of the capabilities of the system to your own specific requirements.



Course Outline

Each workshop fills a five-day week with lectures and laboratories. Monday through Thursday include two laboratories, each following a lecture. Friday afternoon completes the week with additional lectures and a summary of the weeks events. A brief course outline is included in Table 1.

Locations and Schedules

The workshops are scheduled through four basic locations, as shown in the schedule below. However, on-site and special locations can be scheduled for groups of 10 or more. TEKniques will continue to keep you informed of locations and dates; a new schedule will be published in the May issue of TEKniques. The following places and times are scheduled:

March 31—April 4	Washington, D.C. Chicago, Illinois
April 7—April 11	Boston, Massachusetts Santa Clara, California
April 28—May 2	Washington, D.C. Chicago, Illinois
May 5—May 9	Boston, Massachusetts Santa Clara, California

For Information

If you're interested in attending one of these worhshops, or if you think you might be, you can get more information and a more-detailed course outline by contacting your local Tektronix Sales Engineer. Or you can call to Raynor Christianson at (503) 644-0161, ext. 8949. He can also provide you with information on other workshops, such as the newly-established 4020 Series Terminal workshop.

Table 1

Graphic System Workshop Outline

	Monday	Tuesday	Wednesday	Thursday	Friday
Morning	Introduction Review of BASIC with enhancements	Graphics	Disc File Management System	Demonstration of Graphics Tablet Software-System, Plot 50, App. Library	Data Comm. Interface (cont'd)
Afternoon	Continue BASIC review	Magnetic Tape Storage Devices	Hard Copy Units Plotters, and Printers	ROM Packs Data Comm. Interface	4054 Dynamic Graphics Option Advanced 4907 File Manager Concepts Workshop Review

Editor's Note

Contest Closing Soon

This is the last month for entries in the Applications Library Contest; The contest theme, to remind you, is interfacing for data acquisition or instrument control.

Awards

Prizes will be awarded to three places in each category. Winners will have their choice of 4050 Series ROM Packs, PLOT 50 software, or Applications Library software, at catalog price, up to the award amount in their category and place.

Awards will be made in three categories divided by interface:

Category I—Application using the General Purpose Interface Bus (GPIB)

Category II—Application using the Option 1 Data Communications Interface (RS-232)

Category III—Application using any other type of interface—commercially constructed or "home built".

	Category I	Category II	Category III
1st Place*	$750	$750	$750
2nd Place*	500	500	500
3rd Place*	375	375	375

***equivalent value in ROM packs or software**

All entrants will receive three programs in exchange for theirs. This exchange is in addition to any award received, of course.

Complete rules can be found in TEKniques Vol. 3, No. 7.

So put the last touches on your program, fill out the documentation, and send it on in. If you need documentation guidelines or any of the forms, drop us a note; our address is shown under UNITED STATES on the last page.

The New Look

Did you notice our new look? In response to our recent questionnaire, and to our own wish to "freshen up" our look as we started our fourth year of publication, we changed a few things, beginning last issue.

We modified our style of type a little, and changed to a three-column format. This will give us a little more flexibility in presenting articles and ideas, and may also allow us to get a little more information into each issue. Our layout has been modified, too; hopefully, you'll be able to retrieve the information you need even more easily than before. And some new "faces" appear at the start of our regular features (Programming Tips, Basic Bits, Input/Output, even my note—above).

And as we promised last issue, we've added a new column for your questions. Input/Output is now a regular feature of TEKniques, starting with this issue. All of these changes are intended to get you the information you need, in a format that's pleasant to read. Let us know if you have any comments on the "new look".

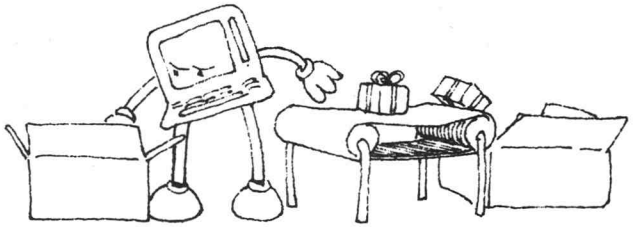
Back Issues Available

We still have copies available of previous TEKniques issues. While we make it a practice to keep these back issues available, in some cases they are not original stock. As our stock of initial printings runs out, we are turning to our local reproduction press to replenish our back issue inventory. This allows us to keep the content of back issues available to all.

Application Library Catalogs

We've added a lot of new Programs to the Library since our last catalog in June, 1979. Now we're working on a new one, to add those new program abstracts, and give you an up-to-date list of the information available through the library. The new catalog will be coming with the June issue, so hold onto your 1979 catalogs until then. (Programs added since the 1979 catalog are documented in your most recent issues of TEKniques.)

INPUT / OUTPUT



The first questions come from a reader who suggested a "queries" column a few months ago and sent along some questions. Thanks to **J. A. T. Curr, Senior Research Engineer at Davy-Loewy Ltd. in Bedford, England,** for his suggestion and inquiries.

Howard Sanders, Technical Support Specialist at Tektronix responds.

How do you retrieve a program accidentally saved in "1,1,1" tape format? I can only retrieve the first 10 or so lines which then appear to repeat.

To retrieve a program SAVED in 128 byte physical record, no checksum, non-header format, the file in which it's saved must be MARKed in the same format. To retrieve the file, make sure your 4050 System's tape unit status byte is in this format (PRI @33,0: 1,1,1) and OLD in your program. However, if the file in which your "1,1,1" formatted program is stored is of 256 byte physical record, checksum, header format (the default tape unit status on the 4050 System), you can't recover the entire program—just the first few lines as Mr. Curr stated.

How do you "TLI @1:" where 1 is the 4662 Plotter?

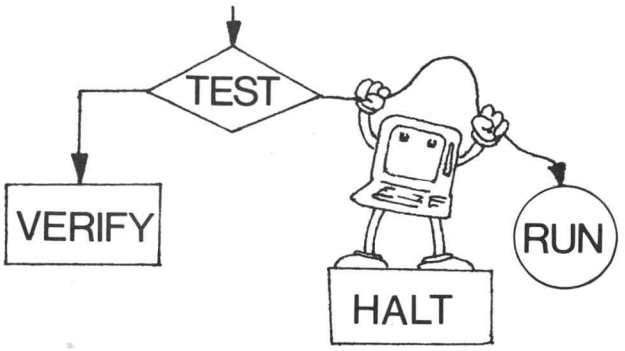
You cannot do a direct TLI to the Plotter. However, the following routine will do a listing to the Plotter.

```
100 REM   TLIST TO A PLOTTER AT ADDRESS 1
110 N=1
120 FIND 0
130 PRINT @33,0:0,0,1
140 FIND N
150 INPUT @33:A$
160 B$=SEG(A$,35,4)
170 B=VAL(B$)
180 B=256*B
190 A$=SEG(A$,1,34)
200 PRINT @1:A$;B
210 PRINT @1:T
220 N=N+1
230 L$=SEG(A$,9,1)
240 IF L$="L" THEN 260
250 GO TO 140
260 FIND 0
270 PRINT @33,0:0,0,0
280 END
```

How do you create "DATA" statements from either an existing array or a tape data file, e.g., from digitizing using the 4662 Plotter or 4952 Joystick?

The following routine will accomplish this task.

```
100 REM      *****CREATE DATA STATEMENTS FROM X,Y DATA*****
110 REM      ============================================
120 REM
130 REM DATA PAIRS ARE STORED ON TAPE & DATA STATEMENTS ARE WRITTEN-
140 REM BACK TO A TAPE TO THE SPECIFIED FILE NUMBER
150 INIT
160 PAGE
170 REM              ****SETUP****
180 REM
190 PRINT "ENTER NUMBER OF DATA PAIRS ";
200 INPUT V
210 REM I$=1 DATA STATEMENT; B=X,Y DATA PAIRS
220 REM
230 DIM I$(110),B(V,2)
240 PRINT "ENTER DATA FILE OF DATA PAIRS ";
250 INPUT F
260 FIND F
270 INPUT @33:B
280 PRINT "ENTER DATA FILE TO RECIEVE DATA STATEMENT ";
290 INPUT F
300 FIND F
310 ON EOF (0) THEN 660
320 N=1
330 REM         **CONVERT X,Y DATA TO DATA STATEMENTS**
340 REM
350 REM START LINE NUMBER AT 100 AND INCREMENT BY 10
360 FOR I=100 TO 50000 STEP 10
370 I$=STR(I)
380 I$=SEG(I$,2,LEN(I$)-1)
390 REM PLACE THE WORD "DATA" IN I$
400 I$=REP(" DATA",LEN(I$)+1,0)
410 REM MAKE THE X,Y DATA PAIRS STRINGS & REMOVE EXTRA SPACE
420 A$=STR(B(N,1))
430 A$=SEG(A$,2,LEN(A$)-1)
440 B$=STR(B(N,2))
450 B$=SEG(B$,2,LEN(B$)-1)
460 REM PLACE A COMMA BETWEEN NUMBERS
470 A$=A$&",
480 B$=B$&",
490 REM INSERT THE STRINGED DATA PAIRS INTO I$
500 I$=I$&A$
510 I$=I$&B$
520 REM IF THE STRING I$ IS LONGER THAN 72 CHARACTER, THEN CUT THE-
530 REM LAST X,Y PAIR OFF & PRINT THE DATA STATEMENT TO TAPE
540 IF LEN(I$)>72 THEN 590
550 REM INCREMENT X,Y DATA PAIRS COUNTER
560 N=N+1
570 IF N=V THEN 640
580 GO TO 420
590 I$=SEG(I$,1,LEN(I$)-(LEN(A$)+LEN(B$)+1))
600 PRINT @33:I$
610 NEXT I
620 REM    **PREPARE TO PRINT LAST DATA STATEMENT TO TAPE**
630 REM
640 I$=SEG(I$,1,LEN(I$)-1)
650 PRINT @33:I$
660 CLOSE
670 END
```



PROGRAMMING TIPS

Rewrite Does Customer Injustice

by Patricia Kelley
TEKniques Staff

When something goes wrong, it seems to multiply and that's what happened to Wayne Miller's programming tip in TEKniques Vol. 3 No. 5: "Listing a Program Over the RS-232-C".

Mr. Miller sent in a programming tip on a method to check for control characters. It was in response to the same subject covered in TEKniques Vol. 2 No. 5: "Flowchart Program 51/00-8005/1 Updated".

Well, we wanted to give some background on why one would look for control characters. In so doing we used a wrong term, made a wrong assumption and ended up referencing some wrong line numbers. Our errors were pointed out by Martin Guiver of the Tektronix European Marketing Centre in Amstelveen, The Netherlands.

Mr. Guiver remarks: "The statement made in the second paragraph of this article is not true; a LIST statement always converts control characters to an alpha/backspace/underline sequence. Control characters transmitted by a PRINT statement, however, are executed."*

Mr. Guiver is absolutely correct. Mr. Miller was also correct, for he was searching for control characters when *printing* a program. Unfortunately, in the write-up we used the term "listing" and also made a wrong assumption that the type of interface made a difference. So let's have another go at the programming tip: see "Intercepting Control Characters".

Note: Although we reserve the right to insert corrected or optimized code, we don't usually rewrite programming tips; we simple edit them for organization and space. This one somehow got away from us. Our apologies to Mr. Miller.

***Mr. Guiver also provided more information on *listing* programs over the Option 1 RS-232-C, which you'll find in a separate programming tip.**

Intercepting Control Characters

by Wayne Miller
Missouri Center for Health Statistics
Jefferson City, MO

```
4000 PRINT "Enter the File Name to be Printed"
4010 INPUT F$
4020 PRINT "Enter the device: 40=PRINTER, 32=CRT
4030 INPUT D
4040 CLOSE
4050 CALL "MOUNT",0,A$
4060 UNIT 0
4070 X=0
4080 OPEN F$!1,"R",M$
4090 ON EOF (1) THEN 4270
4100 U$=CHR(31)
4110 INPUT @1:X$
4120 X=POS(X$,"""",6)
4130 IF X>0 THEN 4160
4140 X=POS(X$,"REM",3)
4150 IF X=0 THEN 4220
4160 X1=LEN(X$)
4170 FOR I=X TO X1
4180 A$=SEG(X$,I,1)
4190 IF A$=>U$ THEN 4210
4200 X$=REP("↑",I,1)
4210 NEXT I
4220 PRINT @D:X$
4230 FOR I=1 TO LEN(X$)%0.7
4240 NEXT I
4250 GO TO 4110
4260 CLOSE
4270 END
```

The following is a fast and easy way to check for control characters in a BASIC program. The program first checks for a quote mark in statement 4120 or REM statement in statement 4140. If neither is found, then no control characters are in that statement. So it's printed, and the next statement is brought in. Since all control characters are 31 or less in decimal value, only one test is required on each character. If the segment is a control character (ASCII value 31 or less), statement 4200 converts it to an "up arrow". If not, it passes to the next character.

Editor's Note:

To print control characters as their alpha equivalents, replace statements 4160 through 4210 with the following:

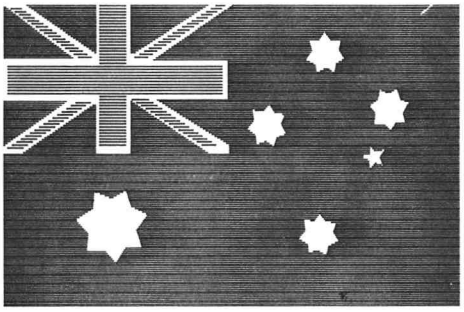
```
4160 FOR I=LEN(X$) TO 1 STEP -1
4170 A$=SEG(X$,I,1)
4180 IF A$=>" " THEN 4210
4190 A$=CHR(ASC(A$)+64)
4200 A$=A$&"H_"
4205 X$=REP(A$,I,1)
4210 NEXT I
```

If you PRINT a string to a printer using either the Option 10 or Option 1 interface, the printer executes any control character in the string. Also, the RS-232-C Interface is unaware of when the printer buffer is filled and may overwrite it. Mr. Miller compensates for the latter in statements 4230-4240.

Solid Colors on the 4662 Plotter

by Herman D'Hondt

Tektronix Australia Pty. Ltd.
Sydney, Australia



This is a drawing shaded on the 4662 Plotter to give the effect of solid colored areas.

Have there been times when you wanted more than an outline drawing for an overhead slide presentation? Using the following routine, you can have the 4662 Plotter fill in solid colored areas of a drawing. The solid colors are actually closely spaced horizontal lines which give the effect illustrated in the Australian flag plot. (The lines above were set for different spacings so the two colors could be recognized in black and white, i.e., closely spaced lines are blue, widely spaced are red.)

How To Do It

The first step is to digitize all line segments (vectors) within your drawing or picture. If one vector has different colors to its right, you'll have to separate it into multiple vectors (see Figure 1). Horizontal vectors need not be digitized, although it won't cause any problem if you do. Two vectors must be digitized to delineate the side borders.

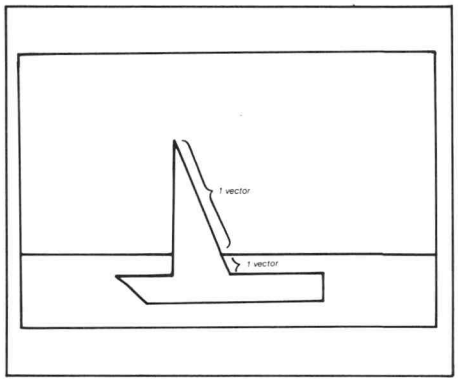


Fig. 1. The right edge of the sail is one long vector, but must be split into two to define the two different colored areas to its right.

Lay your drawing on the Plotter and RUN the routine. Enter the number of colors. When you're counting colors, don't include white (blank) space as a color.

```
100 REM SHADING ROUTINE FOR 4662 PLOTTER
110 INIT
120 D=1
130 PRINT "Digitize the coordinates of all vectors in your drawing."
140 PRINT "The FIRST VECTOR must be a line along the LEFTHAND BORDER"
150 PRINT " with COLOR 0 (NO COLOR). The LAST VECTOR must be "
160 PRINT "along the RIGHTHAND BORDER, again with COLOR 0."
170 PRINT "Use Plotter Coordinates (0:150,0:100)."
180 PRINT "When finished, digitize one more vector & enter a "
190 PRINT "negative" color.                    e.g., -1."
200 N1=INT((MEMORY-1000)/(8*5))
210 PRINT "You may digitize up to "N1" Vectors"
220 DIM V1(N1),V2(N1),V3(N1),V4(N1),V5(N1)
230 PRINT "Enter number of colors"
240 INPUT C0
250 REM ***** DIGITIZE FROM THE PLOTTER *****
260 V1(1)=0
270 V3(1)=0
280 N=0
290 PRINT "Enter Points:"
300 FOR J=1 TO 1
310   FOR I=1 TO N1
320     IMAGE 4D,5X,"X1,Y1",3X,S
330     PRINT USING 320;I
340     INPUT @D,27;V1(I),V2(I)
350     IF V1(I)=>V1(1) THEN 370
360     V1(I)=V1(1)
370     IMAGE 2A,2(4D.2D),S
380     PRINT USING 370;"GO",V1(I),V2(I)
390     PRINT "    X2,Y2"
400     INPUT @D,27;V3(I),V4(I)
410     IF V3(I)=>V3(1) THEN 430
420     V3(I)=V3(1)
430     IMAGE 2(4D.2D),S
440     PRINT USING 430;V3(I),V4(I)
450     PRINT "GO       COLOR "
460     INPUT V5(I)
470     IF V5(I)<0 THEN 500
480     N=N+1
490   NEXT I
500   PRINT "DONE! GO"
510 NEXT J
600 REM ***** SORT ROUTINE *****
610 F=0
620 FOR I=1 TO N-1
630   IF V1(I)>V1(I+1) THEN 840
640   IF V1(I)=V1(I+1) THEN 820
650   F=1
660   T=V1(I)
670   V1(I)=V1(I+1)
680   V1(I+1)=T
690   T=V2(I)
700   V2(I)=V2(I+1)
710   V2(I+1)=T
720   T=V3(I)
730   V3(I)=V3(I+1)
740   V3(I+1)=T
750   T=V4(I)
760   V4(I)=V4(I+1)
770   V4(I+1)=T
780   T=V5(I)
790   V5(I)=V5(I+1)
800   V5(I+1)=T
810   GO TO 840
820   IF V3(I)<>V3(I+1) THEN 840
830   GO TO 650
840 NEXT I
850 IF F=1 THEN 610
900 REM **** RUN THIS LOOP ONCE FOR EACH COLOR *****
910 FOR C=1 TO C0
920   PRINT "INSTALL PEN WITH COLOR ";C;" AND PRESS <CR>G."
930   INPUT Z$
940   Y1=100
950   Y2=0
960   REM ***** FIND MIN AND MAX Y-VALUES FOR COLOR #C *****
970   FOR I=1 TO N
980     IF V5(I)<>C THEN 1010
990     Y1=Y1 MIN V2(I) MIN V4(I)
1000    Y2=Y2 MAX V2(I) MAX V4(I)
1010  NEXT I
1100  REM ***** DRAW RASTERLINES BETWEEN Y1 AND Y2 *****
1110  FOR Y=Y1 TO Y2 STEP 0.3
1120    PRINT @D,2110;Y
1130    R=1
1140    FOR I=1 TO N
1150      REM *** DISCARD VECTORS THAT DON'T CROSS RASTER LINE *****
1160      IF Y<V2(I) MIN V4(I) OR Y>V4(I) MAX V2(I) THEN 1240
1170      REM *** COMPUTE INTERSECTION COORDINATES ****
1180      A=(Y-V4(I))/(V2(I)-V4(I))
1190      X=A*V1(I)+(1-A)*V3(I)
1200      F=21-(C*V5(R))
1210      REM *** MOVE OR DRAW AS REQUIRED ***
1220      PRINT @1,F;X,Y
1230      R=I
1240    NEXT I
1250  NEXT Y
1260 NEXT C
```

Use the digitizing sight accessory for greater accuracy on your vector coordinates. As the 4050 System prompts you for coordinates, use the Plotter joystick to move the Plotter pen or sight to a vector end point, then briefly press the CALL button on the Plotter. When the 4050 beeps, move the pen to the other end of the vector and push the CALL button again. Then enter the color number from the 4050 keyboard and press RETURN. Be sure to enter a color number, and don't press the CALL button at this point. Continue this procedure until all vectors are digitized.

Begin by defining the left-hand border vector of the drawing by digitizing the lower and upper left corners and key in 0 for the color. This ensures that blank areas on the left will stay blank. Next digitize the end points of each vector (in any order) and enter the number of the color to the *right* of that vector. The color number is arbitrary—just be sure vectors to the left of the *same* color all have the same color number. Finally, digitize the lower and upper right corners of the drawing and enter 0 for the color. This ensures that your shading will not exceed the right-hand border. When your drawing is complete, including the last vector for the right-hand border, digitize two more points (anywhere) and enter a minus color number, e.g., -1, to signify you're through. Figure 2 illustrates the vectors digitized for the Australian flag above.

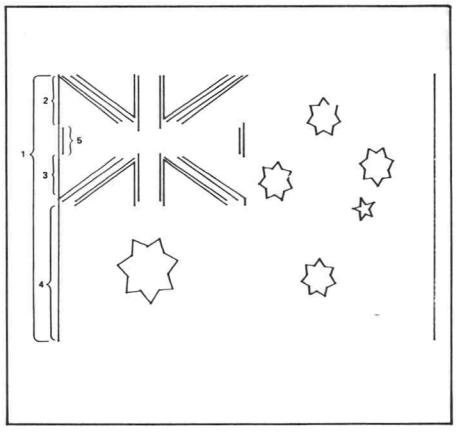


Fig. 2. 112 vectors define the colored areas of the Australian flag. Note the one long vector digitized for the left-hand border and the three subsequent vectors on this border which identify the three blue areas to their right. The fifth vector has a red area to its right, and so on. A horizontal line on one of the stars wasn't digitized since it wasn't necessary.

Place a sheet of transparency or paper on the Plotter and insert the pen with the first color. The Plotter will shade all areas for one color before proceeding to the next. Between colors the 4050 System will prompt you for pen changes.

That's all there is to it.

How It Works

Once the drawing has been digitized, the vectors are sorted according to minimum X. If two vectors have the same minimum X, they are sorted again with respect to maximum X (statements 600—850).

The Plotter draws the shading lines for one color, from bottom to top. As each color loop begins, statements 970 to 1010 inspect all vectors which have the *current* color to

their right and locate the minimum and maximum Y coordinate values. These values define the lower and upper points for the shading (Y1 and Y2 in statement 1110).

The Plotter moves the pen to the left-hand border and down to the first shading line (the lowest point in the drawing for that color). As the Plotter draws each shading line, the 4050 System checks the vectors, left to right, to determine if any intersect the shading line (statement 1160). If a vector intersects a shading line, the intersection is computed using the parametric equations for a line segment:

$$X = AX_1 + (1\text{-}A)\ X_2$$

$$Y = AY_1 + (1\text{-}A)\ Y_2$$

(where A is in the range 0 to 1). The color to the right of this intersecting vector is compared to that of the last intersecting vector which determines a move or draw (statement 1220) to the intersection.

The number of vectors determines the drawing time for each shading line. As the vectors increase, the time increases. The 112 vectors in the Australian flag resulted in five seconds per shading line on the 4051. The 4051 will usually keep slightly ahead of the Plotter.

Look at the flag in Figure 3 and compare the vectors digitized and the color to their right against the array in Figure 4.

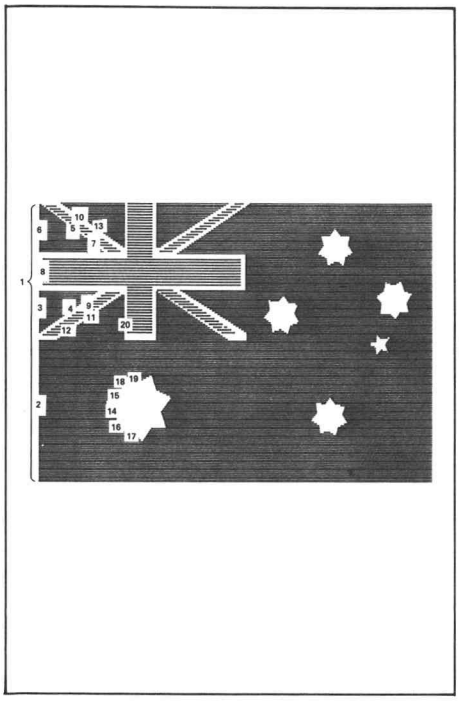


Fig. 3. Twenty vectors on the flag have been identified according to their sorted position in the array. They were not necessarily digitized in this order.

X1	X2	Y1	Y2	COLOR
0.00	0.00	0.00	100.00	0
0.00	0.00	0.00	50.94	1
0.00	0.00	53.24	67.92	1
0.00	22.50	53.41	69.11	0
0.00	23.50	99.32	81.66	0
0.00	0.00	81.66	99.40	1
1.59	25.18	99.32	82.34	2
1.68	1.68	70.31	80.03	2
1.68	25.52	52.56	68.52	2
4.95	29.55	99.32	82.17	0
6.55	30.13	50.94	67.15	1
6.72	30.22	52.56	68.60	0
7.39	30.22	99.74	83.79	1
23.50	27.78	28.58	24.06	0
23.67	29.04	28.75	32.17	0
27.11	27.62	18.09	24.06	0
27.11	32.74	18.26	18.94	0
29.21	29.63	32.17	38.05	0
29.63	35.25	38.05	35.04	1
30.13	30.22	50.94	67.06	0
30.22	30.22	83.96	100.00	0
31.90	31.90	52.65	70.39	2
31.90	31.90	79.00	99.57	2
126.63	129.48	70.37	72.18	0
127.21	129.23	57.00	60.90	1
129.32	132.34	60.90	61.87	1
129.48	130.66	72.18	60.56	1
130.41	133.52	60.56	67.18	1
131.50	132.26	64.00	61.87	1
131.50	133.35	63.82	67.36	1
150.00	150.00	0.00	100.00	0

Fig. 4. A partial listing of arrays which conatin the coordinates and color coding of 112 vectors to produce the Australian flag.

Color legend: 0 = white or blank
1 = blue
2 = red

Editor's Note:

Mr. D'Hondt used the Editor ROM to sort the vectors into minimum and maximum X-coordinates. Since not all readers have the ROM, we included a short sorting program for this task. Also, Mr. D'Hondt used a matrix to store the vector coordinates and color number. We converted this to one dimensional arrays to achieve faster scanning times.

LISTing Program or Data Over the Option 1

by Martin Guiver

European Marketing Centre
Amstelveen, The Netherlands

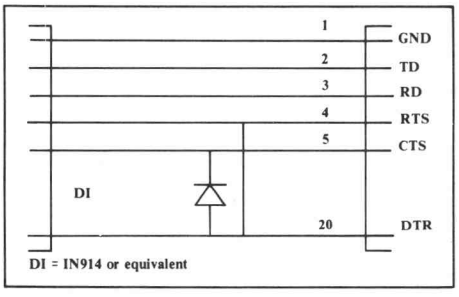
There are several ways to list program or data to a printer over the Option 1 Interface:

1. Using the 4050A08 Utilities "list" program is probably the best for listing BASIC programs. It has extended formatting capabilities, overcomes the printer buffer and control character problems and is easily adapted for use with the 4907. Simply plug your printer cable into the Option 1 Interface.

2. A very simple way to list tape data and programs *not containing control characters** is found in using the tape communication facilities of the Option 1; a sample program is given in Figure 1.

   Since this program uses **half duplex mode**, the "buffer not full" line of the printer (DTR) can be used to drive RTS/CTS. The hardware modification necessary to your printer plus is diagrammed in Figure 2. This program runs on our 4050/4641-1.

```
100 INIT
110 CALL "RATE",2400,0,2
120 CALL "MARGIN",0,2,1
130 PRINT "FILE    ";
140 INPUT F
150 FIND F
160 CALL "DTSEND"
170 GO TO 130
```



Editor's Note:

The buffer won't be overrun but control characters will be executed. To overcome this constraint, perform these additional steps:

1. *OLD the program you wish to list*
2. *FIND an empty file large enough for your program*
3. *Type LIST @33,12:*
4. *When tape movement stops, type CLOSE*
5. *Now, run the listing program on this file*

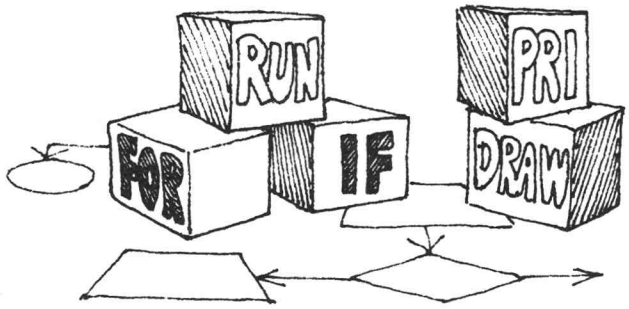
This formats the program on the tape so control characters will appear in the listings and won't be executed. **Do not** *use this new file as your original program; control characters will not execute.*

Another 4050 Series Interface, the Option 10 RS-232-C Printer Interface, housed in a ROM pack, allows you to output data from your 4050 System to an RS-232-C compatible printing device with one statement:

LIS @41: (or LIS @51:)

It handles the printer buffer timing, handshaking and control characters. *You don't need an Option 1, although it may be plugged into an Option 1 backpack. Other commands and environmental control statements may also be used with the Option 10.*

BASIC BITS



Displaying Quotation Marks

by Bill Markwart

Tektronix, Inc.
Wilsonville, OR

If you want your 4050 System to display quotation marks with a PRINT command, keep in mind you'll need *two* quote marks for each one you want displayed, *plus* the normal first and last quotes to delimit the character string. For example:

```
100 PRINT "THE ""CRAZY"" COW JUMPED"
```

and

```
110 PRINT """CRAZY"" COWS JUMP"
```

RUNning these statements produces the following displays:

```
THE "CRAZY" COW JUMPED
"CRAZY" COWS JUMP
```

Although covered in the 4050 Series Graphic System Reference Manual[1] and the PLOT 50 Introduction to Programming in BASIC Manual[2], a new programmer may overlook the requirements to PRINT question marks.

---

[1] Language Elements—String Constants.

[2] Essentials of BASIC—Outputting String Constants.

Programming Tip Exchange

Send in your programming tip. Any one of the following 4050 Series Applications Library programs will be yours when it's published. Simply jot down a brief description of the function, the code, and your choice of program. Mail it to the 4050 Series Applications Library serving you; Library addresses are listed at the back of each TEKniques issue.*

51/00-0501/0	51/00-6002/0
51/00-0901/0	51/00-8004/0
51/00-1403/0	51/00-8017/0
51/00-1603/0	51/00-8022/0
51/00-4002/0	51/00-9507/0
51/00-5204/0	51/00-9533/0

***Documentation and listing only.**

4050 Series Applications Library Program Abstracts

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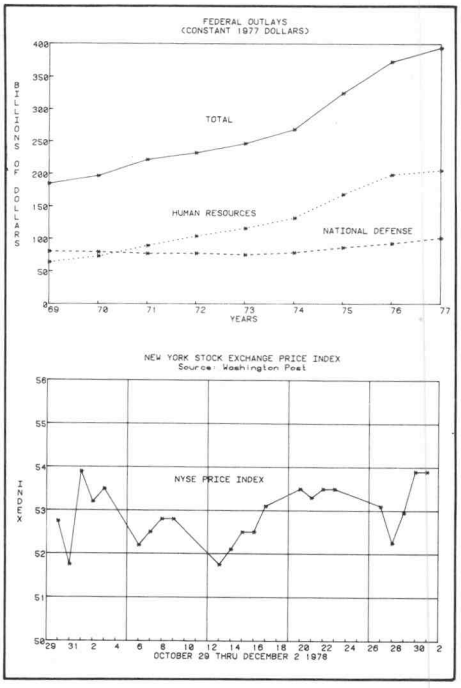
ABSTRACT # 51/07-0906/1

Title: **TIMESERIES II**
Author: Mallory M. Green
U.S. Dept. of H.U.D.
Washington, D.C.
Memory Requirement: 32K
Peripherals: 4952 Joystick or
4662 Plotter
Optional—4907 File Manager
4051R05
Statements: 1199
Files: 3 ASCII Program
Requires data files for storage

This is a revised version of 51/00-0906/0; the purpose of the revision was to make a large number of small improvements in the operation of the program.

The program has the following features:

1. An easy to use prompted chart definition mode.
2. The following output methods:
   a. Tabular display on screen
   b. Drawn on screen
   c. Plotted on plotter in one color
   d. Plotted on plotter in multiple colors
3. Compatibility in approach and data format with BARGRAPH II.
4. Storage of chart definitions on either tape or disc.
5. Easy modification of charts via User Definable Key routines.
6. Three program overlay modes:
   a. ASCII tape overlaying
   b. Binary tape overlaying
   c. Binary disc overlaying
7. A maximum of up to 6 data lines of up to 35 time periods each.



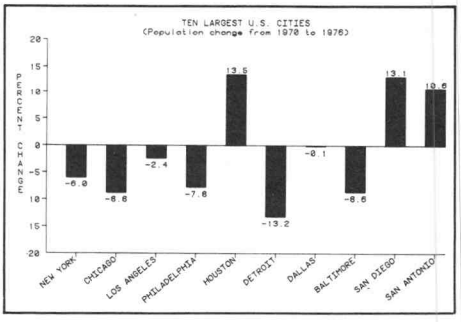
ABSTRACT # 51/07/0907/1

Title: **BARGRAPH II**
Author: Mallory M. Green
U.S. Dept. of H.U.D.
Washington, D.C.
Memory Requirement: 32K
Peripherals: Optional—4662 Plotter
4907 File Manager
4051R05
Statements: 1524
Files: 4 ASCII Program
Requires data files for storage

This is a revised version of 51/00-0907/0; the purpose of the revision was to make a large number of small improvements in the operation of the program.

The program has the following features:

1. An easy to use prompted chart definition mode.
2. The following output methods:
   a. Tabular display on screen
   b. Drawn on screen
   c. Plotted on plotter in one color
   d. Plotted on plotter in multiple colors
3. Approach and data compatibility with TIMESERIES II.
4. Chart storage on either tape or disc.
5. Easy modification of charts via User Definable Key routines.
6. Three program overlay modes:
   a. ASCII tape overlaying
   b. Binary tape overlaying
   c. Binary disc overlaying
7. A maximum of 20 groups of up to 4 bar types per group.



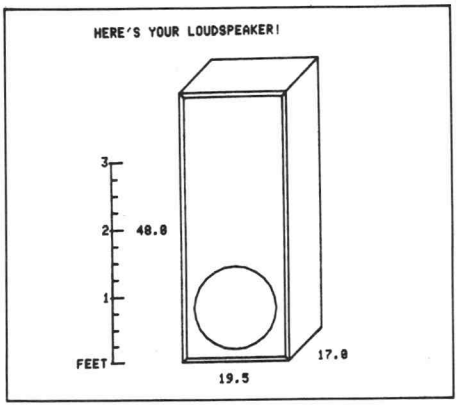
ABSTRACT # 51/00-1406/0

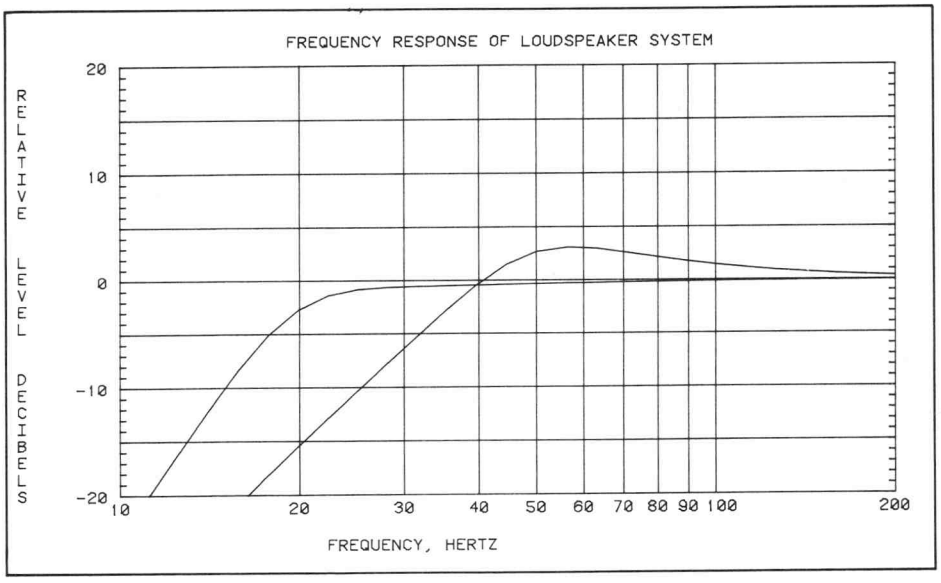
Title: **POWERFULBASS**
Authors: Ronald Glosemeyer
David Lee
Naval Ship R&D Center
Bethesda, MD
Memory Requirement: 16K
Peripherals: Optional—4631 Hard Copy Unit
4662 Plotter
Statements: 437
Files: 1 ASCII Program

POWERFULBASS—Program for **O**ptimizing **W**oofer/ **E**nclosure **R**esponse at **F**requencies **U**nder**L**ying the **B**asic **A**udio **S**ound Spectrum

By knowing three basic electromechanical properties of a woofer, this program allows the user to:

1. Determine the optimum enclosure volume.
2. Enter a desired volume (or bass cutoff frequency) and see the resulting cutoff frequency (or required enclosure volume).
3. See the required enclosure tuning frequency.
4. See the resulting system efficiency.
5. Obtain a plot of the theoretical frequency response at low frequencies.
6. Determine the "ideal" enclosure dimensions.
7. Set any two enclosure dimensions and see the third.
8. "See" a scaled drawing of the completed speaker enclosure.





ABSTRACT # 51/00-5406/0

Title: **Mass Properties**
Author: P.C. Holman
University of Wisconsin
Stevens Point, WI
Memory Requirement: 16K
Peripherals: None
Statements: 451
Files: 4 ASCII Program

The program consists of four separate programs:

1. Mass properties of a right circular cylinder.

   This program computes the following mass properties for a right circular cylinder:

   a. Volume in cubic inches
   b. Weight in pounds
   c. Z centroid in inches
   d. Ix, Iy, Iz, Ixl, and Iyl weight moments of inertia in pounds per square inch
   e. Px, Py and Pz radii of gyration in inches

2. Mass properties of a cube

   This program computes the following mass properties for a cube:

   a. Volume in cubic inches
   b. Weight in pounds
   c. X, Y, and Z centroids in inches
   d. Ix, Iy, Iz, Ixl, Iyl, and Izl weight moments of inertia in pounds per square inch
   e. Pzl and Pz2 radii of gyration in inches

3. Mass properties of a hollow right cylinder—weight known

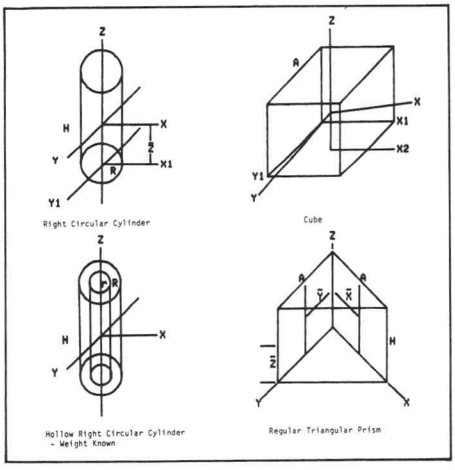
   This program computes the following mass properties for a hollow right cylinder where the weight is known:

   a. Ix, Iy, and Iz weight moments of inertia in pounds per square inch
   b. Px, Py and Pz radii of gyration in inches

4. Mass properties of a regular triangular prism

   This program computes the following mass properties for a regular triangular prism:

   a. Volume in cubic inches
   b. Weight in pounds
   c. X, Y, and Z centroids in inches
   d. Ix, Iy, and Iz weight moments of inertia in pounds per square inch
   e. Px, Py, Pz radii of gyration in inches



ABSTRACT # 51/07-6114/0

Title: **Journal Entry, Edit, Review & Search**
Author: Peter R. Hulick, M.D.
Lynchburg General Hospital
Lynchburg, VA
Memory Requirement: 16K
Peripherals: 4631 Hard Copy Unit
4907 File Manager
Statements: 386
Files: 2 ASCII Program
Requires user created data files

The first program is Journal Entry, Edit and Review. This program allows the user to enter onto disc storage the following:

1. Title
2. Principal author
3. Year of publication
4. Name of journal
5. Up to eight retrieval categories

Each article is stored in a 400 byte record on the disc, allowing the storage of 1500 records on one disc. The program allows retrieval of the data and updating or revision of articles previously entered.

The second program is Journal Search. This program will search the articles stored on the disc using one of the following formats:

1. Selected retrieval categories
2. Listing in numerical order of retrieval categories
3. Listing of all articles on the disc by record number

Articles retrieved are displayed on the screen and automatically copied on the 4631 Hard Copy Unit when the screen is full or the search ends.

```
PROGRAM TO SEARCH THE LITERATURE DISK FOR JOURNAL
ARTICLES BY RETRIEVAL CODE NUMBER
CHOOSE ONE OF THE FOLLOWING SEARCH METHODS:
 1 SEARCH BY SELECTED RETRIEVAL CATEGORIES
 2 ROUTINE SEARCH OF ALL RETRIEVAL CATEGORIES 1 - 86
 3 LISTING OF ALL ARTICLES ON THIS DISK

YOUR CHOICE? 1
YOU MAY SELECT UP TO FIVE RETRIEVAL CATEGORIES TO BE SEARCHED

INPUT HOW MANY CATEGORIES YOU WHICH TO SEARCH  3

WHICH DISK IS BEING SEARCHED?  0_

YOU MAY RESTRICH YOUR SEARCH TO RETRIEVE ANY ARTICLE WHICH
  SATISFIES ANY ONE OF THESE CATEGORIES, OR ALL 3 OF
  THESE CATEGORIES.

DO YOU WISH TO RETRIEVE ARTICLES SATISFYING
  1.  ALL 3 OF THESE CATEGORIES

  2.  ANY OF THE 3 CATEGORIES?

SELECT 1 OR 2 AND HIT RETURN KEY  1

ENTER RETRIEVAL CATEGORY 1 TO BE SEARCHED: 1_

ENTER RETRIEVAL CATEGORY 2 TO BE SEARCHED: 66

ENTER RETRIEVAL CATEGORY 3 TO BE SEARCHED: 67
```

```
SAMPLE TITLE

HULICK, PR

CANCER

 1980

ENTER ARTICLE NUMBER: 1

ENTER HOW MANY TOPIC RETRIEVAL CATEGORIES TO
   BE USED (MAXIMUM OF 8 PERMITTED):          5

ENTER THESE RETRIEVAL CATEGORIES ONE AT A TIME, AND
  HIT THE RETURN KEY AFTER EACH ONE.

     45
     66
     67
     3
     14
```

```
LISTING OF DISK 0 AS OF 05-FEB-80 15:32:31

MAL. PRIMARY MALIG. IN PTS WITH CUTANEOUS MELANOMA
  ARTICLE 0 1  BELLETT, RE  CANCER  1977   1.0 66.0 67.0

THE VALUE OF MICROSCOPIC CONTROL FOR DIFFICULT SKIN CA'S.
  ARTICLE 0 2  OLSHANSKY, K.  VIRGINIA MEDICAL  1978   1.0

ADJUVANT RAD. THERAPHY IN TX OF REG. LYMPH NODE METS FROM MAL MELANOMA
  ARTICLE 0 3  CREAGAN, ET  MEETING PROCEDURES  1979   66.0  1.0

LOCAL CONTROL OF MALIGNANT MELANOMA BY RADIATION
  ARTICLE 0 4  RAPPAPORT, AH  MEETING PROCEDURES  1979   66.0  1.0

COMBINATION HYPERTHERMIA & RAD. THERAPY FOR CUTANEOUS MAL. MELANOMA
  ARTICLE 0 5  KIM, JH  CANCER  1978   1.0 68.0 88.0

RADIOTHERAPY OF KAPOSI'S SARCOMA
  ARTICLE 0 6  HOLECEK, MJ  CANCER  1978   1.0 17.0 67.0

RADIATION THERAPY OF MALIGNANT MELANOMA
  ARTICLE 0 7  HABERMALZ, MJ  CANCER  1976   1.0 66.0

LETTER FROM PUBLIC HEALTH DEPARTMENT
  ARTICLE 0 8  ROSENBERT, SA  LETTER  1977   66.0  1.0

SEARCH COMPLETED  05-FEB-80 15:32:36
```

ABSTRACT #51/00-7003/0

Title: **FORTRAN to BASIC Converter**
Author: Mark R. Mehall
Tektronix, Inc.
Wilsonville, OR
Memory Requirement: 32K
Peripherals: 4924 Digital Tape Drive
4050R06 EDITOR ROM Pack
Statements: 979
Files: 2 ASCII Program
Requires 3 premarked ASCII data files

This program is designed to convert FORTRAN to 4050 Series BASIC. The program is based on the USA Standard FORTRAN, X3.9-1966. The FORTRAN statement labels, variables and subroutine names are changed to their BASIC counterparts and remembered for references throughout the program. The majority of FORTRAN statements are changed into BASIC by this program. The statements that are not directly compatible are made into REMARK's and can be modified using the EDITOR ROM or the 4050 Series Line Editor. The FORTRAN statements: READ, WRITE, FORMAT, IF, GO TO, DO, DIMENSION, CALL, END, RETURN, STOP, SUBROUTINE, and CONTINUE are automatically changed to BASIC. The FORTRAN internal routines are also converted to the corresponding BASIC routines.

The program also prints tables of corresponding FORTRAN statement numbers to BASIC line numbers, FORTRAN variable names to BASIC variables, and FORTRAN subroutine names to BASIC line numbers.

```
LIST
      :       I=0
      :       S=3.141593
      :       ROOT=1.7
      :1      ROOT=(ROOT**2+S)/(2.0*ROOT)
      :       I=I+1
      :       TEST=ROOT**2-S
      :       IF (TEST) 8,5,9
      :4      FORMAT(' PI**.5= ',F8.6/'0',I4,' ITERATIONS')
      :5      WRITE(3,4) ROOT,I
      :       STOP
      :8      TEST=-1.0*TEST
      :9      IF (TEST-.000005) 5,5,1
      :       END
```

```
LIST
      :  100 I=0
      :  110 S=3.141593
      :  120 R0=1.7
      :  130 R0=(R0^2+S)/(2.0*R0)
      :  140 I=I+1
      :  150 T0=R0^2-S
      :  160 GO TO SGN (T0)+2 OF  200,180,210
      :  170 IMAGE " PI**.5= ",ID.6D/"0",4D," ITERATIONS"
      :  180 PRINT USING 170: R0,I
      :  190 STOP
      :  200 T0=-1.0*T0
      :  210 GO TO SGN (T0-.000005)+2 OF  180,180,130
      :  220 END
```

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