PPX EXCHANGE

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A MAJOR TECHNOLOGICAL ADVANCE in handheld, programmable calculators was introduced May 24, 1977 by Texas Instruments. The newly announced TI Programmable 58 and 59 calculators allow the use of plug-in, interchangeable Solid State Software modules containing up to 5000 steps each. The TI Programmable 59 calculator has added storage for up to 960 program steps or 100 data memories entered from magnetic cards. Also announced was the TI Programmable 57 calculator which has a **single** MOS/LSI integrated chip with the equivalent of over 30,000 transistors and is the single most powerful calculator chip ever produced. Details of these revolutionary new calculators are discussed in this issue of **PPX EXC hange.**

PPX POTPOURRI

By now, you should be aware of the vast selection of programs offered in our March Software Catalog. To lighten the load of wading through all these submissions, we added a Key Word Index to help you find just the "gem" to add to your software collection. For example, when you need to find a program for a Quadratic Regression, rather than search through over 125 pages of possibilities, flip to the Key Word Index in the front of your catalog and find program 209013, Quadratic Regression, listed under either "Quadratic" or "Regression". If you then decide you need a Linear Regression performed, merely look again under "Regression" and find programs 209008 and 200001 which should suit your needs. By utilizing this valuable reference, it is possible not only to find the exact program you need, but to also realize vast time savings.

Another new indexing method included in the March Catalog is the Author Index. Once you have purchased a few programs from the exchange, you soon begin to discover those certain authors who you feel not only provide clear and concise documentation, but are also clearly experts in their particular field. The Author Index enables you to locate additional programs originated by the same author. For example, if after purchasing program 470011, "Specific Volume of Seawater" by George Knapp, you wish to acquire the software to perform the calculation of the potential temperature of seawater, you can turn to the Author Index and find Mr. Knapp's "Potential Temperature of Seawater" program (PPX-52 program number 470009A). Thus author crossreferencing aids you in finding not only the programs you desire, but also those authors you feel you can count on.

OCEANOGRAPHY AND THE SR-52

George P. Knapp

Many people share the romantic view that oceanography consists of calm blue water, tropical sunsets and exotic foreign ports. However, work in the field may involve the day-to-day routine of collection and analysis of samples at sea, a tedious, repetitive process. In addition, for every month of field work the scientist can expect four or more months behind a desk analyzing and reducing the data to a more manageable form. Ultimately this involves the quantitative manipulation of numbers.

At the Woods Hole Oceanographic Institution, the introduction of computer systems has greatly reduced the effort and number of man-hours previously spent in processing these vast quantities of numbers. All three of the Institution's major vessels are equipped with minicomputers, and ashore, computation needs are handled by a large central processing unit. There are times, however, when at sea, the shipboard computer is tied up for navigation purposes, or on-line data collection. It is then that a programmable calculator such as the SR-52 can be used to great advantage. Also, ashore there are times when it is necessary to perform a fairly limited number of repetitive calculations. In these cases it is faster and easier to use the SR-52 than to gain access to a large computer.

In Physical Oceanography, dynamic computation of water movement requires the measurement of temperature and salinity at standard depths (or pressures) in the ocean. From these measurements the density of the seawater can be computed (PPX-52 program numbers 470002A and 470008A). There are currently several accepted equations for the density of seawater, all giving **approximately** the same results. At Woods Hole, the favored equations are that of M. Knudsen developed in 1901, and that of N. P. Fofonoff, developed in 1975. Both of these equations are rather lengthy and involve up to 17 constants. These density calculations become relatively painless with an SR-52. By loading the constants into the SR-52's storage registers and then loading the main program from a second card, the problem is easily solved. Once the density value is known, the specific volume of seawater (PPX-52 program number 470011A) can be evaluated, and thence the Specific Volume Anomaly (PPX-52 program number 470010A).

By comparing Specific Volume Anomalies at a pair of oceanographic stations (separated by a known geographic distance) the magnitude of the average current velocity can be computed. This velocity is that expected at right angles to the plane joining the two stations. An SR-52 program for performing this calculation is currently being developed.

Water, because of its compressibility, is subject to an increase in temperature because of the pressure at great depths. This amount of change in temperature per unit of depth is called Adiabatic Temperature Gradient (PPX-52 program number 470013A). Because of this temperature change, oceanographers are often interested in potential temperature, or the temperature the water **would** be if the effect of pressure was removed from it. This can be calculated directly (PPX-52 program number 470009A) knowing the "in situ" temperature and pressure. In deep ocean trenches where the "in situ" temperature rises with increasing depth, the potential temperature is virtually uniform below the level of the surrounding ocean floor.

The velocity of sound in the ocean varies from 1400-1600 m/sec and is dependent on the temperature, salinity and pressure. Because of this, sound waves tend to be refracted, forming shadow zones and sound channels. Submarines have long taken advantage of these shadow zones, effectively hiding themselves acoustically from a surface vessel. It is now possible to acoustically track submarines from shore-based facilities thousands of miles away using sound channels that focus the sound waves along them. Thus it is important to be able to accurately calculate the speed of sound, given the physical properties of the water. (See PPX-52 program number 470015A.)

The importance of keeping electronics dry while at sea cannot be over-emphasized, and the SR-52 is no exception. Exposure to the salt air should be minimized. It is a good idea to spray the electrical contacts with a cleaner and lubricant designed for such use in marine environments prior to locking the calculator into its print cradle for the duration of the cruise.

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PAPER SALE EXTENDED

Due to the excellent response to the thermal paper sale announced in the March issue of PPX EXC hange, PPX-52 is extending the sale for another month, until June 30. PC-100/PC-100A thermal paper, normally sold at $10.20 for 3 rolls, will continue to be sold to PPX-52 members at half price during this extension period. Once again, thermal paper orders should be limited to a 3 package (9 roll) maximum.

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POLITICAL SCIENCE RESEARCH WITH THE PROGRAMMABLE CALCULATOR

Oliver Benson

The author is a Research Professor of Political Science at the University of Oklahoma and author of a methodology textbook, ***Political Science Labratory****. The programs described in this article will very soon be available through PPX-52.*

Today quantitative research in the social sciences depends heavily on two widely used computer packages—SPSS (Statistical Package for the Social Sciences) and OSIRIS, developed by the University of Michigan and the Inter-University Consortium for Political Research. These impressive software collections emphasize data sorting and nonparametric statistics, especially those designed for nominal and ordinal variables. Additionally, they include multiple regression factor analysis, ANOVA, canonical correlation, and other powerful analytic tools for interval data.

Except for those programs requiring large storage capacity, most of the statistical routines in SPSS and OSIRIS can be adapted for the SR-52. The individual researcher may also provide his own programs for useful statistics not available in large computer collections. A few examples follow.

1. The **Gini Index** of inequality, as applied in the social sciences, is usually based on from five to 15 segments of population, measuring the degree to which some value (income, land, education, or representation in legislatures) is equally shared. The SR-52 can be programmed to array up to 19 segments by magnitude of slope, compute the coordinates of the Lorenz curve, and calculate the index.

2. **Multiple regression and correlation.** For four variables, a four-card program will produce R**2, zero-order and partial coefficients, beta weights, and coefficients of separate determination, as well as the regression equation. While it is true that SPSS and OSIRIS will handle many more variables, there are many individual projects for which four variables are adequate. Parsimony in eliminating those variables of lesser impact or those which are collinear with a few significant variables can often reduce the data set to four.

3. For a number of statistics designed for cross-tabulations of nominal or ordinal data, large computer packages omit tests of significance, since special formulas for the standard errors are required. A single confidence table is not possible since values vary with cells, marginals or both. This is true of **Goodman and Kruskal's Lambda and Tau** for nominal data, and of their Gamma and Somers'd for ordinal data. With a little effort, the SR-52 user can program formulas for these standard errors to produce values which may be entered in the normal distribution program (PPX-52 program number 269015) to obtain the significance levels.

4. **Fisher's exact test** for 2 x 2 tables is described in almost every statistics textbook but rarely used since it requires successive iterations of a formula containing nine factorials. For a table with cells, a,b,c,d, marginals e,f,g,h, and total N, the Fisher value is (e!f!g!h!) - (N!a!b!c!d!), a computation which must be repeated and summed for all possible combinations of cells yielding a result as small or smaller. Neither SPSS nor OSIRIS presently offers the Fisher test, though SPSS uses a one-tailed version for 2 x 2 tables with N less than 21. It is available from PPX, with both one-tail and two-tail values, for N below 70 and for certain tables with a larger N (PPX-52 program number 220023).

Size of data sets remains the principle limitation when using a programmable calculator. For largescale team research projects with data input of hundreds or thousands of cases, the computer remains indispensable. Within limits, however, the SR-52 can serve as a counter-sorter for cross-tabulations of data. For example, if the three dichotomous variables each have categories coded 1 or 2, it is easy to program the sorting and counting of the eight combinations 111, 112, 121, 122, 211, 212, 221, 222 in 13 storage-register count-boxes (four for the four cells of the source table, four for each of the two partial tables, and one for the grand total). With the PC-100, the input may be proofread for accuracy. Similar sorting of interval data is possible with routines like the ten-column histogram program described in the SR-52 Owner's Manual (pages 120-124).

The computer will certainly remain the principal computational resource for large research projects in political and social science. However, for the individual researcher, until recently at the mercy of expensive computer time, grant funding, and organizational obstacles, the programmable calculator offers endless opportunities for worthwhile small projects which can be processed with all the statistical sophistication desired.

CALCULATOR DOCTOR

This column is intended to answer frequently occurring questions relating to either SR-52 operation or programming. These questions are obtained from TI's Consumer Relations Department. If you are having difficulty with your calculator or with programming, please contact TI's Consumer Relations Department for assistance.

Question: In my line of work, it is often necessary to analyze large amounts of data, with well over 20 entries for each analysis. "Hand-cranking" the data is cumbersome at best, so that a programmable is ideal for this application. Is there any way to extend the memory on the SR-52 to enable usage of more than 20 data memories?

Answer: Yes, by utilizing program memory for data storage, you can increase the number of data registers at a 1 for 8 tradeoff: 1 data register for each 8 program steps sacrificed. These locations, registers 70 through 97, are not affected by the CMs function, but are destroyed if a magnetic card is read into the machine. You can also use registers 98 and 99, not affected by the CMs or by the input of a magnetic card. These memories increase the storage capacity of the SR-52 to 50 data memories.

Ten more registers are available, but are risky to use. Locations 60 through 69 are normally used as the "stack" to keep up with the pending operations. They are cleared by the use of the clear key, and are therefore easily destroyed. Also as arithmetic operations are performed, numbers are "pushed into the stack" and actually replace the contents of these memories. Using these memories will increase data storage to its maximum: 60 data registers.

It is also possible to use the Data 1/0 (PPX-52 programs 900006 and 900007) capabilities of magnetic card storage to "increase" the memory size. Using a programmed read statement makes this method not only easy but also desirable from the standpoint of the portability of the data base.

Texas Instruments does not support physical modification of the SR-52 to extend memory capability but as illustrated above, this is not really necessary.

Question: With almost any precision instrument, regular, periodic maintenance is required to maintain top operating efficiency. Are any such "tune-ups" necessary for the SR-52, such as oiling, realignment, etc.?

Answer: No periodic maintenance is needed on the SR-52 with the exception of the **infrequent** use of the read/write mechanism head cleaning card. (Note however, that too frequent use of this card may cause permanent damage to the head.)

Question: I recently purchased a PC-100A printer and noticed that the selector switch has three positions: "SR-52", "SR-56", and "Other". What is the "Other" position for and what other differences are there between the PC-100A and the PC-100?

Answer: The "Other" position is for the new TI-59 and 58 Programmable series, which require different hardware for their output to the printer. This different hardware, included in the PC-100A and not the PC-100, is activated by the "Other" position of the switch. The only other difference between the PC-100A and the PC-100 is the on-board battery charger of the PC-100A. PC-100's cannot be modified to the

equivalent of a PC-100A, and Texas Instruments does not plan to make such conversions.

NEW PROGRAMMABLES ANNOUNCED

Texas Instruments announced a revolutionary line of programmable calculators on May 24, 1977 in New York City. Featuring plug-in, Solid State Software libraries, the TI Programmable 58 and 59 bring significant additional program memory capability and programming flexibility to advanced students and professionals in business, engineering and science. These library modules contain up to 5000 prerecorded program steps in each of the areas of Surveying, Marine Navigation, Aviation, Real Estate/Investment, and Applied Statistics. At the heart of these modules is an advance in state-of-the-art technology which enables **one** ROM (Read Only Memory) to contain over 20 library programs. These programs are accessible to the user with only 4 keystrokes in the calculate mode or can be accessed as subroutines from a user written program with only two steps of program memory required. A master library module encompassing math, statistics, finance and general interest subjects is packed with each TI58 and TI59.

A few new features have been added to the Programmable series. All now have Pause, Integer, Absolute Value, Mean (two variables), Data Assimilation, and No-Operation functions. The 58 and 59 also include Engineering notation and a Clear Program function in addition to the standard Clear Memories. Including the above, there are over 175 Programmed functions in the TI-58 and TI-59.

When attached to the PC-100A printer, the TI-58 and TI-59 become the most powerful handheld calculators on the market. Using special predefined operation (op) codes, the PC-100A can prompt, print alphabetic messages (20 characters per line), plot graphs, and print the display contents plus a 4 alpha character descriptor. These characters are obtainable **only** on the PC-100A. The contents and the number of each register and/or a list of all labels may also be printed from memory.

Both new programmables have up to 10 registers available for DSZ looping, (increment, and decrement) and also 10 user flags. Up to six levels of subroutines are available and four types of display testing with an independent test register, similar to that used in the SR-56. The Algebraic Operating System (AOS)™ is also standard on both calculators.

- The TI-58, which does not contain a card reader, can be used with up to 480 program steps or up to 60 data memories, with user partitioning.

- The TI-59 allows up to 960 program memory steps or up to 100 data registers and 160 program steps. The programmer can partition the memory in a way that is most beneficial to him. All 960 steps can be recorded on two magnetic cards, similar to, but not interchangeable with, those used on the SR-52. However, unlike the SR-52, write enable tabs are not required, and there is a "protected write mode" for proprietary software, preventing user access to the program memory.

TI-59 users will be invited to join PPX-59, which will act as an interface between program originators and program users. PPX-59 will provide services similar to those currently provided to PPX-52 members.

WATER SKIING & THE SR-52
Mike Marquis

The SR-52, with its many transcendental functions, conditional branches and sophisticated memories, seems destined for the engineer's desk or scientist's table exclusively. But these same features also liberate the calculator from the fluorescent environs of the professional to the sunshine world of competitive water skiing. Competitive water skiing, like many other sports, involves speed, distance and scoring. Since the interrelation of these are mathematical in nature, the SR-52 can prove to be a valuable asset to the tournament water skier.

In water skiing tournaments, a skier must ski in three different events (slalom, tricks and jump) to be eligible for the overall trophy. Each event is markedly different from the other two. In slalom, the skier runs a zig-zag course around six orange buoys at ever increasing speeds until he misses or falls. His final score is the cumulative total of consecutive buoys he negotiated. The trick event is characterized by spinning and hopping maneuvers, each with its own predetermined point value. The skier has two 20-second opportunities to perform as many tricks as he is capable of. His score is the sum of all individual tricks completed. Distance is the name of the game for the water ski jumper, and it also is the measure of the jumper's final score.

Not only are scores in each event determined differently, but they also vary over a wide numerical range; for example, typical scores for world class competition could be: 51 buoys (slalom), 5350 points (tricks) and 47 meters (jumping). The method used to combine these three events equitably is to take the ratio of each score with an accepted standard score and multiply by 1000. In the case of jumping, the ratio is **squared** before multiplying to increase sensitivity. Previously the common way to calculate a skier's overall point standing was by the use of tedious look-up tables. Now, however, the SR-52 can easily calculate the exact score with a simple program much faster than the best scorekeeper can page through a scoring booklet. Furthermore, with the PC-100, permanent records can be kept.

As mentioned earlier, "distance is the name of the game for the water ski jumper," and measuring distance over a body of water by direct means is inconvenient, at best. This difficulty has led to an indirect measuring method using two or three shore-based observation stations and a scaled-down map of the jump site called a "master board". Each station sights in on the skier's touchdown points and reports his line of sight as an angle to the officials running the "master board". The officials then reconstruct the intersecting lines of sight on the master board and measure the scaled distance. The SR-52 can convert the reported angles to correct jump distances in a matter of seconds. All that is necessary is that a few preliminary measurements be stored in the SR-52, and the appropriate PPX-52 program be loaded. Category 98 of the PPX-52 catalog describes just a few of the ways the SR-52 can be used in the unexpected field of competitive water skiing.

MORE USER DEFINED KEYS
David M. Brender

In many applications, the large number of variables required prevents the use of the SR-52, due to a shortage of user defined keys. However, by using one of the following two separate methods

1. Increase the absolute number of keys
2. Increase the number of single-stroke accessible subroutines

it is possible to incorporate all of these variables into an SR-52 program. In both applications, the small additional amount of program memory required for this expanded capability is far outweighed by the advantages accrued.

- The principle gain of the first method is that the user can distinguish two sets of programs that are normally used together, a very common occurrence. This scheme requires that two (or more) programs be connected to each of the keys A through E, while letting key *A' control a flag which determines which set of programs is to be used. Once *A' is pressed, any combination of subprograms A(1) through E(1) can be executed via single keystrokes. Along the same lines, once INV *A' is pressed, any combination of programs A(2) through E(2) are now available through single keystrokes. For the control key, the implementation is: *LBL, *A', *ST Flag, 0, *RTN. If program space is scarce, the flag could be manually set and reset. For each key, the sequence would be similar to the following: *LBL, A, *If flag, 0, *1' (enter A2 commands), *LBL, *1', (enter A1 commands).

  The logic is similar for B, C, D, and E. At any time, a program from the opposite set can be executed by exactly two keystrokes, e.g., INV, B, without altering the existing set status. This is a real convenience!

- The second method expands the number of SR-52 variables by increasing the number of directly accessible subroutines. For each key A through *E', the implementation is as follows:
  *LBL, C, *If flag, 9, *3', (enter C commands)
  *LBL, *3, (enter INV C commands).
  Flag 9 is always in the zero (reset) state because this flag does not exist. (No error condition is caused.) Pressing C will activate the C

commands, as usual. Pressing INV C directs program flow to *LBL *3', where the INV C commands are, since INV C is logically equivalent to INV if flag 9. (Note that *3' or any label can be replaced with an absolute address.)

If program space is very limited, the above can be replaced by:
*LBL, C, *If err, *3' (enter C commands)
*LBL, *3', (enter INV C commands)
However, on those occasions when C is activated automatically by the program, an earlier error condition can act to misdirect program flow. Thus a disadvantage of this spacesaving scheme is that it does depend upon the existing (non-error) status for execution.

FROM THE ANALYSTS' DESK

1) The advent of "fractured displays" on the SR-52 has caused quite a "shake-up" here on the analysts' desks. "Fractured displays" are displays which incorporate anything other than a numeric character in its normal position (degree signs, leading zeros, spaces, etc.). The high PPX-52 request rate of programs such as "Degree-Minute-Second Display", and "Yahtzee" indicate a great deal of interest in something other than numeric displays—something with a little "pzazzz". We would therefore like to let you know a few facts concerning these unusual characters.

The basis of a fractured display is a so-called "mask" made up of various codes, which can be stored in program memory. Depending on the digits in the register, various types and combinations of displays can be created. The first process is to choose the mask codes to be used and store them in the register or to place them in the display. Twos cause a second symbol (") to appear in the display, while fours cause minute symbols ('), five degree symbols (°), threes and sevens — blanks, and sixes produce dashes or minus signs (-). The easiest way to store these numbers, for example in register 70, is to reset the program counter to 000, enter learn mode, and push the appropriate keys to cause the correct sequence to appear in register 70. For example, to enter 2.222222222 22, push *rset LRN INV INV INV INV INV INV INV INV LRN. Because the code for INV is 22, register 70 will be filled with twos. This process insures that the desired numeric mask codes are present in all positions of the display register, i.e., guard digits. Now that the mask has been chosen, producing a fractured display is relatively easy. Place the mask code in the display (in this example, by recalling register 70), enter an operator (+, -, x, -, $\sqrt[x]{y}$, y^x) and then a display-to-memory function on register 60 (SUM, PROD, STO, EXC, INV SUM, INV PROD). Enter the number to be fractured, press =, and be prepared for a shock as the display becomes "fractured" before your eyes. To change the mask, merely reset, enter LRN mode, enter the new mask codes, and perform the above procedure again. "Fractured" displays can be created in the calculate mode in a similar fashion, however, it is difficult to completely fill the display register in this mode.

"Fractured displays" are unprintable and any following operation will cause the fractured display to be destroyed. We suggest that you experiment with this procedure a little as the results are sometimes unpredictable, but always enjoyable. (For example, entering "23" op codes, produced from the 1nx key, into register 70 and attempting to fracture the display will cause a total wipeout, similar to that produced by 1, +/-, +, SUM 60, =).

2) Some of our members have expressed interest in the "secret" we used to produce the listing of the programs from the Games, Aviation, Navigation, and Surveying Libraries. The characters in these listings are in the dot-matrix format typical of a thermal printer, but they differ from PC-100 or PC-100A listings in that they include the keystrokes as well as the op codes. Our "secret" is really no secret at all: we used a program written for our desk-top programmable, the SR-60. The SR-60 features, among other things, alpha-numeric prompting display and printing capabilities. The suggested retail price of the SR-60 is $1995. (See announcement about alpha listing capability of the PC-100A with TI's new programmables discussed in this issue of PPX EXC hange.)

3) Several members have inquired as to TI publications that would help in programming the SR-52. Aside from the Programming Workbook, available through PPX-52 for $4.95, and of course the Owner's Manual, no such publications are available at this time. Although the following books were not written specifically for the SR-52, they are of a general enough nature to prove useful to most calculator users.

- "The Great International Math on Keys Book" is a good reference for those easily forgotten high-school math formulas. Includes keystroke sequences for the TI-30/SR-40. This book sells for $4.95.

- "Calculating Better Divisions" includes various statistical and financial math formulas, with keystroke sequences for the SR-51 family of calculators. This book costs $4.95.

- "SR-52 Troubleshooting Guide" contains information relating to SR-52 hardware. This includes waveforms, timing diagrams, and block diagram schematics of the calculator. It is invaluable to those persons with an Electrical Engineering background who wish to know more about the exact operation of their SR-52 personal programmable calculator. These books are not available through PPX-52, but can be ordered by writing to Texas Instruments, P. O. Box 53, Lubbock, Texas 79408. Please add $1.00 for shipping and handling when ordering one or more books, and include sales tax if applicable. (We are obliged to collect local and state taxes in all states except Alaska, Montana, New Hampshire and Oregon.)

4) In addition to the new programmable series, TI recently announced another new calculator which will be especially useful to programmers and others who work with computers. Called the **TI Programmer,** this latest innovation from Texas Instruments will convert numbers entered in decimal, octal, or hexadecimal to any of the other bases instantly. It also features all of the arithmetic operators and includes AND, OR, exclusive OR, and SHIFT functions. All operations can be mixed or grouped using parenthesis keys.

Among typical applications, the TI Programmer will convert memory addresses to decimal form, add relative addresses to a base address to find specific computer memory locations, or determine if there is enough space in the computer's memory to hold a block of data. The TI Programmer represents negative numbers by their two's complement form in hexadecimal and octal bases. A one's complement key is also provided. A constant mode can be used for all kinds of repeated arithmetic and logical operations. Other useful features include parentheses and a three key memory with store, recall and sum-to-memory.

The calculator is being marketed initially on a direct-mail basis from Texas Instruments for $49.95 plus applicable sales tax. Additional information for ordering purposes may be obtained by writing to TI Programmer, P. O. Box 53, Lubbock, TX 79408.

The PPX Exc hange is published every other month and is the only newsletter published by Texas Instruments for SR-52 owners. You are invited to submit items you feel are of general interest to other SR-52 users. Inputs should be limited to 3 doublespaced typed pages. Please forward your newsletter inputs and any questions to:

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