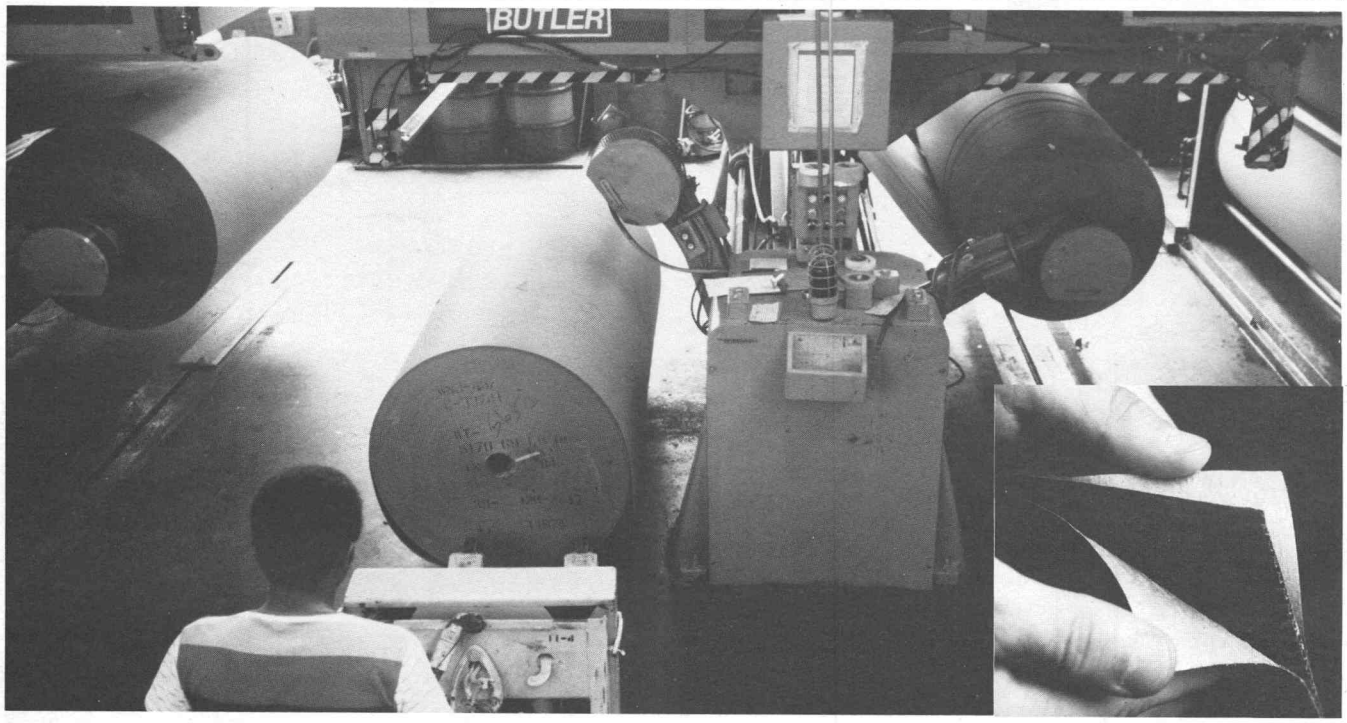
Tekniques

The 4051 Applications Library Newsletter Vol. 2 No. 8



A corrugator at International Paper Company produces the material from which boxes are manufactured. The company's Engineering Services Group employs the 4051 and Modeling and Reporting software to aid in the coordination of manufacturing machinery and systems throughout its 47 Container Division plants.

International Paper Company Streamlines Business Methods Using New TEKTRONIX Modeling and Reporting Software

by Terry Davis and Patricia Kelley

At the International Paper Company offices in Whippany, N.J., a transformation has taken place in their business methods. The Engineering Services Group of the Company's Container Division is doing analysis and planning for their world-wide business with a new and very usable analysis /reporting tool: 4050B01 Modeling and Reporting software.

The Container Division of International Paper Company has 47 plants around the world; which produce corrugated boxes for a variety of agricultural and industrial customers. The Engineering Services Group provides support activities for all of the Container Division plants.

These activities include the specification and purchase coordination of all manufacturing machinery and systems, coordination of all major construction, and administration of all industrial engineering programs. It's a job of enormous magnitude but the conversational nature of Modeling and Reporting, coupled with its accurate columnar and graphic reports, has helped to bring this load down to manageable proportions. Now they're able to consider management analysis projects they didn't have time for before.

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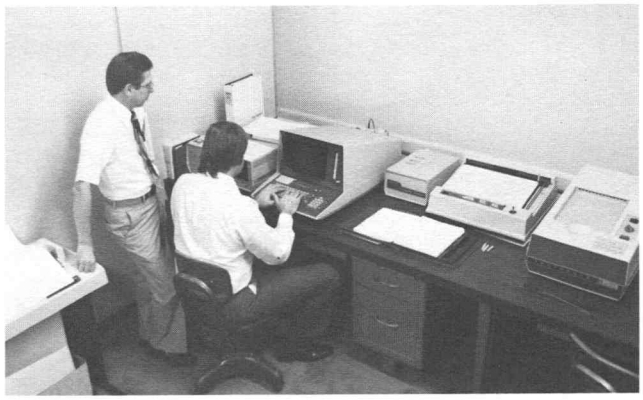


At the Whippany, NJ, offices of International Paper Company, Bill Savage, Manager of Engineering Services, observes Matt Mataya, Manager of Industrial Engineering, prepare a spread sheet using Modeling and Reporting software.

Modeling and Reporting is designed to assist in all model building stages, using plain English. The Engineering Services Group barely had the 4051-based system unpackaged before they set about building a model to use for their manufacturing input to the division's 12-year business plan.

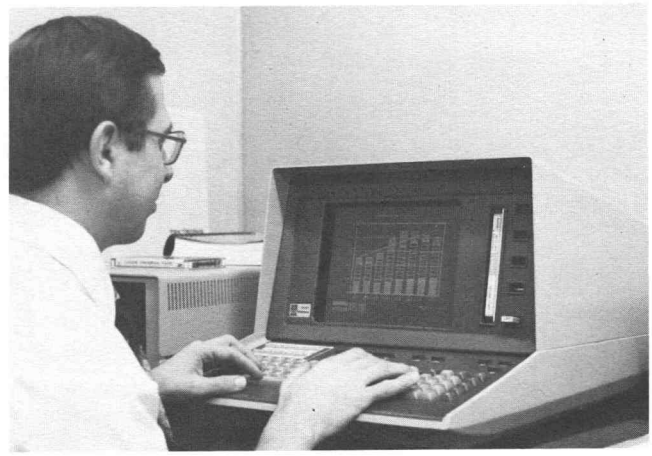
First developed were models of their five U.S. regions, then their three international regions. Another one followed to pull the others together for a division-level summary. There were many facets to consider in building each of these models. The first group, for instance, contained the five U.S. regions; this meant there were 30 plants to be considered. And there were 10 separate variables to manipulate in order to build up the report.

Even with all of these variables, Bill Savage, Manager of Engineering Services, said using the Modeling and Reporting package brought increased credibility to their report. "No one was worried whether someone had made a multiplication error. When you put together a report of this magnitude, it's very different from one that's generated by hand every month with the same variables."

The next item on the Engineering Services Group's agenda was the monthly "trim" report, which tabulates the amount of paper that is recycled at each plant. In this instance, they formatted the report with the Modeling and Reporting package. A secretary now enters the raw data on the source and amount of the trim using the 4051 package to produce a clean, formatted report. The report is large, since it's assembled for all 30 U.S. plants. Eventually they may refine the programming for this regular report, but for now Modeling and Reporting has given them a substantial jump on the formatting.

Another function that International Paper wanted to look at was their compensation program for engineering supervisory personnel. They used their new software package to develop a model that would predict results from various alternatives for this compensation program.

Using the different criteria by which they reward supervisors as program constraints and production data from a tape file, they found out just what effects would be obtained from each alternative. The process took only two and a half hours, whereas manually it could easily have taken a week. With this new package, the model can be developed quickly for all plants.



Savage quickly produces a graph using the data from the model.

Reaction to Modeling and Reporting is highly positive at International Paper Company. Managing their business requires a tremendous amount of report writing and analysis of alternatives; the Container Division is a prime example. But where they used to spend days producing trend graphs for the plants, a draftsman can now sit down at their 4051 and easily key in report data in a fraction of the time. Modeling and Reporting does the rest. It has added useful business software to the graphic capabilities of the 4051—both features for which International Paper had been looking—in a complete package.

They've found this package to be ideal for the infrequent or one-time report. For repetitious reports, it also gets things done quickly and easily; refinements can be added as the program progresses with virtually no difficulty.

In addition to their Modeling and Reporting package, International Paper is using the Data Graphing program from the 4051 Applications Library. And they're just as pleased with that package. For their 12-year plan, for instance, they needed some involved stacked bar graphs to show the plant capacity effects of added efficiency, capital, facilities, and so on. They took data from the newly-generated report and used Data Graphing to

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Editor	Terence Davis
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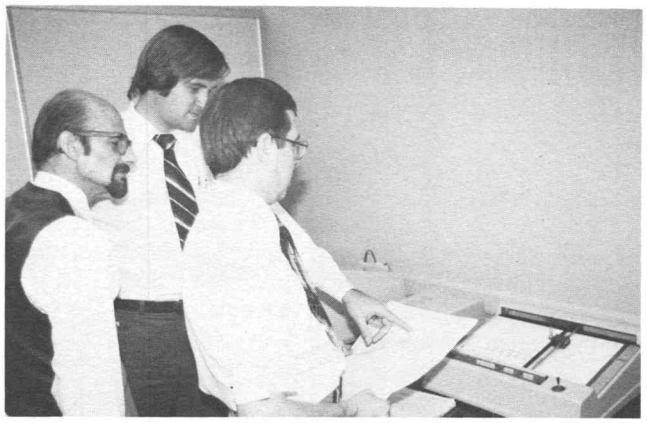
Circulation	Rory Gugliotta

prepare their graphs. The plotted graphs were used directly in the final printed report.

Says Bill Savage: "Modeling and Reporting is a neat answer for any small business where there are many things to do and little programming help available to do them. It's also excellent for large companies where the data processing group can't allocate the time to do the many individual modeling and report-writing jobs by the Engineering Group. You couldn't write programs for what this package costs; compared to hiring a consultant, the cost is minimal. And the time used is one-tenth of generating the reports by manual means. We are very pleased."

Time and money savings are now available in a complete package that provides ease of use, detailed analysis in useful business terms, and graphic output that's easy to interpret. The package is 4050B01 Modeling and Reporting software. More information about this unique new package can be found in the following article in this issue of TEKniques.



Bob Groleau, Project Manager, Mataya and Savage review the completed spread sheet.

TEKTRONIX Announces Modeling and Reporting Software: Business Concepts with 4051 Graphics

by Don Gard

Modeling and Reporting software combines business analysis with graphics for an exciting breakthrough in personal computing. This combination is designed to meet the management analysis and reporting needs of any business unit in ways not available with other systems. Modeling and Reporting communication takes place with English language statements and questions to the operator, in much the same way as the 4051's standard Graphic System Tutorial does. Thus, columnar reports and high-quality business graphics can be developed easily, and in a fraction of the time required by conventional means.

With Modeling and Reporting, you can think of the 4051 memory as a large columnar spread sheet; the screen is your window onto the spread sheet. Your first step is to define the row and column structure of your application's spread sheet, using names and descriptions that are meaningful to you (just as you would use on a columnar pad). The 4051 interacts with you to guide you as you enter the model description; this allows errors to be identified and corrected immediately, to shorten the time to develop your model.

A model is created by linking a series of function blocks together to simulate a process; the model might be a business procedure or an industrial process. (Reports describing various applications will follow in later issues of TEKniques.) As you define the steps for your application, Modeling and Reporting prints an abbreviated English language definition of your application's unique model. The steps in the model, besides defining the "spread sheet" rows and columns, contains function instructions for calculations and manipulations to be performed on the data, report formatting instructions and instructions for graphic output.

Once the model has been created, Modeling and Reporting transforms it into a 4051 BASIC program. Thus, Modeling and Reporting automatically handles many of the details necessary to edit data files, format reports, or produce graphic output. This results in reduced time and cost for developing the many applications that Modeling and Reporting can handle.

CONTRIBUTION INCOME STATEMENT
JULY

MODELING and REPORTING by Tektronix	BUDGET	%	ACTUAL	%	8/2/78 OVER/UNDER BUDGET
GROSS SALES	$ 5,000	113.7%	$ 5,686	110.6%	12.2%
DISCOUNTS AND ADJ.	689	13.7%	545	10.6%	-10.5%
NET SALES	4,460	100.0%	5,141	100.0%	15.3%
VARIABLE COST OF SALES	961	21.5%	977	19.0%	1.7%
CONTRIBUTION	3,499	78.5%	4,164	81.0%	19.0%
PRODUCT RELATED					
MANUFACTURING	117	2.6%	111	2.2%	-5.1%
MFG. VARIANCE	50	1.1%	83	1.6%	66.0%
MARKETING	438	9.8%	590	11.5%	34.7%
ENGINEERING	375	8.4%	392	7.6%	4.5%
ADMINISTRATION	32	0.7%	31	0.6%	-3.1%
TOTAL	1,012	22.7%	1,207	23.5%	19.3%
PRODUCT PROFIT	2,487	55.8%	2,957	57.5%	18.9%
OTHER PERIOD EXPENSE					
FIXED COST OF SALES	161	3.6%	158	3.1%	-1.9%
OTHER	631	14.1%	601	11.7%	-4.8%
TOTAL	792	17.8%	759	14.8%	-4.2%
INCOME BEFORE TAXES	$ 1,695	38.0%	$ 2,198	42.8%	29.7%

Specify the format and calculations you want in your report, then enter your data. Modeling and Reporting does the rest. When it's time for next month's update, simply enter your new data; the report is automatic.

Up to 40 rows and 25 columns of data can be developed in a single model. The full range of 4051 math capabilities, plus special functions to facilitate row and column operations, are available. For conventional tabular reports a wide range of formatting capabilities are

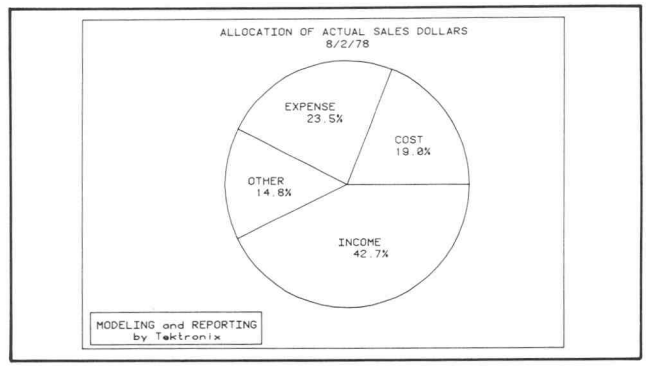
provided, including spacing, underscoring, insertion of dollar signs or commas, and automatic segmentation of reports that exceed the physical capacities of the output device. Graphic report formats available include pie charts, line graphs, bar charts, and scatter charts. Modeling and Reporting also provides a dynamic "what if" capability. This allows you to evaluate alternate scenarios (what if . . .?) by specifying, at run time, changes in your data. The model can run again with the changed data to determine the alternate "what if" results.

One of the real powers of Modeling and Reporting is that it is not limited to any specific application. Any report or analysis that can be defined and solved in a 40-row by 25-column spread sheet, using standard 4051 math capabilities, can benefit from Modeling and Reporting.

Applications from diverse fields such as budgeting, process analysis, financial ratio analysis, equipment utilization, and manpower planning have been implemented in Modeling and Reporting in a fraction of the time that conventional programming techniques required.

Required equipment for 4050B01 Modeling and Reporting is a 4051 Graphic System with Option 22 (32,000 bytes of memory), a 4924 Digital Cartridge Tape Drive, and a 4051R05 Binary Program Loader ROM Pack for fast program loading. The package is also available on disc for the 4907 File Manager (in lieu of the 4924 Digital Cartridge Tape Drive); order 4050B01 Option 5. For output, Modeling and Reporting can use the 4631 Hard Copy Unit, the 4662 Plotter, and the 4641 Alphanumeric Line Printer.

For more information on the new 4050B01 Modeling and Reporting Software package, contact your local Tektronix Sales Engineer.



A pie chart is one of the graphic formats available from Modeling and Reporting.

Center for Naval Analyses Evaluates War-At-Sea Strike Tactics on 4051 Graphic System

by Catherine Anderson
Center for Naval Analyses
Arlington, VA

The Center for Naval Analyses (CNA) was born out of the Anti-Submarine Warfare Operations Research Group formed during World War II. An affiliate of the University of Rochester, CNA consists of five operating groups, each specializing in specific fields. The Operations Evaluation Group (OEG) primarily supports CNA's Navy field program. This group is concerned with how best to use the Navy we have today (and are committed to for the next few years). Toward this end, CNA field representatives help to assess the fleet's current readiness and effectiveness, trying to find ways to improve both. One method is to design exercises at sea to test the latest concepts and equipment, and evaluate the results.

Experience of CNA field representatives at sea indicated the need for an effective and portable tool for evaluating war-at-sea (WAS) strike tactics. The result was a model simulating an aircraft striking a warship, to be used both at sea and ashore. The program, developed on the TEKTRONIX 4051 Graphic System by Jack Nance and Jean Cishek, is used for tactical development and evaluation, training pilots, and evaluation of at-sea exercises before the data becomes "cold."

A Tactical Development Tool

The war-at-sea model is designed as a tactical development tool for training and evaluating alternative ways to successfully locate and attack an enemy surface ship. This time-step model is designed for two players: one controls the aircraft, whose mission is to locate and attack the ship, and the other controls the ship, whose mission is to survive the aircraft attack and while doing so, attempt to destroy the attacking aircraft. Figure 1 is a typical

Catherine Anderson, Research Assistant at the Center for Naval Analyses, shown running the war-at-sea strike tactics model on the 4051.

screen display of the message boards where the aircraft and ship players each receive their messages and a figure showing their perception of the problem. To prevent one player (ship or aircraft) from seeing the other's picture or messages, a divider should be placed perpendicular to the center of the screen.

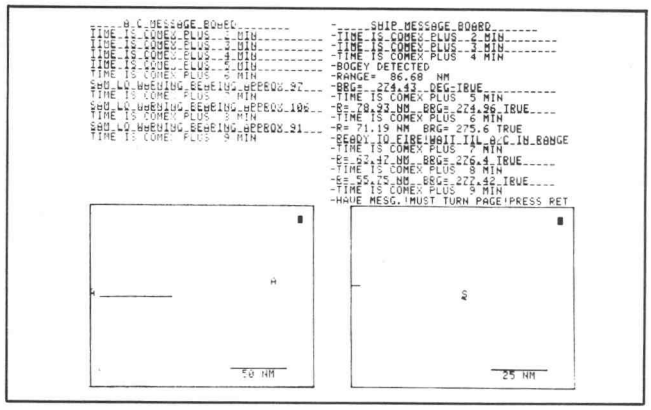


Fig. 1. Screen display of message boards and problem.

Figure 2 is an example of the initial condition prompts relating to the aircraft and ship, respectively; all possible initial selections are shown.

After these conditions are specified, the game begins. The initial area displayed for each player is a 200 n.mi. square of ocean. Each player sees his own position and the center of the area marked by an "X". To reflect uncertainty in the location of the target, the ship's initial position is chosen from a uniform distribution over a 25 n.mi. square centered on the "X". The aircraft and ship automatically move according to the selected courses and speeds until the operator of either the aircraft or ship activates any of the action control defined keys.

Action-Control Defined Keys

The User-Definable Keys have been defined to allow both the aircraft and the ship to change course, change speed, decrease scale, change the time-step, enlarge (zoom in) the picture or terminate the engagement. These keys also provide opportunity for the aircraft to change altitude and to launch SAMs; the ship can fire missiles.

Sample Output

Figures 3 and 4 are examples of the graphic display of a Rockeye series bombing and the results. Upon conclusion, a summary of the engagement details the aircraft's flight profile, ship track, and a chronological listing of the significant events.

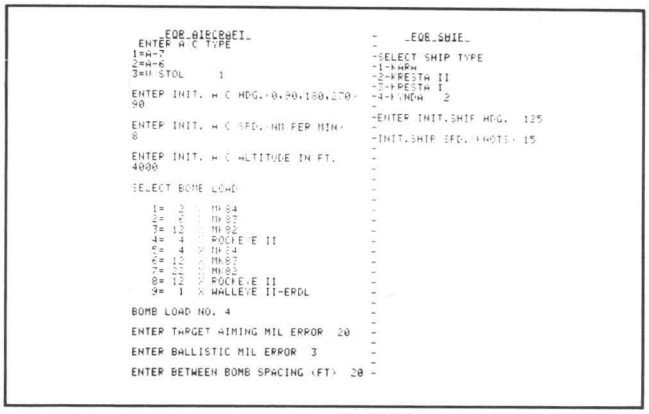


Fig. 2. Initial values.

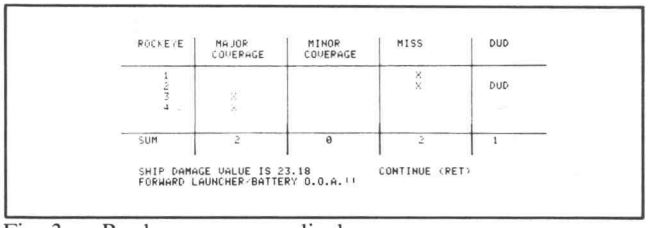


Fig. 3. Rockeye coverage display.

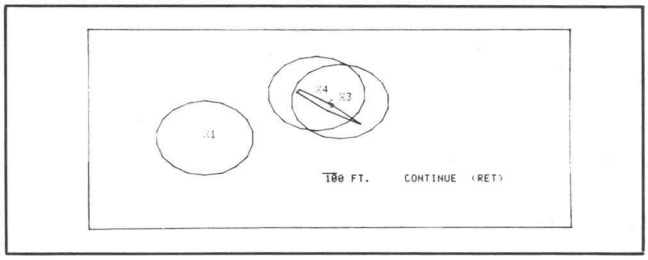


Fig. 4. Rockeye bombing results.

Model Documentation

The OEG war-at-sea evaluation game and documentation (CNA Memorandum (CNA)77-1207) have been contributed to the 4051 Applications Library.

Editor's Note: "A One-on-One Interactive War-at-Sea Game" is described in the New Abstracts section under Abstract 51/00-9525/0. Further information on the center for Naval Analyses is contained in their Annual Report which may be secured by writing: Center for Naval Analyses, 1401 Wilson Blvd., Arlington, VA

American ENKA Uses 4051 in Chromatographic Work

Using his 4051 as a controller, Leonard H. Ponder, Research Chemist at American ENKA Co., acquires chromatographic data over the RS-232 Interface. In stand alone mode the 4051 then plots the data. He has contributed the program for this application to the 4051 Applications Library (see new abstract 51/00-5204/0).

Ponder has also developed a quantitative analysis program which resides in the user library of On-Line Systems. He says by using your 4051 in terminal mode the program will handle quantitative gas chromatography and liquid chromatography work. In some applications the program will also handle data from instruments other than chromatographs such as automatic analyzer and colorimetric detectors. The program is described in *Chemical Engineering*, August 28, 1978, page 114.

University of Minnesota Seminars Update Technical Knowledge

by Patricia Kelley

To help managers in technical fields avoid being left in the dust of galloping technology, the Department of Conferences on Continuing Education in Engineering & Science at the University of Minnesota custom designs intensive seminars on Modern Technical Concepts.

Professors Mahmoud Riaz and Jack Judy from the University's Department of Electrical Engineering recently coordinated two concurrent seminars for engineering managers from Honeywell and IBM.

Among the diverse array of teaching aids were two 4051 Graphic Systems used for problem solving with graphic display. As the seminar advanced, the 4051s also became centers of attention during the participants' free time.

Both conferences were held at two retreats on opposite sides of one of Minnesota's picturesque lakes which provided a 10-day haven from everyday demands allowing the participants to soak up the teachings. Separate computer rooms were established to hold a number of terminals including the 4051 systems.

Although other diversions were offered, many participants spent their off hours in the computer room. In a number of cases, this was the first lengthy hands-on experience with a computer.

"Problem solving and games overcame the reluctance of many to interact with the computers", noted Professor Riaz.

Honeywell and IBM are already making plans for similar seminars next year.

* Editor's Note

Interesting Applications?

Is your application one that others might like to read about? Let us know. We have a questionnaire to help focus on the important information; we'll even help you write the article. Just call or drop a note to TEKniques, and we'll be in touch with you. We're always ready to share your interesting information with other TEKniques readers.

Programming Tips Earn Log/Linear Axis Labeling

Do you have a routine you feel is too small to submit to the 4051 Applications Library? Send it to us as a programming tip. Each issue of TEKniques features documentation and listing for a library program that may be received in exchange for such a tip. This issue features the Log/Linear Axis Labeling Routine as the exchange program; so send in your ideas.

Catalogs Still Available

1978 catalogs for the 4051 Applications Library are still available; it contains 86 programs. If you don't have a copy yet, or would like another, drop us a note or call (503) 682-3411, ext. 2618. It's free for the asking.

Contest Drawing to a Close

Do you have a business applications program for your field? The current Business Applications Contest is the place to send them, but time is drawing to a close. Deadline for entries is December 31, 1978.

First place winner can choose from a 4051R01 Matrix ROM Pack or a 4051R05 Binary Program Loader ROM Pack. Other prizes are as follows:

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

More information on the Business Applications Contest can be found in TEKniques Vol. 2 No. 6.

Programs on Disc Will be Available

Programs from the 4051 Applications Library will be available on disc. However, until we receive our 4907 we don't have the equipment to convert the programs, or duplicate the ones already converted, from tape to disc. (We have to wait our turn in the order processing queue like everyone else.) An announcement will be published in TEKniques just as soon as we can handle disc orders.

Meteorology and Geometric Analysis Occupy 4051

by Patricia Kelley

The Materiel Testing Directorate at the U.S. Army's Aberdeen Proving Ground, Md., takes its responsibility to be a "good neighbor" very seriously. Up-to-date technology ensures that environmental effects of the testing work are kept within acceptable limits.

Careful monitoring of meteorological conditions and the use of mathematical models provide a means for assessing the potential effect on all surrounding areas from planned testing each day. The mathematical models accurately match the actual manner in which sound is transmitted through the air.

Should conditions be such that testing would create a nuisance, it is rescheduled to a time when conditions are more favorable.

Captain Steve Sanford of the Materiel Testing Directorate converted an existing FORTRAN IV program into a sophisticated but easy-to-use program for the 4051 to assimilate environmental data and calculate the location of sound intensity (Fig. 1).

```
*** METRO II OPTIONS ***

   1: ENTER RAWINSONDE DATA
  11: READ RAWINSONDE DATA FROM TAPE
   2: STORE RAWINSONDE DATA ONTO TAPE
  12: LIST RAWINSONDE DATA

   3: TABULATE BALLOON COURSE
  13: PLOT BALLOON COURSE

   4: TABULATE WIND DATA
  14: PLOT WIND DATA

   5: TABULATE SOUND GRADIENTS
  15: PLOT SOUND GRADIENTS

   6: TABULATE MULTIPLICATION FACTORS
  16: PLOT MULTIPLICATION FACTORS

   7: TABULATE OVER-PRESSURE INTENSITY
  17: PLOT OVER-PRESSURE INTENSITY

   8: TABULATE ATMOSPHERIC DENSITY
  18: PLOT ATMOSPHERIC DENSITY

   9: QUIT

  19: PREPARE DATA STORAGE TAPE

  10: AUTOMATIC COPY
  20: MANUAL COPY

>SELECT USER-DEFINABLE KEY<
```

Fig. 1. User-Definable Key functions make a complex program easy to use.

A balloon launched from the site prior to firing contains radio gear which measures temperature, relative humidity, and atmospheric pressure. It also records the time of reading. Radar following the balloon checks its location and elevation. The firing range personnel call in the data gathered by this equipment to the 4051 operator, who keys it into the 4051 (Fig. 2).

Sound gradients are plotted first. At 0 degrees Celsius and no wind, sound waves disperse at a set rate in a specific direction. However, as wind velocity and direction, temperature and humidity change, the waves speed up, slow down and switch direction resulting in varying intensities at different locations. Calculating these variables yields sound gradients for a particular area; in this case it's the firing range.

A quick check to see if the plotted sound gradient lines are spread evenly across the screen verifies data accuracy (Fig. 3). Any data out of the ordinary generates a "haystack effect"—the lines are collapsed to the middle of the plot looking like a haystack—which prompts the operator to recheck the readings. The sound gradient data may also be inspected in tabular form (Fig. 4).

```
EDIT INPUT DATA:

   ENTER   #   TO DELETE
   ENTER   R   TO REPLACE
   ENTER <RETURN> TO LEAVE AS IS
   ENTER   Q   TO QUIT

RELEASE TIME 1425

DATE: 29 AUG 1978

SURFACE DATA:

WIND DIRECTION    WIND SPEED

 260              8

TIME              PRESSURE          TEMPERATURE       HUMIDITY
AZIMUTH           ELEVATION

 0                1013.1            31.2              56
 0                0

 0.5              988.9             27.6              47
 290.7            49.3

 1                965.6             26.4              52
 285.19           51.9

 1.5              949.7             24.4              56
 280.41           47.03

 2                935.3             23.4              55
 282.08           44.88

 2.5              921.2             22.5              64
 277.76           41.88

 3                906.3             21.2              68
 276.77           41.8

 4                871.4             18.3              70
 277.29           41.72

 4.7              850               17.6              54
 274.86           39.21

 5                841.3             17.3              47
 275.23           39.02

 6                806.9             16.8              24
 275.9            37.14

ADDITIONAL DATA? (Y/N): Y
ENTER TIME, PRESSURE, TEMPERATURE, HUMIDITY, AZIMUTH, AND ELEVATION:
999 0 0 0 0 0
```

Fig. 2. The operator may edit the data after it's keyed in.

The 4051 applies the sound gradients to calculate the direction and angles the sound paths will take as they radiate from the firing charge. It translates these paths into sound focusing.

For example, the 4051 could predict where sound waves emanating from a charge meet warmer air, bounce off at an angle to focus and come back down creating greater intensity in one area.

At this point the data is reduced to multiplication factors for different ranges (Fig. 5). These factors are applied against the weight of the charge to predict sound intensity and location (Fig. 6).

The intensity is translated into blast pressure. An easy-to-read tabular chart may be scanned to locate the intensity in those areas above 71 decibels (Fig. 7).

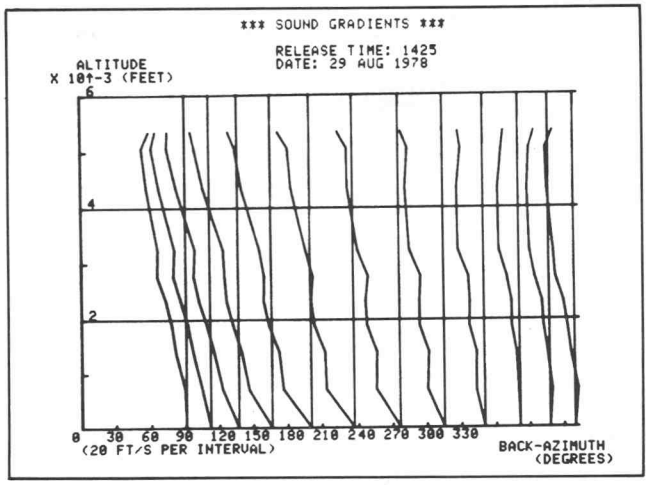


Fig. 3. Direction of sound waves and their displacement from the speed of sound (0 wind and 0 degrees Celsius) are plotted. Reduced sound velocity is indicated as the lines bear left and greater velocity as they angle right. Gradient traces for all compass directions from the Proving Ground (in 30° increments) are displaced across the chart, initially spaced one interval apart.

*** SOUND GRADIENTS ***

RELEASE TIME: 1425
DATE: 29 AUG 1978

ELEVATION (FEET)

BACK-AZIMUTH (DEGREES)
SOUND VELOCITY (FT/S)
VELOCITY GRADIENT TO NEXT LEVEL ((FT/S)/FT)

0.00	710.19	1,406.79	1,888.89
2,330.34	2,767.66	3,235.25	4,353.15
5,057.06	5,347.25		
BACK-AZIMUTH: 270			
1,161.96	1,161.85	1,160.08	1,157.28
1,157.24	1,154.73	1,150.22	1,149.98
1,152.10	1,153.11		
-0.00128	-0.00139	-0.00581	-0.00009
-0.00574	-0.00965	-0.00021	0.00301
0.00350	0.00000		
BACK-AZIMUTH: 300			
1,159.39	1,160.98	1,158.42	1,156.30
1,155.38	1,151.41	1,148.64	1,147.36
1,148.34	1,151.37		
0.00223	-0.00367	-0.00439	-0.00208
-0.00910	-0.00591	-0.00115	0.00140
0.01046	0.00000		
BACK-AZIMUTH: 330			
1,154.41	1,156.14	1,152.04	1,150.10
1,148.01	1,143.15	1,142.17	1,138.63
1,137.84	1,141.93		
0.00243	-0.00589	-0.00401	-0.00474
-0.01112	-0.00208	-0.00317	-0.00112
0.01406	0.00000		

Fig. 4. Tabular output displays elevation in feet for each reading. Then for each compass direction sound velocities followed by sound gradients for each elevation are given. Back-azimuth is the compass direction from the sound wave destination back toward the Proving Ground.

Prior to using the 4051 the data was keypunched onto cards and submitted to a host computer for sound gradient calculation and plotting. A technician would then manually analyze these gradients. With the aid of a small scale, an approximation of sound paths and subsequent intensity could be guessed.

Sanford has gone many steps beyond the original program. In addition to the calculations and graphics

*** MULTIPLICATION FACTORS ***

RELEASE TIME: 1425
DATE: 29 AUG 1978

RANGES (FEET):

1,041.7	3,125.0	5,208.3	7,291.7
9,375.0	11,458.3	13,541.7	15,625.0
17,708.3	19,791.7	21,875.0	23,958.3
26,041.7	28,125.0	30,208.3	32,291.7
34,375.0	36,458.3	38,541.7	40,625.0
42,708.3	44,791.7	46,875.0	48,958.3
BACK-AZIMUTH: 270			
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
BACK-AZIMUTH: 300			
0.0	0.6	1.0	0.8
0.7	0.6	0.5	0.4
0.3	0.2	0.1	0.1
0.5	0.9	0.9	0.8
0.7	0.6	0.5	0.4
0.3	0.3	0.2	0.1
BACK-AZIMUTH: 330			
0.0	0.6	1.1	0.9
0.9	0.8	0.7	0.7
0.7	0.6	0.6	0.5
0.5	0.5	0.4	0.4
0.4	0.3	0.3	0.2
0.2	0.2	0.1	0.1

Fig. 5. Note the multiplication factors at back-azimuths 300 and 330 and the correlation with Fig. 6.

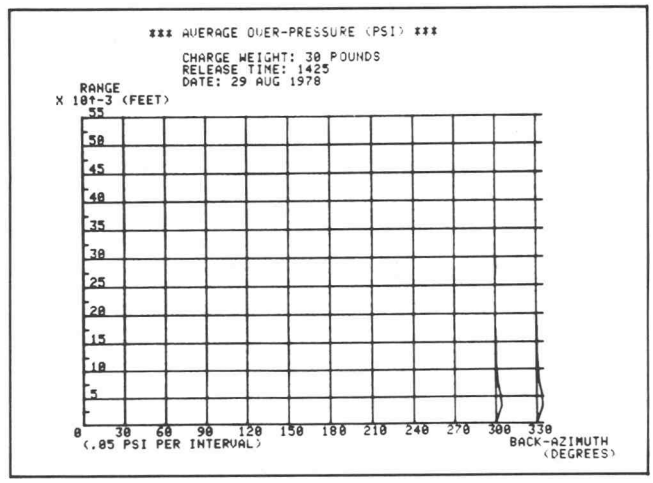


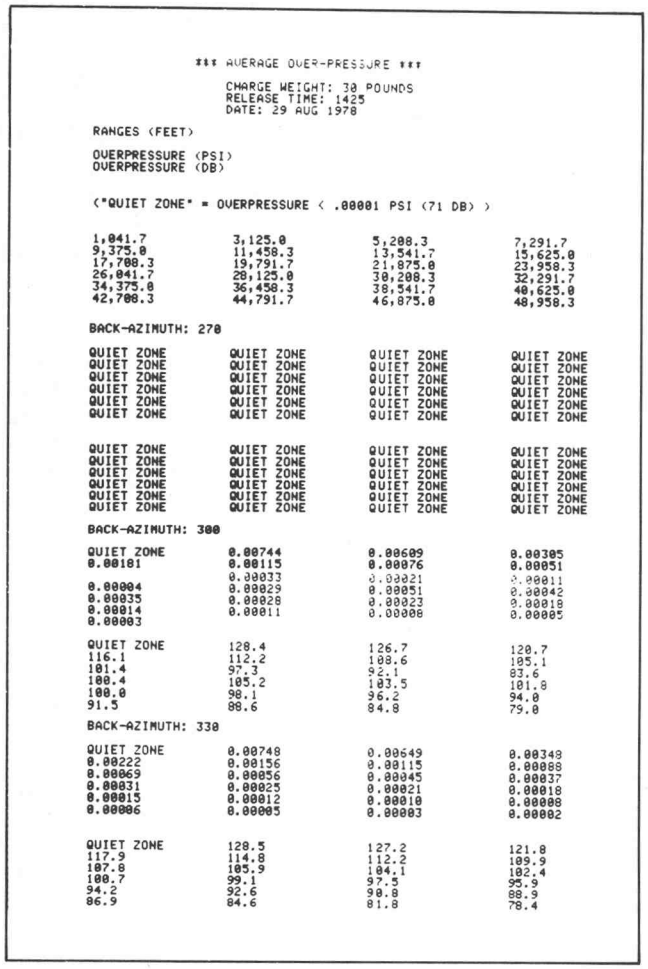
Fig. 6. Visual interpretation quickly locates the area of sound concentration.

discussed above, several others are optional. The balloon's course may be charted, the wind direction plotted or the atmospheric density graphed.

Optimizing the positions of Sky Screens is another job for which Sanford has employed the 4051. These devices, mounted on pedestals in the field, watch the ballistics rounds as they're fired down range. Since a Sky Screen has a very narrow field of view, often several must be aimed perpendicular to the flight of the round, each at a slightly different angle.

Sanford uses the analogy of a horse with blinders; it can see neither right nor left but only straight ahead. In order to see an object passing overhead, its head must be tipped upward at the correct angle. So it is with Sky Screens.

The predicted path of a round is readily obtained from a ballistics table. An imaginary window, sized to view the



```
*** AVERAGE OVER-PRESSURE ***

CHARGE WEIGHT: 30 POUNDS
RELEASE TIME: 1425
DATE: 29 AUG 1978

RANGES (FEET)

OVERPRESSURE (PSI)
OVERPRESSURE (DB)

("QUIET ZONE" = OVERPRESSURE < .00001 PSI (71 DB) )

1,041.7          3,125.0          5,208.3          7,291.7
9,375.0          11,458.3         13,541.7         15,625.0
17,708.3         19,791.7         21,875.0         23,958.3
26,041.7         28,125.0         30,208.3         32,291.7
34,375.0         36,458.3         38,541.7         40,625.0
42,708.3         44,791.7         46,875.0         48,958.3

BACK-AZIMUTH: 270

QUIET ZONE       QUIET ZONE       QUIET ZONE       QUIET ZONE
QUIET ZONE       QUIET ZONE       QUIET ZONE       QUIET ZONE
QUIET ZONE       QUIET ZONE       QUIET ZONE       QUIET ZONE
QUIET ZONE       QUIET ZONE       QUIET ZONE       QUIET ZONE
QUIET ZONE       QUIET ZONE       QUIET ZONE       QUIET ZONE
QUIET ZONE       QUIET ZONE       QUIET ZONE       QUIET ZONE

QUIET ZONE       QUIET ZONE       QUIET ZONE       QUIET ZONE
QUIET ZONE       QUIET ZONE       QUIET ZONE       QUIET ZONE
QUIET ZONE       QUIET ZONE       QUIET ZONE       QUIET ZONE
QUIET ZONE       QUIET ZONE       QUIET ZONE       QUIET ZONE
QUIET ZONE       QUIET ZONE       QUIET ZONE       QUIET ZONE
QUIET ZONE       QUIET ZONE       QUIET ZONE       QUIET ZONE

BACK-AZIMUTH: 300

QUIET ZONE       0.00744          0.00609          0.00305
0.00181          0.00115          0.00076          0.00051
                 0.00033          0.00021          0.00011
0.00004          0.00029          0.00051          0.00042
0.00035          0.00028          0.00023          0.00018
0.00014          0.00011          0.00008          0.00005
0.00003

QUIET ZONE       128.4            126.7            120.7
116.1            112.2            108.6            105.1
101.4            97.3             92.1             83.6
100.4            105.2            101.5            101.8
100.0            98.1             96.2             94.0
91.5             88.6             84.8             79.0

BACK-AZIMUTH: 330

QUIET ZONE       0.00748          0.00649          0.00348
0.00222          0.00156          0.00115          0.00088
0.00069          0.00056          0.00045          0.00037
0.00031          0.00025          0.00021          0.00018
0.00015          0.00012          0.00010          0.00008
0.00006          0.00005          0.00003          0.00002

QUIET ZONE       128.5            127.2            121.8
117.9            114.8            112.2            109.9
107.8            105.9            104.1            102.4
100.7            99.1             97.5             95.9
94.2             92.6             90.8             88.9
86.9             84.6             81.8             78.4
```

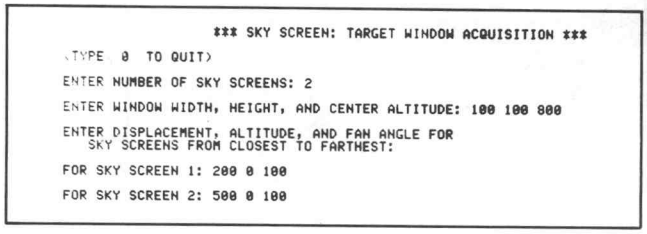
Fig. 7. Tabular output reflects sound intensity greater than 71 decibels.

path where the round will pass over the Sky Screens, is keyed into the 4051 (Fig. 8).

The problem is one of geometric adjustments. In a matter of seconds the 4051 calculates the correct angle for each Sky Screen and displays the configuration on the 4051 graphic screen (Fig. 9). It's easy to see if more or less Sky Screens are needed (Fig. 10). The margin of error has been within one percent.

This is a long way from the old method of manually drawing the positions and angles with pencil and ruler, then computing the angle measurements. Often it would take upwards of an hour.

Sanford also keeps the 4051 busy streamlining schedules, test forms and mailings. The Option 1 RS-232 allows the 4051 to go online in the ARPA network delivering test results to a computer "mail box" in Boston. This computer dispatches these results to computers in California, London and other points. An interested individual may then dial up his computer to receive the test results. Since equipment testing is the Directorate's function, graphically editing the many required test reports offline and then transmitting them online has saved immense amounts of time and paper.



```
*** SKY SCREEN: TARGET WINDOW ACQUISITION ***

(TYPE  0  TO QUIT)

ENTER NUMBER OF SKY SCREENS: 2

ENTER WINDOW WIDTH, HEIGHT, AND CENTER ALTITUDE: 100 100 800

ENTER DISPLACEMENT, ALTITUDE, AND FAN ANGLE FOR
   SKY SCREENS FROM CLOSEST TO FARTHEST:

FOR SKY SCREEN 1: 200 0 100

FOR SKY SCREEN 2: 500 0 100
```

Fig. 8. Prompted input for Sky Screens includes window size and altitude, the Sky Screens' horizontal distance from the window (displacement), height above ground (altitude), and vertical field of vision (fan angle) in mils.

The graphics and off-line processing capability of the 4051 have relieved the Materiel Testing Directorate of many tedious and routine tasks. These three applications are only a fraction of what Sanford has tucked away on his tapes and discs.

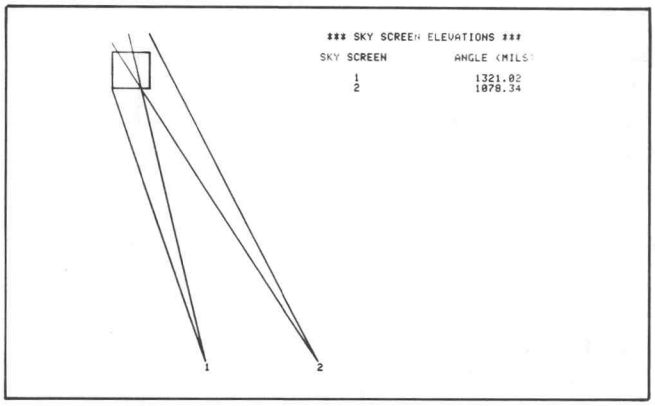
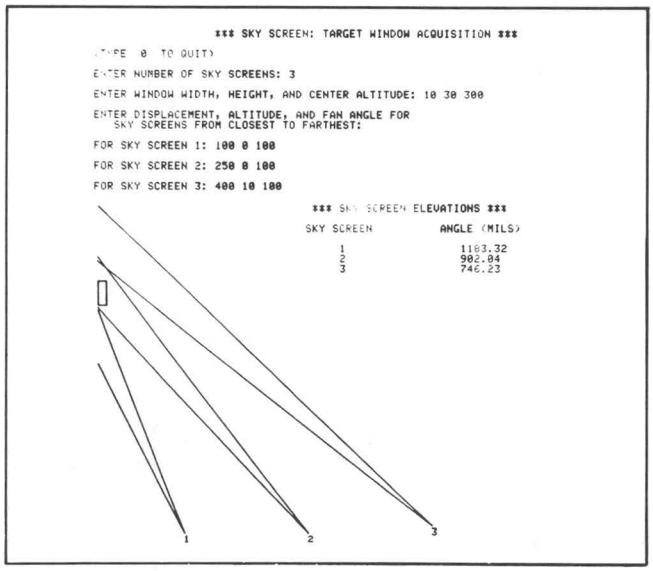


Fig. 9. Two Sky Screens positioned accurately to cover the entire window.



```
*** SKY SCREEN: TARGET WINDOW ACQUISITION ***

(TYPE  0  TO QUIT)

ENTER NUMBER OF SKY SCREENS: 3

ENTER WINDOW WIDTH, HEIGHT, AND CENTER ALTITUDE: 10 30 300

ENTER DISPLACEMENT, ALTITUDE, AND FAN ANGLE FOR
   SKY SCREENS FROM CLOSEST TO FARTHEST:

FOR SKY SCREEN 1: 100 0 100

FOR SKY SCREEN 2: 250 0 100

FOR SKY SCREEN 3: 400 10 100

*** SKY SCREEN ELEVATIONS ***

SKY SCREEN          ANGLE (MILS)

1                   1183.32
2                   902.04
3                   746.23

1
2
3
```

Fig. 10. The Sky Screen closest to the window is angled to view the bottom, the one farthest away to cover the top. Note that three Sky Screens are unnecessary in this case.

The Sky Screens are numbered and shown accurately in their positioning with respect to the window. The view fields are drawn showing areas of the window included.

Using the 4051C01

by Bob Haas

The TEKTRONIX 4051C01 implements IBM Binary Synchronous 2780 protocol, allowing high-speed error-free communication between the 4051 and IBM host computer systems. TEKniques Vol. 2 No. 3 discussed its capabilities and advantages. Here we'll use the 4051C01 to submit a job to a host computer, process the job, and return the job output for graphing on a 4051. The application is a simple one, but it contains all the steps necessary to implement any application.

You can use the 4051C01 by entering individual commands through the 4051 keyboard, executing each in immediate mode. However, it's much easier to use a BASIC program on the 4051 that contains commonly-used 4051C01 functions, all invocable by User-Definable keys. Portions of such a program are illustrated. Changes will likely be needed to adapt the program to your own application and the host computer operating system.

The first portion of the program is shown in Fig. 1. It assumes that the program will be file 1 on a tape and will be autoloaded. The first three statements initialize the 4051C01, print a message to the 4051 screen, and return control to the 4051 keyboard.

```
1 PRINT "AUTOLOADED"
2 CALL "C01INI","N3,R1,P1,E0"
3 RETURN
```

Fig. 1. First portion of 4051C01 interfacing program.

The next step is to establish communication with the host computer. If the 4051C01 is connected to a dial-up modem, dial the host computer modem number, wait for the answer tone, then place the local modem in "data" mode.

You can now transmit the "sign-on" message. The manager of a host computer system assigns each remote terminal an identifying number, and the sign-on message must contain this number. In the example, the host operating system is an IBM VS2/JES and our terminal (4051) is remote 5.

The BASIC statements necessary to sign-on are shown in Fig. 2. In this case, the sign-on message is 80 characters long because it must contain a password (required by the host operating system) in columns 73—80. Pressing User-Definable key 1 invokes sign-on. File 2 is found and transmitted to the host using the CALL "C01MTR" function. File 2 contains only one record of data—the sign-on message—which was created by statements 1000—1040 executed previously.

```
4 PRINT "FN KEY 1"
5 FIND 2
6 CALL "C01MTR"
7 RETURN
LIS 1000,1040
1000 REM PUT 80-CHARACTER ON TAPE
1005 FIND 2
1010 PRINT @33:"/*SIGNON       REMOTE5                    "!
1020 PRINT @33:"                                  C01TEST "
1030 CLOSE
1040 RETURN
```

Fig. 2. Statements 4 through 7 transmit sign-on to host. Statements 1000 through 1040 must be executed prior to sign-on.

If the sign-on message is less than 57 characters (the maximum allowed in a PRINT literal statement), it could be sent using the following BASIC statements:

```
4 PRINT @59:"/*SIGNON      REMOTE5"
5 CALL "C01CLO"
6 RETURN
```

(Device number 59 in statement 4 assumes the 4051C01 interface connector is plugged into the right backpack slot of the 4051. Device number 49 would indicate the left slot.)

The next step is to transmit the job to the host. In this example, the job is a simple FORTRAN program which calculates 200 sine and cosine values. The program and the BASIC statements required to transmit it to the host are shown in Fig. 3.

```
8 PRINT "FN KEY 2"
9 GO TO 8000

8000 REM FORTRAN "APPLICATION"
8010 PRINT @59:"//U4051F JOB U4051,BOB,CLASS=G"
8020 PRINT @59:"//STEP EXEC FORTGCLG"
8030 PRINT @59:"//C.SYSIN DD *"
8040 PRINT @59:"       Z=0.0"
8050 PRINT @59:"       ZINC=3.14159265/100."
8060 PRINT @59:"       DO 100 I=1,200"
8070 PRINT @59:"       X=SIN(Z)"
8080 PRINT @59:"       Y=COS(3.0*Z)"
8090 PRINT @59:"       Z=Z+ZINC"
8100 PRINT @59:" 100   WRITE (7,200)X,Y"
8110 PRINT @59:" 200   FORMAT(1X,2F10.6)"
8120 PRINT @59:"       END"
8130 PRINT @59:"/*"
8140 PRINT @59:"//G.FT07F001 DD SYSOUT=C"
8150 PRINT @59:"//"
8160 CALL "C01CLO"
8170 RETURN
```

Fig. 3. Pressing User-Definable key 2 transmits the FORTRAN program to the host.

The text of the program appears in a series of PRINT@59: statements. This is a convenient way to enter and edit a small FORTRAN program since the editing features of the 4051 can be used to edit the FORTRAN program simply by editing the PRINT@59: statements.

Another application might consist of fixed program statements and/or Job Control Language (JCL) followed by variable data, perhaps from a tape file, and terminated with more fixed JCL. A BASIC program to do this would be coded as follows:

```
110 PRINT @59:"//STEP 1 EXEC ....."   preceding JCL as required
 |
 |
200 FIND n                            file "n" contains the data
210 ON EOF (0) THEN 300
220 INPUT @33:A$
230 PRINT @59:A$                      transfer to C01
240 GO TO 220
300 PRINT @59:"/*"                    transmit required ending JCL
310 PRINT @59:"//"
320 CALL "C01CLO"                     send end of transmission
330 RETURN
```

If file "n" on the tape ended with terminating JCL, statements 210 through 330 could be replaced with a single CALL "C01MTR". C01MTR automatically calls "C01CLO" when the end-of-file mark on the tape is read. Since we assume this was not the case, an INPUT@33:, PRINT@59: loop was required to transmit the data followed by additional PRINT@59: statements to transmit the ending JCL. If several tape files were to be joined and transmitted as one host job, additional INPUT@33:, PRINT@59: loops would be required.

To transmit this job change statement 9 to: GO TO 110.

After a sufficient time has elapsed for the host to process the job, the output will be returned. The returned output will include a log of activity, accounting information, and, in the first case, a listing of the program produced by the FORTRAN compiler. This printed output will be directed to the remote terminal printer.

In statement 8100 the data output is directed to FORTRAN logical unit 7. In statement 8135 a JCL statement directs FORTRAN unit 7 to output class "C", a remote terminal punch on this particular host computer.

In general, printer output is less predictable, hence harder for the remote user to control, than punch output. Therefore, data to be processed by a 4051 BASIC program should be directed to the remote terminal punch. Of course, the 4051C01 must be defined by the host computer system manager as having both a punch and a printer.

```
16 PRINT "FN KEY 4"
17 GO TO 9000

9000 REM RECEIVE TO TAPE (PUNCH) AND SCREEN (PRINT)
9010 ON EOF (9) THEN 9300
9020 FIND 4
9030 DELETE B$,C$
9040 DIM B$(150),C$(150)
9050 INPUT @59:B$
9060 D$=SEG(B$,1,1)
9070 IF D$<>"C" THEN 9200
9080 D$=SEG(B$,2,1)
9090 C$=SEG(B$,3,LEN(B$)-2)
9100 IF D$<>"4" THEN 9220
9110 PRINT @33:C$
9140 GO TO 9050
9200 PRINT B$
9210 GO TO 9050
9220 PRINT C$
9230 GO TO 9050
9300 PRINT "**** END OF TRANSMISSION ****"
9310 RETURN
```

Fig. 4. Pressing User-Definable key 4 will input data from the host and send it to the tape (statement 9110) or to the screen (statements 9200 and 9220).

In the 2780 protocol used by the 4051C01, the host prefixes each data record with a two-character sequence, consisting of an ESCAPE character (hexadecimal 27 in EBCDIC, translates to 1B in ASCII) and a destination-designating character. Records destined for the remote terminal punch have a "4" as the second character. Figure 4 shows the BASIC statements necessary to receive data from the host, and to separate the punch from the printer data. All punch records are sent to file 4 of the tape, and all print records are sent to the 4051 screen. (It is assumed that no permanent copy of the printer output is to be made.)

Now you can signal the host computer that its services are no longer required by transmitting a "sign-off" message and breaking the data connection (hanging up the phone). Figure 5 shows the statements that accomplish the sign-off, invoked by User-Definable key 5.

```
20 PRINT "FN KEY 5"
21 PRINT @59:"/*SIGNOFF  "
22 CALL "C01CLO"
23 RETURN
```

Fig. 5. This portion of the program signs off from the host.

It is assumed that the data received from the host is to be processed "off-line"; that is, not while the data connection to the host is still established. The data could be graphed by the 4051 while it's being received, but it is more likely that several BASIC programs will process the data. This would require that the data be stored on tape.

```
 0.844327 -0.992114
 0.860741 -0.999506
 0.876305 -0.998027
 0.891005 -0.987698
 0.904825 -0.968587
 0.917752 -0.940887
 0.929774 -0.904836
 0.940878 -0.860754
 0.951054 -0.809033
 0.960291 -0.750131
 0.968580 -0.684571
 0.975914 -0.612935
 0.982285 -0.535859
 0.987686 -0.454027
 0.992113 -0.368165
 0.995561 -0.279036
 0.998026 -0.187430
 0.999506 -0.094168
 1.000000 -0.000055
 0.999507  0.094058
 0.998028  0.187321
 0.995564  0.278930
 0.992118  0.368063
 0.987692  0.453929
 0.982292  0.535766
```

Fig. 6. Data returned by the FORTRAN program.

```
10000 FIND 4
10010 INPUT @33:A$
10020 INPUT @33:A$
10030 ON EOF (0) THEN 10110
10040 VIEWPORT 15,115,0,100
10050 WINDOW -1,1,-1,1
10055 VIEWPORT 50,130,0,80
10060 INPUT @33:X,Y
10070 MOVE X,Y
10080 INPUT @33:X,Y
10090 DRAW X,Y
10100 GO TO 10080
10110 END

RUN 10000
```

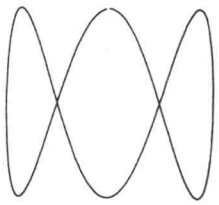


Fig. 7. Program to plot the data in Fig. 6.

A sample of the data returned by the FORTRAN program is shown in Fig. 6. The BASIC program to plot the data is shown in Fig. 7. This host computer system punches two "separator" cards between each job's punched output to aid a 2780 operator in separating job decks. These two records are discarded by BASIC statements 10010 and 10020. It's possible to suppress the generation of these separator cards by the following statements:

```
400 PRINT @59:"/*T RM5.PU1,S=N"
410 CALL "C01CLO"
420 RETURN
```

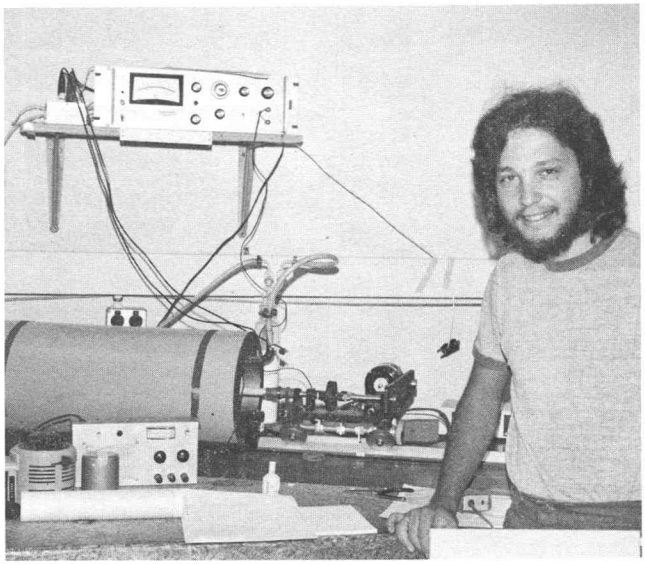
These statements must be executed after the sign-on and before submitting the job to the host.

Now you have an easy-to-use 4051 BASIC program to send a job to and receive output and data from a host computer using a 4051C01 Synchronous Communications interface.

4051 Graphs Age-Old Geomagnetic Data

by Patricia Kelley

The Department of Geology and Geophysics at the University of Minnesota is conducting studies of the ancient history of the Earth's magnetic fields. Equipment housed in the Space Science Center on the Minneapolis campus includes a 4051 which graphs paleomagnetic and rock magnetic data.



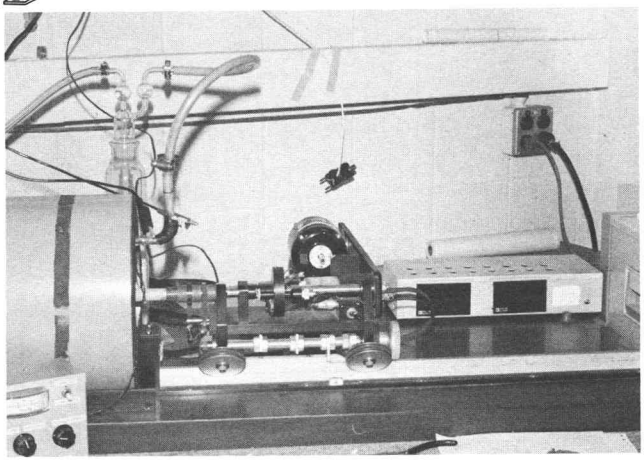
Bruce Moskowitz, geophysics graduate student at the University of Minnesota, explains how the Schonstedt spinner magnetometer and digital voltmeter gather fossil magnetization data from ancient rocks. The 4051 then graphs the data for quick interpretation.

Magnetic field history is preserved in old rocks as fossil magnetization. This is the result of miniscule particles of the rock becoming oriented with the Earth's magnetic field as it existed at the time and place of the rock's formation.

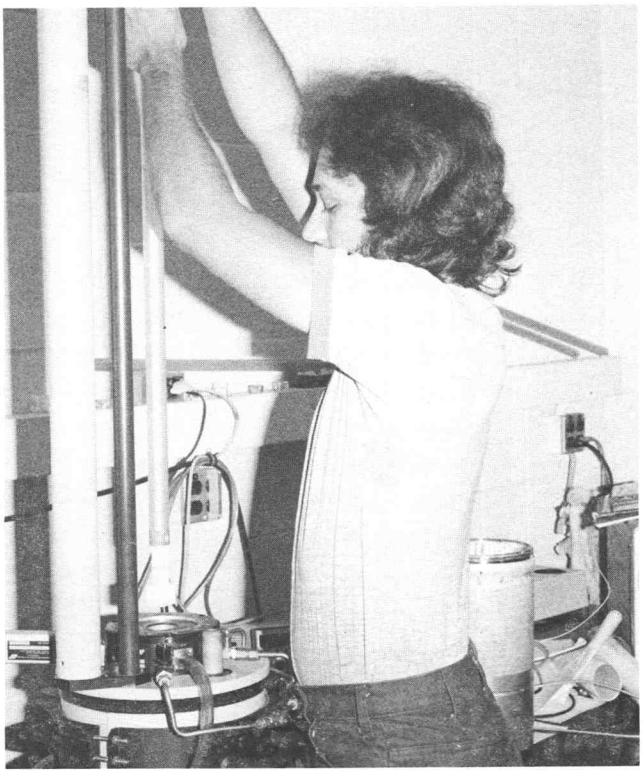
To measure this faint residual magnetic moment, a rock specimen is placed in the Schonstedt Instrument Company spinner magnetometer or the SCT superconducting rock magnetometer. As the magnetic moments are measured, the signals are passed to digital voltmeters and the data is captured by a Hewlett-Packard 2108.

At the conclusion of each experiment, the HP2108 prints out the table of results; the data is then transferred to the 4051 through the RS-232 interface. The 4051 graphs the data for quick visual examination and for preliminary modeling.

In addition to its duties in the laboratory, the 4051 is connected as a terminal to the University's Cyber 74 system for additional data handling. And in its stand alone mode the 4051 is used by department personnel to carry out independent graphics manipulation and output.



The spinner magnetometer picks up signals as faint as 10^{-7} emu total.



A more sensitive machine, the Schonstedt superconducting technology magnetometer measures signals as small as 2×10^{-8} emu total in one second. To obtain this sensitivity, a Superconducting Quantum Interface Device (SQUID) is used which must be maintained at liquid helium temperatures. As demonstrated by Moskowitz, the rock specimen is then placed into a tube and lowered into the machine for measurement.

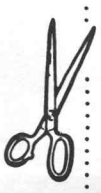
4051 Graphic System Publications

The following table contains a summary of all current manuals related to the 4051 Graphic System. The correct nomenclature, latest published date, and Tektronix part number are included. This list contains all manuals published up to December, 1978.

Contact your local Tektronix office for prices, availability, and to order any of these publications.

4051 and RELATED PERIPHERAL MANUALS

Manual	Publication Date	Part No.
STANDARD		
4051 Graphic System Operator's	JAN 76	070-1940-00
4051 Graphic System Reference	JAN 76	070-2056-00
Reference Guide to 4051 BASIC	3rd Printing	070-2142-00
PLOT 50: Introduction to Programming in BASIC	SEP 78	070-2058-01
PLOT 50: Introduction to Graphic Programming in BASIC	SEP 78	070-2059-01
SERVICE		
4051 Graphic System Service Vol. 1	MAY 77	070-2065-00
4051 Graphic System Service Vol. 2	NOV 78	070-2286-01
#067-0746-00 System Test Fixture	JUN 77	070-2304-00
ROM PACK		
4051R01 Matrix Functions	JUN 76	070-2127-00
4051R05 Binary Program Loader	AUG 76	070-2171-00
4051R06 Editor	FEB 77	070-2170-00
4051E01 ROM Expander Instruction	DEC 76	070-2215-00
4050 Series R07 Signal Processing ROM Pack No. 1 Instruction	OCT 78	070-2557-00
INTERFACE		
4051 Option 1 Data Communications Interface	MAR 77	070-2066-01
4051 Option 10 RS-232 Printer Interface	JUN 76	070-2119-00
4051 GPIB Hardware Support	MAR 77	070-2270-00
4051 GPIB Application Support	APR 77	070-2307-00
4051C01 Synchronous Communications Interface	SEP 78	070-2436-00
021-0206-00 P7001/IEEE Interface Instruction	JUL 78	070-2623-00
SOFTWARE		
4050A01 PLOT 50: Statistics Vol. 1	DEC 75	062-1854-00
4050A02 PLOT 50: Statistics Vol. 2	JUN 76	062-1855-00
4050A03 PLOT 50: Statistics Vol. 3	DEC 75	062-1856-00
4050A04 PLOT 50: Mathematics Vol. 1	DEC 78	070-2776-00
4050A05 PLOT 50: Mathematics Vol. 2	DEC 75	062-1858-00
4050A06 PLOT 50: Electrical Engineering Vol. 1	DEC 75	062-2280-00
4050A07 PLOT 50: Graph Plot	MAR 77	070-2288-00
4050A08 PLOT 50: General Utilities Vol. 1	MAR 77	070-2287-00
4050A09 PLOT 50: Business Planning and Analysis	OCT 76	070-2226-00
4050A10 PLOT 50: Statistics Vol. 4	MAR 77	070-2214-00
4051B01 Modeling and Reporting Users	APR 78	070-2544-00
4051B01 Modeling and Reporting Opt. 5 Flexible Disc Users	SEP 78	070-2673-00



PERIPHERAL

4631

4631 Hard Copy Unit Users	SEP 74	070-1830-01
4631 Hard Copy Unit Service	DEC 76	070-1831-01

4641

4641/4641-4 Character Printer Operator's	OCT 76	070-2110-00
4641/4641-4 Printer Service	NOV 76	070-2111-00

4642

4642/4642-1 Printer Operator's	NOV 77	070-2486-00

4662

4662 Interactive Digital Plotter User	DEC 76	070-1932-01
4662 Interactive Digital Plotter Service	JAN 77	070-1933-00
4662 Interactive Digital Plotter Users Reference Card	MAR 78	070-2556-00
#067-0829-00 4662 Test Tape Operators	JUN 77	070-2366-00
4662 Diagnostic Test Fixture Instruction	APR 78	070-2564-00

4907

4907 File Manager Operator's	MAR 78	070-2380-00
4907 File Manager Pocket Reference Card	DEC 78	070-2381-01
4907 Service	NOV 78	070-2405-00
4907 Installation Guide	FEB 78	070-2493-00

4924

4924 Digital Cartridge Tape Drive Operator's	SEP 76	070-2128-00
4924 Digital Cartridge Tape Drive Service	NOV 76	070-2131-00
4924 Reference Guide	MAR 77	070-2302-00

4952

4952 Joystick Option 2		070-2098-00

4956

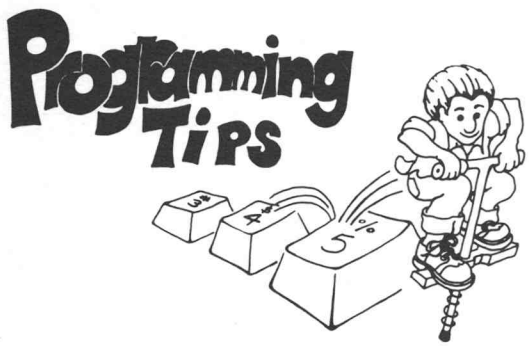
4956 Graphics Tablet Operator's	FEB 77	070-2210-00
4956 Graphics Tablet Service	FEB 77	070-2211-00

7912

7912AD Programmable Digitizer	AUG 78	070-2689-00

MODIFIED 4051 and RELATED MODIFIED PERIPHERAL MANUALS

Manual	Publication Date	Part No.
4051		
4051 (Option 1) Mod AA Half-Duplex BASIC I/O	JUN 78	061-1843-00
4051 Mod AB (with XYZ Output) Scan Converter I/F	APR 78	061-1807-00
4051 Mod SA Current Loop Backpack I/F	SEP 78	061-1842-00
PERIPHERAL		
(CM020-0198-00) 4051 Auto-Start ROM Pack	MAR 78	061-1147-00
(CM021-0211-01) 4051 General Purpose Output Interface	MAY 78	061-1803-00
(CM021-0212-01) 4051 General Purpose Input Interface	MAY 78	061-1804-00



Fast Random Arrangement of a Data Set

by Ralph Deutsch
Deutsch Research Laboratories, Ltd.
Sherman Oaks, CA

Experiments and card games are two areas of application for random data. The following technique quickly places a set of positive integers in random order without duplicating prior selections. The scheme works equally well for data sets having a multiplicity of the same value.

For this example, statements 180 through 200 generate a data set of numbers 1 through 64. Data sets could be generated using DATA and READ statements as well as many other ways.

Statements 220 through 250 convert the data to four character segments and fill the string A$ with the data. A loop is then employed to randomly select data from the string.

L represents the number of data segments. Each time through the loop the range of segments is adjusted downward (STEP -1 in statement 280).

Statement 290 generates a random number within the data set range. Statement 300 assigns a data segment to B$. The position of the segment in A$ is keyed off the random number after adjusting it to reflect the four-character nature of the data segments. Statement 310 converts the segment to its original numeric value and assigns it to position L in array Y. Statement 320 then removes the segment from the string.

Statements 360 through 430 print out the original data in array X and the randomly ordered data in array Y.

```
100 INIT
110 DELETE S$,X,Y
120 DIM S$(256),X(64),Y(64)
180 FOR I=1 TO 64
190 X(I)=I
200 NEXT I
210 S$=""
220 FOR I=1 TO 64
230 A$=STR$(X(I)+100)
240 S$=REP$(A$,LEN(S$)+1,0)
250 NEXT I
260 K=RND(-1)
280 FOR L=64 TO 1 STEP -1
290 K=INT((L-1)*RND(1)+0.5)+1
300 B$=SEG$(S$,(K-1)*4+1,4)
310 Y(L)=VAL(B$)-100
320 S$=REP$("",(K-1)*4+1,4)
330 NEXT L
340 END
360 PRINT "        I     X     Y          I     X     Y"
370 PRINT
380 FOR I=1 TO 32
390 PRINT USING 400:I,X(I),Y(I),I+32,X(I+32),Y(I+32)
400 IMAGE 2(6X,3D,3X,4D,3X,4D,2X)
410 NEXT I
430 END
```

Menu String Saves Time and Memory

by Roger Chan
USV Laboratories Division
USV Pharmaceutical Corporation
Tuckahoe, NY

Reduce display time and memory overhead by storing your menu in a string. Not only is printing a string faster than executing a series of PRINT statements, but elimination of the PRINT statements results in memory savings.

The following routine compresses the menu listing into A$. Statement 360 then recovers memory.

```
100 DELETE A$
110 DIM A$(1000)
120 A$=""
130 DATA "   MENUJJ"
140 DATA " 1 ENTER DATA"
150 DATA " 2 DISPLAY DATA"
160 DATA " 3 EDIT DATA"
170 !
180 !
300 B$=CHR$(13)
305 REM SET K EQUAL TO NUMBER OF DATA STATEMENTS
310 FOR I=1 TO K
320 READ C$
330 C$=C$&B$
340 A$=A$&C$
350 NEXT I
360 DELETE 100,360
370 PAGE
380 PRINT A$
390 !
400 !
```

Choose Your Delimiter

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

Do you have a program sending output to a peripheral requiring a CR/LF delimiter but you wish to retain optional 4051 screen output requiring only a CR delimiter? Incorporate the following lines of code into your listing routine; the proper delimiter will be set with minimum user input. Pressing RETURN without entering anything from the keyboard will default to the screen.

```
1000 D=32
1010 PRINT "OUTPUT TO SCREEN OR PRINTER? "!
1020 INPUT D$
1030 IF POS("SCREEN",D$,1)=1 THEN 1050
1040 D=(Device # for peripheral)
1050 PRINT @37,26:D<>32
```

Consistent Plotter Window

by Robert Thomson
Florida Solar Energy Center
Cape Canaveral, FL

By appending the following lines of code into a program, you can ensure consistent graphs or charts on the 4662 Plotter. For example, we use the 4051 and the Plotter to produce collector efficiency plots which are then incorporated into test reports. Using this code, we can be confident that all plots are directly comparable.

The code locates the lower left and upper right page boundary coordinates in exactly the same spot every time a program is run ensuring the plots are the same size. This technique is simpler and more accurate than setting the boundaries manually.

For standard paper placement on the Plotter, we have drawn a line approximately 2.25 inches from the left edge of the Plotter surface. All of our programs are coded so output will be directed to paper placed along that line. If you're running labels or plots on different size paper, simply change the coordinate points in lines 130 and 160 to reflect the boundaries desired.

CAUTION: The page size must be set only once; therefore, insert the code into an early portion of your program. If the code should be executed a second time without cycling power, press RETURN twice in response to lines 140 and 170; the 4051 will accept it as dummy input without changing the page size. Otherwise the pen will move to positions smaller than desired.

To return to the Plotter's original page size, cycle the Plotter's power or manually position the joystick and reset the lower left and upper right coordinates.

(assumes the plotter is device 1)

```
100 PRINT "DEVICE? "!
110 INPUT D
120 IF D<>1 THEN 190
130 MOVE @3:21.5,0
140 PRINT "GGGSET LOWER LEFTGGG"
150 INPUT D$
160 MOVE @3:124.5,75
170 PRINT "GGGSET UPPER RIGHTGGG"
180 INPUT D$
190 REM----TARGET----
```

Correct Use of RND(-1)

The (-1) parameter for the random number generator function (RND) should only be used to select a random starting point on the random number chain. Continued use of the (-1) parameter in a random number generator loop doesn't even come close to yielding true random numbers.

Although the target of the RND function is a chain of numbers, these numbers are linked together in a scientifically selected random sequence. Progressing through this chain from a starting point produces a close approximation of truly random numbers. And its size of 140 trillion numbers guarantees a wealth of starting points.

Therefore, pick a random starting point on the chain using RND(-1). Then use RND(1) to advance the random

number generator. A simple loop illustrates these parameters:

```
DEL B
DIM B(10)
M1=RND(-1)
FOR I=1 TO 10
B(I)=RND(1)
NEXT I
PRINT B
END
```

Review pages 8-27 and 8-28 of the 4051 Graphic System Reference manual for additional information on other parameters which specify starting points.

Close Data Files

When WRIting or PRInting data to an **internal** tape file, before you remove the tape be sure to end the operation with a CLOSE, END, or FIND command to ensure all data is sent to the tape. When sending data to the 4924 Tape Drive, execute a PRINT@4,2: (where 4 is the address of the 4924) at the end of a WRIte or PRInt operation to close the file. If the file is not closed before the tape is removed, some of the data will be lost.

A PRInt command with a secondary address of 2 must not be issued to the internal tape. Therefore, include a small test in a program before closing a file:

(D is device number for 4924)

```
850 IF D<>33 THEN 900
860 CLOSE
870 GO TO 910
900 PRINT @D,2:
!
!
```

Pages 7-23 and 7-24 of the 4051 Graphic System Reference manual and page 2-14 of the 4924 Digital Cartridge Tape Drive Operator's manual discuss these points in more detail.

Quick Array of Random Numbers

by Dan Taylor

Function Operation on Arrays

When an array is the parameter of a numeric function, the function is applied to each element of the array. The result must be assigned to another array of the same dimension (or the same array). In the following example, array A, containing different angles, is the parameter of the SIN function. When this statement is executed array B will contain the sines of all the angles.

```
B=SIN(A)
```

RND Function on Array

You can extend this technique to quickly produce an array of random numbers without using a loop. Statement 100 fills the array with 1's. In statement 120, the array is specified as the parameter of the Random Number (RND) function. Therefore, execution of statement 110 applies the RND function to each element of the array and (in this example) assigns the resulting number to that element in the same array.

```
100 DIM A(15)
110 A=1
120 A=RND(A)
```

Publication Deadlines

TEKniques will retain its six-week publication schedule through 1979. Contributions are welcome and should be submitted eight weeks prior to the publishing date. The following schedule will aid those of you planning to send in those useful tips and articles.

TEKniques Issue	Copy Deadline	Publish Date
Vol. 3 No. 1	Dec. 7, 1978	Feb. 1, 1979
Vol. 3 No. 2	Jan. 18, 1979	Mar. 15, 1979
Vol. 3 No. 3	Mar. 6, 1979	May 1, 1979
Vol. 3 No. 4	Apr. 10, 1979	Jun. 15, 1979
Vol. 3 No. 5	Jun 6, 1979	Aug. 1, 1979
Vol. 3 No. 6	Jul. 21, 1979	Sept. 15, 1979
Vol. 3 No. 7	Sept. 6, 1979	Nov. 1, 1979
Vol. 3 No. 8	Oct. 20, 1979	Dec. 15, 1979

4051 Applications Library Program Abstracts

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

ABSTRACT NUMBER 51/00-0716/0

Title: **MIPS—A Management Information Processing System**
Author: Revised by Ed Mitchell
Tektronix
Memory Requirement: 32K
Peripherals: 4631 Hard Copy Unit
Statements: 921
Files: 2 ASCII, 1 Binary

This program maintains a data base from which it produces tabular and graphic comparison reports. The data structure provides for 80 files on a data tape with 14 subfiles in each. The subfiles each have space for 13 entries representing 13 accounting periods in a fiscal year.

MYSTERY DISTRICT -- INFORMATION DISPLAY GROUP SALES ORGANIZATION
COMPARISONS REPORT -- ORDERS VS TARGET; THRU 613

A/P	F/Y600 ORDERS	F/Y600 TARGET	A/P DIFF	A/P %	600YTD ORDERS	600YTD TARGET	YTD DIFF	YTD %
1	351234	420000	-68766	83.63	351234	420000	-68766	83.63
2	451025	420000	31025	107.39	802259	840000	-37741	95.51
3	1285412	420000	785412	287.00	2087671	1260000	747671	159.34
4	456235	420000	36235	108.63	2463906	1680000	783906	146.66
5	365235	420000	-54765	86.96	2829141	2100000	729141	134.72
6	298565	420000	-121435	71.09	3127706	2520000	607706	124.12
7	95865	450000	-354135	21.30	3223571	2970000	253571	108.54
8	546213	450000	96213	121.38	3769784	3420000	349784	110.23
9	156235	450000	-293765	34.72	3926019	3870000	56019	101.45
10	254654	450000	-195346	56.59	4180673	4320000	-139327	96.77
11	852346	450000	402346	189.41	5033019	4770000	263019	105.51
12	265845	450000	-184155	59.08	5298864	5220000	78864	101.51
13	476855	450000	26855	105.97	5775719	5670000	105719	101.86

Fig. 1. This report could also provide percentages. Had EXPENSES been indicated as the actuals rather than ORDERS, and ORDERS as the goals instead of TARGET, the A/P % column would yield expenses as a percent of orders.

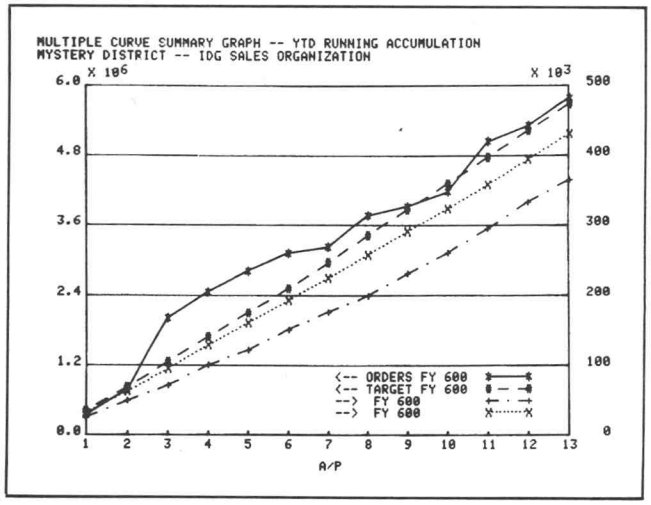


Fig. 2. Since the EXPENSE and BUDGET items were less than 20% of the ORDERS and TARGET items, the program generated a second axis on the right. The arrows in the legend indicate the EXPENSE and BUDGET curves are associated with that axis.

Choosing an actuals graph would have produced a graph of the actual accounting period values rather than a running total.

The User-Definable keys invoke 16 routines allowing easy building and editing of the data, graphing and utility functions.

Tabular or graphic comparison may be made of any two subfiles from one of the 80 major files (Fig. 1). In addition, multiple curve graphs may be obtained for up to five curves based on data from any subfiles chosen from any files (Fig. 2).

Ratio or percentage graphs, which use any subfile as the numerator and any subfile as the denominator, are unique features of MIPS.

Newcomers to the 4051 should be able to manipulate and graph data with ease. A sophisticated user will be able to modify and add code easily to perform special functions.

The program is general purpose and can be used on any type of data (dollars, man-years, percentages, expenses, orders and so on).

ABSTRACT NUMBER: 51/00-5204/0

Title: **Chromatographic Data Acquisition and Plotting (CHROMPLOT)**
Author: Leonard H. Ponder
American ENKA Company
Enka, NC
Memory Requirement: 24K/16K
Peripherals: Opt. 1 Data Communications I/F
Optional-4631 Hard Copy Unit
Statements: 523
Files: 1

Chromatographic data from an electronic integrator (or digitizer) is recorded on magnetic tape and subsequently plotted on the basis of the original time axis, relative time axis, or molecular size axis. Relative retentions and molecular sizes are calculated automatically. The program is useful in liquid chromatography, gel permeation chromatography, and gas chromatography, or with similar data.

Each chromatogram or selected portion of the chromatogram is scaled to fit the allotted plotting area.

The program is easy to use. Pressing a User-Definable Key activates the desired routine; the routines are shown below. Documentation includes a variable table, flowcharts and detailed instructions.

UDK	Function
1	Minimum and maximum for entire chromatogram
2	Scale and plot entire chromatogram
3	Data to tape
4	Plot entire chromatogram
5	Return to BASIC
6	Change ordinate and abscissa
7	Plot selector
8	Label under chromatogram
9	Read tape
10	Display-only (terminal mode)
11	Minimum and maximum, specific interval
12	Not used
13	Data to tape (no instructions)
14	Molecular size label
15	Display molecular size
16	Print times and min-max
17	Continue over-plot
18	Label above chromatogram
19&20	Not used

ABSTRACT NUMBER: 51/00-9525/0

Title: **A One-on-One Interactive War-at-Sea Model**
Authors: Jack Nance, Jean Cishek
Center for Naval Analyses
Arlington, VA
Memory Requirement: 32K
Peripherals: 4051R05 Binary ROM
4631 Hard Copy Unit
Statements: 1,880
Files: 17

A one-on-one war-at-sea model has been developed as a first step in creating a graphics interactive model to be used for evaluating tactics and for training pilots in their use. Aircraft and missile system parameters used in implementing the model are hypothetical to keep the memorandum unclassified. The feasibility of a many-on-many game and a model for the desk-top calculator has been explored.

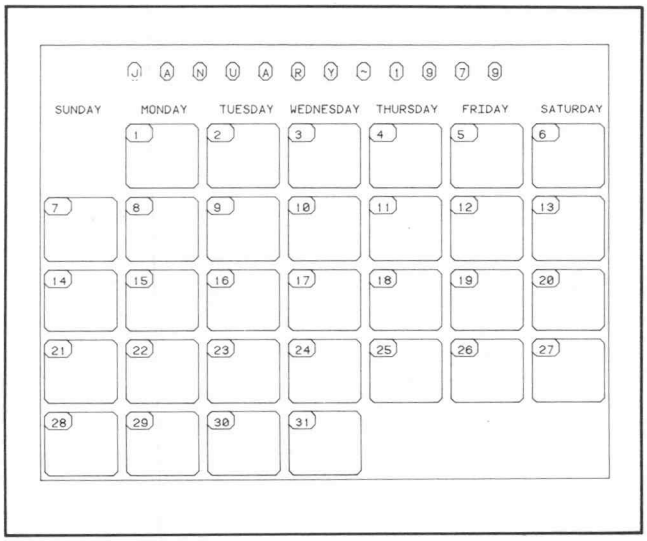
ABSTRACT NUMBER: 51/00-9526/0

Title: **Calendar Generator**
Author: LeRoy Nollette
Tektronix
Memory Requirement: 8K
Peripherals: Optional-4662 Plotter
Statements: 84
Files: 1

This program will draw a calendar one month at a time on either the 4051 screen or on the 4662 Plotter.

The user changes variable "A" in the listing to specify the first day of the week in January. Variable "Y" is the year and variable "T" specifies the output device number.

User Definable Key 1 may be used to switch the output device number between the screen and the Plotter.



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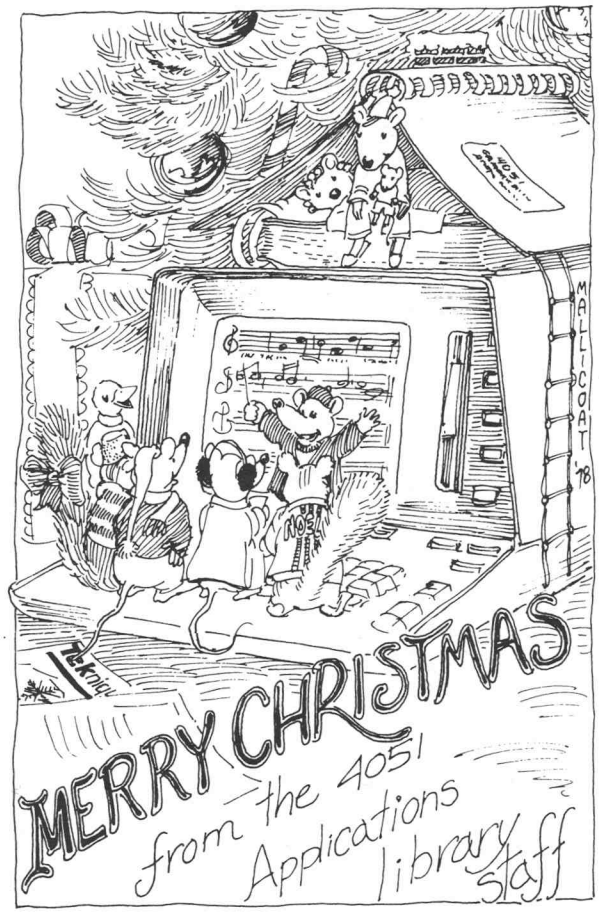

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