TI PPC NOTES

NEWSLETTER OF THE TI PERSONAL PROGRAMMABLE CALCULATOR CLUB

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Welcome back for the fourteenth subscription year in the life of our newsletter. You will find that the emphasis in this issue is on the use of TI-95 programs as subprograms. William Hawes introduced that idea in V12N1P17, but there have been few subsequent programs which use the technique. Specific items in this issue include the treatise on the subject by TI which was promised in the last issue, two subprograms for solving linear equations, and demonstrations of the use of the linear equations subprograms to find the parameters for a sphere through four points.

This issue also contains one more iteration (we think, the last) in the development of the "smallest circle" program for the TI-74. What that means is that the likes of Carl Rabe, Larry Leeds, Myer Boland and George Thomson are looking for a new problem to solve. So, if you have a long-standing problem that you haven't been able to solve, or haven't had the time to solve, why not send it in?

In the next issue we will present a circular and necklace permutations program by Peter Messer which calls the "phi" routine in the TI-95 MATH module. We will also present a conversion of a linear regression program for the TI-95.

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We continue to offer magnetic tapes for TI-74 and TI-95 programs from the newsletter. Send five dollars for a tape with ten programs.

We also continue to offer magnetic card service for TI-59 programs in earlier issues back to 1983. Send one dollar per card plus a stamped, self-addressed envelope.

ERRATA

The TI-95 MTH Library - V12N1P17. In the instructions in the sixth line from the bottom of the page an INV should be inserted between RUN and 2nd.

Solution of Linear Equations on the TI-95 - V11N4P8 reported the conversion of the TI-59 linear equations solution from V9N1P17 for use on the TI-95. The V9N1P17 program is a revision of an earlier program from V8N6P15-17. The original program in the series was written by Henrik Ohlsson and appeared in the 81-2 issue of the Swedish newsletter *Programbiten*. The primary attraction of the TI-59 programs is the ability to run in fast mode and to solve for as many as sixteen variables.

The TI-59 programs provide prompting and annotation for the entry of matrix elements; e.g., the notation for the matrix element in row 2 and column 3 is "2.03" and the notation for the matrix element in row 10 and column 11 is "10.11". The only idiosyncrasy in the notation is due to the truncation that occurs for column 10; e.g., for the matrix element in row 11 and column 10 the notation will be "11.1" not the "11.10" that we would like. The discussion in V11N4P8 indicates that the TI-95 program is a direct translation from the TI-59 program. That is not true for the prompting and annotation routine. The translation uses CHR IND commands to assemble the matrix element identification with an interposed comma. The result is that the prompts and annotation are incorrect for rows or columns greater than 9. For example, the annotation for row ten and column 11 will be ":,;". Only the annotation will be in error. The calculations will be correct.

The number of the highest data register which is used by the linear equations routine is needed if the routine is to be interfaced with other calculations. For the TI-95 program on V11N4P8 the highest data register used versus the order of the solution is

Order	Register	Order	Register
2	R014	6	R025
3	R016	7	R029
4	R018	8	R034
5	R021	9	R039

The first element of the solution appears in R010, the second element of the solution in R011, etc.

Data Entry in Fast Mode - As a part of the investigation of the annotation routine limitations of the TI-95 implementation of Ohlsson's linear equation solution (see above) I also verified that the annotation routine was correct in the TI-59 implementations. The test problems I used were the sub-Hilberts proposed by George Thomson in V8N6P18. The entry of reciprocals of integers is required, and for accurate answers one needs to calculate the reciprocal to thirteen digits, not merely enter ten digits from the keyboard.

I was using the program from V9N1P17 and operating in fast mode. When I tried to assemble the value of a reciprocal by the sequence 1 / N = I found that the fast mode calculations were initiated with an entry value of 1 as soon as I pressed the divide key. My solution was to enter the integer in the display and press the 1/x key. The reciprocal would be determined and the fast mode matrix calculations would be initiated without pressing R/S for data entry. It turns out that many of the function keys such as sin, square root, etc., yield similar responses. So, if you are operating in fast mode and need to assemble a value before pressing R/S to enter the value and return to fast mode you may have to use some ingenuity.

MAILBAG

"The newsletter is getting better with each issue. I thought that the spreadsheet program for the TI-95 was excellent. The articles on collectors of older calculators are very interesting. ..." R.G.

"Looking forward to the evaluation of the PC to TI-74 interface cable." L.K.

Several members have reported successful use of the interface cable.

"I rely heavily on homemade calculator programs for accounting and investment management. I also find that programming is excellent recreation." R.C.

"I am primarily interested in TI-66 or TI-95 programs related to the stock market: price momentum, advance-decline, etc., usually with exponential moving averages for use as short to intermediate term market indicators. Are there any market programs out there?" J.A.

The two foregoing entries suggest that there is a need for financial analysis programs for the TI-95. There were a number of TI-59 market analysis programs published in PPX Exchange under the finance heading (1XXXXX). I am not aware of any translations for the TI-66 or TI-95. Can anyone help?

"Glad you've put the smallest circle to bed" H.L.

"Hopefully someone will come up with a problem as interesting as the smallest circle problem." L.L.

As you can see from the participation in the smallest circle problem we have a number of members in the club who are waiting for problems which test their analytical and programming skills. So if you have a problem which you haven't been able to solve, why not write down a description and send it in?

"I am interested in practical programs for the TI-59 and TI-95 to be used in everyday activities. I keep an accurate account of all expenditures with seven main categories, 20 secondary categories and 19 tertiary categories. Each category is totaled each month and then transferred to annual records." H.B.

COLLECTOR'S CORNER - Leo Helmer writes: "I have a Collectors Catalog Progam for the TI-95 (books, tapes, records, adaptable for stamps and coins). An 8K TI Memory Cartridge will hold 100 to 200 items. A 30 minute magnetic tape will hold 2000 or more. I'll put it on a blank tape for anyone. Write to Leo C. Helmer, 4333 Itaska Street, St. Louis, MO 63116.

Thomas Jefferis of Ocracoke, NC writes: "We were in Norfolk a few days ago and I saw a book in a Salvation Army Thrift store and bought it for thirty cents. It was published by TI in 1976, I think for the TI-30 (SR-30?). It is called *The Great International Math on Keys Book*. It does have a lot of information in it, formulas, etc."

V13N1P2 and V13N4P12 reported that interest is developing in collecting early model calculators. It seems that there is also some interest in collecting early calculator books. For example, issues 46 and 47 of the EduCALC catalog list a hardbound collector's edition of George McCarty's classic *Calculator Calculus*. The book is listed at $29.95 as stock number 107.

HOW TO ACCESS A TI-95 PROGRAM AS A SUBROUTINE FOR A MAIN PROGRAM - TI PR001-1187

One of the more powerful features of the TI-95 is the ability to have one program use another program, in RAM or ROM, as a subroutine. This means that a commonly used routine does not need to be keyed in for each program. This feature will save memory and time.

Using a Program in File Space as a Subroutine

This simple example will have the main program take a numeric value, perform a subroutine branch to a program stored in RAM, add two to the value and return to the main program.

The main program is named "PG1" and can be in main memory, file space, or the 8K RAM module; this example assumes that it is in main memory. The program used as a subroutine is named "SR1" and can be in file space or in the 8K RAM module; this example assumes it is in file space.

```
0000 GTL GO `PGM "PG1" `
0013 `DEMO PGM TO ACCES`
0030 `S A PGM (SR1) IN `
0047 `RAM FILE SPACE (M`
0064 `EM) AS A SBR`
0076 LBL GO CLR DFN CLR
0082 DFN F1: +2@L1 RTN
0090 LBL L1 `MEMSR1` RUN
0100 SBL AA RTN
```

```
0000 GTL GO `PGM "SR1" `
0013 `DEMO PGM USED AS `
0030 `A SBR FOR A CALLI`
0047 `NG PGM`
0053 LBL AA +2= RTN
```

Program SR1 is called by the following program ((PG1). Step 53 is the entry point, LBL AA. The routine takes the value in the display, adds two to it, and returns to the calling program. Enter this program and save it to file space using the name SR1.

The line beginning with step 90 is entered as [2nd] [LBL] L1 [ALPHA] MEMSR1 [ALPHA]. "MEMSR1" means "in memory block MEM, use program SR1." MEM is used because when [RUN] is pressed, MEM is the name of the file space. If a program in the 8K RAM is used, use the name of the module that is displayed over F3 when [RUN] is pressed. SR1 is the name given the program when it was saved to file space. RUN SBL AA means "run the program (SR1) as a subroutine beginning at label AA."

Note: Both programs begin with a comment. This is very useful to identify a program. The GTL (goto label) preceding the comment assures that the comment will not scroll through the display.

Using a Program in the Statistics Module as a Subroutine

In this example, the user's program branches to the Chi-Square Distribution program in the Statistics module. The module programs (Statistics, Mathematics, etc) do not use labels; they reference program steps. The user must TRACE the module program to locate the program step number of the needed entry points. To do this, connect a PC-324 printer to the TI-95, press [2nd] [TRACE] and run the module program. If you do not have a PC-324, you will need to write down the information in the display. The trace of the needed portion of the Statistics module program is shown at the right and shows the entry points at 5331 for degrees of freedom and 533C for chi-square value. These numbers are in hexadecimal notation and are used in the user program (TST).

```
TRC
SELECT:
F3:STA
                0.
SF 15
DFA F1:MNT@4056
DFA F2:DST@40E6
DFA F3:ADV@42E9
DFA F4:RGR@4307
DFA F5:-->@4037
RTN
STATISTICS
F2:DST
DFA F1:NML@413C
DFA F2:  t@4183
DFA F3:  F@41AC
DFA F4:CHI@41D2
DFA F5:-->@4118
RTN
DISTRIBUTIONS
F4:CHI
ADV

TF 74
PRT
CHI-SQUARE
ADV

DFN CLR
DFA F1: df@5331
DFA F2: Qx@533C
DFA F5:ESC@40E6
RTN
CHI-SQUARE
```

How to Access a TI-95 Program as a Subprogram - (cont)

```
0000 GTL GO `PGM "TST" `
0013 `DEMO PGM TO ACCES`
0030 `S CHI SQUARE PGM `
0047 `IN STAT MODULE`
0061 LBL GO CLR DFN CLR
0067 DFN F1: df@DF
0074 DFN F2: Qx@QX HLT
0082 LBL DF `STA` RUN
0089 SBR 5331 RTN
0093 LBL QX STO B HEX 53
0101 3C STO A DEC RCL B
0108 `STA` RUN SBR IND A
0115 RTN
```

Enter the user program (TST), install a Statistics module in the module port of the TI-95, and run the user program.

When a value is entered, and "df" (F1) is pressed, the user program branches to LBL DF at program step 82. The entry point for "df" is at 5331. Starting with step 82, the program would read, "Label DF, use memory block STA (the Statistics module) and run that program as a subroutine starting at program step 5331." You do not need to use a program name with the ROM module because only one, very large program is in the module. When the routine in the module program is complete, it returns to the user program and halts.

When a second value is entered, and "Qx" (F2) is pressed, the user program branches to LBL QX at program step 93. The entry point for "Qx" is at 533C, but since the SBR command can not take a hexadecimal value with a letter value (A-F) in it, an indirect method must be used. The value in the display is stored in memory register B. The system is put into HEX mode, 533C is stored in memory register A, and the system is returned to DEC mode. The value in register B is then recalled. The program continues, "use memory block STA and run that program as a subroutine starting at the program step stored in memory register A." When the routine in the module program is complete, it returns to the user program and halts.

These examples were developed from information found in the *TI-95 Programming Guide* on pages 8-33 and 8-34. For more information on this application of the TI-95 PROCALC, please contact the Programming Assistance Group at (806)-741-2663. This is a toll call, and representatives are unable to accept collect calls.

Editor's Note: The existence of this treatise by Texas Instruments was mentioned in V13N4P19. TI has given us permission to reprint the treatise in our newsletter. Readers will find that the information parallels that presented by William Hawes in V12N1P17. Additional examples of the use of these techniques appear elsewhere in this issue.

NEW HAND-HELD HARDWARE FROM TI - Two new hand-held machines have been announced, the TI-74B and the TI-78. The TI-74B is much the same as the TI-74 except that (1) the keyboard has been simplified to include only the alphanumeric notation. and (2) the capability to handle ROM modules with larger memory has been included. The device seems to be aimed at users who will primarily use programs developed by others.

The TI-78 is described on pages 79 and 86 of the February 1990 issue of *Vulcan's Computer Buyer's Guide*. According to the article:

> "The TI-78 is designed to run powerful PC-type application programs that can be developed on MS-DOS(TM) and downloaded in seconds. Application programs can be written in assembly language or the high-level C programming language. TI also provides a library of standard programs, including system management, communications, and extensive built-in self-diagnostic functions. ..."

The device comes with 64K bytes of system ROM and up to 768K bytes of static RAM. Options include a bar code reader for data collection and an optical port for communication with a PC. The display is a 160x64 dot matrix format which can be used for text or graphics. For more information write to Texas Instruments Consumer Relations, P.O. Box 53, Lubbock TX 79408 or call (214)-917-1627.

REFERENCES ON TI-59 TEST AND REPAIR - P. Hanson. In response to a continuing flow of letters asking for information on TI-59 and PC-100 malfunctions and repair I decided to compile the following index of all the related material from the past issues of our newsletter:

Hardware Descriptions and Patents

V5N3P2 - Defeating the memory protection feature.

V5N3P5 - Availability of hardware descriptions.

V6N2P4 - Patent 4,153,937 on the TI-59.

V6N4/5P7 - Patent 4,006,455 on the magnetic card interface chip and patent 3,900,722 on the SR-51.

V6N6/7P13 - Patent 3,934,233 on the ROM and patent 4,020,4565 on an unidentified thermal printer (not the PC-100).

V7N6P11 - Patents:
3,904,862 Calculator system having a constant memory.
3,904,863 Calculator system using instruction words as data.
3,916,169 Calculator system having precharged virtual ground memory.
3,919,532 Calculator system having an exchange data memory register.
3,919,536 Precharged digital adder and carry circucit.
3,922,538 Calculator system featuring relative program memory.
3,924,110 Calculator system featuring a subroutine register.

TI-59 Diagnostics

V5N2P9 - Diagnostic using the SST command (code 41).

V5N6P3 - A reported success with the SST diagnostic.

V5N8P16 - The SST diagnostic will not find an erroneous code 31.

V7N3P10 - A memory malfunction which was not diagnosed by the SST routine.

V9N4P11 - Extended memory malfunction diagnostic.

V9N5P3 - Extended memory malfunction diagnostic in fast mode.

V11N1P10 - A summary of diagnostics.

V12N1P4-7 - Comprehensive discussion of testing a used TI-59 including an easy way to make an SST test card and a memory test using all 44's.

V12N2P5 - The need to run diagnostics.

V12N4P11 - A modified memory malfunction diagnostic for use without a printer.

TI-59 Repair

V5N2P3 - Opening the TI-59 and adjusting the reading speed of the card reader.

V7N3P4 - Opening the TI-59 and repairing sticking keys.

References on TI-59 Test and Repair - (cont)

TI-59 Repair (cont)

V8N5P11 - Card reading problems and the CCL144 cleaning strip.

V8N6P24 - More on CCL144 cleaning strip use and availability.

V9N2P13 - More on CCL144 use.

V11N1P12 - A summary of magnetic card reading problems.

V11N2P26 - TI's dealer parts facility.

V12N1P3 - Ordering replacement parts from Texas Instruments.

V12N2P7 - Repair of a magnetic card by inserting a card in the exit slot.

V12N2P9 - CCL144 cleaning strips are no longer available.

V13N3P4 - TI-59 malfunctions due to battery contact touching C7 body.

Batteries

V6N8P14 - Connecting external batteries in an emergency.

V7N1/2P2 - More experience on connecting external batteries in an emergency.

V7N6P10 - Internal shorts in NiCad batteries and how to clear them.

V12N1P3 - Battery pack repair using NiCad cells from Radio Shack.

PC-100

V5N3P3 - PC-100 print dot cleaning routine.

V9N2P13 - Use of a crocus cloth head cleaning card for the PC-100.

V11N1P11 - A summary of print head cleaning techniques.

V11N1P12 - The "eraser fix" to circumvent improper paper advance problems.

For the benefit of latecomers who may not have access to the earlier issues I have also put together a compilation of all the material in the above references. If you would like a copy of the 24 page compilation send five dollars.

RETRACTION OF HARDWARE FOR SALE NOTICE - V13N4P2 reported the availability of a TI-59 and PC-100 with some paper and magnetic cards for sale for $125.00 . It was reported that the calculator passed the extended diagnostic. I tested the hardware in preparation for shipment to one of our members. I found that it was extremely difficult to read magnetic cards, and use of a Drive Roller Cleaning Card and a Head Cleaning Card did not improve the capability. I was never able to successfully write to a card. In addition, there was some sort of intermittent in the on-off switch or the battery contacts. The serial number of the defective TI-59 is 0000792. In contrast, the PC-100 runs well. It's serial number is 3962357.

MODIFIED LINEAR EQUATION PROGRAM FOR THE TI-95 - P. Hanson

V11N4P8 provided a translation of the TI-59 linear equation solution from V9N1P17 for use on the TI-95. The program accepted manual inputs of the matrix and vector elements. The modified program at the right preserves the manual capability, and adds a capability to be called from another program using the techniques described on page 8-34 of the *TI-95 Programming Guide*. The modifications relative to the listing on V11N4P8 are:

1. Insertion of the sequence TF 01 GTL YY immediately after the LBL PR in line 0003.

2. Insertion of the sequence LBL YY RCL IND A INC A RTN immediately after the RTN at the end of line 0025.

3. Insertion of INV TF 01 before the ADV in line 0065.

4. Insertion of the sequence INV TF 53 GTL ZZ 'ERROR FLAG SET' PRT INV TF 74 BRK ADV LBL ZZ TF 01 RTN before the ADV at line 0347.

5. Replacement of the HLT in line 0366 with ADV RTN.

6. Insertion of LBL XX before the STO 001 at line 0385.

All line number references are to the listing on V11N4P8 to permit easy modification of that program. Remember to enter the changes is reverse order to make it easy to find the line numbers.

User Instructions - Manual Mode

The user instructions for manual entry are the same as in V11N4P8 except that a message is displayed or printed if an error occurs:

1. Start the program and see "Order?" in the Display and "GO" in the window above F1. Enter the order of the solution (n) and press F1. Note that if an order greater than 9 is used the annotation will be incorrect--see page 2 of this issue for details.

2. The prompt "1,1" will appear in the display indicating the program is ready to accept the matrix element A_{11} and "GO" will appear in the window above F1.

3. Enter the first element of the first row of the matrix and press F1. If the PC-324 is connected the element will be printed with annotation. The calculator will run for a short period of time and stop with "1,2" in the display indicating the program is ready to accept matrix element A_{12}. Continue entering the matrix elements by row in response to the prompts in the display. When the column portion of the prompt becomes "1,n+1" enter the vector element B_1 and press F1. The calculator will run for a short period of time and stop with the prompt for the first matrix element in the next row in the display. Continue entry of the matrix and vector elements in response to the prompts.

```
0000 GTL BB
0003 LBL PR TF 01 GTL YY
0011 INC 009 CHR IND 004
0018 `,` CHR IND 009 BRK
0024 RCA = CDL 20 MRG =
0030 TF 74 PRT RTN
0034 LBL YY RCL IND A
0040 INC A RTN
0043 LBL A1 INV INC 007
0050 10 STO 003 STO 006
0058 LBL AA RCL 007
0064 STO 002 48 STO 009
0072 RCL 004 -48=
0079 STO 005 INC 004 INV
0086 TF 01 ADV 0 IF= 005
0093 GTL AD
0096 LBL AB SBL PR +/-
0103 LBL AC * x~t
0108 RCL IND 006 )
0113 ST+ IND 003 INC 003
0120 INC 006 x~t DSZ 002
0127 GTL AC RCL 007
0133 STO 002 ST+ 003
0139 DSZ 005 GTL AB
0145 LBL AD SBL PR
0151 STO 005 RCL IND 003
0158 ST+ 005 INC 002
0164 LBL AE SBL PR
0170 STO IND 003 INC 003
0177 0 EXC IND 003 INV
0183 INC 003 ST+ IND 003
0190 RCL 005 ST/ IND 003
0197 INC 003 DSZ 002
0203 GTL AE RCL 004 -48=
0213 STO 005 INV DSZ 005
0220 GTL A1 9 STO 003
0227 RCL 001 STO 008
0233 LBL AF INC 003 INV
0240 INC 002 0
0244 EXC IND 003 x~t
0249 LBL AG INC 003 0
0256 EXC IND 003 -
0261 RCL 002 ST+ 003 x~t
0268 * x~t RCL IND 006 )
0275 STO IND 003 RCL 002
0282 ST- 003 INC 006
0288 DSZ 008 GTL AG
0294 RCL 001 ST+ 006
0300 STO 008 DSZ 005
0306 GTL AF RCL 002
0312 ST+ 003 INC 003
0318 LBL AH 0
0322 EXC IND 006 INC 006
0329 STO IND 003 INC 003
0336 DSZ 008 GTL AH
0342 LBL A1 INC 007 10
0350 STO 006 DSZ 001
0356 GTL AA 48 ST- 004
0364 INV TF 53 GTL ZZ
0370 `ERROR FLAG SET`
0384 PRT INV TF 74 BRK
0389 ADV
0390 LBL ZZ TF 01 RTN
0396 ADV
0397 LBL AJ RCL IND 006
0404 PRT INV TF 74 BRK
0409 INC 006 DSZ 004
0415 GTL AJ 0 ADV RTN
0421 LBL BB RF 01 `Orde`
0430 `r?` BRK +/- x~t
0435 CMS x~t
0437 LBL XX STO 001
0443 STO 007 48 STO 004
0451 GTL A1
```

Modified Linear Equation Program for the TI-95 - (cont)

4. When the last vector element has been entered the calculator will run for a short period of time. If the PC-324 is connected the solution will be printed and the calculator will stop with a zero in the display. If the printer is not used the calculator will stop with the first element of the solution in the display. Press F1 as needed to display the remaining elements of the solution. If an error occurred during the calculations such that the small error indicator is set then an error message will be displayed or printed before the output of the solution occurs.

1,1	7.
1,2	9.
1,3	1.
1,4	1.
1,5	-131.
2,1	-2.
2,2	-3.
2,3	2.
2,4	1.
2,5	-17.
3,1	1.
3,2	5.
3,3	5.
3,4	1.
3,5	-51.
4,1	-6.
4,2	2.
4,3	5.
4,4	1.
4,5	-65.
	8.
	-14.
	18.
	-79.

User Instructions - Subroutine Mode

1. The elements of the matrix and vector must be placed in data registers beginning at R050. The sequence of the transfer must be the same as that required by the manual mode; that is, the elements of the first row of the matrix followed by the first element of the vector, followed by the elements of the second row of the matrix, etc.

2. Prior to calling the linear equations program as a subroutine flag 1 must be set, the value 50 must be stored in data register A (000), and the negative of the order of the solution must be in the display.

3. The call to the linear equation subroutine will be 'MEMLIN' RUN SBL XX if the linear equation solution is in user memory. "MEM" will be replaced by the appropriate letters if the program is in some other memory location.

Note that the printing of the elements as they are entered and the printing and display of the solution is suppressed in the subroutine mode. The elements of the solution will be found in sequence starting at R010. A sample printout for operation in the manual mode appears at the right. An illustration of the use of the linear equations program as a subroutine appears as part of the "Sphere through 4 Points" program elsewhere in this issue.

INTEREST SURVEY - I tabulated the responses to the interest survey which was part of the subscription form for this year. For the first 85 subscribers the results were:

TI-58	-	2	TI-95	-	46
TI-59	-	44	CC-40	-	5
TI-66	-	3	fx-7000G	-	7
TI-74	-	23	HP15/28	-	2

where the total is greater than 85 because many members checked more than one machine. The distribution is similar to that reported for the previous subscription year in V13N1P3, except that the TI-95 is now is slightly in the lead. Many members who checked the TI-95 also checked the TI-59. Even though interest surveys continue to say that the TI-59 is popular with our members one wouldn't know it from the submissions. So, if you have a TI-59 program you would like to share with other members please send it in.

SPHERE THROUGH FOUR POINTS - Bill Wilburn proposed this problem. After several iterations we arrived at the solution which appears at the right. The solution method involves (1) the generation of four linear equations through evaluation of a standard equation for a sphere at the four points, (2) solution of the four linear equations to find the coefficients of the equation of the sphere, and (3) conversion of the coefficients into the radius and the coordinates of the center of the sphere using published results. For example, the second problem on page 271 of *Analytic Geometry* by Ross Middlemiss (McGraw-Hill, 1945) asked the student to show that for an equation of a sphere of the form

$$x^2 + y^2 + z^2 + Gx + Hy + Iz + K = 0$$

the center is at (-G/2, -H/2, -I/2) and the radius is $(SQR(G^2 + H^2 + I^2 - 4K))/2$.

TI-95 Program Description

Steps 0019-0136 provide for data entry including a full set of prompts for input of the X, Y and Z coordinates of the four points. The input data is stored starting at data register 050 in the sequence X , Y , Z , 1, $-(X^2 + Y^2 + Z^2)$ where the first four elements form a row of the input matrix and the fifth term is the corresponding vector element. This sequence provides for easy entry to the linear equations solution from page 8.

Steps 0137-0171 clear the registers used by the linear solution, set flag 01 to suppress printout of intermediate results by the linear equations program, store the location of the initial data point in data register A, place the negative of the order (-4 in this case) in the display register and call the linear equations program. As shown the call assumes that the linear equations solution is stored in user memory (MEM) as LIN. If you use other storage you must adjust the call in line 0161 accordingly.

Steps 0172-0274 convert the linear equations solution to the sphere parameters and display or print the results.

Two sample solutions appear at the right. One solution is representative of those normally expected with four points which are not co-planar.

The second solution is for the case of four co-planar points. That case causes a divide by zero to occur in the solution of the linear equations. The indication "ERROR FLAG SET" for that case is provided by the test of flag 53 at line 0364 of the linear equations program on page 8.

```
0000 `4 POINT SPHERE`
0014 ADV PRT PSU ADV CLR
0019 CMS 4 STO A 49
0025 STO B 50 STO C
0031 LBL AA 3 STO D 88
0039 STO E
0041 LBL AB CLR
0045 CHR IND E CHR IND B
0051 `?` BRK STO IND C
0056 CHR IND E CHR IND B
0062 COL 16 MRG = PRT
0067 INC C INC E DSZ D
0073 GTL AB 1 STO IND C
0080 2 ST+ C INC B ADV
0086 DSZ A GTL AA
0091 LBL BB 50 STO B 4
0099 STO A
0101 LBL CC 3 STO C
0107 LBL DD RCL IND B
0113 x^2 INC B + DSZ C
0119 GTL DD 0= +/- INC B
0127 STO IND B INC B
0132 DSZ A GTL CC 39
0139 STO A CLR
0142 LBL EE STO IND A
0148 DSZ A GTL EE CLR
0154 SF 01 50 STO A 4
0161 +/- `MEMLIN` RUN
0169 SBL XX CLR `   SPH`
0179 `ERE PARAMETERS`
0193 PRT ADV 3 STO A 10
0200 STO B 88 STO C
0206 LBL FF CLR
0210 RCL IND B /2= +/-
0217 `D` CHR IND C ` =`
0223 COL 16 MRG = PRT
0228 INC B INC C DSZ A
0234 GTL FF ADV CLR
0239 RCL 010 x^2 +
0244 RCL 011 x^2 +
0249 RCL 012 x^2 -4*
0256 RCL 013 = SQR /2=
0264 `R  =` COL 16 MRG =
0272 PRT ADV HLT
```

```
4 POINT SPHERE

X1          7.
Y1          9.
Z1          1.

X2         -2.
Y2         -3.
Z2          2.

X3          1.
Y3          5.
Z3          5.

X4         -6.
Y4          2.
Z4          5.

   SPHERE PARAMETERS

DX =       -4.
DY =        7.
DZ =       -9.

R  =       15.
```

```
4 POINT SPHERE

X1          2.
Y1          1.
Z1          4.

X2         -1.
Y2          0.
Z2          1.

X3          0.
Y3          0.
Z3          2.

X4         -1.
Y4         -1.
Z4          1.

ERROR FLAG SET

   SPHERE PARAMETERS

DX =     2.5 99
DY =        6.5
DZ =    -2.5 99

R  =       5. 49
```

MEMBERSHIP LISTING - Several members have suggested that we publish a membership list. I have declined to publish a complete list. Such a list eventually falls into the hands of orgsanizations that do mass mailing, and some members may not want to be on any additional mailing lists (the editor is one). However, as we did in V10N4P9 and V11N1P7, I will publish listings for those members who specifically agree to it. I have obtained permission from some members for inclusion in the sample listing which follows:

Myer Boland
66 Overlook Way
Englishtown NJ 07726
(201)-536-2855
Solution of equations, puzzles, extended precision, interpolation.

Don Laughery
112 W. 2nd Avenue
Baltimore MD 21225
(301)-789-2494 H; (301)-787-3833 W
TI-95 and TI-74, inspection utility, program enhancement for speed.

Laurance M. Leeds (Larry)
10232 El Dorado Drive
Sun City AZ 85351-4243
(602)-933-4379
Unusual problems, multiprecision, programs in BASIC

Peter Messer
3344 W. Grace Avenue
Mequon WI 53092
(414)-242-1116
Probability and statistics, multi-precision calculations.

Bill Wilburn
14333 Domart Ave.
Norwalk CA 90650
(213)-868-0387
Quality control and inspection

Charlie Williamson
P. O. Box 7177
Sacramento CA 95827
(916)-363-2395
Puzzles

Telephone numbers are optional. Interest areas are also optional, but try to limit that to about seventy characters. To make your response easier I have attached a self-addressed postcard to each copy of this issue.

ON THE USE OF THE CHANGE SIGN (+/-) KEY - P. Hanson. I was studying the example for the bivariate models program on page 5-37 of *TI-95 Statistics Library Guidebook*. The first x entry is -10. The instructions prescribe the input sequence +/- 1 0 rather the 1 0 +/- we have typically used with other machines. It worked! I went to page 2-8 of the *TI-95 User's Guide* and found the following paragraph:

> "The +/- key changes the sign of the number in the display. This enables you to enter negative numbers and negative exponents. To enter a negative number, press the +/- key before, during, or after entering the number. To enter a negative exponent, press the +/- key after entering the exponent."

Pressing the +/- key with a zero in the display yields a -0 display. Pressing the +/- key before, during or after the numerical entry also works with the TI-57, the TI-58C and the TI-59. With the TI-66 pressing the +/- key before the numerical entry will not change the sign, but pressing the +/- key during the numerical entry will change the sign. I haven't been able to find this feature described in any of the documentation for the TI-57, the TI-58C, the TI-59 or the TI-66.

I had thought that I had thoroughly exercised key sequences which had not been defined for the TI-59. If I failed to recognize the extended +/- feature, how many more features have I missed?

BOOK REVIEW - Graphic Scientific Computers Application Book, Casio 125 pages. Charles Struble called my attention to a book of thirty programs for the fx-7000G, fx-7500G and fx-8000G. The book is available from Computer Services, P.O. Box 321, Owatonna MN 55060 for $5.95 plus $4.60 for insurance, shipping and handling. The programs are listed below. Words after the - are comments by the editor.

MATHEMATICS
- Simultaneous Equations - two equations and two unknowns
- Hyperbolic Tangent and Locus
- Solution of Inequalities
- Lissa Jous Figure
- Area of Pattern Enclosed by Quadratic Curves
- Fourier Series
- Cubic Equation Solution - see comments on the solution below
- Maximum/Minimum Values - for a cubic
- Simpson Rule Definite Integration
- Bessell Function of the First Kind

STATISTICS
- Frequency Table
- Depreciation Calculation - straight line and declining balance
- Binomial Theorem
- Binomial Distribution
- Poisson Distribution
- Experimental Data Verification
- Population Mean Testing
- Population Mean Estimation
- x-R Control Charts
- Statistical Values Approaching a Limit Value - logistic curve

ELECTRIC/ELECTRONICS
- RC Circuit Pulse Response
- RLC Series Circuit Resonance
- Amplitude Modulation
- AC Waveform Sum and Difference (compound wave)
- Magnetic Field and Electrical Field of a Radio Wave
- Amplifier Frequency Characteristics
- Transistor Static Characteristics
- LPF Design
- Smoothing Circuit - power supply RC filter design
- Distributed Constant Circuit

I tested the cubic solution with Peter Messer's equation from V11N4P16 which has two complex roots and one real root, and is admittedly a stringent test. The following table compares the result from the fx-7000G program with the first fifteen digits of the exact solution:

$$x^3 - 2x^2 + (4/3)x - 2/9 = 0$$

Source	Re	Im	R3
Exact	0.87665 35083 15812	0.36370 78786 57240	0.24669 29833 68375
fx-7000G	0.87666 20582	0.36369 30698	0.24667 58836

where we see that only four significant digits are correct. The built-in cubic solution on the TI-95 and the built-in polynomial solution on the TI-68 yielded eleven correct digits. I have reviewed my key-in of the program and have not found an error. I will try to examine the fx-7000G program more completely in a coming issue.

TI-95's FOR $49.95 FROM EDUCALC - Bill Wilburn reports that a co-worker called to buy one, but that they will have to order one. This suggests that they are selling at the current price beyond their current stock.

TI-68 AVAILABILITY - Over the holidays the TI-68 became available at the local Service Merchandise. The price is $49.94 plus tax.

MORE ON PAPER FOR THE PC-324 - V13N4P3 described Carl Rabe's experience in cutting a roll of PC-100 paper to a 2 1/4 inch width for use in a PC-324. The question was asked "Has any member found a source of black printing 2 1/4 inch wide paper on larger rolls?" One of our members (Sorry, I don't remember which one!) wrote to tell me that Hewlett-Packard's 82175 paper comes in 1 3/4 inch diameter rolls. I bought some from EduCALC. It prints black on white with contrast which is equivalent to that with TI's PC-324 paper, but not at all as good as with the Radio Shack Cat. No. 26-3592B paper. The contrast of my paper is certainly good enough to support such activities as program development and printouts where there is no need to save the results.

The really attractive feature is the price. A package of six rolls (EduCALC Stock No. 82175A) is $9.95 plus $1.00 for shipping and handling. Each roll is 80 feet long. That figures out to 2.28 cents per foot. You can also buy the H-P paper in a two roll package for $3.95 plus $1.00 shipping, or at about 3.09 cents per foot.

By way of comparison, the Radio Shack 26-3592B paper comes in packages of five rolls for $2.49. Each roll is 86 inches long, so the cost is about 6.95 cents per foot. TI's TP-324 paper is the most expensive. A package of 3 rolls can be ordered for EduCALC for $4.95 plus $1.00 shipping. The length isn't mentioned on the package, so I unrolled and measured a new roll and found it to be about 21 feet long. The cost is 9.44 cents per foot.

Based on price it seemed like a good idea to recommend the HP paper for use with the PC-324, at least for draft work. But then Scott Garver sent a sample of the HP paper for which the contrast was very poor. So, it seems that there is variability in the capability of the HP paper at least as run on a PC-324, and if you get a box of six bad rolls you have a lot of bad paper.

There is an advantage to the TI paper. The one inch diameter rolls are as large as they can be and still fit in the receptacle of a PC-324. By comparison, the Radio Shack rolls are very small, and it seems as if one is always changing paper. To use the H-P paper the user will either have to rig up some sort of external paper holding capability or transfer the paper to smaller rolls.

FOR BI-LINGUALS - Recent issues of the EduCALC catalog include a notice that "Hewlett-Packard intends to discontinue the sale of the HP41-CV/CX within the next few months (they are no longer-cost effective to manufacture). They will continue to offer Application Pacs, Supplies and Support for the HP-41 during the next five years." EduCALC then suggests that users should assess their future requirements and place their orders accordingly.

It may be true that the HP-41 is no longer cost-effective to manufacture. Even so, it is sad to accept the eventual phaseout of the other great programmable. The TI-59 and the HP-41 are representative of an apex in the development of programmable calculators. No devices prior or since have offered the ease and convenience of program storage afforded by the magnetic card reader technology.

USING FUNCTION KEYS IN A PROGRAM - William Hawes' treatise in V12N1P17 and the discussions on pages 4 and 8 in this issue illustrate techniques for finding entry addresses for use in calling subroutines from an installed Constant Memory cartridge. The examples with those discussions are adequate to illustrate some subroutine calls, but are not adequate for use with more complex routines such as those for the data entry of matrix and vector elements. It turns out that the use of function key commands (F1 through F5) in a program provide an efficient way to cycle in and out of the Constant Memory cartridge subroutines. The program at the right illustrates the use of function key commands in a program which can be called as a subroutine to solve linear equations using the program in the Mathematics cartridge. This particular program is tuned for use with a modification of the four point sphere program on page 10 of this issue. Comments follow.

```
0000 LBL XX 24637 STO A
0010 `MTH` RUN SBR IND A
0017 4 F1 F2 4 STO 049 5
0025 0 STO A
0028 LBL MA 4 STO 048
0035 LBL MB RCL IND A F1
0042 5 ST+ A DSZ 048
0048 GTL MB 19 ST- A
0055 DSZ 049 GTL MA F3
0062 F2 4 STO 049 54
0069 STO A
0071 LBL MC RCL IND A F1
0078 5 ST+ A DSZ 049
0084 GTL MC DFN CLR ADV
0090 CLR RTN
0092 LBL YY 31 STO A 4
0100 STO 049
0103 LBL MD RCL IND A
0109 BRK INC A DSZ 049
0115 GTL MD CLR HLT
```

24637 STO A 'MTH' RUN SBR IND A provides entry at the NEW option of the INV/LINEAR SYS menu in the MATRIX ALGEBRA portion of the Mathematics library. The value 24637 is the the decimal equivalent of hexidecimal 603D. Entry at the NEW option also sets data register 009 to zero as required on page A-4 of the *TI-95 Mathematics Library Guidebook*.

At that point in a manual use of the NEW option the user enters the order of the matrix and presses F1 (n), presses F2 (EOD) to set up for data entry, and proceeds to enter the matrix elements in response to the prompts in the display. But, how does a user accomplish the equivalent operations as part of a running program? This question is pertinent to programs such as the four point sphere solution where the coordinates of the four points have been stored as a input data list and are to be transferred to the appropriate data registers for use by a linear equations solution.

The use of a function key in a program provides the answer. Steps 0020 through 0060 set up a pair of loops which bring each of the matrix elements in turn to the display register. (Note that matrix elements are entered by column as with ML-02 in the TI-59 Master Library module, not by rows as in the linear equation solution on page 8 of this issue.) As each element is brought to the display the F1 function key command at step 0041 causes the program in the Mathematics Library to enter the value in the proper register for use by subsequent calculations.

After all of the matrix elements have been entered the F3 (EOD) at step 0061 rejects the option to edit the matrix elements and the F2 (SYS) function key command at step 0062 selects the system option.

Steps 0063 through 0086 mechanize a loop which brings the vector elements in order to the display, and the F1 at step 0077 causes the values to be stored for use by the linear equations solution.

At this point there is an idiosyncrasy. The Yes/No Test after vector elements (the b's) have been entered does not respond to either an F1 (YES) or an F2 (NO) in the program. This must be circumvented by an operator input of F2 from the keyboard. The program in the Mathematics Library module then proceeds to solve the linear equations.

But, see page 24!

The loop from step 0092 to the end of the program provides a capability to read out the solution. It is not used in the four point sphere application.

SPHERE THROUGH FOUR POINTS USING TI-95 MATH MODULE

The program on page 10 solved this problem by calling a linear equations solution stored in user memory. This program solves the problem using the subprogram on page 14 to access the linear systems program in the Mathematics Library module.

The data entry in steps 0019-137 is essentially the same as in the program on page 10. The only difference is the insertion of a CLR at step 091. The result is that the input data is stored in the sequence X, Y, Z, 1, $-(X^2 + Y^2 + Z^2)$ starting at data register 050. This sequence provided easy data transfer for the program on pages 8 and 10. It requires a relatively complex data transfer here as seen in the subprogram on page 14.

Steps 138-151 set up the call of the subprogram on page 14. The DEV 099 command suppresses the built-in printing in the linear systems program in the MATH module. As shown the program assumes that the program on page 14 in stored in user memory as LNM. If you use other storage identification you must adjust the call in steps 142-0147 accordingly.

The DEV 012 in line 0152 enables the printer for printout of the solution.

The remainder of the program is the same as in the program on page 10 except that the addresses of the coefficients from the linear equation solution are changed.

The resulting printouts from this program will be the same as those illustrated on page 10 for the case where the four points are not co-planar. For the four co-planar point case no error indication will occur. It turns out that the determinant should be zero for the co-planar example on page 10. The linear systems program in the MATH module calculates the determinant as -6E-13. The very large sphere parameters, different from those on page 10, must be used to decide that the solution is unreasonable.

```
0000 `4 POINT SPHERE`
0014 ADV PRT PAU ADV CLR
0019 CMS 4 STO A 49
0025 STO B 50 STO C
0031 LBL AA 3 STO D 88
0039 STO E
0041 LBL AB CLR
0045 CHR IND E CHR IND B
0051 `?` BRK STO IND C
0056 CHR IND E CHR IND B
0062 COL 16 MRG = PRT
0067 INC C INC E DSZ D
0073 GTL AB 1 STO IND C
0080 2 ST+ C INC B ADV
0086 DSZ A GTL AA CLR
0092 LBL BB 50 STO B 4
0100 STO A
0102 LBL CC 3 STO C
0108 LBL DD RCL IND B
0114 x^2 INC B + DSZ C
0120 GTL DD 0= +/- INC B
0128 STO IND B INC B
0133 DSZ A GTL CC
0138 DEV 099 CLR `MEMLN`
0147 `M` RUN SBL XX
0152 DEV 012 CLR `   SP`
0161 `HERE PARAMETERS`
0176 PRT ADV 3 STO A 31
0183 STO B 88 STO C
0189 LBL FF CLR
0193 RCL IND B /2= +/-
0200 `D` CHR IND C ` =`
0206 COL 16 MRG = PRT
0211 INC B INC C DSZ A
0217 GTL FF ADV CLR
0222 RCL 031 x^2 +
0227 RCL 032 x^2 +
0232 RCL 033 x^2 -4*
0239 RCL 034 = SQR /2=
0247 `R  =` COL 16 MRG =
0255 PRT ADV HLT
```

REDUCED PRICE FOR *Algorithm* - A. K. Dewdney, the long-time editor of the "Computer Recreations" column in *Scientific American*, is the editor of the new newsletter *Algorithm*. The first issue was released in late 1989 with a subscription rate of $29.95 for six issues. A recent letter from the Managing Editor offers *Algorithm* to our members at a reduced rate of $26.95. To receive the reduction merely mention the name "TI Personal Programmable Calculator Club" with your subscription order. Send a check or money order (no C.O.D.'s please) to Algorithm, P.O. Box 29237, Westmount Postal Outlet, 785 Wonderland Road South, London, Ontario, Canada N6K 1M6.

I will loan a copy of *Algorithm* to members who would like to look at a copy before subscribing. Send one dollar to our club address. I will send the copy by first class mail and expect you to return it promptly so that others may have access to the magazine.

INTERSECTION OF TWO CIRCLES - Bill Wilburn asked if anyone had a program for finding the coordinates of the intersections between two circles. The index for PPX Exchange shows that the TI-59 program 398007A should perform that task. That program is not included in the listing in V13N1P10-20 of PPX programs which are available from other members. If you have a copy please write to Bill at the address shown in the membership listing on page 11 of this issue.

One solution method is to solve simultaneously the equations of the two circles; i.e,

$$(x - H_1)^2 + (y - K_1)^2 = R_1^2 \quad \text{and}$$

$$(x - H_2)^2 + (y - K_2)^2 = R_2^2$$

where the H's and K's are the x and y coordinates of the centers of the circles and the R's are the radii. Paragraph 54 of Wilson and Tracey's *Analytical Geometry - Alternate Edition* (D.C. Heath, 1937) shows that a linear equation in x and y which passes through the intersections can be obtained by simply subtracting one of the equations from the other, say the first equation from the second equation, yielding after a little rearrangement

$$2(H_1 - H_2)x + 2(K_1 - K_2)y =$$

$$(R_2^2 - R_1^2) - (H_2^2 - H_1^2) + (K_2^2 - K_1^2)$$

The expressions in the parentheses and the entire expression on the right hand side are comprised of constants. For convenience we will define

$$(H_1 - H_2) = H_3,$$

$$(K_1 - K_2) = K_3,$$

$$(R_2^2 - R_1^2) - (H_2^2 - H_1^2) - (K_2^2 - K_1^2) = 2R_3$$

Then, the linear equation becomes simply

$$H_3x + K_3y = R_3$$

Solving for x in terms of y, substituting appropriately in the first circle equation multiplied by H_3^2 and collecting terms yields the three coefficients of a quadratic equation in y:

$$A = K_3^2 + H_3^2$$

$$B = 2H_1H_3K_3 - 2K_3R_3 - 2K_1H_3^2$$

$$C = R_3^2 - 2H_1H_3R_3 + H_3^2(H_1^2 + K_1^2 - R_1^2)$$

```
10 A$="Intersections of
Circles"
20 B$="(X-H)^2 + (Y-K)^2
 = R^2"
30 REM March 20, 1990
40 PRINT A$:PAUSE 1
50 PRINT B$:PAUSE 1
60 INPUT "Use Printer (Y
/N)? ";C$
70 IF C$="Y"OR C$="y"THE
N PN=1 ELSE 110
80 INPUT "Device Code (P
C-324=12)? ";P$
90 OPEN #1,P$,OUTPUT
100 PRINT #PN:PRINT #PN,
A$:PRINT #PN
110 INPUT "H1 = ";H1
115 PRINT #PN,"H1 = ";H1
120 INPUT "K1 = ";K1
125 PRINT #PN,"K1 = ";K1
130 INPUT "R1 = ";R1
135 PRINT #PN,"R1 = ";R1
:PRINT #PN
140 INPUT "H2 = ";H2
145 PRINT #PN,"H2 = ";H2
150 INPUT "K2 = ";K2
155 PRINT #PN,"K2 = ";K2
160 INPUT "R2 = ";R2
165 PRINT #PN,"R2 = ";R2
:PRINT #PN
170 IF H1=H2 AND K1=K2 T
HEN 600
180 HA=H1:HB=H2:KA=K1:KB
=K2
190 IF H1=H2 THEN Z=1 EL
SE 210
200 HA=-K1:HB=-K2:KA=H1:
KB=H2
210 H3=HA-HB
220 K3=KA-KB
230 R3=(R2*R2-R1*R1-HB*H
B+HA*HA-KB*KB+KA*KA)/2
240 A=K3*K3+H3*H3
250 B=2*HA*H3*K3-2*K3*R3
-2*KA*H3*H3
260 C=R3*R3-2*HA*H3*R3+(
HA*HA+KA*KA-R1*R1)*H3*H3
270 D2=B*B-4*A*C
280 IF D2<0 THEN 650
290 IF D2=0 THEN ZZ=1
300 D=SQR(D2)
310 Y1=(-B+D)/(2*A)
320 Y2=(-B-D)/(2*A)
330 X1=(-K3*Y1+R3)/H3
340 X2=(-K3*Y2+R3)/H3
350 IF Z=0 THEN 390
360 I=X1:J=X2
370 X1=Y1:X2=Y2
380 Y1=-I:Y2=-J
390 PAUSE ALL
400 PRINT #PN,"X1 = ";X1
410 PRINT #PN,"Y1 = ";Y1
420 IF PN=1 THEN PRINT #
PN
430 IF ZZ=0 THEN 460
440 PRINT #PN,"Tangent -
 1 Intersection"
450 GOTO 710
460 PRINT #PN,"X2 = ";X2
470 PRINT #PN,"Y2 = ";Y2
480 GOTO 710
600 IF R1<>R2 THEN 630
610 PRINT #PN,"Identical
 Circles"
620 GOTO 700
630 PRINT #PN,"Concentri
c - No Solution"
640 GOTO 700
650 PRINT #PN,"Circles D
o Not Intersect"
700 IF PN=0 THEN PAUSE
710 IF PN=1 THEN PRINT #
1:CLOSE #1
720 PAUSE 0:END
```

Intersection of Circles - (cont)

which can then be solved to find the y values of any intersections. The y values can then be substituted into the linear equation through the intersections to obtain the corresponding x values.

There are some potential difficulties with special conditions. First, if the line through the centers of the two circles is a vertical line (their H values are equal) then the solution for the x values will involve a divide by zero. That can be avoided by rotating the solution axes by ninety degress. Second, if the centers of the two circles are coincident (the circles are concentric) the coefficients of the quadratic will be zero, again resulting in division by zero. That can be avoided by skipping the quadratic solution if the circles are concentric.

The major portion of the TI-74 program on page 16 is a straightforward implementation of the foregoing analysis. Lines 10-90 provide annotation and printer setup if desired. Lines 100-165 provide for input of the centers and radii of the two circles. Lines 170 and lines 600-640 handle the case of concentric circles. Lines 180-200 rotate the solution axes if the x coordinates (the H's) of the centers are identical and lines 360-380 rotate the solution back after solution of the quadratic and linear equation, lines 210-340 solve the quadratic and linear equations, and lines 390-480 print the coordinates of the intersections. If there is only one intersection because the circles are tangent that condition is noted and only one intersection is printed. Finally, line 280 tests for no solution based on a negative discriminant of the quadratic equation and line 650 indicates that no solution is available if that is the case. Sample printouts for five different cases follow:

```
Intersections of Circles

H1 =  1
K1 =  2
R1 =  5

H2 =  3
K2 =  4
R2 =  4

X1 =  .2993363611
Y1 =  6.950663639

X2 =  5.950663639
Y2 =  1.299336361
```

```
Intersections of Circles

H1 = -3
K1 =  1
R1 =  4

H2 =  3
K2 =  1
R2 =  2

X1 =  1
Y1 =  1

Tangent - 1 Intersection
```

```
Intersections of Circles

H1 =  1
K1 =  2
R1 =  2

H2 =  2
K2 =  6
R2 =  1

Circles Do Not Intersect
```

```
Intersections of Circles

H1 =  1
K1 =  1
R1 =  5

H2 =  1
K2 =  1
R2 =  7

Concentric - No Solution
```

```
Intersections of Circles

H1 =  2
K1 =  2
R1 =  3

H2 =  2
K2 =  2
R2 =  3

Identical Circles
```

A TI-95 solution can be obtained by implementing the same equations. But we might note that a possible TI-95 solution would be to use the non-linear equations option in the Math module. I tried that with the function sub-routine shown at the right, where, as defined on page 13-3 of the *TI-95 Mathematics Library Guidebook*, the x variable is in data register B and the y variable is in data register C. Also, I used data registers 030-035 as storage locations for the H, K, and R values which define the two circles. Unfortunately, I was unable to arrive at a satisfactory method for finding initial points which would consistently lead to a solution.

```
0000 LBL f1 (( RCL B -
0008 RCL 030 ) x^2 +(
0015 RCL C - RCL 031 )
0022 x^2 - RCL 032 x^2 )
0029 RTN
0030 LBL f2 (( RCL B -
0038 RCL 033 ) x^2 +(
0045 RCL C - RCL 034 )
0052 x^2 - RCL 035 x^2 )
0059 RTN
```

I then implemented the equations on page 16 on a TI-95. I used the built-in QAD routine to solve the quadratic equation. That led to additional difficulties. In V12N1P21 Robert Prins reported that the QAD solution gives incorrect answers when c = 0, probably due to the use of "more accurate" formulas for the roots such as the equation shown at the right.

$$r = \frac{2c}{-b - \sqrt{b^2 - 4ac}}$$

Intersection of Circles - (cont)

With that equation a divide-by-zero will result when c is equal to zero. It turns out that the situation is worse than that. Consider the short program at the right which stores 36 as A and zeroes as B and C, where there should then be two zero roots. The QAD function returns one zero root and one root which is 1E+100 divided by 36, and sets the error flag. Unfortunately, the TI-95 doesn't give any other indication of an error, say such as the flashing display or question mark by a printed output with the TI-59, and the error flag is easily overlooked. This suggests that TI-95 users need to incorporate error flag tests (flag 53) in their programs.

```
0000 36 STO A 0 STO B
0007 STO C QAD RCL A `R`
0013 `1=` COL 16 MRG =
0019 PRT RCL B `R2=`
0025 COL 16 MRG = PRT
0030 HLT


R1=            0.
R2=  2.777778 98
```

Since I didn't have time to investigate the QAD function completely I have provided two versions of a TI-95 solution for the intersections of two circles. In the listing below the right hand column is the same for both versions. The version which includes the center column was the first one written and is similar to the TI-74 program on page 16. It relies (hopefully) on the various "traps" to prevent a bad solution from the QAD routine. The revised version which includes the right hand column examines the value calculated for c. If c = 0 the program skips the QAD solution and obtains the roots as 0 and -b/a . So far I have not found a problem which cannot be properly solved with that method.

```
0000 GTL AA
0003 LBL IN BRK
0007 STO IND A INC A CE
0013 OLD
0014 LBL PT COL 16 MRG =
0021 PRT CE RTN
0024 LBL AA ADV `Circle`
0034 ` Intersections`
0048 PRT ADV CLR CFG CMS
0053 10 STO A `H1=`
0060 SBL IN `K1=` SBL IN
0069 `R1=` SBL IN ADV
0076 `H2=` SBL IN `K2=`
0085 SBL IN `R2=` SBL IN
0094 ADV RCL N INV IF= K
0100 GTL BB RCL O IF= L
0107 GTL DD SF 01 RCL K
0114 EXC L +/- STO K
0119 RCL N EXC O +/-
0124 STO N
0126 LBL BB RCL P x^2 -
0133 RCL M x^2 - RCL N
0139 ST- H x^2 + RCL K
0145 ST+ H x^2 - RCL O
0151 ST- I x^2 + RCL L
0157 ST+ I x^2 =/2=
0164 STO J RCL I x^2 +
0170 RCL H x^2 = STO A 2
0177 * RCL K * RCL H *
0184 RCL I -2* RCL I *
0192 RCL J -2* RCL L *
0200 RCL H x^2 = STO B
0206 RCL J x^2 -2* RCL K
0214 * RCL H * RCL J +(
0222 RCL K x^2 + RCL L
0228 x^2 - RCL M x^2 )*
0235 RCL H x^2 = STO C
0241 RCL B x^2 -4* RCL A
0249 * RCL C = STO D QAD
0256 1 IF= C GTL GG
0262 RCL I * RCL A +/- +
0269 RCL J =/ RCL H =
0276 STO F RCL I * RCL B
0283 +/- + RCL J =/
0289 RCL H = STO G INV
0295 TF 01 GTL CC RCL A
0302 EXC F +/- STO A
0307 RCL B EXC G +/-
0312 STO B
0314 LBL CC CE RCL F `X`
0321 `1=` SBL PT RCL A
0328 `Y1=` SBL PT ADV
0335 CLR IF= D GTL EE
0341 RCL G `X2=` SBL PT
0349 RCL B `Y2=` SBL PT
0357 ADV HLT
0359 LBL DD RCL P INV
0365 IF= M GTL FF CLR
0371 `Identical Circles`
0388 PRT ADV HLT
0391 LBL EE CLR `Tangen`
0401 `t - 1 Intersectio`
0418 `n` PRT HLT
0421 LBL FF CLR `Concen`
0431 `tric Circles` PRT
0444 ADV
0445 LBL GG CLR `No Sol`
0455 `ution` PRT HLT
```

```
0235 RCL H x^2 = STO C 0
0242 IF= C GTL AB QAD
0248 GTL AC
0251 LBL AB EXC A +/-
0257 ST/ B
0259 LBL AC 1 -IF= C
0265 GTL GG RCL B IF= A
0272 SF 02 RCL I * RCL A
0279 +/- + RCL J =/
0285 RCL H = STO F RCL I
0292 * RCL B +/- + RCL J
0299 =/ RCL H = STO G
0306 INV TF 01 GTL CC
0312 RCL A EXC F +/-
0317 STO A RCL B EXC G
0323 +/- STO B
0326 LBL CC CE RCL F `X`
0333 `1=` SBL PT RCL A
0340 `Y1=` SBL PT ADV
0347 TF 02 GTL EE RCL G
0354 `X2=` SBL PT RCL B
0362 `Y2=` SBL PT ADV
0369 HLT
0370 LBL DD RCL P INV
0376 IF= M GTL FF CLR
0382 `Identical Circles`
0399 PRT ADV HLT
0402 LBL EE CLR `Tangen`
0412 `t - 1 Intersectio`
0429 `n` PRT HLT
0432 LBL FF CLR `Concen`
0442 `tric Circles` PRT
0455 ADV
0456 LBL GG CLR `No Sol`
0466 `ution` PRT HLT
```

UNIFORM RANDOM NUMBER GENERATOR FOR THE TI-59 - Gene Friel writes: "I found that the uniform random number generator $x_{n+1} = (2^9 + 1)x_n \bmod(2^{31} - 1)$ with seed $x_0 = 8^7 - 1$ and $y_{n+1} = x_{n+1}/(2^{31} - 1)$ yields a fairly good distribution over 40,000 points for Monte Carlo Quadrature. The low, high, average, and standard deviation over 40,000 points from a TI-59 are 0.0000162059... , 0.9999791393... , 0.4999765411... , and 0.2887042612... , respectively. The standard deviation should be $1/\sqrt{12} = 0.28867513...$. From what I have read the generator uields a full cycle of $2^{31} - 2$ different values. This is the best and fastest one that I am aware of. A TI-59 listing is enclosed. Have you found a better uniform random number generator or has anyone else evaluated other parameters for the above generator?"

000	76	LBL	022	05	5	044	76	LBL	066	02	2	088	43	RCL	110	75	-
001	12	B	023	01	1	045	13	C	067	00	0	089	32	32	111	43	RCL
002	08	8	024	03	3	046	47	CMS	068	95	=	090	69	DP	112	40	40
003	45	Y^x	025	75	-	047	29	CP	069	42	STO	091	06	06	113	33	X^2
004	07	7	026	53	(	048	42	STO	070	31	31	092	06	6	114	55	÷
005	65	×	027	46	INS	049	30	30	071	84	DP*	093	07	7	115	43	RCL
006	59	INT	028	55	÷	050	42	STO	072	31	31	094	69	DP	116	32	32
007	42	STO	029	43	RCL	051	32	32	073	01	1	095	04	04	117	95	=
008	20	20	030	21	21	052	12	B	074	22	INV	096	43	RCL	118	55	÷
009	04	4	031	54	)	053	76	LBL	075	44	SUM	097	40	40	119	53	(
010	45	Y^x	032	59	INT	054	14	D	076	30	30	098	55	÷	120	43	RCL
011	05	5	033	65	×	055	11	A	077	43	RCL	099	43	RCL	121	32	32
012	95	=	034	43	RCL	056	44	SUM	078	30	30	100	32	32	122	75	-
013	59	INT	035	21	21	057	40	40	079	22	INV	101	95	=	123	01	1
014	42	STO	036	95	=	058	33	X^2	080	67	EQ	102	69	DP	124	95	=
015	21	21	037	42	STO	059	44	SUM	081	14	D	103	06	06	125	34	FX
016	92	RTN	038	20	20	060	41	41	082	69	DP	104	05	5	126	69	DP
017	76	LBL	039	55	÷	061	34	FX	083	00	00	105	04	4	127	06	06
018	11	A	040	43	RCL	062	65	×	084	03	3	106	69	DP	128	91	R/S
019	43	RCL	041	21	21	063	01	1	085	01	1	107	04	04	129	00	0
020	20	20	042	95	=	064	00	0	086	69	DP	108	43	RCL	130	00	0
021	65	×	043	92	RTN	065	85	+	087	04	04	109	41	41	131	00	0

Editor's Note: In the listing above the first two columns (up through step 043) are the random number generator implementation. The INS (code 46) at step 027 prevents the subroutine from clearing an error condition which would happen if CE (code 24) were used. To use the random number generator portion in your program call subroutine B to initialize the generator and then call subroutine A each time you want a random number.

The last four columns in the listing are an evaluation program. To use the evaluation program enter the sample size to be evaluated and press C. The program sorts the generated numbers into ten equal width bins, accumulates the sum and sum-squared of the numbers, and calculates the mean and the standard deviation.

V10N1P24 observed that if the generated numbers are sorted into ten equal width bins then if the numbers are truly uniform random numbers the numbers in each bin should be close to one-tenth of the total number generated. V10N1P25 reported the results of such sorting for several uniform random number generators. Some representative results for 1000 numbers with TI-59 routines are:

Bin	Pgm15SBRDms	V9N4P11	Friel
1	107	104	111
2	90	113	84
3	117	118	98
4	106	90	105
5	110	102	104
6	93	100	111
7	96	87	87
8	97	86	94
9	95	89	105
10	89	111	101

A TI-59 DIAGNOSTIC ANOMALY - During a recent checkout of a calculator for sale to one of our members I ran the the 598-TEST-1 program from the *TI 58/59 Service Manual*, the Master Library Diagnostic (2nd-Pgm-01-SBR-=) and then the 598-TEST-1 program again to get a quick check of the status of the calculator. (This takes only six minutes versus the sixteen minutes of the extended diagnostic from V9N4P11). The portion of the printout which appears at the right indicated that the calculator passed the 598-TEST-1 diagnostic the first time and passed the Master Library Diagnostic before proceeding to fail the 598-TEST-1 diagnostic for every register. Furthermore, the title for the diagnostic was incorrect and the register numbers in the printout were erratic. After some puzzling I remembered seeing this sort of thing before and went to my copy of PPX 908175 where I found the following notes:

```
598-TEST-1

          MASTER
     1.

598-TEST-1ASTER
     0.      77
     0.      78
     0.      77
     0.      76
     0.      75
     0.      74
     0.      73
     0.      72
     0.      71
     0.      70
     0.      87
     0.      88
     0.      87
     0.      86
     0.      85
     0.      84
     0.      83
     0.      82
     0.      81
     0.      80
     0.      77
     0.      78
     0.      77
     0.      76
     0.      75
     0.      74
     0.      73
     0.      72
     0.      71
     0.      70
     0.      67
     0.      68
     0.      67
     0.
     0.
     0.
     0.
```

> The program requires a zero in the t register, but does not provide it. If the program is loaded and initiated with a non-zero value in the t register then erratic and incorrect error indications will occur.
>
> The program does not provide an Op-00 before the printout of the title. If the program is loaded and initiated with previous code in the print registers an incorrect title may result.

The moral of this story is that if your program needs a particular register to be zero then the program should put it there. One way to avoid the major problem (that due to a non-zero t register) without adjusting the absolute addresses in the 598-TEST-1 program is to change the CMS at step 032 to a CP. I have not received permission to publish the complete 598-TEST-1 program. I will try to obtain that permission in time for the next issue.

PPX 908175, Memory Malfunction Diagnostic, is a thirteen page discussion of the 598-TEST-1 program and the extended diagnostic program. It includes listings for both programs, descriptions of the methods and limitations, a sample problem which simulates the output for a malfunctioning calculator by stopping the program half-way through and storing incorrect values in selected locations, and the printout from a defective calculator. If you would like a copy send two dollars. No checks, please.

SURVEY-6 WILL NOT SUPPORT THE TI-95 - Based on two sources of information V13N1P4 reported in late 1988 that a surveying module was available for the TI-74, and would be available in the near future for the TI-95. Recently Kenneth Wassall tried to order the TI-95 module. The developer of the module stated that "... I may get around to putting Survey-6 over to the TI-95 platform, but I could not promise when."

CAN YOU MAKE A CALCULATOR TAPE WITH THE TI-74? - Old-timers will recall that it was possible to generate a running tape of calculations with the TI-59 and PC-100 by operating in TRACE mode. You can do the same thing with a TI-95 and PC-324. Jim Nugent asks: "Does anyone know how to print a running tape while in the calculator mode with a TI-74?" If there isn't an easy way to do this, will anyone write a program to do that?

PROBLEMS WITH THE PROGRAM DOCUMENTATION IN THE KOLB BOOK

V13N2P4-6 reported that the "Multiple Curve Fitting Program for the TI-59" in Kolb's *Curve Fitting for Programmable Calculators* contained an inadequacy in the linear/hyperbolic program. A corrected program was published and a corrected table of data register useage was made avaialble for a nominal fee. Now it turns out that there are inadequacies in the instructions as well. Robert Cruse writes:

> "I purchased the curve fitting book (3rd edition) by Kolb. I have two TI-59 calculators and could not get your Multiple Curve Fitting Program for the TI-59 to work on either device. ..."

I reviewed the user instructions on page F-4 of the Kolb book and found the following errors:

> The response to step 1 is a "0" in the display and a printout of the prompt "ENTER DATA" on one line and "X R/ S Y R/S" on the next.
>
> The display in response to the Y entry in step 3 does not include the value of y as indicated in the column headed "DISPLAY". Rather, the calculator stops with the point number in the display after printing the point number and entered X and Y values with annotation.
>
> With a printer the complete output is printed in step 8 without additional R/S input from the keyboard. Without a printer, the calculator stops after step 8a with the curve number of the best fitting curve (i) in the display. You must press R/S to see the coefficient of determination. Then you must prss R/S two more times as in steps 8b and 8c to see the coefficients.
>
> For the polynomial curve fit (steps 12 to 15) and the linear/hyperbolic curve fit (steps 17 to 20) you must press R/S to cycle through the results, even with a printer.

```
ENTER DATA
   X R/S        Y R/S

        1.
        5.          X
       21.          Y

        2.
       10.          X
       12.          Y

        3.
       15.          X
       15.          Y

        4.
       20.          X
       21.          Y

        5.
       25.          X
       28.          Y

     *BEST FIT*

        3.
    Y = A +BX²
 .5223502883        R²
14.31176471          A
.0185026738          B

   Y = AX² + BX +C
0.916449086         R²
        0.1          A
-2.539999999         B
29.99999999          C


   Y = A  +BX +C/X
.9999382074         R²
-23.62839986         A
1.781335217          B
178.5588131          C
```

Mr. Cruse continued on to ask for example outputs. The printout at the right is taken from the example which accompanies the discussion of the "Linear/Hyperbolic" curve fit on page 33 of the 2nd edition of the text. First, I entered the five points. Second, I performed the "Best Fit" search which indicated that the quadratic curve (3) was the best fit, but the coefficient of determination was not very good. Third, I tried the parabolic curve to see a substantial improvement in the coefficient of determination. Finally, I tried the linear/hyperbolic curve and received results which compare very well with the answers in the text for that function.

32K CAPABILITY IN THE TI-74 - V13N4P25 reported that a 32K RAM capability was available from TI for special applications but was not yet available to the public, and that for most TI-74's in circulation it would be necessary to load a special MEMADD subprogram prior to use of the 32K module. Robert Prins writes that there is an easy test to determine if your TI-74 has a built-in 32K capability. Go to the calculator mode and look at the separator line. If it is a single pixel wide you will need the MEMADD subprogram. If it is three pixels wide you have the capability built in.

A FINAL SMALLEST CIRCLE PROGRAM? - V13N4P14-16 presented Carl Rabe's revision of earlier smallest circle programs which provided increased speed. The discussion noted that that program sometimes used more cycles (and time) than would be expected due to interaction of truncation errors with comparison tests. After some letters had passed between Carl, Don Laughery and the editor we realized that the truncation problems occurred when points which had been used to define the circle were tested against the circle. Carl revised the program and wrote:

"I used the approach you suggested of setting a screen to keep the points used in the subset from entering into the calculation that checks for points outside the circle determined by the subset. Actually, when I finally hit on how to do it, it was quite simple and didn't require much modification to the program. Probably, best of all, it eliminates any need to do any truncating, which was a sort of messy thing at best.

While reworking to set the screen I noticed that the way I had the main computing section set up there was a lot of unnecessary cycling back and forth between two arrays. I eliminated this and did away with one set of arrays entirely. I believe this has caused the marked improvement in operating speed. As an example of that consider the time for running the "canned" eleven point test data: in the version with the program in V13N4P14 it finishes in 47 seconds; with this version it comes through in 38 seconds."

There was little change in lines 10-470 from earlier programs. Notice that the delimiters at line 135 are now null strings "" rather than 999's.

Lines 475-715 are the main computing section. Notice that in lines 505, 525, 530, 555, 590, 595, 600 and 685 the X and Y arrays are now XX and YY. These are the subset variables and begin with the first four points from the original sorting, and are added to with the new points found outside the circle on each cycle.

Lines 720-780 are the test section. LIne 740 tests if a point is outside by checking D2 against M2. If D2 is greater then in lines 740 through 770 the X and Y values for that point are exchanged for the fifth position of the main arrays. The values are placed at the front of the main arrays so that in line 730, when each testing cycle starts, (Fac+1) acts to begin at the next point in the main array after the values used in the subset. The result is that points of the subset are not tested. This saves operating time and avoids bogus values for D2 being used and causing unnecessary cycles.

```
SMALLEST CIRCLE
# 1 X= 9.8      Y= 3.9
# 2 X= 6.1      Y=-9.8
# 3 X= 11.3     Y= 2.1
# 4 X= 8.4      Y=-8.3
# 5 X=-9.8      Y= 7.5
# 6 X= 5.5      Y= 13.9
# 7 X= 5        Y= 8.7
# 8 X= 9.6      Y= 8.1
# 9 X= 16.5     Y= 1.1
# 10 X= 11.8    Y= 12.5
# 11 X=-9.8     Y=-7.2
NUMBER OF CYCLES: 3
PAIRS FINAL COMPUTE: 6

 H =  1.84275743
 K =  1.725961397
 R =  14.67060283
DIA=  29.34120566
```

The program listing appears on page 23. A sample printout for the "canned" problem appears at the right.

TI-59's AND PC-100 FOR SALE - Syd Spain reports that he has the following hardware for sale: "... two TI-59's with cases, a TI-58, a PC-100C printer with cover and two rolls of paper, two Master Library modules, a Real Estate module, a Surveying module and extra magnetic strips. All work well and are in very good condition (the TI-58 is in average condition) but the card readers have become more obstinate in recent years on the TI-59's. ..." He will sell the lot for $99.00 . You can write to him at the School of Architecture, Auburn University, AL 36849-5313 or call him at (205)-844-4524.

A Final Smallest Circle Program? - (cont)

Program Listing:

```
10 A$="   SMALLEST CIRCL
E":PRINT A$:PAUSE 1
15 !FROM PPC NOTES V13N2
P15
20 !MODIFIED 12/18/89 C.
RABE
25 DIM X(52),Y(52),XX(21
),YY(21)
30 INPUT "USE PRINTER? Y
/N ";Z$
35 IF Z$="Y"OR Z$="y"THE
N PN=1 ELSE 80
40 !PRINT "PRINTER NUMBE
RS:":PAUSE 1
45 !PRINT "FOR THE HX-10
00 ENTER 10":PAUSE 1
50 !PRINT "FOR THE PC-32
4 ENTER 12":PAUSE 2
55 !INPUT "ENTER PRINTER
 NUMBER ";D$
60 D$="12"
65 OPEN #1,D$,OUTPUT
70 IF D$="10"THEN PRINT
#1,CHR$(18)
75 PRINT #1:PRINT #1,A$
80 INPUT "USE CANNED DAT
A? Y/N: ";ZZ$
85 IF ZZ$="Y"OR ZZ$="y"T
HEN 90 ELSE 140
90 FOR I=1 TO 51
95 READ X$,Y$
100 IF X$=""OR Y$=""THEN
 265
105 X(I)=VAL(X$):Y(I)=VA
L(Y$):N=N+1
110 NEXT I
115 DATA 9.8,3.9,6.1,-9.
8,11.3,2.1
120 DATA 8.4,-8.3,-9.8,7
.5,5.5,13.9
125 DATA 5,8.7,9.6,8.1,1
6.5,1.1
130 DATA 11.8,12.5,-9.8,
-7.2
135 DATA "",""
140 INPUT "USE RANDOM PA
IRS? Y/N:";ZZ$
145 IF ZZ$="Y"THEN 150 E
LSE 205
150 INPUT "NUMBER OF PAI
RS?: ";N
155 PRINT "LOADING ARRAY
$..PLEASE WAIT"
160 FOR I=1 TO N
165 RANDOMIZE
170 X(I)=(RND*2-1)/100
175 RANDOMIZE
180 Y(I)=(RND*2-1)/100
185 X(I)=INT(X(I)*10000)
/10000
190 Y(I)=INT(Y(I)*10000)
/10000
195 NEXT I
200 GOTO 265
205 PRINT "ENTER INPUT X
 & Y VALUES":PAUSE 1
210 PRINT "(TO END INPUT
 ENTER A NULL)"&CHR$(255
):PAUSE 1
215 N=1
220 X$="X = "
225 Y$="Y = "
230 INPUT X$;XX$:IF XX$=
""THEN 260
235 INPUT Y$;YY$:IF YY$=
""THEN 260
240 X(N)=VAL(XX$)
245 Y(N)=VAL(YY$)
250 IF PN=0 THEN 255
255 N=N+1:GOTO 230
260 N=N-1
265 PRINT "NUMBER OF DAT
A PAIRS IS:";N:PAUSE 1
270 INPUT "WISH TO RECHE
CK INPUT? Y/N:";ZZZ$
275 IF ZZZ$="Y"OR ZZZ$="
y"THEN 280 ELSE 320
280 FOR I=1 TO N
285 PRINT "PAIR#";I;"  X
:";X(I);" Y:";Y(I):PAUSE
290 NEXT I
295 INPUT "CHANGE AN INP
UT? Y/N:";ZZ$
300 IF ZZ$="Y"OR ZZ$="y"
THEN 305 ELSE 270
305 INPUT "WHICH PAIR #
?: ";I
310 INPUT "ENTER NEW X:"
;X(I)
315 INPUT "ENTER NEW Y:"
;Y(I):GOTO 295
320 IF Z$="Y"OR Z$="y"TH
EN 325 ELSE 340
325 FOR I=1 TO N
330 PRINT #PN,"#";I;"X="
;X(I),"Y=";Y(I)!:PAUSE
335 NEXT I
340 PRINT "NOW SORTING .
.PLEASE WAIT":PAUSE 1
345 TOTAL_N=N
350 FAC=4
355 IF FAC>=N THEN FAC=N
:GOTO 460
360 PSN,I=1:LOWX=X(I):PT
R=0
365 FOR I=I TO N
370 IF X(I)<LOWX THEN LO
WX=X(I):PSN=I
375 NEXT I
380 CALL PLACE(X(),Y(),P
SN,PTR)
385 PSN,I=2:HIX=X(I):PTR
=1
390 FOR I=I TO N
395 IF X(I)>HIX THEN HIX
=X(I):PSN=I
400 NEXT I
405 CALL PLACE(X(),Y(),P
SN,PTR)
410 PSN,I=3:LOWY=Y(I):PT
R=2
415 FOR I=1 TO N
420 IF Y(I)<LOWY THEN LO
WY=Y(I):PSN=I
425 NEXT I
430 CALL PLACE(X(),Y(),P
SN,PTR)
435 PSN,I=4:HIY=Y(I):PTR
=3
440 FOR I=I TO N
445 IF Y(I)>HIY THEN HIY
=Y(I):PSN=I
450 NEXT I
455 CALL PLACE(X(),Y(),P
SN,PTR)
460 FOR I=1 TO FAC
465 XX(I)=X(I):YY(I)=Y(I
)
470 NEXT I
475 CYCLES=CYCLES+1
480 PRINT "CYCLE:";CYCLE
S;"/ PAIRS THIS CYCLE:";
FAC
485 N=FAC
490 M1=0
495 FOR I=2 TO N
500 FOR J=1 TO I-1
505 D2=(XX(I)-XX(J))*(XX
(I)-XX(J))+(YY(I)-YY(J))
*(YY(I)-YY(J))
510 IF D2>M1 THEN M1=D2:
S=I:T=J
515 NEXT J
520 NEXT I
525 HH=(XX(S)+XX(T))/2
530 KK=(YY(S)+YY(T))/2
535 M2=M1/4
540 Z=0
545 FOR I=1 TO N
550 IF I=S OR I=T THEN 5
65
555 D2=(XX(I)-HH)*(XX(I)
-HH)+(YY(I)-KK)*(YY(I)-K
K)
560 IF D2>M2 THEN M2=D2:
Z=1
565 NEXT I
570 IF Z=0 THEN 720
575 FOR I=N TO 3 STEP -1
580 FOR J=(I-1)TO 2 STEP
 -1
585 FOR L=(J-1)TO 1 STEP
 -1
590 A=XX(I):B=YY(I)
595 C=XX(J):D=YY(J)
600 E=XX(L):F=YY(L)
605 A=A-E:C=C-E
610 B=B-F:D=D-F
615 G=C*B-A*D:G=G+G
620 IF G=0 THEN 705
625 H1=C*C+D*D
630 X1=B:B=H1
635 B=X1*B:H1=A*H1
640 X1=X1*X1+A*A
645 D=X1*D:C=X1*C
650 B=B-D:C=C-H1
655 B=B/G:C=C/G
660 E=E+B:F=F+C
665 R2=B*B+C*C
670 H=E:K=F
675 FOR M=1 TO N
680 IF M=L OR M=J OR M=I
 THEN 695
685 D2=(XX(M)-H)*(XX(M)-
H)+(YY(M)-K)*(YY(M)-K)
690 IF D2>R2 THEN R2=D2
695 NEXT M
700 IF R2<M2 THEN M2=R2:
HH=H:KK=K
705 NEXT L
710 NEXT J
715 NEXT I
720 N=TOTAL_N
725 CNT=0
730 FOR I=(FAC+1)TO N
735 D2=(X(I)-HH)*(X(I)-H
H)+(Y(I)-KK)*(Y(I)-KK)
740 IF D2>M2 THEN CNT=CN
T+1:FAC=FAC+1:XX(FAC)=X(
I):YY(FAC)=Y(I) ELSE 775
745 TEMPX=X(FAC)
750 TEMPY=Y(FAC)
755 X(FAC)=X(I)
760 Y(FAC)=Y(I)
765 X(I)=TEMPX
770 Y(I)=TEMPY
775 NEXT I
780 IF CNT<>0 THEN 475
785 PRINT "   SOLUTION C
OMPLETED. ":PAUSE 2
790 PRINT #PN,"NUMBER OF
 CYCLES: ";CYCLES:PAUSE
795 PRINT #PN,"PAIRS FIN
AL COMPUTE:";FAC:PAUSE
800 PRINT "   CIRCLE DAT
A FOLLOWS":PAUSE 1
805 PRINT #PN:PAUSE ALL
810 PRINT #PN," H = ";HH
815 PRINT #PN," K = ";KK
820 PRINT #PN," R = ";(S
QR(M2))
825 PRINT #PN,"DIA= ";(S
QR(M2))*2
830 IF PN=1 THEN PRINT #
1
835 PAUSE 0
840 PRINT "PROBLEM COMPL
ETED":PAUSE 1
845 SUB PLACE(X(),Y(),PS
N,PTR)
850 PTR=PTR+1
855 TMPX=X(PTR)
860 TMPY=Y(PTR)
865 X(PTR)=X(PSN)
870 Y(PTR)=Y(PSN)
875 X(PSN)=TMPX
880 Y(PSN)=TMPY
885 SUBEND
890 END
```

MORE ON HITCHHIKING - V13N4P9 reported that Robert Prins had set a hitchhiking record for the most miles in any 24-hour period. Robert writes that a later accomplishment, 2318.4 kilometers (1440.6 statute miles) in 24 hours will be included in the next issue of the *Guinness Book of Records* unless someone submits a better claim before mid 1990.

MORE ON USING FUNCTION KEYS in TI-95 PROGRAMS - R. Prins

The discussion on page 14 notes that the Yes/No test does not respond to either F1 (YES) or F2 (NO) in a program. Robert writes: "The solution can be found in Appendix C of the *TI-95 Programming Guide*" by combining data from pages C-6, C-8 and C-18. On page C-6 you can find a table of codes returned by the key wait <KW> function, on page C-8 you can find the function of flag 55, and finally, on page C-18 you can find that byte 0025 contains the current key code (which is the code of the last key pressed). Combine the information on these pages and insert the code

```
      3   Keycode for F2
STB 0025  Make it the last keycode
   SF 55  Tell SBA 236 to skip the wait-for-a-key-to-be-
          pressed loop, and use the previous key instead.
```

immediately after LBL MC in the program on page 14."
It works, as they say, like a charm.

```
0000 LBL XX 24637 STO A
0010 `MTH` RUN SBR IND A
0017 4 F1 F2 4 STO 049 5
0025 0 STO A
0028 LBL MA 4 STO 048
0035 LBL MB RCL IND A F1
0042 5 ST+ A DSZ 048
0048 GTL MB 19 ST- A
0055 DSZ 049 GTL MA F3
0062 F2 4 STO 049 54
0069 STO A
0071 LBL MC 3 STB 0025
0078 SF 55 RCL IND A F1
0084 5 ST+ A DSZ 049
0090 GTL MC DFN CLR ADV
0096 CLR RTN
0098 LBL YY 31 STO A 4
0106 STO 049
0109 LBL MD RCL IND A
0115 BRK INC A DSZ 049
0121 GTL MD CLR RTN
```

Robert has also found a way to generate hex code subroutine addresses in user programs. This should allow users to replace sequences such as the 24637 STO A 'MTH" RUN SBR IND A in this program with the shorter, and clearer, 'MTH' RUN SBR 603D. I managed to generate the addresses, but was unable to get the program to run with them in place. More on this next time.

A SOURCE FOR USED BOOKS - Bill Wilburn asked if I had copy of *Personal Programming*, the manual for the TI=59, for sale. I did not and suggested that he call TI. He called 1-800-TI-CARES and obtained the price for a new book (yes, they still have them) of $12.95 plus $3.00 for postage. Then, he found a used copy in a bookstore for only $3.00 ! For the benefit of members on the west coast who need used technical books the bookstore is "Acres of Books", Inc., 240 Long Beach Blvd., Long Beach CA 90802. Telephone 437-6980.

A HOLDER FOR HP PAPER ON THE PC-324 - The discussion of the use of H-P paper in the PC-324 on page 13 notes that to conveniently use the H-P paper the user will have to rig up a holding fixture or transfer the paper to smaller rolls. Carl Rabe set up a box to support the paper at the rear of the printer. I have fabricated a wire support which "clamps" over the printer and feeds paper in through a slot cutin the rear of the Pc-324 cover. I used 1/8" diameter piano wire to get sufficient clamping force.