MAC'S SERVICE SHOP

SELECTING A CALCULATOR

By John T. Frye, W9EGV

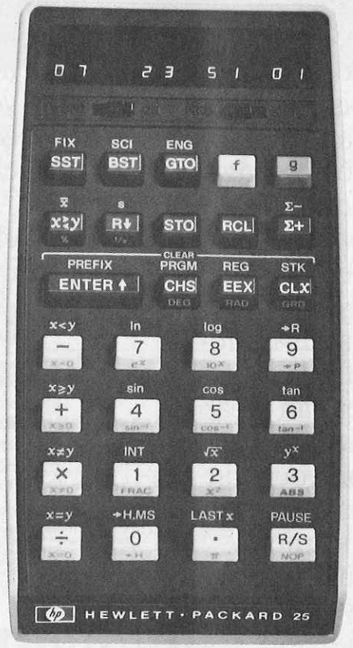
IT WAS late autumn, and TV commercials on the portable color receiver Mac was checking out were frantically hustling both Thanksgiving and Christmas. Heaving a sigh, Mac snapped off the set and remarked, "People are beginning to drive me flakey asking what type of calculator they should buy for a christmas present."

"I know," Barney, the *numero dos* technician of Mac's Service Shop, replied sympathetically. "I'm being shot down with the same question, and it's as tough to answer as that oldy: 'What camera should I buy?' What do *you* tell them?"

"I say it all depends on such factors as: (1) who will use the calculator and for what purpose—and don't forget more than one family member may use it; (2) how much math the user has and whether he intends to study more math; and finally (3) how much the buyer wants to pay. If these factors are considered in depth, a wise purchase can be made."

The Basic Four-Banger. "For instance, let's consider who should buy the basic four-function calculator that adds, subtracts, multiplies, and divides—called a 'four-banger' in the trade—and can be had in a battery-powered form for less than $20. It will do everything an electric adding machine will do except provide hard-copy printout, and it will do it silently, lightning-fast, and every bit as accurately. Every member of the family will find a use for a pocket calculator. The housewife can use it to check grocery slips, work out her budget, and keep household accounts. Dad will use it to balance his checkbook, do his income tax arithmetic, and estimate how many cubic yards of concrete he needs for a new patio or squares of roofing for a new roof. The children can use it to check the answers they've worked out for their school arithmetic problems, but I'm opposed to the indiscriminate use of calculators by children who have not completed the eighth grade in school. It's most important they learn to manipulate numbers accurately and confidently with pencil and paper and in their heads before they start leaning on a calculator.

"Actually the basic calculator has a lot going for it besides mere price. The simplicity of the keyboard allows for large, well-separated keys that encourage the learning of touch operation for greater speed and accuracy—something much more difficult with a complicated calculator that has 40 or 50 smaller keys crowded into the same area. You use all the keys every day and quickly acquire proficiency and confidence. While you cannot work trigonometric problems or those involving extremely large or extremely small numbers directly, the use of supplementary trig and log tables allows such problems to be handled easily with the aid of the calculator. It does the tedious addition, subtraction, multiplication, and division of multi-digit numbers obtained from the tables. The tables can be used to extract any root of a number or to raise a number to any power. There is, however, a method that will permit the extraction of a square root by a simple calculator without resorting to log tables.



Hewlett-Packard HP-25 programmable scientific calculator.

"While the four-function calculator is sufficient for general family use, the owner of a small business will need a few extras that will run the cost of the improved four-banger up to around $50. One such extra is rechargeable nickel-cadmium batteries so the unit can be operated off these batteries or from the power line. During long hours of continuous operation, as when taking inventory or doing year-end book balancing, power-line operation is preferable; yet battery-operation portability is not sacrified. A percent (%) key that will figure mark-ups or discounts at a single stroke will be a great help. So will a 'constant' or a 'memory' facility. When a problem requires the repeated use of a single constant, you key this in only once and then multiply, divide, add, or subtract with this constant by simply pressing the constant key. A 'memory' allows you to park a displayed number in invisible storage with a stroke of a key for as long as you like; then the touch of another key magically brings it back, over and over again, for use in a problem. This saves having to write down sub-totals and partial answers to problems before proceeding."

"How about a calculator for the high school kid who is wrestling with trigonometry and logarithms?"

Slide-Rule Calculators. "Now you're talking about the so-called 'slide-rule' calculators in the neighborhood of $100. They are intended to do (aside from addition and subtraction), the things you can do with a good log-log-duplex-decitrig slide rule: display common and natural logarithms of any number, square a number or extract its square root with a single key stroke, display the sine, cosine, tangent, or the inverse trignometric functions of any angle, instantly find the reciprocal of a number, display *pi* with the stroke of a special key, raise a number to any power or extract any root of a number—while doing all the things an advanced basic calculator will do. Be warned, however, that 'Slide Rule Calculator' is a very loose term. You can buy slide rules that have six to more than twenty scales, and some so-called slide-rule calculators may have more functions than I have mentioned, but a great many will have far fewer; so *caveat emptor*!"

"I can understand how one of those calculators would see a bright youngster through high school and into college; but if he takes up engineering, business administration, statistical analysis, nuclear physics, or some other course involving advanced math, can he buy a pocket calculator still better suited to his needs?"

"That he can—if he has enough money. You're talking about professional calculators that divide into two broad classes: the *scientific* and *business* types. These instruments sell for $100 and up and they should be selected carefully. Only the user knows his own math background and how much calculator he requires in his study or work. In general, though, it's a good idea for a college freshman to buy all the calculator he can possibly afford. That way he won't outgrow it as he goes through college. Once he has become thoroughly familiar with it and has learned to trust it, it will save much precious time during his hectic college career and will continue to be his strong right arm after graduation."

"What can a professional calculator do that a good slide rule calculator can't?" Barney wanted to know.

"It's not that the professional calculator is capable of doing so much more; it just does it easier and quicker," Mac replied. "The professional calculator is pre-programmed so that one or two key strokes will do what might require a half dozen operations on a simpler calculator. An advanced scientific calculator can convert polar coordinates to rectangular coordinates and vice versa. It can calculate trig functions in any of three angular modes—degrees, radians, or grads—and can convert decimal angles into degrees, minutes, and seconds. It performs metric/U.S. conversions, calculates the factorial of positive integers, and simultaneously calculates the mean and standard deviation of an *x* value. It has several addressable memories instead of only one, and you can do register arithmetic—"

"Hold it!" Barney interrupted. "What does all that mean?"

"It means the calculator has several memories into which you can store constants or other numbers used more than once in a problem and you can call any one of these back at will so that you have to do very little writing down of numbers. What's more, you can directly add to, subtract from, divide into, or multiply the contents of a memory register. This is mighty handy in solving three simultaneous linear equations or doing similar problems. In addition, certain pocket calculators such as the Novus I'm going to show you presently and the Hewlett-Packard line, have a memory called an operational stack. With these, entries and intermediate answers are stored automatically and then re-entered into the calculation at the appropriate time. We haven't time to go into this thoroughly, but it works sort of like pushing 'Dixie Cups' one at a time up into a bathroom dispenser from the bottom and then having the stack of cups inside the dispenser drop down one cup at at time every time you take a cup away. This vertical stack ar-

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rangement is an essential part of RPN (Reverse Polish Notation) logic.

Logic Systems. "A logic system describes how you key in problems and the way the calculator is designed to handle them. There are essentially two logic systems used in pocket calculators: the RPN system just mentioned and the algebraic system. The latter, used in most basic calculators, works well with simple calculations and may be a little easier for the average person to use in entering a problem, but in working complex problems it often requires restructuring the equation, although a few calculators feature nested parentheses to simplify things. Calculators with RPN logic handle equations with nested parentheses much more easily. All Hewlett-Packard calculators use RPN logic with a four-stack memory."

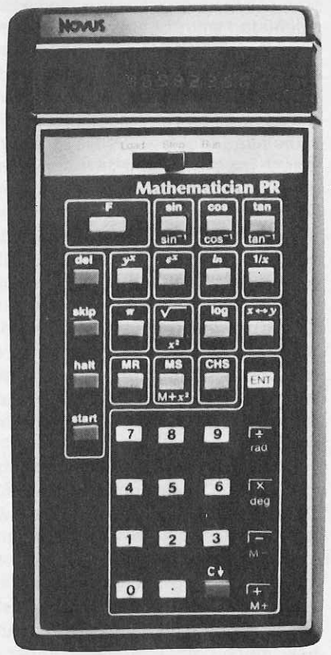
"What's different about business pocket calculators?"

"They feature more preprogrammed operations especially designed to solve business problems. While having deceptively fewer keys, they can solve specialized problems in compound interest, discounts, markups, remaining principle on a mortgage, future value of an annuity, depreciation, statistics, bond prices and yields, etc., far quicker than can scientific calculators. But now I want to show you an example of the next step up in pocket calculator complexity."

Mac took a slender calculator out of his shirt pocket and put it on the bench. "That," he said, "is a Novus 4515 Programmable Mathematician Calculator marketed by the Consumer Products Division of the National Semiconductor Corporation, Sunnyvale, California 94086. Selling for less than $150, it's the lowest priced programmable calculator I know of. It's not mine. I just borrowed it to find out how a programmable calculator really works."

"So how does it work?"

"As the key legends tell you, it's an advanced slide-rule calculator with three-stack RPN logic. Several of the 36 keys are made to do double duty by use of a gold-colored shift key. When this is touched before pressing a key, the function printed in gold beneath the key is brought into play instead of the one in silver above it. The programmable feature is controlled by these four blue keys arranged vertically along the left side of the keyboard



Novus 4515 programmable calculator.

and labelled from top to bottom: DEL, SKIP, HALT, and START; plus a three-position slide switch at the top labelled: LOAD, STEP, RUN.

"Learn-mode programming is essentially automatic key pressing. With the slide switch at LOAD, you press START and then key in a sequence of steps to solve a problem, pressing HALT each time before you insert a variable. The calculator 'remembers' exactly how you did it, and when you put the slide switch at RUN and press START, it will go through the same sequence of steps automatically, only stopping at any HALT for you to insert a new variable, and with the new answer displayed at the end of the sequence.

"There are 100 steps of programming available at one time so you can program the 4515 with one large program or as many small programs as will fit into 100 steps. Pressing SKIP in the LOAD position terminates one program and marks the beginning of another. In the RUN position, the SKIP key is used as a kind of tab key to skip over unwanted programs to reach the one you want. The DEL key is used to erase, or delete, erroneous steps. With the switch in the STEP position, you can go through a program or programs a step at a time by repeatedly pressing the START key.

"I can see that programmable feature would really be a time-saver and error-avoider in situations requiring the repeated working of the same basic problem with different data used each time," Barney said. "But isn't the program you've keyed in lost when the calculator is switched off?"

"That's right. But for $795 you can buy a Hewlett Packard HP-65 fully programmable calculator in which programs are stored on tiny magnetic program cards. One of the cards can be slipped into the calculator and in two seconds the program is duplicated in the calculator's memory and the card exits for use another time. You can buy these prerecorded magnetic cards with programs for solving problems in any math-connected discipline, or you can custom-record your own programs on blank magnetic cards for repeated use."

"Enough!" Barney said wearily, holding up his hand. "It's possible to know too much. As Lee Segal remarked, 'A man with one watch knows what time it is; a man with two watches is never sure.' After listening to your parade of calculator choices, I know what he means." ◈

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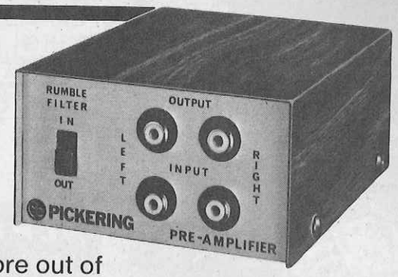

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