

# Tekniques

The 4051 Applications Library Newsletter

Vol. 2 No. 7



Pictured here is a logging operation going on at the Six Rivers National Forest using a suspended cable system called a Skyline. The location of the head-spar (tall pole) at the yarder machine and the maximum load of logs is computed using the 4051.

## 4051 Helps Plan Resource Use at Six Rivers

by Thomas C. Bruce  
U.S. Forest Service  
Six Rivers National Forest  
Eureka, CA,

With Terry Davis and Pat Kelley

Demand for all kinds of resources is increasing the world over; forest resources are no exception. And sometimes the only way to manage that demand effectively is to reduce the time necessary to handle requests for those resources and accompanying services. At Six Rivers National Forest, the U.S. Forest Service is using a TEKTRONIX 4051 system to accomplish just such time

savings in the management of forest resources.

### It's a Big Job

The Forest Service of the U.S. Department of Agriculture manages land parcels across the United States. These lands include both forest and grasslands, and comprise a National Forest System. Forest System lands, in turn, produce a wide array of resources. The primary resources within the National Forest System are timber, water, forage, wildlife, and visual.

Six Rivers National Forest (Fig. 1) contains all of these resources. This area stretches from the Oregon border southward along the Pacific Coast. It's a long but narrow jurisdiction with many wilderness miles in its boundaries. There are no major airports nearby, few minor ones. Many roads in the Six Rivers National Forest are primitive. Six major rivers within the region give it its name. Mad River, Klamath, Smith, Trinity, Eel, and Van Duzen Rivers. All are known for their excellent fishing, another example of the resources present.

Of course management of such a wide array of natural resources must consider the intensified concern for environmental quality along with the increasing demands for resources. The goal of resources management is to fulfill the needs and desires of the many National Forest users which include skiers, hunters, loggers, fishermen, ranchers, hikers and others. All of these uses must be coordinated with the given land capabilities. Requests for resource use must also be coordinated to long and short range programs that Congress and the Forest Service have agreed to. Such a planning process entails a lot of data handling.

### Pressing Considerations

All Forest Service units are directed to develop a general land management program. The Six Rivers National Forest is in a unique position because of the controversies about land and resource use in the region, particularly

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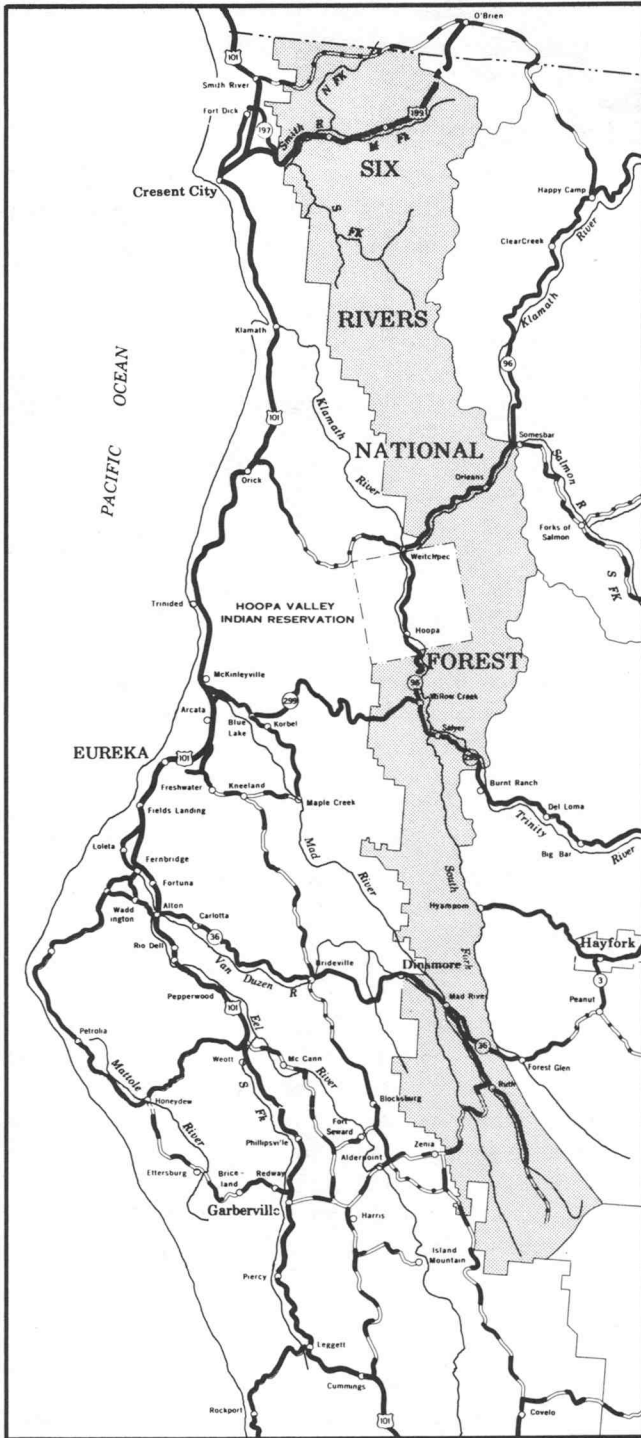


Fig. 1. The Six Rivers National Forest encompasses 1,120,657 acres in Northern California.

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regarding those giant trees, the redwoods. This has made it necessary to complete the Six Rivers land and resources plan by 1981. The plan must include environmental assessments, reports on physical effects of many possible ground activities, as well as predictions of social and economic impacts.

Formulating an overall direction for future activities requires planning for the future, "as we see the future now!". Public involvement is critical and hundreds of letters of opinion are being reviewed in preparing recommendations to Congress. Concurrently inventory assessments and demand forecasting are part of this planning process. The intent is to provide a long range, forest-wide planning system based on information that can be handled and retrieved in many ways. It is not possible to anticipate all the questions that will ever be asked. Such a system with its inherent public input is consistent with the Forest Service's long-standing management concept of Multiple Use and Sustained Yield. These Congressional directions are intended to provide the maximum benefits for the greatest number of people, now as well as in the future.

#### 4051 a Useful Tool

As demand for more detailed information continues to increase, the Forest Service has had to find new tools. At the Six Rivers National Forest, one of these new tools is a system based on the 4051 which includes a 4956 Graphic Tablet, a 4662 Plotter and several other peripherals (Fig. 2).

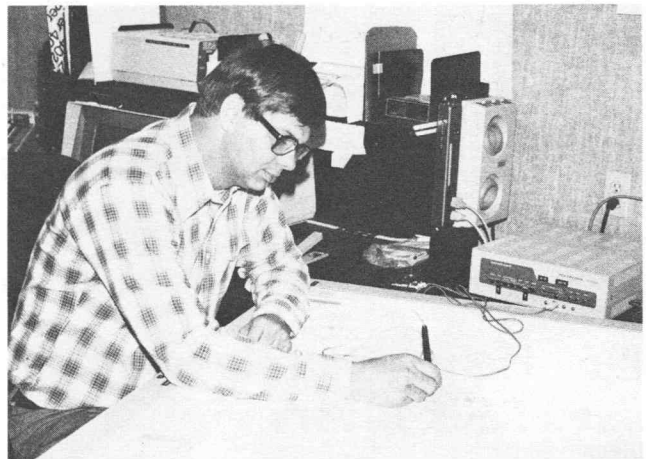


Fig. 2. Tom Bruce is using a 4051-based system to aid in developing a land management plan for the Six Rivers National Forest.

This system is accessible and set up to operate by forest resource specialists. These people are not necessarily technicians; their expertise is in their unique knowledge of the ground situation, functional skills, and the judgments necessary to analyze problems and develop solutions utilizing an information base that they develop and control. This data is not an end product, but rather the basis for providing visual displays, computer parameters, or simply lists of related resource inventories.

One information base is being assembled by Bruce Marcot, a wildlife biologist with the Fisheries and Wildlife group, and Jim Rogers, who has done the actual programming. They will look at some 400 vertebrate species in the Six Rivers Forest — mammals, amphibians, reptiles and birds. Each animal's response to successional changes in vegetative types from grassland to old growth trees will be examined and correlated with the vegetative data of Northern California. The related effects on breeding, feeding, nesting, season of use, territory size will establish the expected natural life history of each animal. For example, if an animal needs a minimum five acre patch of grassland surrounded by old growth forest for summer forage, we can pretty well infer that the animal will be missing from a two acre patch of grassland surrounded by a young stand of Douglas Fir. Similar files will be set up for fisheries with key stream habitat factors.

This biological information base was originally punched on cards and later transmitted to the 4051 using the new TEKTRONIX 4051C01 high speed interface which is being tested at Six Rivers. All of the data is very soft, and depends on the careful eye of the field biologist who still must authenticate many of the key habitat relationships. The 4051 is used as a tool for aiding, not replacing personnel. Once the data has been verified it will be sent to a remote UNIVAC 1142 computer at Fort Collins, Colo. for general use.

With these information bases on hand, inventories will be accessible before ground activity is started. We envision a resource specialist utilizing a broad range of informational elements before going into the field. Environmental analysis reports can be easily generated which determine the impacts on wildlife or timber production, for example. This information will not only assess what adverse impacts a particular land use might have but also what may benefit (Fig. 3). The system will look at all mitigating actions and their trade-offs.

| SPECIES          | TAXON ID NO. | LEGAL STATUS | ECOLOGICAL STATUS | NEST AXIS | CANOPY FORAGER | HABITAT USE MATRIX |        |
|------------------|--------------|--------------|-------------------|-----------|----------------|--------------------|--------|
|                  |              |              |                   |           |                | REDWOOD            | FOREST |
| BARN OWL         | B001         |              | CDM               | GM        | NO             | B > <              | > <    |
| SCREECH OWL      | B002         |              | CMH               | F         | YES            | F > <              | > <    |
| GREAT HORNED OWL | B004         |              | CDM               | IKND      | NO             | F > <              | > <    |
| PYGHY OWL        | B005         |              | UNC               | F         | YES            | F > <              | > <    |
| SPOTTED OWL      | B007         | 064B         | UNC               | EIMD      | YES            | B > <              | > <    |
| SAW-WHET OWL     | B010         |              | UNC               | F         | NO             | F > <              | > <    |

Fig. 3. A trial run from the biology data base shows that thinning a timber stand would benefit the screech owl and saw-whet owl. However, it would destroy the breeding and nesting habitat of the spotted owl which has a legal status.

### Field Design Programs

The system is being designed to be user oriented. The

ability to display questions and responses in terms that a biologist, logging engineer, or landscape designer understands provides a tool that the field design specialist needs. A package of field design programs is also available including Skyline Analysis (S.A.P.) and the Perspective/Stereo Projection Programs. These two programs were developed from research at Oregon State University and the Regional Forest Service in Portland.

Many forest habitat areas have critical ecological environment, for example, areas with thin soils or near stream sides. This means that logs cannot be harvested by dragging them across the ground. They must be entirely lifted or "flown". In Fig. 4, note the head-spar and tail-hold locations. In logging operations logs are brought up the side of a slope from the tail-hold to the head-spar where the yarding system is located. At the yarder the logs are collected and shipped to the mill. Of critical interest is the positions of the head-spar, tail-hold, road locations, cable size, and allowable cable tensions for a given yarder system. All of these parameters change as each portion of the ground is cut and logged. Besides the ecological impact logging would have, the economical feasibility must be considered. A logging road may have to be built on a ledge to haul out the logs with less environmental impact, for example.

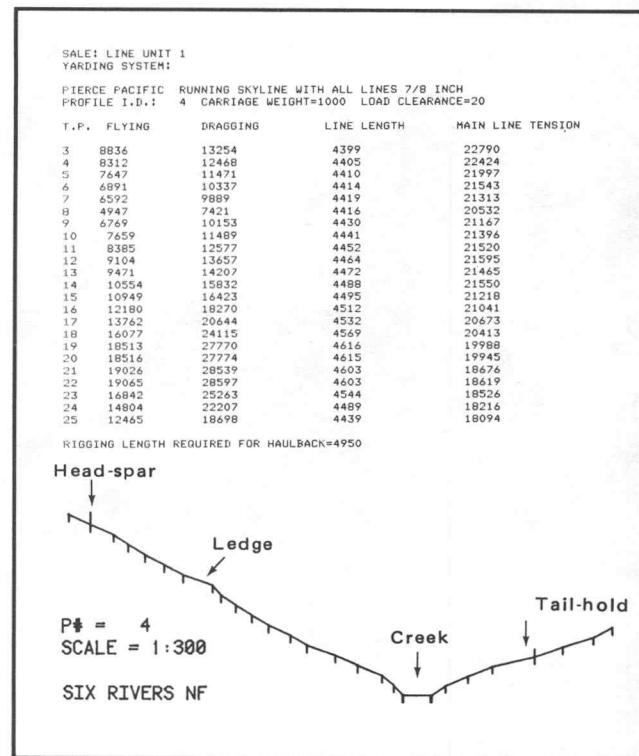


Fig. 4. A profile of a proposed log loading area, with alternative flying and dragging loads.

At Six Rivers the logging specialist, Bob McRae, is using the TEKTRONIX 36" X 48" graphic Tablet to measure hundreds of ground profiles for analysis using the 4051. Previously we had to estimate a particular configuration using a "chain and board" method—and hoped it worked.

It usually took 45 minutes for the solution that may have to be re-worked with different factors. It now takes about 30 seconds for a solution on the 4051. Now over 85 profiles, plots and tables, listing allowable load productions can be made in an eight hour day. We are not using district personnel, those closest to the field situations, to run their own analyses with similar equipment.

It is usually very difficult to tell how land will look after it has been cut or treated (not all timber is clear cut, as timber production is usually increased by thinning). It is even difficult to tell by just looking at a map or by standing at a site looking at the proposed treatment area. In the past, photographs of the proposed activity were used to develop sketches which would show trees, roads or whatever changes might be planned. Often the photos were difficult to interpret and the sketches were inaccurate.

Ward Blackburn is the landscape architect at the Six Rivers National Forest and the prime mover in getting a 4051 system there. Blackburn cites clear cutting of timber for ski slopes as one example of an extreme visual impact. When clear cut areas are shaped to the natural lines and slopes of the area, their visual impact can become complimentary for recreational users as well as to optimize animal habitat sites.



Fig. 5. Clearings for ski runs above the parking area follow form, line and texture of the natural landscape. (From "National Forest Landscape Management, Volume 2," Page 30, U.S. Department of Agriculture Handbook Number 462.)

Perspective/Stereo has been developed to provide field design specialists with a tool for evaluating the visual characteristics of a proposed treatment area. They can use the graphic tablet to digitize ridges, contour lines, cut-unit boundaries or any other land feature that can be drawn on a map. Other picture information, such as tree types, poles, and towers can be digitized and plotted along with the terrain data. The program can produce a scaled perspective view or a stereo plot (Fig. 6) from several critical viewing points. Looking through the stereo

viewer, its very simple to see if a proposed cut or road lies across a sensitive area. Many actual boundaries have been altered because of this. It is done rapidly, accurately, and doesn't require running out to the site to check.

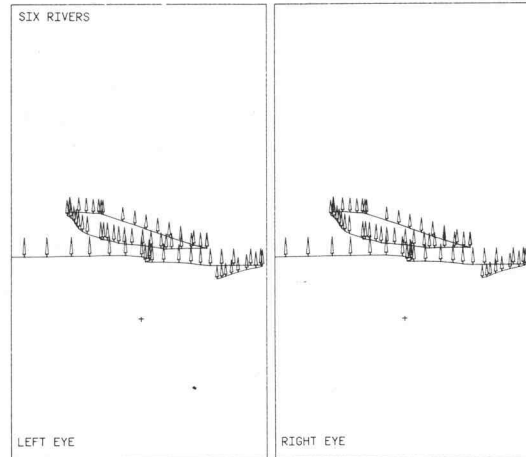


Fig. 6. Plots for use under the stereo viewer. Note the taller trees on the closer ridges.

### Land Mapping Program

The Land Mapping Package is at the heart of the system. It pulls all of the various inventories and applications together by utilizing a common data structure. The Forest is divided into large "management compartments" and each compartment is sub-divided into "land-type polygons". Functional resource specialists then lay out their resources on these compartment maps. Their main concern is to be able to generate a summary of characteristics for various combinations of polygons. The program can selectively plot single or aggregated areas, compute areas, and can plot overlays of various resource layers including linear features such as stream and road networks. Fig. 7 shows a plot from the Land Mapping Package.

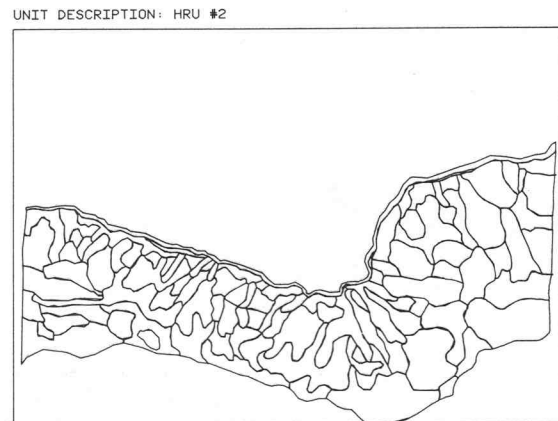


Fig. 7. Management compartments are broken down into polygons of resources.

These maps will show where streams and roads are in relation to timber stands, for example. If a main road is being proposed, other specialists must know what's there

before a work plan can be developed. Past work is examined to prevent placing one clear cut next to another. The system shows the results of a particular action before it is even put into motion.

Much of the system's local intelligence resides in the graphic tablet itself. The menu-type control pad (Fig. 8) on the tablet is the key to the use of the tablet. This pad can be placed in any position convenient to the user. By digitizing its corner the 4051 "knows" the pad's location and therefore the location of the characters and control functions within the pad. This allows users to digitize, label and control the digitizing process using maps and field notes that they're used to.

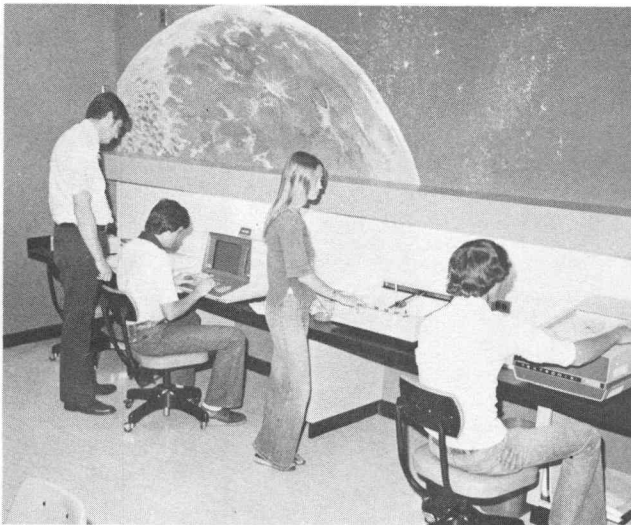
|       |   |   |   |     |   |   |
|-------|---|---|---|-----|---|---|
| A     | B | C | D | E   | F | G |
| H     | I | J | K | L   | M | N |
| O     | P | Q | R | S   | T | U |
| ↖ (S) | 7 | 8 | 9 | V   | W |   |
| ↙ (F) | 4 | 5 | 6 | X   | Y |   |
| ↘ (R) | 1 | 2 | 3 | Z   | , |   |
| ↗ (B) | 0 | - | . | (H) | ● |   |

Fig. 8. The control pad for the 4956 allows the user to concentrate on his mapping task.

The specialist's attention is on the map. He is thinking about what is in front of him and doesn't want to break his train of thought by having to turn his attention back to the computer system. The pad can be used to enter a descriptive label for each feature without having to type it in. Simply hitting the alpha pad spells out the label. In addition, four digitizing functions are included for measuring a contour map: uphill, level, downhill, and change contour interval.

The pad also contains several error correcting functions; you can backspace or delete a series of previous points. Or, if you have digitized 10 points and found that you were going downhill instead of up, you can redo from the beginning of the downhill journey instead of having to backspace those 10 points to wipe them out. Also an automatic labeling and re-draw function have been provided.

The 4051 system is aiding Six Rivers National Forest personnel in a complex and pressing task. Current efforts to build the plan and meet the deadline prevent sparing manpower to help others build a similar system. Like the Forest Service Fire Lab (TEKniques Vol. 2, No. 2) we wanted to share our application in hopes that it may help others define and develop similar plans to solve comparable problems. **TEKniques**



An up-to-the-minute laboratory provides an ideal environment for Oklahoma State Tech drafting technology students.

## Oklahoma State Tech Meets the Future with 4051-Based Computer Aided Design

Knowing that an ideal environment often stimulates the learning process, Oklahoma State Tech drafting technology instructors designed a unique lab for their Tektronix computer-aided drafting equipment. They

wanted a lab that would both inspire students and also serve as a public showcase to demonstrate new horizons in drafting skills.

And now that the lab is complete, both visitors and students readily agree that the instructors have succeeded.

Forget your image of a typical college drafting lab—rows of wooden drafting tables, tall drafting stools and bright lights. This lab has no drafting tables or high stools. Around the room's perimeter are specially designed desktop units to accommodate Tektronix' computer graphic equipment. And the lights have been dimmed so students can more easily read information on the graphic computer terminal screens on which they develop their programs.

Catching the first time visitor's eye is a massive Moonscape that dominates one wall. The lunar scene was painted by Forrest Johns, head of Tech's Drafting Technology Department. It's a constant reminder, instructors note, of the space-age technology being taught in this course.

Oklahoma State Tech, the residential, technical branch of Oklahoma State University located at Okmulgee, has more than 150 full-time students enrolled in its three drafting programs of study—technical drafting, industrial drafting and technical illustration. The computer

graphics course is a 75 class-hour elective taught daily each 15 week trimester.

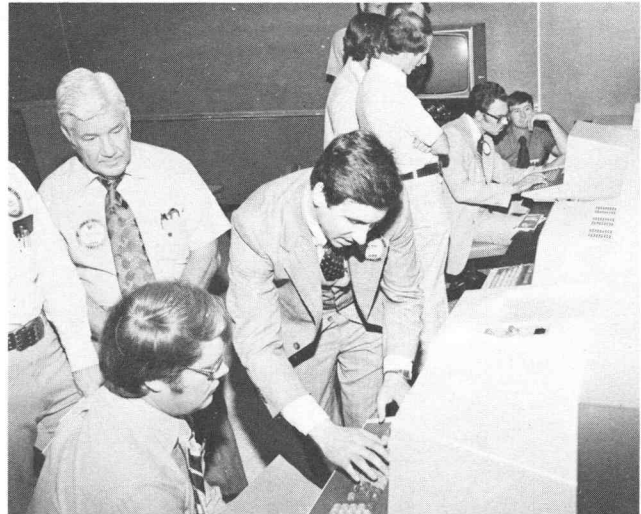
"We've been teaching computer graphics for several years, but always had to rely on someone else's equipment primarily because of the cost, according to Don Wills, one of the course's instructors. "But the new microprocessor-based Tektronix 4051 system and its related hardware finally has put the cost of such modern equipment within our budget," Wills said.

Tech's computer aided drafting course is directed toward providing students with an in-depth introduction to such equipment.

"We stress the basics of programming, utilization of each part of the system, and discuss the capabilities of such equipment," Johns notes. "We are not training our students to be programmers. Rather we are more concerned that they become familiar with computerized equipment so they can easily adapt when they get on the job and have a need to use such equipment."

Tech's computer aided drafting lab includes three 4051 graphic systems, two 4662 Digital Plotters, one 4956 Graphic Tablet, and a 4631 copier. A 4952 Joystick and 4641 Printer complete the system.

"Our Tektronix equipment more than proved its worth within the first week it was installed," Wills noted. "The administration presented us with a rush job of preparing 50 graphs needed in less than two days. Imagine their surprise when we handed them the finished graphs, produced by the Tektronix system, in a matter of a few hours." **Techniques**



Mark Mehall (hands on keyboard), Tektronix Systems Analyst, explains a procedure to one of the participants in a seminar hosted by Oklahoma State Tech at Okmulgee, OK.

## The 4051/7912AD: An Automatic Waveform Acquisition System

By Jim Kassebaum and Jim Kimball

When you need waveform processing but don't need the speed of standard waveform processors, you'll like the economics of interfacing the TEKTRONIX 7912AD Programmable Digitizer to the TEKTRONIX 4051 Graphic System. It's a direct connection, thanks to the IEEE 488 General Purpose Interface Bus (GPIB).

The 7912AD, with its 7A16P Programmable Amplifier and 7B90P Programmable Time Base plug-ins, is a fully programmable waveform digitizer. Input sensitivities, offset, sampling rate—all important front-panel controls can be operated either manually or under 4051 program control.

The 4051 itself provides general waveform processing capabilities. If you need more or want to go faster, there's the possibility of an RS-232-C link to a host computer.

Putting the 4051/7912AD combination to work does require some applications programming. The authors developed routines for a typical system that might be used at either a research or a production site to acquire,

process, store, and display data. Besides the 4051 system controller and the 7912AD with programmable plug-ins, two monitors are used to display acquired waveforms. There is a TV monitor for a real-time display of the 7912AD input, and an XYZ monitor for a refreshed display of the digitized waveform once it is stored in the 7912AD data memory.

Although the 7912AD is useful for viewing very fast



The Tektronix 7912AD Programmable Digitizer with its 7A16P Programmable Amplifier and 7B90P Programmable Time Base plug-ins (lefthand side of front panel) operates under program control from the 4051. Sitting on top of the 7912AD, an XYZ monitor and a TV monitor display the digitized waveform in 7912AD data memory.

transients, its main function is acquiring transients as data and transferring the data over the GPIB for processing. Therefore, data is recovered from the scan converter by detecting the trace written on a diode matrix, in a manner similar to plotting the X-Y coordinates of points on an oscilloscope trace. Rather than a single pair of X-Y coordinates to represent a data point, however, two Y values are detected by the 7912AD for each X: one Y represents the top of the trace at that point and another Y represents the bottom of the trace. The distance between these two Y values is caused by trace width, which varies with waveform shape, sweep speed, waveform repetition rate, and writing beam intensity.

This is not as complicated as it might appear to be, however, thanks to an internal bit-slice microprocessor system. This system has several routines in firmware that can massage the data before transferring it over the GPIB. One routine, ATC (average-to-center) is especially handy with a controller such as the 4051. The ATC routine converts the raw data to a single-valued function by summing the top and bottom trace values and filling in any missing points.


A digitize/average statement is used to initiate a digitize operation on the next time-base sweep. It then resets the instrument mode for a TV display of the input waveform. If the waveform is repetitive, the TV monitor and XYZ monitor both display the waveform, the TV in real-time

and the XYZ as a plot of ATC-processed data.

Although the ATC waveform format is the simplest and reduces much of the burden of further processing, it may not provide the ideal data for all applications. For this reason, the full internal data array as well as the data arrays that result from several other internal processing routines can be read out over the GPIB.

To see the waveform, graph the data on the 4051 screen. A graticule can be simulated by a box with tic marks around the viewing area. The data plot can be scaled by reading in the scale factors.

Thanks to the common use of the GPIB, the 4051, 7912AD, 7B90P, and 7A16P can be easily connected and can be programmed to play together as an automated waveform acquisition system.

Editor's Note: An in-depth discussion of the interfacing details, programming, and data appears in the summer publication of **Handshake**. **Handshake** is provided free of charge as a forum for people interested in digital signal processing. Obtain a copy by writing: 

HANDSHAKE Editor  
Group 157 (94-384)  
Tektronix, Inc.  
P.O. Box 500  
Beaverton, Or 97077

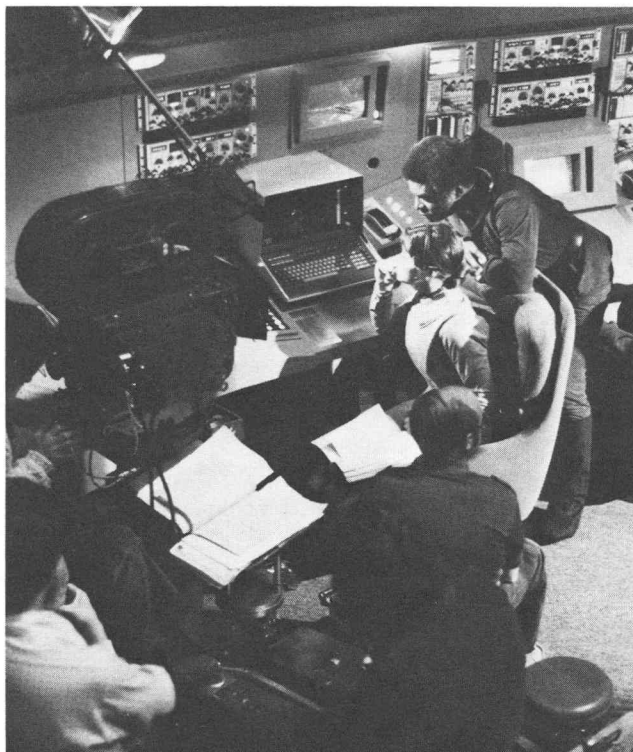
## 4051 Guides Spaceship in TV Series

Ten 4051 Graphic Systems and other Tektronix instruments will be guiding the "Battlestar Galactica" through outer space this fall. The show, named after the spaceship, is a new science fiction extravaganza released as a television series by Universal Studios and ABC in late September.

Battlestar Galactica is the most ambitious undertaking ever for a television production. Budget for the first three-hour segment exceeded \$7 million. The Special Effects Director is John Dykstra, who won a 1978 Oscar for special effects in "Star Wars."

Use of Tektronix equipment evolved from a discussion between Mickey Michaels, Universal's Set Designer, and one of the Tektronix District Sales Managers. Tektronix equipment was chosen for its quality and technological sophistication to lend an air of authenticity to the control bridge of Galactica.

Several hundred Tektronix instruments are used on the bridge, in the cockpit and at all battlestations, plus in the control room along three walls. Mr. Dykstra has been



Starship crew members study 4051 screen on the set of "Battlestar Galactica."

working with Tektronix Field Engineers to program the equipment to function in real time and with real readouts to reflect the events being portrayed.

In the communications center of the imaginary ship, the 4051's represent controllers. They report the status of communication channels, and switch from channel to channel as need dictates. They also act as message transmitters and receivers.

At the flight operations console, 4051's simulate controllers and data transmitters for spaceship control functions such as pitch and yaw information, navigation and engine control.

The 4051's graph all data being generated for the Galactica crew. Thus, the crew assimilates the data quickly through visual interpretation. It is envisioned that this type of visual communication with a computer will actually be the predominant information vehicle in the future.

The TEKTRONIX 4081 Interactive Graphics Terminal is

used for real time fighter target display, enemy spaceship identification, and acts as the commander-in-chief's personal console. The hard copy units record the graphics output on the display screens.

Oscilloscopes and other test instruments and instrument modules from Tektronix Test and Measurement Group monitor the ship's electronics functions like engine temperature, fuel supply, navigations and systems operation.

The first episode shown Sept. 17, included an hour inside the spaceship where Tektronix instruments played their parts. The instruments will also be important in the succeeding episodes. Outside the United States the movie "Battlestar Galactica" is a feature film in movie theaters. The feature was scheduled in Canada, Europe, and Japan this summer.

People are finding graphics a fast and efficient way to communicate with a computer. It is only appropriate then that the 4051 make its television and movie debut representing the way of the future in control and communication. **Tekniques**

## New ROM Pack—Adds Fast Graphing and Data Analysis Functions to the 4051

by Dave Barnard

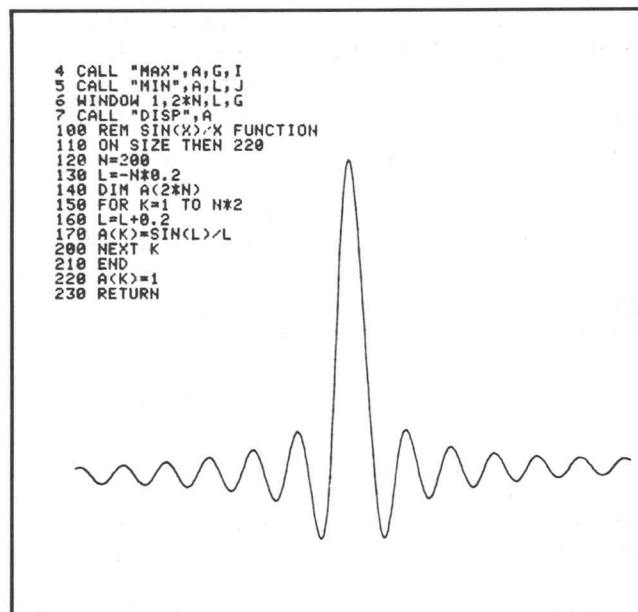
The 4051R07: Signal Processing ROM Pack #1 adds seven new functions to the 4051. The functions locate minimum, maximum, threshold crossing, determine derivative (slope), integral (area) or perform fast unlabeled screen graphing of data with just one 4051 BASIC statement per function.

You can execute all seven functions — MIN, MAX, CROSS, DIF2, DIF3, INT, DISP — directly from the 4051 keyboard, or you can incorporate them into a BASIC program. ROM Pack algorithms perform 2 to 10 times faster than equivalent BASIC programs, and the functions consume no memory. The functions are added by simply plugging the 4051R07 into one of the two slots provided in the 4051.

The data must be able to fit into 4051 memory as a sequence of numeric values. The only special restriction on data is that it must be in a one dimensional array when accessed by the ROM Pack functions. Data may be sales revenue per period, strip chart data or anything in between.

The seven functions are:

- "MIN" (Minimum) performs a fast search of the data and returns both the lowest numeric value and its location in the data array.
- "MAX" (Maximum) is similar to "MIN" but returns the value and location of the largest numeric value in the data array.
- "CROSS" (Crossing) locates points where data meets or exceeds a threshold. The threshold



A fast graph of SIN(X)/X using three functions of new 4051R07 ROM Pack.



and crossing (1st, 2nd, or nth) are programmable. "CROSS" simplifies comparing large amounts of data to a baseline. Determining when actual data exceeds forecast (sales, for example), is simplified.

- "DIF2" (2 point difference) provides a simple forward two-point derivative (slope) of specified data. Time-series analysis, contour studies, inflection point determination are all much easier using a simple call "DIF2" statement. "DIF2" is designed to make accurate slope estimates of rapidly varying data.
- "DIF3" (3 point difference) resembles "DIF2," but uses a three point algorithm for closer approximation to an ideal derivative. "DIF3" will yield more accurate results than "DIF2" for data that is less varied.
- "INT" (Integral) determines the area under the curve of specified data using a trapezoidal approximation to an ideal integral. The "INT" function can rapidly convert sales-per-period data into annual or total sales, or can rapidly handle area determination for analytical applications in several scientific disciplines.
- "DISP" (Display) simplifies graphing of raw data or results of other commands. Graphing is accomplished in half the time required by an equivalent routine programmed in 4051 BASIC.

Even a minimal use of these added functions can simplify the use of graphics on the 4051. For example, data or process results of unknown numeric range can be graphed with the MIN, MAX, DISP and one other command — WINDOW built into the 4051 BASIC language. Use "MIN" and "MAX" to find the data limits and assign them to variables used by the WINDOW command. Then use "DISP" to give unclipped graphing of all the data. The ROM Pack permits putting all the data on the screen even

if the data range is unknown in just four 4051 BASIC statements:

```
4 CALL "MAX",A,G,I
5 CALL "MIN",A,L,J
6 WINDOW I,N,L,G
7 CALL "DISP",A
```

Fig. 1. Four line data graphing routine. Line 4 assigns MAXimum values to Y2; Line 5 assigns MINimum values to Y1; Line 6 uses these two values plus total number of points (2N) to set the window. Line 7 graphs the array.

The ability to automatically set the graphics window to fit the data is important whenever the data range is unknown. Even if the data limits are known, the derivative or integral of the data may not be known exactly beforehand. The program listed graphs the N values found in array "A" every time User-Definable key #1 is depressed. All the variables must be defined before using the routine, or an error message results. A summary of the commands and their parameters is included in Figures 2 and 3.

```
CALL "MAX",a,M,I
CALL "MIN",a,M,I
CALL "CROSS",a,t,I
CALL "CROSS",a,t,I,n
CALL "DIF2",a,B
CALL "DIF3",a,B
CALL "INT",a,B
CALL "DISP",a
```

Fig. 2. Feature commands and parameters.

```
a VECTOR ARRAY INPUT
B VECTOR ARRAY OUTPUT
I INDEX OUTPUT
M MINIMUM OR MAXIMUM OUTPUT
n Nth CROSSING INPUT
t THRESHOLD INPUT
```

Fig. 3. Legend for parameters.

Other functions could be assigned to the remaining User-Definable keys. For added information on this ROM Pack, you should contact your nearest Tektronix representative. Ask about 4051R07: Signal Processing ROM Pack #1. **Techniques**

## The 4051R06 EDITOR: Sorting Operations

by Cathy Cramer

(This is the third in a series of articles on the 4051R06 EDITOR ROM pack.)

The 4051R06 EDITOR ROM pack provides two sorting commands, SORT and REVSORT (REVERSE SORT). Both allow you to sort data or text of any kind. They're a lot faster than BASIC programs that perform the same sorting operations. And because they're ROM pack commands, SORT and REVSORT don't take up any 4051 memory space.

SORT and REVSORT rearrange lines according to the ASCII values of characters in certain positions within each line. You specify the positions when you enter the command. For example, SORT 100,500:1,2,3 rearranges lines 100 through 500 according to the ASCII values of the first three characters in each line.

You can specify as many character positions as you want, and in any order you want. Sorting begins with the last position you specify, and ends with the first position. For example, REVSORT 100,500:4,3,1,2 rearranges lines 100 through 500, first according to the second character in each line; then according to the first character; then according to the third; and finally, according to the fourth character.

**SORT** arranges the lines so the ASCII values increase from line to line. You can use it to alphabetize names, and arrange lists of numbers in increasing order. **REVSORT** arranges the lines so the ASCII values **decrease** from line to line. You can use it to "reverse alphabetize" names, and arrange lists of numbers in decreasing order.

The following example shows the **SORT** command being used to alphabetize a list of names:

```

L
1:Zimmerman, Neil D.
2:Millstrom, A. A.
3:Carmichael, David
4:Brockway, Marius E.
5:Harvey, Richard A.
6:Taylor, Owen
7:Gardner, Keith W.
8:Foster, Alice
9:Siebold, William B.
10:Lentz, John F.
11:Sloan, Irene
12:Pollock, Robert
13:Kearney, John D.
14:Ellis, Terry L.
15:Keller, Suzanne

SORT 1,15:1,2,3

L
:Brockway, Marius E.
:Carmichael, David
:Ellis, Terry L.
:Foster, Alice
:Gardner, Keith W.
:Harvey, Richard A.
:Millstrom, A. A.
:Kearney, John D.
:Keller, Suzanne
:Lentz, John F.
:Pollock, Robert
:Siebold, William B.
:Sloan, Irene
:Taylor, Owen
:ZIMMERMAN, Neil D.

```

In the example, an initial listing obtained by entering **L** for **LIST** shows that the text consists of fifteen names. The command **SORT 1,15:1,2,3** is given to sort lines 1 through 15 according to the first three characters in each line. (For this particular list, no two names are identical in the first three or more positions; so you need only specify positions 1, 2, and 3 in the **SORT** command to correctly alphabetize the list.)

After the **SORT** command, a new listing shows that the names are completely alphabetized. The line numbers to the left of each line have been removed by the **SORT**

command. You can obtain new line numbers by executing a **RENUMBER** command.

In the following example, the **REVSORT** command is used to arrange numbers in decreasing order:

```

L
1:SALESMAN
2:
3:CLIFFORD          $  920,000
4:ETHERIDGE        $  150,990
5:GLINES           $  249,800
6:KINTZ            $  820,000
7:LENZ             $  950,300
8:NOAKES           $  433,600
9:PARKER           $  1,320,500
10:SAUER           $  1,570,000
11:THOMPSON        $  720,400
12:VAN DYKE        $  565,300
13:VERMIERE        $  450,800
14:WENTWORTH       $  1,102,000

REVSORT 3,14:33,34,35,36,37,38,39,40,41

L
1:SALESMAN
2:
:SAUER             $  1,570,000
:PARKER            $  1,320,500
:WENTWORTH         $  1,102,000
:LENZ              $  950,300
:CLIFFORD          $  920,000
:KINTZ             $  820,000
:THOMPSON          $  720,400
:VAN DYKE          $  565,300
:VERMIERE          $  450,800
:NOAKES            $  433,600
:GLINES           $  249,800
:ETHERIDGE         $  150,990

```

The initial listing obtained by entering **L** shows a list of names and amounts sold. The **REVSORT** command is used to rearrange the lines so that the numbers in the **AMOUNT SOLD** column decrease.

The numbers appear in positions 33 through 41 of lines 3 through 14, so the command given is **REVSORT 3,14:33,34,35,36,37,38,39,40,41**. After the **REVSORT** command is executed, a new listing shows that the lines have been correctly arranged so that the numbers in the **AMOUNT SOLD** column decrease.

These articles on the Editor ROM have provided a basic understanding of how the **EDITOR** works, and what it can do for you. We haven't attempted to cover all of the **EDITOR**'s commands and features. If you've found features or have applications that you'd like to share with other readers, write and let us know. **Techniques**

## Interfaces Increase Versatility of 4051

by Pat Kelley

If you want to use a 4051 with equipment not designed for use with the GPIB, there are two interfaces that may be your answer. With these the 4051 is compatible with your devices that require ASCII, BCD or Binary in a parallel format, but that do not require high data rates. Examples are paper tape readers/punches, multimeters, counters, function generators, power supplies, spectrometers, and so on.

The General Purpose Output Interface (CM021-0211-00) and the General Purpose Input Interface (CM021-0212-00) each consist of two 26-wire microribbon cables with 25-pin female connectors on each, and a ROM pack. Two male connectors are supplied with each which you wire to your peripheral cables.

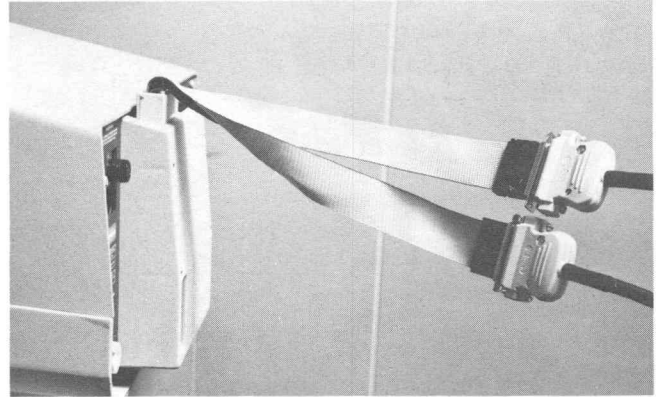
The male and female connectors must be pin-to-pin compatible and explicit directions are given in the manuals accompanying the interfaces. Once your peripheral cable is wired, simply plug these two connectors together and insert the ROM pack into the backpack of your 4051 or into your ROM Expander unit. If you need only 16 data-command lines, only one connector

need be wired to your peripheral cable.

The many programmable parameters, each of which has two or more values from which to choose, give the interfaces their flexibility. Only four statements are required to set these parameters. The parameters are: data code, number of data lines, data logic, commands, number of command lines (data-command lines cannot exceed 40), command logic, interrupts, handshake, data flag and four transfer signals.

Just about all I/O circumstances are covered by the nine statements transmitting data and the four receiving data.

Contact your local Tektronix Sales Engineer who will be glad to discuss these interfaces in more detail with you.



The CM021-0212-00 microribbon cables allow pin-to-pin connection with a peripheral permitting input of ASCII, BCD or Binary data in a parallel format. **TEKNIQUES**

## \* Editor's Note

### Programming Tips Earn String Arrays/String Matrices Program

If you have a routine that you feel is too small to submit to the library, you can send it in as a Programming Tip. Documentation and listing for program 51/00-8008/0\* may be yours free in exchange for your tip.

\*A different exchange program will be featured in each issue of TEKniques.

### New Catalog Reminder

The 4051 Applications Library catalog for 1978 is available, featuring 86 programs. If you don't have your copy yet, give us a call at (503) 682-3411, ext. 2618, or drop us a note. It's free.

### Business Contest Reminder

Do you have a favorite program (or programs) that you use in day-to-day or periodic business analysis? Well, the Business Applications Contest is under way, so it's time to document them and send them in to the library.

The first place winner will choose a prize of either the 4051R01 Matrix ROM Pack, or a 4015R05 Binary ROM Pack.

In addition to the first prize Matrix or Binary ROM Pack, other winners will receive:

Second Prize: 6 tapes and 6 programs

Third Prize: 4 tapes and 4 programs

Fourth Prize: 2 tapes and 2 programs or a complete set of 4662 plotter pens (13 packages of 3 each)

Fifth Prize: Roll of Hard Copy Paper or Box of Printer Paper

Sixth Prize: 1 tape or 2 packages of overlays

Every entry will be placed in the 4051 Applications Library, which means every entrant will get three programs from the Library, on a new tape, in exchange for each one sent in. So everyone's a winner!

More information may be found in the previous issue of TEKniques (Vol. 2, No. 6). Deadline for entries is Dec. 31, 1978.

### Membership Applications Enclosed

You've probably noticed two membership applications enclosed with this issue of TEKniques. These are for you to pass along to friends and associates that might be interested in becoming members of the 4051 Applications Library. We're always interested in new members and their interests and applications, so encourage them to join.

### Software Notices Discontinued

The Software Notice service in TEKniques has been discontinued.

TEKniques is intended as a vehicle for idea exchange among 4051 users, and the software library is maintained to promote 4051 software exchange among users at a nominal fee. Advertising software for sale detracts from these purposes. Also, TEKniques is not a commercial publication; it is not intended to draw business away from publications that are supported through advertising.

With these factors in mind, TEKniques has discontinued its Software Notice service. **TEKNIQUES**

# Programming Tips



## INTEGER Function

by Robert G. Huenemann  
United Airlines

The INTEGER function doesn't always return results that agree with the value displayed on the graphic screen. For instance,  $A=.1 * 10$  and  $B=INT(A)$ . B is equal to 0 while A is equal to 1. Using the STRING and VALUE functions prior to the INTEGER function will result in agreement:

```
A=.1*10
A$=STR(A)
B=INT<VAL<A$>>
```

B will now be returned as 1.

Ed Mitchell of Tektronix explains the reason for these differences: The 4051 is a binary machine. Therefore, internally  $.1 * 10$  is represented as  $.99 \dots 9$  (actually  $FFFFF_{16}$ ). When a number is printed to the display, it is rounded at the 12th place, which in this case will result in a 1 being printed. However, the INTEGER function returns the largest integer without exceeding the value of a number and does not round a number.

Dan Taylor suggests setting  $E0=1E-12$ , then  $INT(A+ABS(A) * E0)$  which is a "fuzzy" INT(A). This could also be used as a function:

```
DEF FNI<A>=INT<A+ABS<A>*E0>
```

Use the FNI instead of INT. It might be easier than the STRING and VALUE above, and is almost the same speed.

## Storing Strings in Binary

by Virg Tomlin

One long string, accompanied by a pointer array that identifies word separations, can serve as a pseudo string array when filing lengthy lists of people or things.

However, while string length seems only limited by

available memory, strings to be stored on tape in a binary file are limited to 8191 characters (about 113 full lines) because of the 16 bit header that accompanies each entry. The first 3 bits identify the type of data and the last 13 indicate its length ( $2^{13}-1=8191$ ). Lengthy files can be broken conveniently into segments of 100 lines each. Store each segment in a separate data file rather than stringing them out in one file; storage and retrieval are then faster and simpler.

String length limit does not occur using an ASCII data file. However, carriage returns (CHR(13)) embedded in the string won't allow the string to be INPUT from an ASCII file in one long string. The string will delimit when reaching the Carriage Return.

## 4907 Secret File Handling

by Chuck Eng

A useful table provides at-a-glance information for 4907 secret file handling by the 4051.

|  | ASCII<br>Unsecret<br>File | ASCII<br>Secret<br>File | BINARY<br>Unsecret<br>File | BINARY<br>Secret<br>File |
|--|---------------------------|-------------------------|----------------------------|--------------------------|
| APPending to Unsecret<br>Program in 4051 | VALID                     | INVALID**               | VALID                      | VALID                    |
| APPending to Secret<br>Program in 4051   | INVALID*                  | VALID                   | VALID                      | VALID                    |
| OLD                                      | VALID                     | INVALID**               | VALID                      | VALID                    |

\*Invalid operation on tape file.

\*\*Valid operation on tape file.

## Pause and Continue Using the Function Keys

by Ken Cramer

Often it is necessary to put a pause into a program for viewing some display on the screen. Usually the pause times are some optimal value and variations are required. This is one solution which can be invoked by the function (UDK) keys.

```
1 SET KEY
2 N=20
3
4
5
6
7
8
9
10
11
12
13 REM PAUSE LOOP-N IS NUMBER OF SECONDS
14 FOR N9=1 TO 220*N
15 NEXT N9
16 RETURN
17 REM CONTINUE - SET N9 LARGE TO EXIT LOOP
18 N9=1.0E+27
19 RETURN
20
```

Pressing UDK #6 will initiate a timing delay of N seconds. The timing delay loop can be exited by pressing UDK #7 which sets variable N9 arbitrarily large and effects an exit from the loop.

If N9 is used as the loop counter for other timing loops the

continue UDK #7 will exit any timing loop within the program.

## Recovering ASCII Programs Saved With Alternate Delimiters

by Ted Webber  
Laurie Montgomerie & Pettit Pty Ltd  
Sydney, Australia

Listing a program to an external printer, the following commands might be given:

```
FIND 1
OLD
PRI @37,26:1
LIST @1:
```

Then some editing might be done on the program which you save but forget to reset the environmental parameters (PRI @37,26:0).

```
FIND 1
SAVE
```

Later, you wish to access it:

```
FIND 1
OLD
```

Now you receive the error message:

```
NO PROGRAM FOUND - MESSAGE NUMBER 59
```

or a syntax error, depending on your environmental status.

```
↓ SYNTAX ERROR
J110 INIT
```

Examination of the memory contents may show that the first line of the program has been loaded. The problem is caused by having inadvertently saved a line feed (CTRL-J) at the beginning of all subsequent lines. What can you do?

Three solutions are possible depending on your equipment. The Editor ROM gives the easiest as follows: (Make sure parameters are 37,26:0)

```
CALL "EDITOR"
F1
O
R
NL1,999 /J/,/J/
F1
SA
FIND 1
OLD
```

... and the program loads, no worries!

No Editor ROM? A small program will delete the unneeded line feeds (CTRL-J) and keep your program intact.

The problem does not arise if your program is stored on binary format, using the Binary Loader ROM and CALL "BSAVE".

```
100 M$=CHR(13)
110 DIM B$(80),A$(MEMORY-300)
120 PRINT "WHICH FILE"
130 INPUT J
140 FIND J
150 ON EOF (0) THEN 220
160 INPUT @33:A$
170 INPUT @33:B$
180 B$=SEG(B$,2,100)
190 B$=B$M$
200 A$=REP(B$,1+LEN(A$),0)
210 GO TO 170
220 FIND J
230 PRINT @33:A$
240 END
```

## Avoid Moving Lines of Code Containing DEF FN or ON THEN

The DELETE command and using the edit keys can move lines of code. When a memory compress occurs (whether generated by the 4051 system or the program), the program in memory will be relocated as a result of these previous commands. This relocation affects two statements: the DEF FN and the ON THEN. When a statement containing a DEF FN is executed, an internal pointer is set indicating the location in memory of that function. Likewise, the pointer to the location of the target line of an ON THEN statement is set when that statement is executed.

When the program is relocated in memory because of memory compress, these two pointers will no longer show the proper location. Thus, when either DEF FN or the target line of an ON THEN is later referenced, a system error may be generated because the 4051 can't find the correct function or target line. For example:

```
99 DELETE A
100 PRINT "START"
101 REM
102 REM
103 REM
104 REM
105 REM
106 ON SRQ THEN 180
107 WAIT
108 DELETE 101,103
109 DIM A(3500)
110 PRINT MEMORY
111 GO TO 130
112 PRINT "SRQG"
113 POLL M,M14
114 RETURN
115
116 RUN
117 START
118 SRQ
119 1899

100 REM
110 REM
120 REM
130 REM
140 REM
150 DEF FNA(A)=2
160 A=2
170 REM
180 REM
190 REM
200 REM
210 A=FNA(A)
220 DELETE 100,140
230 PRINT FNA(A)
240 M=MEMORY
250 B=FNA(A)
260 END

100 REM
110 2
111
112 RUN
113 2
```

```
SYSTEM ERROR - MESSAGE NUMBER 0 - 7F9F BC30 981B 60 00 00 00
```

Therefore, try to locate these statements in lines which won't be moved. If that's not possible, you'll have to re-define them:

```
100 DEF FNA(A)=2
110 A=2
120 REM
130 REM
140 REM
150 A=FNA(A)
160 PRINT FNA(A)
170 DELETE 100,140
180 M=MEMORY
190 DEF FNA(A)=2
200 B=FNA(A)
210 PRINT B
220 END
221
222 RUN
223 2
224
225 START
226 SRQ
227
228 SRQ
229 SRQ

99 DELETE A
100 PRINT "START"
101 REM
102 REM
103 REM
104 ON SRQ THEN 220
105 WAIT
106 DELETE 110,130
107 DIM A(3500)
108 M=MEMORY
109 PRINT "G"
110 ON SRQ THEN 220
111 GO TO 150
112 PRINT "SRQG"
113 POLL M,M14
114 RETURN
115
116 RUN
117 START
118 SRQ
119
120 SRQ
121 SRQ
```

Tekniques

# Basic Bits



## Never Branch to REMark Statements

by Dan Taylor

Often all REMark statements of a program are eliminated to save space. If the program contains REMark statements at a branch entry, they'll be deleted leaving invalid target line numbers in the branching statements. For example:

```

150 GOSUB 4000
4000 REM Begin Driver Routine
  
```

If statement 4000 is deleted, the target line in statement 150 is invalid and will result in program abortion.

Also keep in mind that pressing a User Definable Key is the same as executing a GOSUB statement; program control is transferred to the line number which is four times the key number. So avoid REMark statements on lines numbered 4\*n. Put them at 4\*N-1.

|             |                      |
|-------------|----------------------|
| Instead of: | 4 REM Driver Routine |
|             | 5 GOSUB 6000         |
|             |                      |
| Use:        | 3 REM Driver Routine |
|             | 4 GOSUB 6000         |
|             |                      |

**Techniques**

## 4051 Applications Library Program Abstracts

### Order

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 responsibility and shall have no liability, consequential or otherwise, of any kind arising from the use of this program material or any part thereof.)

### Domestic U.S. Prices:

|                            |                  |
|----------------------------|------------------|
| Documentation and listings | \$15 per program |
| Recording Fee              | 2 per program    |
| Tape Cartridge             | 26 per tape      |

### Contribute

Contribute one program to the Library and receive three in exchange. Send in the membership card from your 4051 Graphic System Reference Manual to get the details. Or call us (503) 682-3411, ext. 2618.

### Forms

Please use the Applications Library Order Form. Order forms are included in the Membership Packet and are available from your local Tektronix Sales Engineer.

### Outside U.S.

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: 51/00-6106/0

Title: **PDP 1140 Interface to the 4051**

Author: Joan M. McDonald  
Department of Defense  
Ft. Meade, MD

Memory Requirement: 8K  
Peripherals: Option 1 Data Communications I/F  
Statements: 62  
Files: 1

This program provides an interface between the Tektronix 4051 Graphic System and a PDP 1140 computer which uses the RSX 11M system.

Three options are available:

#### Option 1:

1. "T" puts the Tektronix 4051 into Terminal mode as a terminal on the PDP 1140.
2. "S" sends a tape file to the PDP 1140.
3. "R" receives a tape file from the PDP 1140.

Option 2 is used with the TSX 11M EDIT utility program.

Option 3 is used with PIP utility program.

**ABSTRACT NUMBER: 51/00-6107/0**

Title: **Library Catalogue**

Author: J.L. Cornellison

U.S.B.M.

Lakewood, CO

Memory Requirement: 16K

Peripherals: 4051R05 Binary ROM

Statements: 188

Files: 1

This program organizes articles from scientific and engineering journals although it can be used in any field. It is similar to a card catalogue of a library. Each "reference card" is stored in a file on magnetic tape; each file contains 15 cards.

The user may then search the entire catalogue or a part of the catalogue. The program searches through the files for a key word or a phrase that is specified by the user. The 4051 then lists on the screen all reference cards that contain the key word or phrase.

**ABSTRACT NUMBER: 51/00-8021/0**

Title: **Draw**

Author: Wade H. Nelson

GTE

Huntsville, AL

Memory Requirement: 16K

Statements: 855

Files: 2 Program

2 Data

Draw a program for the Tektronix 4051 Graphic System which rapidly produces and edits graphic designs. The User-Definable Keys are used to move the cursor about the screen and to initiate various graphic operations.

Designs may be stored on tape in one of two data modes. The first is for reading back into the Draw program at a later session; the other is in the format of BASIC data statements for use in other programs, either as data or to produce a desired picture.

Graphic operations are two-part; that is, are defined by two points connected either with a visible line or a non-visible move. While the program is running, a plus sign (+) indicates the last point moved to, or line drawn to. The graphic cursor is used to indicate where you would like a graphic operation to begin, or in the most basic operations, such as move and draw a line, to end.

These two points are saved when you have to type in information for an operation to be performed. As an example, the program prompts you for the height and width of an ellipse you want drawn. Prior to prompting

you, the cursor is moved to the top left of the screen, and earlier lines skipped over. The cursor is returned to its original position prior to execution of any graphic operation.

| UDK   | Mnemonic           | Function   |
|-------|--------------------|--|
| 1-4   | ↑ → ↓ ←<br>(Arrow) | Move the cursor L units. L may be reset from its initial value of 10 units by using the # UDK.   |
| 5     | Line               | Draws a line from + to ✓   |
| 6     | Ellipse            | Draws ellipse of specified height, width and tilt with cursor indicating either a point on the edge or the center.   |
| 7     | #                  | Set displacement of cursor.  |
| 8     | Delete             | Deletes last move or line drawn. Pressing DELETE twice consecutively will give option of deleting N moves. Pressing DELETE immediately after ZAP will replace the line ZAPPED. |
| 9     | Redraw             | Redraws the current picture.   |
| 10    | Move               | Moves + to the current cursor position without drawing a line.   |
| 11-13 |                    | Unassigned   |
| 14    | Rotate             | Draws a line or moves the cursor in response to polar displacement input.  |
| 15    | ?LI                | Draws a line from + to a specified location.   |
| 16    | Shift              | Shifts current picture so + will correspond with position of cursor (✓).   |
| 17    | Tape               | Write out data to tape to read in from tape.   |
| 18    | Zap                | Deletes a line in the picture.   |
| 19    | Scale              | Enlarges or shrinks the current picture.   |

## **4051 Applications Libraries**

### **Africa, Europe, Middle East**

4051 Applications Library  
Tektronix Datatek N.V.  
P.O. Box 159  
Badhoevedorp, The Netherlands

### **Australia**

4051 Applications Library  
Tektronix Australia Pty. Limited  
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