For everything there is a season,
and a time for every matter under heaven,
a time to be born, and a time to die, ...

That passage from Ecclesiastes 3 is pertinent to this last issue in two ways. First, I am sorry to report that Carl Rabe died of a cerebral hemorrhage due to a heart attack. I never met Carl face-to-face, but considered him as a good friend. I talked to him several times on the telephone and accumulated a lengthy file of letters on programs and other subjects of common interest. Members will recall that Carl was instrumental in the fine tuning of the smallest circle analysis.

Second, it is time to publish the last issue of our newsletter. I am even later than usual with this final issue, primarily due to difficulty in generating much enthusiasm for a final issue. Several members have asked about the possibility of continuing some level of support in the coming year. My present plans are to:

1. Maintain the post office box address through mid-1992. During that time I will continue to provide magnetic tape service and magnetic card service, will provide back issues if ordered, and will answer correspondence as time permits.

2. Make up compilations of material from the V14 issues for the TI-74, the TI-95 and the TI-81 and offer them to past purchasers.

My personal plans are not well defined. I still like to work on problems whether of the programming variety or of the more basic mathematical kind, so if you have a vexing problem and would like some assistance feel free to write. If the problem captures my imagination I will try to help. I also hope to write some technical papers on some of my work in the early days of inertial navigation.

Finally, I want to thank all of those who have supported the club through the years through continuing membership, submission of programs, and the like. May you all have a Happy Holiday Season.

This newsletter is not copyrighted and may be reproduced for personal use. When material is used elsewhere we ask as a matter of courtesy that TI PPC NOTES be mentioned. The use of material in this newsletter is entirely at the user's risk. No responsibility as to the accuracy and the consequences due to the lack of it will be borne by either the club or by the editor.
ERRATA

V14N4P4-7 Polynomial Curve Fit on the TI-81 - George Thomson notes that once again I failed to point out that the solution was done by the method of least squares minimizing errors in Y, and with the X values assumed to be error free and of equal weight. George also wondered how many readers really know how tricky polynomials can be because of the "hill-and-valley" problem. The equation may fit well at or near the observed data points but have ridiculous values between the points. One way to observe problems of this sort is to overlay the plot of the function on the input data as was done in the TI-81 program.

One final personal note: if you look closely at nature you will find that the Lord tended to use logarithmic and exponential functions and statistical methods - He didn't have much use for polynomials.

HARDWARE AND SOFTWARE WANTED - HP-35, HP-45 and HP-65 together with the original documentation (owner's manual, programming guide, handbook, etc.) and external power adapter. Slide rules of any configuration plus books and pamphlets on such items. Also interested in programs which calculate residential heat loads; e.g., to solve for in-house temperatures given various ambient outside temperatures, solar inputs, interior thermal mass and other related parameters. This would be used to size construction parameters for a solar heated greenhouse or solar heated living spaces. Desirable, but not mandatory, that programs will run on an HP-45, HP-65 or TI-59. Write to William S. West, 731 Monroe Street, Apartment 303, Rockville MD 20850-2716.


CONTINUING SUPPORT FOR THE CC-40 - The Lima User Group emphasizes support of the TI-99/4, but is also a source of continuing information on the CC-40 including articles on hardware availability and software. Examples of the kind of material available appear in the article on the Wafertape in V14N4P2-12 and the data bank program on page 3 of this issue. Membership dues are $15.00 per year in the United States, $20.00 per year overseas. Members receive ten issues of the newsletter Bits Bytes & Pixels each year. Send your subscription to the Lima User Group, Box 647, Venedocia OH 45894.

All back issues that contain CC-40 articles are available for three cents per page. Members are billed for the cost of back issues they request after the material is sent. The CC-40 software library consists of 24 CC-40 BASIC programs, five of which were typed in from TI PPC NOTES. The entire collection is available to any member who sends a QuickDisk or Wafertape and a paid return mailer.

Another example of the kind of support that is available is a video tape in which the CC-40 PLUS, with built-in cassette interface is shown. The CC-40 PLUS is a never released product that was under development by TI. The tape also shows the never released TI-99/2 which was designed to compete with the Timex/Sinclair 1000. The price for the tape is five dollars. It runs for six hours, but only an hour or so is devoted to the CC-40 and TI-99/2. The tape was made at the Lima User Group's May 1991 TI-99/4A conference.
USING THE CC-40 (and the TI-74) AS A PORTABLE DATA BANK - Charles Good. Have you seen those electronic "organizers" in the department stores? They are battery operated dedicated computers that look like large calculators. Marketed under names such as "THE BOSS" or "THE ORGANIZER", they are designed to store lists of names and addresses or hour by hour appointment calendars. With these devices it is easy anywhere and anytime to sort through a large data base for a particular name, address, or phone number. With many of these devices you can download their data to a desktop PC or print the information on a printer.

Well, you can do the same thing with a CC-40. Since the CC-40 has CMOS RAM, any BASIC program entered into the CC-40 stays in memory even after the computer is turned "off". BASIC programs will remain in the CC-40's memory for many months in the "computer is turned off" mode before the batteries finally need to be changed. Short appointment calendars, notes or address lists can be stored in the CC-40 as text that is displayed when any of the ten user-programmable hot keys are pressed from command mode. Data can also be stored as part of a memory resident BASIC program, but there is a potential problem with this method. Although the CC-40 retains a BASIC program in memory when it is turned "off", it does not retain any of the numeric or string variables generated by the BASIC program. There are CC-40 programs in my software library that allow you to open a disk (or videotape) file and read in a list of names, addresses and phone numbers. When you do this and then later turn the CC-40 "off" to conserve battery power, the BASIC program remains in memory. However, the data read in from disk and stored in strings is GONE! There is certainly no advantage to the CC-40's portability if you have to go to a disk or tape drive every time you want to look up someone's phone number! The solution to this problem is to store your information as an actual part of the BASIC program in line numbers with DATA statements. When stored in this way, your data is retained in the CC-40's memory even when the computer is "off".

I wrote a CC-40 program to deal with this situation. A somewhat similar CC-40 program was published in the Volume 1 Number 2 issue of ENTHUSIOAST 99, but it doesn't work on many CC-40's because it POKES to an absolute memory address. My program works: It stores a name/address/phone number list as data statements. Only one person's data at a time is read into string variables; thus, the CC-40's memory is not wasted storing the entire data bank twice, once in data statements and a second time in strings. From the running program you can view all the data or search for the data of one particular person by inputting the person's last name. Because of the POS statement in line 200, you don't even have to enter the entire last name for a search. All you need to enter is a text string that is contained within the last name, such as inputting BUCK when searching for the last name ARMSTRONG. If the data base includes more than one person with the same last name the program will still help you find the information you want. An option also permits the user to view all input in sequence. The data for each person is displayed on a single 80 column line. You can scan left and right across this line of data at your leisure using the CC-40's arrow keys.

You can store about 100 program lines of names, addresses, and "other information" as DATA statements with this program in a minimum 6K CC-40. It takes just a few seconds to find the last of the 100 DATA statements in a name search. Editing is easy. From the CC-40's command mode just bring up the appropriate line number containing the DATA statement and type over or add to the existing DATA of that line number. To add more names to the data bank, just create more BASIC line numbers for the additional data. To obtain a hard copy of the data you can LIST the program to a HexBus compatible printer. You can also use the HexBus RS232 peripheral to list the program with all of your DATA to a non HexBus printer or dump the program (via a cable linking the HexBus RS232 to the TI-99/4A RS232) directly into a TI-99/4A.

Although you can't put a CC-40 in your pocket as can be done with many modern electronic organizers, you can easily put the "smaller than most books" CC-40 in a small briefcase or purse. And do so much more with the CC-40! Unlike most of the modern "organizers" the vintage 1983 CC-40 is a portable and truly flexible programmable computer. "Modern" does not always mean "better". (Editor's Note: The listed program will operate equally well in either a TI-74 or CC-40. Members will recall that the 16-bit mode of data in the TI-74 was discussed in V14JSKP3.)
AN ANOMALY IN THE LINEAR EQUATIONS SOLUTION ON THE TI-81, TI-68 AND TI-74

Timothy Baumgartner writes: "My Pre-calculus students have been using the TI-81 to solve matrix equations representing systems of linear equations. To introduce the topic of inconsistent systems I asked them to solve the system

\[
\begin{align*}
3x + 4y &= 7 \\
6x + 8y &= -2
\end{align*}
\]

hoping that they would get an error message after entering the matrices

\[
[A] = \begin{bmatrix} 3 & 4 \\ 6 & 8 \end{bmatrix} \quad \text{and} \quad [B] = \begin{bmatrix} 7 \\ -2 \end{bmatrix}
\]

and entering the expression \([A] [B]\). Instead, they saw the display

\[
\begin{bmatrix}
-1.06666666666666667 \times 10^{-13} \\
8 \times 10^{-12}
\end{bmatrix}
\]

Upon investigating, we found that the determinant of \([A]\) had been calculated as -6E-12 instead of the correct value of zero. This should be a very straightforward calculation:

\[
\det[A] = 3 \times 8 - 6 \times 4 = 0
\]

My question is this: How does the TI-81 calculate its determinants?"

Editor's Note: I do not know the exact sequence of calculations used to calculate determinants and solve linear equations in the TI-81. The method used is certainly not the simple one you describe since it will not work for systems of higher order. Of course, one can use the old artifice for a 3rd order system of rewriting the first and second columns to the right of the third column, and then doing the diagonal calculations, but as my old college algebra text says "... this method of expansion applies to a determinant of third order but not to one of higher order." Also, almost certainly the TI-81 does not evaluate a determinant by brute force expansion by minors. More probably it accomplishes the task through appropriate matrix manipulations such as additions and subtractions of one row (or column) from another such that zeroes are generated for selected elements of the matrix. Those methods typically involve multiplying or dividing one row (or column) by one of the elements of another row (or column). For example, suppose we want to place a zero in the first element in the second row. One way to do it would be to

(1) Divide each element of the first row by the first element of the first row.

(2) Multiply each element of the result from (1) by the first element of the second row.

(3) Subtract the result from (1) and (2) element by element from the elements of the second row.

Errors can be introduced if divisions occur which result in answers with repeating decimals. The calculations for the replacement values for the second row for your particular problem follow:

(1) Start with the elements of the first row, [3,4] and divide each element by 3, yielding [1,4/3] where the important point is that the second element is not exactly 4/3 as shown, but is actually 1.333333333333 (thirteen decimal digits).

(2) Multiply [1,1.333333333333] by 6 yielding [6, 7.999999999998].
An Anomaly in the Linear Equations Solution on the TI-81, TI-68 and TI-74 - (cont)

(3) Subtract [6, 7.999999999998] from the second row of the original matrix yielding the matrix

\[
\begin{bmatrix}
3 & 4 \\
0 & 2E-12 \\
\end{bmatrix}
\]

(4) Evaluate the matrix as 3 x 2E-12 - 0 x 4 = 6E-12. That answer is the same magnitude as the answer from the TI-81, but of different sign, suggesting that our algorithm is similar, but not identical to that in the TI-81.

What if we interchange the variables x and y in the original problem statement? Then the columns of the matrix would be interchanged. For that problem the TI-81 calculates the determinant as exactly zero, and an attempt to solve the linear equations results in the error message "ERROR 05 MATH".

Tests of other linear equation solvers show that for the test problem:

* The ML-02 program in the Master Library module for the TI-59 finds the determinant to be exactly zero. If the user then tries to solve the linear equations, which violates the instructions on page 10 of the manual, then the solution is returned as -1.6666667E99 and 9.9999999E99 where the second output is flashing to indicate an error has occurred. If the columns are reversed the results are the same.

* The linear equations solution of the TI-68 does not display the determinant. Page 7-6 of the manual states "If the system is singular, an error condition occurs." An attempt to solve the test problem yields the solution X1 = 1.0666667E13, X2 = -8E12, the same magnitudes as with the TI-81, but with opposite signs. If the columns are reversed the message "Error" appears in the display.

* The linear equations solution portion of the Mathematics module for the TI-74 finds the determinant to be -6.8E-12 and the solutions of the linear equations to be X1 = -1.0666667E+13 and X2 = 8.8E+12, the same results as those obtained with the TI-81. If the columns are reversed the message "THE SYSTEM IS SINGULAR" is returned.

* The linear equations solution portion of the Mathematics module for the TI-95 finds the determinant to be exactly zero. An attempt to solve the linear equations yields the message "SINGULAR". If the columns are reversed the determinant is still zero and an attempt to solve the linear equations results in the "SINGULAR" message.

There is no discussion of the method of solution in the guidebooks for the TI-68, TI-81 or TI-95 Mathematics Library. Pages 5-10 and 5-11 of the TI-74 Mathematics Library Guidebook states that the lower-upper decomposition method is used to find the determinant and to solve the linear equations. The detailed description is nearly identical with that which appeared on page 13 of the manual for the Master Library module for the TI-59. The reference in both the TI-59 and TI-74 manuals is Numerical Methods, Germund Dahlquist and Ake Bjork, Prentice Hall, 1974.

------------------------------------------------------------------------

ANOTHER SOURCE OF CC-40 HARDWARE - Charles Good writes: "A source of used CC-40 computers, peripherals, and user manuals (including the Wafertape manual) is Jim Lesher, 722 Huntley, Dallas TX 75214. Telephone 214-821-9274. I purchased a used 6K CC-40 with all of the original documentation for $50.00 plus shipping. Prices are subject to change at any time."
EXPERIENCE WITH THE PC INTERFACE CABLE - Greg Lind writes: I recently purchased the PC-Interface for the TI-74 and TI-95.

Since I own a TI-74 I'll be referring to that device. This interface lets you connect your TI-74 to any IBM or compatible computer. With the interface connected you now have disk drives for storage, an 80 column printer, and the computer screen for displaying output or program lines. This is now all connected to the TI-74 as if it was all one unit. It is really easy to use. Here's how it works. The interface connects to your parallel printer port. TI uses this port for rapid transmission of data and it's very fast. The only drawback is if your PC has only a single parallel port and your printer needs the parallel port as well. You have to disconnect the interface if you want to use the printer. I made a cable extension to bring the port connection to the front of the computer instead of always trying to reach behind my computer to connect the interface or printer cable.

Once the interface is connected you type PCIF at the DOS prompt. Now your TI-74 has your IBM or compatible at its disposal. Each access device has a special number:

- Computer parallel printer --------------- 14
- Computer screen ------------------------ 45
- Computer disk for program storage ----- 100
- Computer disk for data storage or
- ASCII format for text editor ----------- 101

Device "14" is for the parallel port if you have two ports. If not, all you do is save in an ASCII format and use a word processor program or anything similar to print to the printer. For example LIST "14.R=C" where R=C is the printer option would dump the entire program to the printer. You can limit the listing to certain line numbers with a command such as LIST "14.R=C",150-200 which will then print only lines 150 through 200. You can print output from a program as well.

Device "45" is for the computer monitor screen. You can use this to list program lines; for example LIST "45.P=Y" where P=Y is also an option. This stops the output when the screen is full until you press ENTER. You can also use device "45" in a program to move text from your program to the monitor. For example:

10 AS$="TEXAS INSTRUMENTS, PC INTERFACE"
20 OPEN #2,"45.P=Y",VARIABLE 80, OUTPUT
30 PRINT AS$
40 CLOSE #2

By changing the information inside the quotes in line 20 to "14.R=C" you would send the string to the printer if you had two ports on your PC.

Device "100" is used to store your programs to disk and also to retrieve them. SAVE "100.filename.xxx" is the basic option to save your programs where the filename.xxx portion of the statement would equal the name you give to your program with an extension. For example: SAVE "100.program.doc" stores a program. To retrieve the program you would enter OLD "100.program.doc" on your TI-74.

Device "101" is used for data storage and to save your program in ASCII format. When saved in ASCII format you can use a text editor to make changes or to print the program. You can also save data that the program produced while running. For example:

10 AS$="TEXAS INSTRUMENTS, PC INTERFACE"
20 OPEN #2,"101.filename.xxx",VARIABLE 80,OUTPUT
30 PRINT #2,AS$
40 CLOSE #2

will save AS$ to the disk for storage. To retrieve it later use the program.
Experience with the PC Interface Cable - (cont)

20 OPEN #2,"101.filename.xxx",VARIABLE 80,INPUT
30 INPUT #2,A$
35 PRINT A$
40 CLOSE #2

LIST "101.filename.xxx" would save it in the ASCII format for a word processor to read.

The nice part is that you can take any program written in, let's say GW-BASIC and run it on the TI-74. You have to change some things. For example, TI-BASIC doesn't use WHILE and WEND statements. These would have to be changed to IF-THEN-ELSE statements. First you need any of the programs in the ASCII format. You need to save the TI-74 programs by using LIST "101.filename.xxx". You need the TI program to convert it to a binary format for the TI-74 to read. When you save your text from the text editor you save it with B74 as the extension, i.e., as filename.B74. Then at the DOS prompt you type TIC74 filename.B74 and the program does its thing and stores the new binary form as "filename.PGM". To retrieve this you type OLD "100.filename.PGM" on the TI-74 and presto you have a working program and you did not have to use the TI-74 keyboard to enter it. This also works for programs written in Pascal. You can also direct output to the computer screen for all of the software cartridges, i.e., Chemical Engineering, Finance, Mathematics, Statistics and Learn Pascal. In conclusion, the interface is a worth while piece of equipment for use with your TI-74 if you have an IBM compatible computer.

-------------------------------

A PUZZLE - Dan Mahony. On the parallel sides of a river which is five miles wide are located the villages A and B. Village B is located 4 miles north of a point directly opposite village A. For a width of 3 miles on village A's side of the river the current flows south at 2 mph. The rest of the channel flows north at 5 mph. You can row your boat at 7 mph. You wish to row from A to B using a constant heading relative to north. What is that angle? What is the time of transit?

The heading is 56.4602... degrees.
The time of transit is 0.8566961599... hours, or exactly (25/1993 - 80)/1209 hours.

George Petersen notes that the time of transit should be able to be reduced if heading changes are allowed during the transit. He asks "What is the minimum time of transit?" Send your solution to the editor who will forward it to George.

-------------------------------

MORE ON PC-324 BATTERY USAGE - V14N4P11 reported that the editor's PC-324 seemed to be a "battery eater". Members Greg Lind, Scott Garver and Bill Wilburn reported similar experience. They noted that since the PC-324 has no ON/OFF switch it is always in the ON state and there must be some power drain. I also found the following note at the bottom of page 4 of the PC-324 User's Guide:

"We recommend that you use alkaline batteries in your printer. If non-alkaline batteries must be used, remove the batteries when you are not using the printer."

I wrote to TI for an interpretation. Tom Perriello called to confirm a small drain when the printer is not in use. TI expects a set of alkaline batteries should last 6 to 12 months.
RIGGING A SHIP - Gordon Wichart. I found this problem in the Dover Publications book Ingenious Math Problems and Methods by L. A. Graham. The problem was originated by H. F. Spillner, Chief Engineer, Johnson & Jennings of Cleveland, Ohio. A 100 foot rope is stretched from the top of one mast (point x) to a point on the deck (point z) and back to the top of a second mast (point y). The distance between the masts is 50 feet and the height of the masts is 25 feet. The problem is to find the distance from the second mast to point z. From the figure below \((G + B)^2 + H^2 = (I - C)^2\) and \(B^2 + H^2 = C^2\).

I solved the problem with the non-linear systems program in the TI-95 Mathematics Library using procedures similar to the solution to the ladder problem in V12N1P10. The listing for the subroutine functions is at the right. One thing I did differently was storing the knowns before starting. For the particular problem:

1. Store the knowns as 50 STO G, 25 STO H, 100 STO I.


3. Enter 2, the number of expressions, and press F1 (n); enter .0000001 and press F2 (err); enter 8 and press F3 (#it); press F4 (EOD).

4. Enter 20 as an estimate for B (xo(1)) and press F1 (ENT); enter 35 as an estimate for C (xo(2)) and press F1 (ENT).

5. In response to the prompt EDIT? press F2 (NO). Note the RUN annunciator at the right side of the display.

6. After 37 seconds B is displayed as \(x_1=15.82482905\).

7. Press F1 (NXT) and C is displayed as \(x_2=29.58758548\).

The printout from the PC-324 appears at the right.

Editor's Note: There is another method of solution which yields an equation which can be easily solved. We start by recognizing that the definition of the problem is identical to the usual definition of an ellipse; for example, page 105 of my Analytic Geometry by Wilson and Tracey, (D.C. Heath, 1937) states "The ellipse is the locus of a point such that the sum of its distances from two fixed points is constant." The fixed points, X and Y, in the diagram of the problem are called foci. We are not particularly interested in their function other than to note that one of the axes of symmetry will pass through the foci, and the other will be the perpendicular bisector of the line segment between the foci.
Rigging A Ship - (cont)

The formula for an ellipse with its center at the origin of the coordinate system is

\[
\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1
\]

where a and b are the semi-major and semi-minor axes of the ellipse. We can determine a and b by inspection from the diagram at the right on page 8 by

1. Pulling the rope tightly so that it lies along the x axis. The distance from the origin to the end of the string will be \( \sqrt{2} / 2 \) which is 50 feet for our problem. \( a^2 \) in the formula will be 2500 feet squared.

2. Pulling the rope tightly so that the end is on the y axis. The square of the distance from the origin to the end of the string will be \( b^2 = (1/2)^2 - (G/2)^2 \) which is 1875 feet squared. The distance is not needed to solve the problem.

The distance B in the problem is the difference between the x coordinate of the ellipse when \( y = -25 \) and half of the distance between the masts. Substituting in the equation and doing a little arithmetic yields an x coordinate of exactly \((50/5)/3\). The distance B is then 15.82482905 ...

---

MORE MEMBER LISTINGS

John Wong
38 Monroe Street E-9C
New York NY 10002
TI-95, TI-99/4A

Gordon R. Wichart
17176 Redford Ave.
Detroit MI 48219
(313)-533-8754
TI-95, diagramatic puzzles

Timothy M. Baumgartner
28524 Vista Madera
Rancho Palos Verdes CA 90732
(213)-514-0713
Use of TI-81 & fx-7000G in high school mathematics education

---

RECENT TI-95 PRICES - Page 34 of the October 1991 DAMARK catalog offers a TI-95 together with the Statistics and Chemical Engineering cartridges for $59.99 plus $6.50 shipping and handling, where shipping is normally by UPS. Ask for Item No. B-477-183604. Write to 7101 Winneta Ave. N., P. O. Box 29900, Minneapolis MN 55429-0900 or call 1-800-729-9000.

EduCALC Catalog #52 offers a TI-95 for $49.95 where you must also buy at least one of the cartridges (Mathematics, Statistics or Chemical Engineering) which are offered at $5.00 each. Shipping and handling is $2.00 for regular mail with two week delivery, or $5.00 for UPS. Write to 27953 Cabot Road, Laguna Niguel CA 92677 or call 1-800-677-7001.

Thus, the cost for the package of a TI-95 with the Statistics and Chemical Engineering cartridges, and shipped by UPS is $66.49 from DAMARK and $64.95 from EduCALC. Furthermore, you have other options with EduCALC such as (1) saving $3.00 if you aren't in a hurry, (2) saving $5.00 if you are only interested in one of the cartridges, (3) obtaining the Mathematics cartridge, etc. Thus, if EduCALC can fill your order there seems to be no good reason to order from DAMARK.
The TI-95 Utilities Cartridge

In the beginning of '82 I joined PPC Notes, and shortly afterwards both Maurice and later Palmer started receiving long letters. Quite a lot of what I sent them during the past almost 10 years has never seen the light, probably because it was too sophisticated (?)

However, now that TI PPC Notes is going to be discontinued, I will give those of you that are really devoted to the TI-95 one last chance to obtain the best program ever written for it, "The TI-95 Utilities Cartridge".

POH has already mentioned it in an earlier issue, but to remind you what it is. It is an almost 8kb long TMS 7000 assembly language routine, that, once loaded into a RAM cartridge, will add more than 30 new functions to the TI-95.

Those functions include:

- OFF - saves the entire machine state
- CP - CP from the current step
- BKU - a complete backup system for use with the PC Interface
- CRC - the ultimate checksum
- GLT - LL like lister for GTO
- DFN - LL like lister for DFN
- LR - but with many new features
- MRP - merge files to end of PGM
- CJ - date to number (ML-20)
- NOR - normal distribution
- SFF - a really fast PF replacement
- ENT - mathematical integer
- POL - polynomial evaluator (ML-08)
- CHR - redefine CHR 000..004
- SOR - square roots up to 2500 digits
- DOW - SBA 600 creator (????)
- REX - access the keystroke coded ROM functions
- ROM - transfer any memory to PGM
- R=B - RTN or BRR (TI-59's RTN)
- SBR - print SBR stack
- STU - system alpha to user alpha

In other words, I'm talking about several hundred hours of blood, sweat and tears, not to mention dozens of "MEMORY CLEARED"s, which I'm now offering to everyone interested, be it in an unfinished state - the program itself is bug-free, but the documentation is not up to standard, everything is there, but it may take some time to find it. ... Also, it is a virtual necessity to own a PC Interface, as loading more than 7000 bytes manually, even with the supplied loader program, is almost impossible.

Everything is supplied on a 3 1/2" 720K floppy, including some other goodies, such as a routine to turn an 8k RAM into 1000 directly (through SBA 004!), an improved and highly optimized version of TIS PCL PC Interface interface program, supporting 32K cartridges, my own copies of the disassembled and extensively commented TI-95 ROMs and even a TMS 7000 disassembler, so that you can disassemble my code. I will even include some useful source code. (For an additional sum, I will even throw in the complete and fully commented source, be it in assembled format!)

Sofar for the description, if you're still interested, then

- send me 3 one-dollar bills, and I will send a copy of complete dialog as contained in the system, longer descriptions of all functions, and the contents of the disk you can order, OR
- you can order it directly by sending me
  - For the normal package (= limited source):
    $25.- + p&p (Registered Airmail, so about $30.- in total)
  - For the power-user package (= full source, but in assembled format):
    $60.- + p&p (Registered Airmail, so about $65.- in total)

These last two options also include unlimited technical support.

Payments either cash, or by INTERNATIONAL POSTAL MONEY ORDER with the equivalent in Dutch guilders.

Send all further enquiries to: Robert AH Prins
A Nobelln 112
3731 DX DE BILT
NETHERLANDS

However, as I'm currently living in the UK, there might be some delay in both answering your letters and shipping the software.
DATAFILE V1ON2 : Published by the HANDHELD AND PORTABLE COMPUTER CLUB, 42 Heathfield Rd, London W3 8EJ & printed by the Kemble Press Ltd, Bodicote, Banbury, Oxon, with a print run of 300 & a target of 8 issues annually.

DATAFILE is the journal of the HANDHELD AND PORTABLE COMPUTER CLUB, a voluntary, independent body run by & for users of HEWLETT-PACKARD Handheld & Portable Computers. HPCC is devoted to helping members obtain the optimum from their equipment & to further the exchange of information & ideas. HPCC is not sponsored or endorsed by Hewlett-Packard or any other commercial organization & all its activities are funded & undertaken by the members. Members will receive issues of DATAFILE. All memberships expire on Dec 31st. There is a registration fee of £3 for new members which is waived in the case of lapsed members rejoining.

The basic membership rates for 1991 are as follows:

<table>
<thead>
<tr>
<th>UK Surface</th>
<th>Europe</th>
<th>Air Mail</th>
<th>Air Mail</th>
<th>Air Mail</th>
<th>Air Mail</th>
<th>Air Mail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel is</td>
<td>Surface</td>
<td>1st</td>
<td>Mid East &amp; Americas</td>
<td>Far East</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(not Eire)</td>
<td>Mail</td>
<td></td>
<td>&amp;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worldwide</td>
<td>N Africa</td>
<td>Con Africa</td>
<td>Australasia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FOR 91</td>
<td>£25.00</td>
<td>£27.00</td>
<td>£29.00</td>
<td>£31.00</td>
<td>£33.00</td>
<td>£35.00</td>
</tr>
<tr>
<td>Apr-Dec</td>
<td>£19.00</td>
<td>£20.00</td>
<td>£21.00</td>
<td>£22.00</td>
<td>£23.00</td>
<td>£24.00</td>
</tr>
<tr>
<td>Jun-Dec</td>
<td>£13.00</td>
<td>£13.50</td>
<td>£14.00</td>
<td>£15.00</td>
<td>£17.00</td>
<td>£18.00</td>
</tr>
<tr>
<td>Oct-Dec</td>
<td>£6.00</td>
<td>£6.50</td>
<td>£7.00</td>
<td>£8.00</td>
<td>£8.50</td>
<td>£9.00</td>
</tr>
</tbody>
</table>

For further information, send a SAE to the Membership Secretary at the address given below. Return postage will be appreciated. Those wishing to pay/renew their subscriptions by means of a VISA/MASTERCARD are welcome to do so.

COPYRIGHT: All Copyright in material published by HPCC remains with the author. Exclusivity is not required, though the Club's function is to provide information not normally available elsewhere. Contributions based on another's ideas must be so credited. Extracts may be published for review purposes, provided that copies & an acknowledgement are sent to HPCC & the original author.

DATAFILE EXISTS SOLELY DUE TO YOUR CONTRIBUTIONS - SO KEEP THEM COMING! ALL SUBMISSIONS OF MATERIAL ARE WELCOME AND SHOULD BE SENT TO THE EDITOR. Please use the following guidelines whenever possible.

1. Use black type wherever possible, even for Program Listings.
2. All material is assembled into A4 'master' pages. Use either one 170mm wide column of <= 80 characters or two 80mm wide columns of <= 38 characters separated by a 10mm 4 character gap. The maximum page length is 255mm, at <= 6 lines per inch. Drawings & diagrams in black INK please.
3. Submit the master - Remember to keep a copy for yourself.
4. HP41 programs should always be submitted on magnetic media. If you use ROM subroutines please identify & list them, as some members may not have the appropriate ROM & would not be able to use the program otherwise. Remember that some members are more expert than others, so explain your program's construction & function. Please explain synthetic functions & text & include their decimal codes. Remember that worked examples are ALWAYS valuable.
5. Submit PROGRAMS & TEXT on MAGNETIC MEDIA whenever possible. It makes the work of preparation for the printer much easier. All cards, discs or cassettes will be returned to the author. Textiles should be pure ASCII, in HP or IBM format, on 3.5" or 5.25" discs. Other formats should only be used by prior arrangement with the Editor.

ADDRESS FOR CORRESPONDENCE. (Please quote your membership number)

Chairman: Wlodek Miur-Jedrzejowicz, 42 Heathfield Rd, London W3 8EJ.
Secretary: John Cole, Goggs Lodge, Hempton Road, Deddington, Bicester, Oxford OX15 0G.
Treasurer/Memb.Sec: Mark Cracknell, 6 Stratton Mews, Off South St, Leigham Buzzard, Beds. LU7 8NT.
Editor: John Cole, Goggs Lodge, Hempton Road, Deddington, Bicester, Oxford OX15 0G.

A MEETING is held on the 2nd Saturday of each month in the Physics Common Room of Imperial College, Prince Consort Rd, London SW7, commencing about 1330 hrs.

THE EDITORIAL
HEXATOM - A GAME FOR THE HP48S
HP48S
JURGEN BOS

HP48 IN AND OUT
HP48S
JOHN BRUCE

NON-ERASABLE VARIABLES
ON THE HP48
HP48S
IB JORGENSEN

THE NO ZONE
GENERAL
MARK CRACKNELL

BANK BALANCE ON THE HP48S
HP48S
JEREMY HAWDON

AN IMPROVED HP48S
STACK VIEW ROUTINE
HP48S
JAKE SCHWARTZ

CHANGE ONE ROW OR COL OF A
MATRIX USING HP41 ADVANTAGE MOD.
HP41
R.D. KENDON

CIRCLES ON HP-48
HP48S
MARK POWER

HP-28 PROGRAMMING - EDITING A
PROGRAM WITHIN A STRING
HP-28
J.C. HENTSCH

HPCC ACCOUNTS 1990
GENERAL
JOHN COLE

MASTERMIND
HP48S
NEIL MATTHEW

HP41CV EMULATOR CARD
HP48S
S.J. THOMAS

DATAFILE BACKNUMBER
AVAILABILITY
GENERAL
JOHN COLE

A QUICK PEAK INSIDE THE HP42S
HP42S
JEREMY SMITH

PROGRAMMABLE OFF FOR THE HP28C
HP28C
S.J. THOMAS

FOR SALE
GENERAL

IF UNDELIVERED PLEASE RETURN TO SENDER

HPCC
GEGGS LODGE, HEMPTON ROAD, DEDDINGTON, BANBURY,
OXFORD OX15 0QG

TI PPC NOTES
V14N21

THE LAST OF THE NEWSLETTERS?
GRAFPING ON THE TI-81 and fx-7000G - Timothy Baumgartner writes: I wanted to demonstrate a function which was discontinuous at a single point for my pre-calculus class. Consider the function

\[ y = f(x) = \frac{x^2 - 4}{x - 2} \]

which is not defined when \( x = 2 \). Otherwise the graph of the function should be that of the line \( y = x + 2 \). When graphed on the TI-81's standard viewing window the gap is apparent since \( x = 2 \) happens to be one of the horizontal coordinates. For the fx-7000G the sequence Range Shift Delete will give the default viewing window which must be modified to \( Y_{\text{min}} = -1.1 \) and \( Y_{\text{max}} = 5.1 \) to see the gap in the graph. I like the way the gap shows up--it is a great motivator of class discussion.

Editor's Note: The example above is one of those discontinuous functions that mathematicians love, but which I find to be somewhat contrived. What first year algebra student wouldn't factor the numerator and divide by the denominator to yield the linear function \( y = x + 2 \)? The figure at the right is an example of a more typical discontinuity which occurs with the function

\[ y = \frac{x^2 - 5}{x - 2}. \]

Timothy's discussion of the \( \frac{x^2 - 4}{x - 2} \) function continued: "... One of my students, Duke Zupanski, used his TI-81 to zoom in on the discontinuity at \( (2,4) \) and found a strange result. He set the range screen to show:

<table>
<thead>
<tr>
<th>xmin</th>
<th>ymin</th>
<th>xmax</th>
<th>ymax</th>
<th>xsc1</th>
<th>ysc1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.999995</td>
<td>3.999995</td>
<td>2.000005</td>
<td>4.000005</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

and then put the calculator in the dot mode (rather than connected mode). The behaviour of the graph [at the right] was anything but linear! I was guessing when I told my students that this had something to do with round-off error, and assured them that the graph should appear linear except for the missing point at \( (2,4) \). My question here is: Is this due to round-off error for these values close to \( x = 2 \), or is there some other factor I am not aware of?"

Editor's Note: An immediate indication that the non-linearity is associated with the calculations can be obtained by graphing the function

\[ \frac{(x + 2)(x - 2)}{(x - 2)} \]

which is algebraically equivalent. The non-linearity does not appear. We will show that the problem with the version of the function which uses \( x^2 - 4 \) in the numerator is induced by the roundoff which occurs after the value of \( x \) is squared. To do so we eventually have to determine the values to be plotted to the full accuracy carried internally in the calculator; i.e., thirteen digits as described on page B-3 of the TI-81 Graphics Calculator Guidebook. How do we do this? Consider the \( \pi \) function. It is displayed on the screen to ten digits as 3.141592654, but page 2-2 of the guidebook states that the number 3.1415926539 is used in calculations. We can determine the additional digits for ourselves by entering the expression 100(\( \pi - 3.14 \)) and seeing the value .15926359 in the display. Similarly, if we calculate the value of \( e \) by entering the expression \( e^1 \) we see the ten digits 2.718281828 in the display, but by entering 100(e\( ^1 - 2.71 \)) we can determine that the thirteen digit value in the calculator is 2.718281828459.
Graphing on the TI-81 and fx-7000G - (cont)

Additional roundoff appears in the display of the graphed values in TRACE mode. With the \((x^2 - 4)/(x - 2)\) function entered as Y1, and with Zupanski's range values press GRAPH TRACE and then press the right arrow seven times. The trace indicator should be on the first point which is not on the short horizontal line at the center of the display. The coordinates are displayed at the bottom of the screen to eight digits. The exact values of x and the function are available from the X and Y variables. The following table compares the three pairs of values which can be obtained depending upon the method of readout:

<table>
<thead>
<tr>
<th>X From the TRACE readout</th>
<th>2.00000008</th>
<th>4.00000013</th>
</tr>
</thead>
<tbody>
<tr>
<td>X and Y variables from the display</td>
<td>2.000000789</td>
<td>4.000001267</td>
</tr>
<tr>
<td>Internal values</td>
<td>2.000000789474</td>
<td>4.000001266666</td>
</tr>
</tbody>
</table>

Using these techniques I read out the x and y values to thirteen digits for the \((x^2-4)/(x-2)\) function over one of the more non-linear portions of the plot, the set of seven points starting at the right hand end of the short horizontal line at the center of the display. (You can get to that point by pressing GRAPH TRACE and then pressing the right arrow six times.) A magnified view of that portion of the display appears at the right. I also read out the corresponding y values for the function \(((x-2)(x+2))/(x-2)\). The results are in the following table:

<table>
<thead>
<tr>
<th>x</th>
<th>((x^2-4)/(x-2))</th>
<th>(((x-2)(x+2))/(x-2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.000000684211</td>
<td>4.0000000684211</td>
<td>4.0000001266666</td>
</tr>
<tr>
<td>2.000000789474</td>
<td>4.0000001266666</td>
<td>4.0000000894737</td>
</tr>
<tr>
<td>2.000000894737</td>
<td>4.0000001117647</td>
<td>4.000000894737</td>
</tr>
<tr>
<td>2.000001</td>
<td>4.0000001</td>
<td>4.000001</td>
</tr>
<tr>
<td>2.000001105263</td>
<td>4.0000000904762</td>
<td>4.000001105263</td>
</tr>
<tr>
<td>2.000001210526</td>
<td>4.0000000826870</td>
<td>4.000001210526</td>
</tr>
<tr>
<td>2.000001315789</td>
<td>4.0000001520001</td>
<td>4.000001315789</td>
</tr>
</tbody>
</table>

The x values increase in value monotonically. The difference between adjacent x values is, as expected, \((x_{\text{max}} - x_{\text{min}})/95 = 0.000000105263\) where 95 is the number of x axis increments. For the \(((x-2)(x+2))/(x-2)\) function the y values in the right hand column also increase monotonically and are exactly 2 greater than the x values, as would be expected with a linear function. But, for the \((x^2-4)/(x-2)\) function the y values decrease monotonically from the second through the sixth points, and show larger positive steps from the first to the second and from the sixth to the seventh points. This confirms the non-linearity seen in the graph, but with more precision.

The differences between the values for the function \((x^2 - 4)/(x-2)\) and the nearly exact values for the function \(((x-2)(x+2))/(x-2)\) begin at the seventh significant figure. To see why that occurs consider the calculation of the numerator \((x^2-4)\) for the second x value in the table, 2.000000789474. The exact square of that value is 4.0000003157896 623269196676 where the gap in the number is after the thirteenth significant figure. Since the TI-81 carries only thirteen significant figures it rounds that square to 4.0000003157897. Then, when the 4 is subtracted, the remaining value is 0.000003157897 which includes only seven significant figures, and where the last significant figure is higher than the exact value due to the rounding in the calculator. That is consistent with the difference between the two function values in the table.
Graphing on the TI-81 and fx-7000G - (cont)

As an exercise, you should convince yourself that the specific characteristics of
the graph are consistent with the function values as read from the Y variable. You
should also convince yourself that the rounding which occurs in the x-squared values
is consistent with the resulting function values which are in the Y variable. To
assist you with that I have included a table which presents the exact x-squared
values for the seven x values which appear in the table on page 13:

<table>
<thead>
<tr>
<th>x</th>
<th>x^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0000000684211</td>
<td>4.0000002736844 468144692521</td>
</tr>
<tr>
<td>2.000000789474</td>
<td>4.0000003157896 623269196676</td>
</tr>
<tr>
<td>2.000000894737</td>
<td>4.0000003578948 800554299169</td>
</tr>
<tr>
<td>2.000001</td>
<td>4.0000004000001 000001</td>
</tr>
<tr>
<td>2.000001105263</td>
<td>4.0000004421053 221606299169</td>
</tr>
<tr>
<td>2.000001210526</td>
<td>4.0000004842105 465373196676</td>
</tr>
<tr>
<td>2.000001315789</td>
<td>4.0000005263157 731300692521</td>
</tr>
</tbody>
</table>

"Hamming's Law of logarithms" - Charlie Williamson called my attention to the
interesting observation that the logarithm to the
base 2 of a number is equal to the sum of the natural logarithm of the number and
base 10 logarithm of the number, within one per cent. Charlie noted that Volume 1
of Knuth's The Art of Computer Programming ascribes the observation to Hamming,
but that he had personal correspondence suggesting that Hamming may not have been
the originator. I looked in my copy of Knuth's book. I found no reference to
Hamming! After some additional correspondence we realized that, in the first
edition, which Charlie uses, Exercise 22 on page 25 states:

22. [20] Prove "Hamming's law of logarithms":

$$\log_2 x \approx \ln x + \log_{10} x,$$

with less than 1% error! (Thus a table of natural logarithms and of common
logarithms can be used to get approximate values of binary logarithms as well.)

But, in the second edition, which the editor uses, the problem begins as:

22. [20] Prove that

$$\log x \approx \ln x + \log_{10} x,$$

where we note that the reference to Hamming has been deleted and the notation \( \log x \)
is introduced for the binary logarithm. Of course, the mystery is, if Hamming
wasn't the source of the relationship, then who was?

---

REPAIR OF TI-74/TI-95 PERIPHERALS - P. Hanson. I had a still unexplained double
failure of both my CI-7 Cassette Interface and
PC-324 Printer. I called 1-800-TI-CARES for repair information. Repair service is
not available for the CI-7 so I ordered a replacement from Edu CALC for $26.95 plus
$2.00 for shipping. Repair service is available for the PC-324. The cost is $45.50
plus state sales tax plus $4.00 for shipping and handling, substantially less than
the $89.95 listed for a new unit in the Edu CALC catalog. TI reserves the right to
either repair the returned unit or to replace it with a reconditioned unit. I
shipped my defective unit on October 2 and received a reconditioned unit on October
22.
DISTANCE FROM A POINT TO A PLANE FOR THE TI-95 - W. Wilburn

This program finds the perpendicular distance from a plane defined by three points to a fourth point. When the plane is defined by the equation

$$ Ax + By + Cz + D = 0 $$

the distance to a point $$(x, y, z)$$ is found from the equation

$$ d = \frac{|Ax + By + Cz + D|}{\sqrt{A^2 + B^2 + C^2}} $$

The coefficients for the equation of the plane are obtained by solving the three linear equations which result when the equation for the plane is evaluated at the three points. The linear equations are solved using similar methodology to that used in the sphere through four points program on V14N1P10, where the solution assumes that the linear equations program from V14N1P8 is available to be called as a subroutine. A program listing and sample solutions appear at the right.

Comments on the program:

Steps 0021-0136 provide for entry of the three points which are used to define the plane. The original mechanization defined $$D = -1$$. That precluded the use of the origin as one of the input points as discussed in more detail in the documentation for the ellipse through five point program in V14N2P17. Steps 0113-0136 relocate the input data such that $$A = 1$$, but to simplify the process the location of the coefficients of the solution are changed from the sequence BCD to DBC.

Steps 0137-0171 set up the problem for solution by the linear equations subroutine and call the subroutine. In this mechanization the subroutine is assumed to be stored as MEM in a module defined as V12. If you have the subroutine stored in user memory as LIN then the call in steps 0162-0167 would be MEMLIN.

Steps 0172-0204 provide for entry of the point for which the distance from the plane is desired. Steps 0205-0263 solve the equation for the distance from the point to the plane and display the results. Remember that $$A = 1$$ by definition and that data registers K through M contain the coefficients of the plane in the order DBC.

Steps 0264-0282 provide for finding the distance from the plane other points.

<table>
<thead>
<tr>
<th>3 PT PLN-PT DIST</th>
<th>3 PT PLN-PT DIST</th>
<th>3 PT PLN-PT DIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1</td>
<td>21.8193</td>
<td>X1</td>
</tr>
<tr>
<td>Y1</td>
<td>9.0628</td>
<td>Y1</td>
</tr>
<tr>
<td>Z1</td>
<td>0.0000</td>
<td>Z1</td>
</tr>
<tr>
<td>X2</td>
<td>26.3223</td>
<td>X2</td>
</tr>
<tr>
<td>Y2</td>
<td>4.3818</td>
<td>Y2</td>
</tr>
<tr>
<td>Z2</td>
<td>0.3032</td>
<td>Z2</td>
</tr>
<tr>
<td>X3</td>
<td>21.8490</td>
<td>X3</td>
</tr>
<tr>
<td>Y3</td>
<td>1.0353</td>
<td>Y3</td>
</tr>
<tr>
<td>Z3</td>
<td>0.7396</td>
<td>Z3</td>
</tr>
<tr>
<td>DIS=</td>
<td>24.9865</td>
<td>DIS=</td>
</tr>
<tr>
<td></td>
<td>3.0453</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.4787</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ERROR FLAG SET</td>
<td></td>
</tr>
</tbody>
</table>
AVAILABILITY OF PUBLICATIONS - Even though this is the final issue of our newsletter I will continue to provide back issues and other publications through mid-1992. The material that will be available includes:

Back Issues:

<table>
<thead>
<tr>
<th>Volume</th>
<th>Pages</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>V5</td>
<td>146</td>
<td>$20.00</td>
</tr>
<tr>
<td>V6</td>
<td>152</td>
<td>20.00</td>
</tr>
<tr>
<td>V7</td>
<td>154</td>
<td>10.00</td>
</tr>
<tr>
<td>V8</td>
<td>168</td>
<td>10.00</td>
</tr>
<tr>
<td>V9</td>
<td>150</td>
<td>20.00</td>
</tr>
<tr>
<td>V10</td>
<td>104</td>
<td>$16.00</td>
</tr>
<tr>
<td>V11</td>
<td>102</td>
<td>16.00</td>
</tr>
<tr>
<td>V12</td>
<td>104</td>
<td>16.00</td>
</tr>
<tr>
<td>V13</td>
<td>114</td>
<td>16.00</td>
</tr>
<tr>
<td>V14</td>
<td>108</td>
<td>16.00</td>
</tr>
</tbody>
</table>

The lower price for the V8 and V9 issues is due to the availability of a limited number of complete sets of the original printing where printing costs were lower due to the large number of copies made. For the remaining years some issues are out of print and copies will be made only in response to requests so the printing costs will be higher. Masters are not available for the V5 and V6 issues so some degradation in legibility must be accepted.

Compilations:

For owners of the TI-74, CC-40, TI-95 and fx-7000G who may not be interested in material about other devices we offer compilations from back issues. We also offer a compilation of material on TI-59 and PC-100 test and repair. Add one dollar per compilation for delivery overseas.

<table>
<thead>
<tr>
<th>Compilation</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC-40 Compilation from Volumes 8 and 9, 26 pages</td>
<td>$5.00</td>
</tr>
<tr>
<td>CC-40 Compilation from Volume 10, 16 pages</td>
<td>4.00</td>
</tr>
<tr>
<td>CC-40/TI-74 Compilation from Volume 11, 25 pages</td>
<td>5.00</td>
</tr>
<tr>
<td>TI-74/CC-40 Compilation from Volume 12, 32 pages</td>
<td>6.00</td>
</tr>
<tr>
<td>TI-74/CC-40 Compilation from Volume 13, 44 pages</td>
<td>8.00</td>
</tr>
<tr>
<td>TI-95 Compilation from Volume 11, 18 pages</td>
<td>4.00</td>
</tr>
<tr>
<td>TI-95 Compilation from Volume 12, 32 pages</td>
<td>6.00</td>
</tr>
<tr>
<td>TI-95 Compilation from Volume 13, 30 pages</td>
<td>6.00</td>
</tr>
<tr>
<td>Casio fx-7000G Compilation, 17 pages</td>
<td>4.00</td>
</tr>
<tr>
<td>TI-59 and PC-100 Test and Repair Compilation, 24 pages</td>
<td>5.00</td>
</tr>
</tbody>
</table>

We also still have several copies of the listing and flowchart of the TI-95 mathematics cartridge as developed by SeTIC. You can obtain a copy for eight dollars. No additional copies will be printed - first come, first served.

TI-59 MAGNETIC CARDS - I also have two boxes of magnetic cards for the TI-59. The boxes contain forty magnetic cards and a carrying case. Send eight dollars per box. First come, first served.
FUNCTION ANALYSIS ON THE TI-95 - Richard Skarda. V14N2P23 reported the receipt of a function analysis program which provided:

A plotting capability.

Calculation of first and second derivatives at a selected point.

Trapezoidal rule, Simpson's rule, Romberg, and Gauss Legendre quadrature integration.

A routine to calculate the data base for the Gauss Legendre integration.

Neither a detailed program description nor a program listing was published at that time. Several members did take advantage of an offer to obtain preliminary documentation of the program together with a magnetic tape. A complete program listing appears on pages 18 and 19. Detailed documentation including sample outputs follow.

Program Description

Given a function HX the program can calculate the first and second derivatives at given points, and can calculate the definite integral using the trapezoidal rule, Simpson's rule, Romberg integration, or Gauss Legendre quadrature. The Gauss Legendre quadrature routine is capable of using n = 2, 4, 8, 16, 32, 64, 128, 256 or 512 points. It is also capable of dividing the domain into m panels and integrating each panel with n points. Other options include a subprogram "Evaluation" which calculates a series of values of the function which could be used for a hand plot, and another subprogram "Plot" which plots the function on the PC-324. Finally, a subprogram "Generator" calculates the data base, the abscissas and weight factors, used by the Gauss solution. The data base is stored in an 8K Constant Memory cartridge, and uses almost all of the cartridge.

Installing the Program

To place the complete program in operation, install a 8K Constant Memory cartridge and clear the directory of MEM and the cartridge, clear the memories, and program. Set the partitioning to 0 file space, 584 registers, and 2528 program steps. Enter the program.

Editor's Note: The instructions above provide for implementation of the full capability of the function analysis program. However, a potential user can get a feel for the capability of the program without committing the entire user memory (MEM) and an 8K RAM. In fact, that is all that the editor has done to date. First, set the partitioning for 2400 program steps and enter the program. Second, set the number of data registers to as large a value as possible depending upon the amount of file space tied up with other programs, but not less than 150. Third, change the STO 540 at program steps 0962-0963 to STO XYZ where XYZ is consistent with the number of data registers which are available, and also change the 540 at program steps 1043-1045 to XYZ. Fourth, run the Generator program (described below) for a short period of time (a few minutes will do) to calculate and store the values needed by the Gauss Legendre integration. Fifth, proceed to exercise the various options, but remember that the Gauss Legendre integration is limited to the use of smaller values of n (with 150 registers you can use values of n up to 32), and the number of iterations with the Romberg integration will be limited by the XYZ value. Finally, remember to return the XYZ values to 540 if you want to restore full capability of the program.
Function Analysis on the TI-95 - (cont)

0020 LBL D
0028 : childbirth 'Rule' PRT
0042 DFN F1: f1:0CB
0072 RCL C ='' +RCL C ='' 0.0001 STD H
0090 GTO LG
0100 LBL B1 .00001 STD H
0120 TBL RLC C +/1000= 
0130 TBL H GTL BG
0210 LBL LCA CLR 'Trapez' 
0330 'oidal Rule' PRT
0342 DFN F1: a 0CB
0349 DFN F2: b 0CC
0356 DFN F3: n 0CD
0363 DFN F4: + 0CE
0370 DFN F5: 13@CF HLT
0378 LBL C8 STD A 'a=' 
0385 COL 16 MRC A PRT
0390 RTN
Function Analysis on the TI-95 - (cont)

If you plan to use the Gauss Legendre quadrature option you must run the Generator program to calculate the data base. The complete calculation requires 37 hours, 43 minutes. You can test it by pressing RUN PGM --> Dat Gen. Wait a few minutes, press HALT and list the data registers starting with 026. Stop listing when you get to a string of zeroes or R060 and compare with the listing at the right. If the listing is OK, restart the generator program and run until it prints "File +D2 SAVED" and stops. The weight factors \( W_i \) follow immediately after their \( X_i \). There are a total of 1020 numbers stored in the 8K RAM under the name GLQ. File +D1 stores the data base for \( n = 4 \) through 256. File +D2 stores the data base for \( n = 512 \). Data registers 026 and 027 store the data base for \( n = 2 \). The correct data file is brought into data registers when the user enters the value of \( n \) in the Gauss program.

Function Definition

The function to be evaluated must be entered as a subroutine which starts with LBLHX and ends with RTN. Press 2nd GTLHX LRN F2 (PC) and enter the function. The current value of \( X \) will be in the display register when subroutine HX is called from the main program. You may use \( \sin \) in your routine. Be sure to select radians, degrees or grads as needed for any trigonometric functions. A sample HX subroutine for the function \( x^3 - 6x^2 + 11x - 6 \) appears at the right.

Differentiation

To perform differentiation press RUN PGM and D1f. The A-h key (F1), which stands for automatic \( h \), instructs the calculator to determine \( h \) according to the following equations: \( h = \frac{0.001}{|x|} \) if \( |x| > 0.01 \) or \( h = 0.00001 \) if \( |x| \leq 0.01 \). To select your own value for \( h \) use the h key (F2). Then, when \( h \) has been determined, enter the value of \( x \) at which the derivatives are to be calculated and press the x key (F3). Press the 1st key (F4) for the first derivative and the 2nd key (F5) for the second derivative. The printout at the right is for differentiation of the sample function at \( x = 0.1 \) using the A-h mode. The exact answers are 9.83 and -11.4.

Integration

For all of the integration programs the limits of integration \( a \) and \( b \) are stored in data registers A and B so that you can go from one integration method to another without re-entry of the limits.

The function which will be used to demonstrate the integration programs is

\[
I = \int_{0}^{1} \frac{dx}{1 + 0.5 \sin(10\pi x)}
\]

\[
= \int_{1}^{10} \frac{dx}{1 + 0.5 \sin(10\pi x)}
\]

Gen requires 37 hours, 43 minutes. It sets calculator to radians.

\[
\begin{align*}
026 & : 5773502692 \\
027 & : 1. \\
028 & : 8611363116 \\
029 & : 3478548451 \\
030 & : 3399810436 \\
031 & : 6521451549 \\
032 & : 9602898565 \\
033 & : 1012285363 \\
034 & : 7966664774 \\
035 & : 2223810345 \\
036 & : 5255324099 \\
037 & : 3137066459 \\
038 & : 1834346425 \\
039 & : 3626837834 \\
040 & : 999400935 \\
041 & : 0.027125499 \\
042 & : 9445750231 \\
043 & : 0.0622535239 \\
044 & : 8656312024 \\
045 & : 0.0951585117 \\
046 & : 755044084 \\
047 & : 0.1246289713 \\
048 & : 6178762444 \\
049 & : 0.149595888 \\
050 & : 0.4580167777 \\
051 & : 0.1691565194 \\
052 & : 0.2816035508 \\
053 & : 0.182603415 \\
054 & : 0.0950125908 \\
055 & : 0.0954506105 \\
056 & : 0.9972638618 \\
057 & : 0.00701861 \\
058 & : 0.9856115115 \\
059 & : 0.0162743947 \\
060 & : 0.947622556
\end{align*}
\]

\[
\begin{align*}
2323 & \text{LBLHX STD X}\times 3-1 \\
2331 & 6 \times \text{RCL X} \times 2 +11* \\
2340 & \text{RCL X} \times -6= \text{RTN}
\end{align*}
\]

\[
\begin{align*}
\text{Differentiation} \\
x &= & 0.1 \\
h &= & 0.0001 \\
D^1 &= & 9.83000001 \\
D^2 &= & -11.4
\end{align*}
\]

\[
\begin{align*}
2323 & \text{LBLHX } \ast 10^* \text{ PI } = \\
2332 & \text{SIN } / 2 +1= / \times \text{RTN}
\end{align*}
\]
Function Analysis on the TI-95 - (cont)

The exact integral is \(2/\sqrt{3} = 1.154700538379\) to thirteen significant figures. An appropriate subroutine appears to the right of the function on page 20. There is no need to use a STO X at the beginning of the subroutine with this mechanism. The calculator must be set to the radians mode.

To perform trapezoidal rule integration press RUN PGM and Trp. Enter the lower limit and press a (F1). Enter the upper limit and press b (F2). Enter the number of subintervals n and press n (F3). Press I (F4) to perform the integration. The 13d key (F5) sets data register V equal to one which causes the 13d display to be printed following the 10 place display. To eliminate the 13 digit printout press 0 STO V. Of course, you can also start the 13 digit printout by pressing 1 STO V. The 13 digit mode only applies to the integration programs. The printout at the right is for the test function using 16 subintervals.

To perform Simpson's rule integration press RUN PGM and Sum. The data entry is the same as with trapezoidal rule integration except that the number of subintervals must be an even number as prompted by the 2n key (F3). An odd entry will result in an error message. The printout at the right is for the test function using 50 subintervals.

To perform Romberg integration press RUN PGM and Rom. The lower and upper limits are entered as with other integration methods. Once the I key (F3) is pressed the program continues to print answers for the integral with increasing accuracy. To stop the Romberg integration press OFF and then ON so that the subroutine stack is cleared. The program will stop itself when \(j = 43\). It then prints "\(j=43\)". (Note that you may not be able to observe this feature if you are operating with a reduced number of data registers as discussed in the Editor's Note on page 17.) The Romberg program automatically sets the 13 digit mode. The HX= key (F4) provides a way to test the function subroutine. Simply enter a value for X and press HX=. The value of the function of X will be displayed.

The printout at the right shows 6 iterations of Romberg integration for the test function.

To perform Gauss quadrature you must first be sure that the required data base is in place as described on pages 17 and 20. If you are operating without the full implementation it is advisable to run the Gen routine immediately before using the Gauss routine. Then press RUN PGM --> and Gau. The upper and lower limits are entered as with other integration methods. Enter the number of points and press n (F3). Enter the number of panels and press m (F4). To calculate the integral press I (F5). To calculate using other values of \(m\) and \(n\) you need only enter the changed values. The printout at the right shows evaluations of the test function for \(n = 2\) and for \(m\) from 14 through 21.

### Trapezoidal Rule
- \(a = 0\)
- \(b = 1\)
- \(n = 16\)
- \(I = 1.15470054 + 1154700540011\)

### Simpson's Rule
- \(a = 0\)
- \(b = 1\)
- \(2n = 50\)
- \(I = 1.154696133 + 1154696132597\)

### Romberg Integr.
- \(a = 0\)
- \(b = 1\)
- \(I = 1\)
- \(I = 1 + 1000000000000\)
- \(I = 1.237037037\)
- \(I = 1.144587217603\)
- \(I = 1.155121718961\)
- \(I = 1.15469622\)
- \(I = 1.154696219749\)
- \(I = 1.154700531 + 1154700530973\)

### Gauss Quadrature
- \(a = 0\)
- \(b = 1\)
- \(n = 2\)
- \(m = 14\)
- \(I = 1.154700517 + 1154700517089\)
- \(m = 15\)
- \(I = 1.155456448 + 1155456447741\)
- \(m = 16\)
- \(I = 1.15470054 + 1154700539906\)
- \(m = 17\)
- \(I = 1.154700538 + 1154700538378\)
- \(m = 18\)
- \(I = 1.154700538268\)
- \(m = 19\)
- \(I = 1.154700538\)
- \(m = 20\)
- \(I = 1.1575105 + 1157510499554\)
- \(m = 21\)
- \(I = 1.154700538 + 1154700538379\)
Function Analysis on the TI-95 - (cont)

The Evaluation Function

To run the "Evaluation" routine press RUN PGM --> and Evl.
Enter the first value to be evaluated and press F-X (F1).
Enter the last value and press L-X (F2). Enter the spacing
of the x values (delta) and press DEL (F3). Press RUN to
obtain the evaluation. The printout at the right is for the
test integration function.

The Plot Function

To run the plot routine press RUN PGM --> and Plt. Enter
the maximum value of the function over the interval to be
plotted and press MAX (F1). Enter the minimum value of the
function over the interval and press MIN (F2). Enter the
first x value to be plotted and press F-X (F3). Enter the
last x value to be plotted and press L-X (F4). Press -->
(F5) and enter the interval between plotted values (delta)
and press DEL (F1). Press RUN to obtain the plot. The *
key can be pressed to plot additional points at the end of
the run in order to take care of cases where the last point
is not plotted due to roundoff. The plot at the right is
for the integration evaluation function.

The evaluation and plot routines use completely different
sets of data registers so that you can switch between the
two routines using different parameters.

Some Notes on the Gauss Quadrature Routines

The Gauss quadrature data base is calculated by the data
generator program with errors in the eleventh, twelfth and
thirteenth digits. Thus, the Gauss quadrature program
usually gives results which are accurate to only ten digits.
A user also needs to consider that it is necessary to obtain
at least two evaluations of the integral as stated on page
91 of H. L. Meck's Scientific Analysis for Programmable
Calculators

"...there is no reliable way to determine the accuracy
of Gauss integration in advance. It is always necessary
to carry out at least two evaluations of an integral
using different values of n. The results may be assumed
to be correct up to the point through which the digits
coincide."

Editor's Note: Generally the accuracy of the solution
increases as n and/or m are increased. But that is not
always so and it may be prudent to perform more than two
evaluations in order to achieve the best accuracy for the
range of values of m and n being used. For example,
consider the printout for the test problem on page 21 where
for values of m divisible by five the solution is
substantially worse than for adjacent values of m. When the
argument for the sine in the test function is changed the
intervals between degraded solutions change. Similar
effects are also apparent in results obtained from Robert
Prins' program on V14N2P22.
Function Analysis on the TI-95 - (cont)

The following table lists part of the generated data base for the Gauss program to thirteen digits so that you obtain a precision partial check of your Gen program. For n=2, R026 = 0.5773502691895, and R027 0.9999999999987.

<table>
<thead>
<tr>
<th>n</th>
<th>W = 0</th>
<th>W = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n&lt;512 +D1 in registers</td>
<td>n=512 +D2 in registers</td>
</tr>
<tr>
<td>4</td>
<td>R028 0.8611363115941</td>
<td>R028 0.9999889909844</td>
</tr>
<tr>
<td>4</td>
<td>R029 0.3478548451378</td>
<td>R029 0.0000825263731350</td>
</tr>
<tr>
<td>4</td>
<td>R030 0.3399810435849</td>
<td>R030 0.9999419946068</td>
</tr>
<tr>
<td>4</td>
<td>R031 0.6521451546624</td>
<td>R031 0.00006576573169996</td>
</tr>
<tr>
<td>8</td>
<td>R032 0.9602898564976</td>
<td>R032 0.9998574463700</td>
</tr>
<tr>
<td>8</td>
<td>R033 0.1012285362912</td>
<td>R033 0.00011033319034104</td>
</tr>
<tr>
<td>256</td>
<td>R532 0.01837081847882</td>
<td>R532 0.02145312295978</td>
</tr>
<tr>
<td>256</td>
<td>R533 0.01224583436957</td>
<td>R533 0.006128523194201</td>
</tr>
<tr>
<td>256</td>
<td>R534 0.006123912375182</td>
<td>R534 0.01532423508490</td>
</tr>
<tr>
<td>256</td>
<td>R535 0.01224767164009</td>
<td>R535 0.006129214171627</td>
</tr>
</tbody>
</table>

Acknowledgements

The H. R. Beck book contains programs which are the basis for the Romberg and Gen routines. The Gen routine was speeded up using an initial estimate formula from Methods of Numerical Integration by Davis and Rabinowitz. The differentiation routine is from The Sourcebook for Programmable Calculators.

FAST FACTOR FINDING - Larry Leeds writes "The program UBASIC contains a large number of functions. For my purposes the functions for FACTORS and PRIMES are the important ones. Many of the others are Greek to me but just what a professor of mathematics would appreciate. One function for PI returns any selected number of digits up to 2500. Another solves the Tower of Hanoi (12 disks) which requires 4095 moves. On my machine this runs so fast that the display is almost a blur. It took the 386SX about one minute to factor

99999999999999999999999999999999998 (that is, 34 nines followed by 2 eights) into

2 * 2 * 11 * 23 * 1774093100831 * 556984462668427315679

For another test I multiplied together three eleven digit primes to obtain

778438393067011463161307972470183. It took about 75 seconds to find the factors

99999999907 * 99999999977 * 77843839397

And we worked so hard to get a speedy factor finder for the TI-59!"

A FALSE ALARM? - V13N3P22 and V13N4P25 discussed the indications in the 8K RAM documentation that the battery life may limit the service life of the RAMs to three to five years. In a recent telephone conversation with Hewlett Ladd we noted that we have had many modules in operation since May 1987 and have seen no indication of failure to date, four and one-half years later.
CONTOUR GRAPHS ON THE TI-59 - Gene Friel writes "Recently I used the contour graph program described in V5N9/10P5 and V6N6/7P3. I'm including a page of notes that may help describe the details of the program."

1. For any number of strips, the range of $X_1$ is from the start value, $X_1$, to $X_1 + (N-1)\Delta X_1$ where $N$ is the number of steps.

2. For NL strips, the range of $X_2$ is from $X_2$ to $X_2 + [19 + 20(NL - 1)]\Delta X_2$.

3. Enter levels only in an ascending sequence of values.

4. For equal gaps between levels, $\Delta L$, setting $e = 0.25\Delta L$ will make the printed gaps about the same thickness as the numbered levels and can effectively generate 17 levels. If $e = 0.5\Delta L$, no gaps will occur between numbers.

5. Since the start value, $X_2$, for each line is reset by subtraction rather than by restoring the initial value, drift can occur in the $X_2$ values due to truncation causing unexpected contour plots. To avoid this drift, transform the function so that values of $\Delta X_1$ and $\Delta X_2$ are exact to less than about ten digits which depends on the number of steps and strips.

Editor's Note: V5N9/10P5-6 presented a contour graph program for the TI-59 written by Harald Otto. V6N6/7P3-4 presented a fast mode version, also by Harald Otto.

---

ONE LAST HARDWARE OFFER - Through the end of the year the club will continue the offer to obtain used TI-59's for fifty dollars plus shipping. Send sixty dollars. We will give fifty dollars to the present owner, ship the calculator to you, and refund anything remaining. All of the TI-59's will have passed the extended diagnostics in V12N2P4/5. Even so, all used hardware is provided entirely at the buyer's risk. We also can obtain PC-100C's, but most will need the eraser fix to print properly. Write for more information on specific units.

---

TABLE OF CONTENTS

| SUPPORT FOR THE CC-40 | ........................................... | 2 |
| THE CC-40 AND TI-74 AS A PORTABLE DATA BANK, C. Good | ........................................... | 3 |
| LINEAR EQUATION ANOMALY IN THE TI-81, T. Baumgartner | ........................................... | 4 |
| THE PC INTERFACE CABLE, C. Lind | ........................................... | 6 |
| PC-324 BATTERY USAGE | ........................................... | 7 |
| A PUZZLE | ........................................... | 7 |
| RIGGING A SHIP, G. Wichard | ........................................... | 8 |
| MORE MEMBER LISTINGS | ........................................... | 9 |
| TI-95 UTILITY CARTRIDGE, R. Prins | ........................................... | 10 |
| HANDHELD AND PORTABLE COMPUTER CLUB | ........................................... | 11 |
| GRAPHING ON THE TI-81 AND FX-7000G, T. Baumgartner | ........................................... | 12 |
| NANNING'S LAW OF LOGARITHMS, C. Williamson | ........................................... | 14 |
| REPAIR OF TI-74 AND TI-95 PERIPHERALS | ........................................... | 14 |
| DISTANCE FROM A POINT TO A PLANE ON THE TI-95, W. Wilburn | ........................................... | 15 |
| AVAILABILITY OF PUBLICATIONS | ........................................... | 16 |
| FUNCTION ANALYSIS ON THE TI-95, R. Skarda | ........................................... | 17 |
| FAST FACTOR FINDING, L. Leeds | ........................................... | 23 |
| BATTERY LIFE IN 8K RAMS | ........................................... | 23 |
| CONTOUR GRAPHS ON THE TI-59, G. Friel | ........................................... | 24 |
| HARDWARE AVAILABILITY | ........................................... | 2, 9, 16, 24 |

---

We will continue to offer magnetic tape service for TI-74 and TI-95 programs which were published in TI PPC Notes. Send five dollars for a tape with ten programs.

We will also continue to offer magnetic card service for TI-59 programs which were published in TI PPC Notes. Send one dollar per card plus a stamped and self-addressed envelope.