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Volume 13
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HP-35 Scientific Calculator awarded IEEE Milestone

The HP-35 calculator changed the way people worked and lived. See how and find out what it takes to be an HP award winning calculator.

HP announced that IEEE, the world's largest technical professional association, has awarded HP the prestigious IEEE Milestone in Electrical Engineering and Computing award for its HP-35 Scientific Calculator.

Introduced in 1972, the HP-35 was the world's first handheld-sized scientific calculator, standing apart from its peers, which could only perform four basic functions – addition, subtraction, multiplication and division.

The HP-35, named for its 35 keys, performed all the functions of the slide rule to 10-digit precision and could determine the decimal point or power-of-10 exponent through a full 200-decade range. This combination of features ultimately made the slide rule, which had been used by generations of engineers and scientists, obsolete.

The HP-35 was HP's first product that contained both integrated circuits and LEDs (light-emitting diodes). Both technologies had been developed in HP Labs, the company's central research arm.

The HP-35 was an innovative culmination of mechanical design, state-of-the-art technology, algorithm development and application – all unique at the time of its development.

"The HP-35 fundamentally changed the way engineers, mathematicians, scientists and students worked, delivering unprecedented portable computing power," said Jason Zajac, vice president and general manager, Worldwide Attach Group, HP. "The HP-35 was the company's first consumer electronic device, and from that bright beginning, HP has continued to innovate and grow a technology portfolio that spans calculating solutions that dynamically capture physical data and leading-edge touch technology that is changing how people interact with technology."

The HP-35 was developed when HP co-founder Bill Hewlett challenged HP engineers to take their current desktop computer, the HP-9100, and create a similarly capable device that fit in his shirt pocket. Even as initial market research deemed the $395 product to be too expensive, HP recognized its significance and the market need and plunged ahead. While HP expected to sell 10,000 to break even, the demand for the HP-35 exceeded expectations and more than 100,000 were sold during its first year on the market.

IEEE established the Electrical Engineering Milestones program in 1983 to honor significant achievements in the history of electrical and electronics engineering. To be awarded, technologies must have stood the test of time. Currently, there are fewer than 100 IEEE milestones; among these are Benjamin Franklin's work with electricity and Volta's invention of the electrical battery.

"The HP-35 helped accelerate the pace of technological change and revolutionized the engineering profession by allowing almost-instantaneous, extremely accurate scientific calculations anywhere and anytime," said Lewis Terman, 2008 IEEE president. "The HP-35 made it possible to conduct complicated calculations wherever they were needed, with speed and accuracy that well surpassed the slide rule. It played a key role in the lives and projects of countless engineers and scientists."

An IEEE Milestone plaque recording the award will be permanently displayed at HP Labs in Palo Alto, Calif., the site where the HP-35 was originally developed.

Since the introduction of the HP-35, HP has ushered in a new era of computing and redefined the way people learn, teach and use calculating technologies and solutions for students, professionals and consumers of all stages of life. HP continues its heritage of developing innovative calculating solutions for the scientific, financial, education and general home and office markets.

The milestone event will also be broadcast online at Ustream.TV. The broadcast will begin at 11:30 a.m. PT. Learn more about the complete line of HP graphing, scientific, financial and home and office calculators.

15% off HP Calculators for our loyal readers

– **Article**

We appreciate our readers and wanted to extend our sincere gratitude by offering a special discount. It is simple! Just visit the HP Calculator store when you're shopping for a calculator. When you decide to purchase use the code below at checkout and receive 15% off! Limited time offer. Good from April 1 until July 1.

Coupon Code: AC8972

# The "RPN" Stack - Future & Past

RPN and the four high HP RPN stack was described in detail in *HP Solve* Volume 4. HP RPN was defined, and a table (Table 1) of the five basic "RPN" stack operators was provided that show the keys used on all HP calculators to that time. In order to understand and explore the RPN stack, the RPN operators as described in Volume 4 are reproduced below.

---

1. <u>ENTER,↑</u>, is the most important RPN operator. See the description under <u>Basic RPN</u> above. ENTER is never a shifted operator on the RPN keyboard.

2. <u>X⇄Y</u> is the second most important RPN operator. X⇄Y exchanges the contents of the X and Y registers. X⇄Y is never a shifted operator on the RPN keyboard.

3. <u>Roll down</u>, R↓: The third most important RPN operator. Roll down rotates the (shoe box) stack downward. The contents of X are copied into T, T into Z, Z into Y, and Y into X. Roll down is a primary operator on all RPN models except the HP-34C, 37E, and 38E/C.

4. <u>LAST X</u> is the very important error correction operator. LAST X recalls the value of the X Register prior to the most recent operation performed. LAST X is a shifted operator on all RPN models except the six early models that do not have it – the HP-35A, 21, 22, 37E, 70A, and 80A.

5. <u>Roll up</u>, R↑, rotates the stack upward. The contents of X are copied into Y, Y into Z, Z into T, and T into X. R↑ is a shifted operator and it is not found on 24 of the 43 RPN models (58%).

The classic HP RPN stack is usually described as a vertical stack and it was also described in the Volume 4 article.


The RPN Stack

The ENTER key, ↑, and a group of four data storage registers, called an automatic RPN stack, is what makes RPN very powerful and simple to use. The stack may be visualized as a stack of "shoe boxes" as shown in figure 1. Each stack shoe box, register, is vertically related to each other. The contents of the X register are shown in the display. The original RPN machine, the HP-35A, utilized a single line display. More recent machines that have a multiline display may also show additional stack registers in the order of Y to T.

Register Name	Stack Register
T	
Z	
Y	
X	
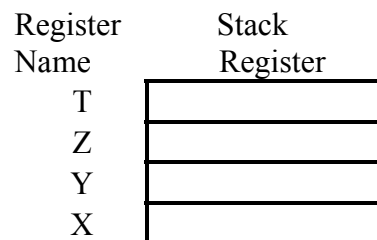
Fig. 1 – Automatic 4 high stack.

The history of the HP RPN stack (not commonly known) will be covered in the next issue of *HP Solve*. What is important to realize is that this representation of a "stack" is not standard or common in terms of how computer scientists usually represent memory. Memory is typically listed just as you would make a shopping list. The beginning is at the top. The HP RPN stack is shown order reversed to make it visually correspond to what you see in the calculator display.

One of the considerations for efficient RPN problem solving is knowing where the various intermediate values are on the stack, and having them in the correct order. For example, let's examine the problem described as the product divided by the sum: AB/(A+B). From a solution perspective you may visualize the stack as shown in figure two at the right. In true RPN style you have entered the data onto the stack and now you perform the operations, +, R↓, ×, R↑, ÷. Note: As always there are other solutions.

Register Name	Stack Register
T	A
Z	B
Y	A
X	B
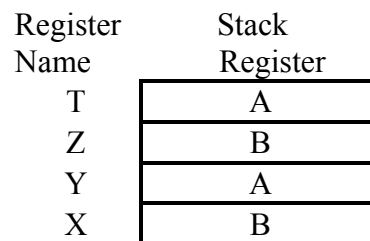
Fig. 2 – AB/(A+B) stack.

Normal problem solving doesn't require this detail of analysis and this approach is usually only justified by programmers (or teachers) who seek efficiency in their work.

T	D		A
Z	C		B
Y	B	⇒	C
X	A		D
	Start		End

Fig. 3 – Vertical stack.

Let's look at another example of stack ordering. Suppose you need to reverse the order of the stack as shown at the right. What RPN Stack operators do you use?

	X	Y	Z	T
Start	A	B	C	D
		⇓		
End	D	C	B	A

Fig. 4 – Horizontal stack.

If you are describing a lot of RPN Stack Operations you will not use the more display/textbook visually appealing vertical stack. You will, instead, show the stack horizontally as shown at the right in order to conserve space and make your work much easier.

Take a few minutes and try your RPN skill at this stack reverse order problem. Can you reverse the order of the stack using four RPN Stack Operators?

If you start thinking about the RPN stack order possibilities and the most efficient way to order the stack from any starting order to any other order you may conclude that a table of these operations would be useful. As long as you are thinking about such a table you may also want to include two additional variables to the general A, B, C, D variables – 0 and 1.

Fortunately this hard work has been brilliantly done for us by Tony Hutchins of Wellington New Zealand. See his table and an important description of the history of such tables at:

http://homepages.paradise.net.nz/th/xyzt.pdf

Tony's tables (302 KB, 56 pages) contain all XYZT stack orders with the optimum RPN operators to order the stack as desired. Tony describes stack ordering from several perspectives and his table is a powerful analytical tool. He also describes the programming tools (RPL) he used. You may find the solution to the stack reverse order problem on page 4 and page 40 at the link above. The XYZT table is especially useful to programmers, teachers, and students.

As RPN "matured" additional stack operators were added to the high end models. The HP41 series, for example, has an operator: X<> __ with the Z and T (and L) registers (X<>Z, X<>T). The stack operator keystroke savings these provide may be easily seen on page 4 in Tony's XYZT tables. These are five and three operations respectively.

The four high HP RPN stack is early 70's technology. Even today a four high stack is very useful for a broad class of problems. What about the future? The ultimate is an open ended (only memory limited) stack and this stack may be found on HP's current high end RPL (Reverse Polish Lisp) calculators such as the HP 48gII and HP 50g. RPL stack operators are different, and in many ways more effective/efficient. RPL is the next logical step in efficient (more complex) problem solving and may be thought of as a more efficient and complete RPN.

Why is the HP RPN stack four high? Why did HP use RPN? What was the basis for the first HP RPN pocket calculator? These and other RPN related questions will be discussed in our next issue.

What is the Mean Height of Female US Mathematics Teachers?

This activity uses height data unscientifically gathered from mathematics teachers at an NCTM annual meeting. What can this sample of data tell us about the average height of all female mathematics teachers in the United States?

The general question of what a sample mean can tell us about the population mean arises in many circumstances. Statistics allows us to make a statement that the mean of the population is within some interval with a certain level of probability. This interval is called the confidence interval around the population mean. It is easy to compute this interval on the HP 39/40gs.

To compute this confidence interval, we need to know: the sample mean, $\bar{x}$; the sample size, n; the sample standard deviation, s. We also need to decide what level of confidence to insist upon. One common level of confidence is 95%.

Using the HP 39/40gs to Calculate Confidence Intervals
In this activity, we are working with raw data; specifically we have a list of heights of female mathematics teachers gathered at the NCTM annual conference. So first we have to enter the data in the Statistics Aplet (or an Aplet built upon the Statistics Aplet) and then import the data into the Inference Aplet.

Start the Statistics Aplet and enter data into one of the columns. Remember the column number. Figure 1 shows our height data entered in column C1 of the Statistics Aplet.

Figure 1

Start the Inference Aplet. Choose CONF INTERVAL and T-INT: 1 μ for the method and type, as shown in Figure 2.

Now press the SHIFT of the NUM key to enter the Numeric Setup view. In this view we enter the statistics needed to compute our confidence interval. Since our data is in the Statistics Aplet, press the IMPRT menu key. Choose the aplet from which you would like to import and then choose the column that holds the list of data. Figure 3 shows summary statistics from column C1 in the Statistics Aplet ready for import into the Inferential Aplet. Press the OK menu key to paste these values into the Numeric Setup view.

Figure 2

Figure 3

Figure 4 shows the completed setup. On this same screen, set the confidence level to C = 0.95.

Figure 4

Of course, you have the option of entering these statistics manually if the data has been summarized for you and these statistics are known.

Press NUM to complete the calculation. Your display will be similar to Figure 5. Of course we are dealing with data so your numbers could be different.

Figure 5

This Inferential Statistic Numeric View includes:
- C: the confidence level, carried over from the Numeric Setup View
- Critical T: the values of the t statistic between which the area under the standard t distribution curve is equal to C
- μ min: the lower bound of the confidence interval
- μ max: the upper bound of the confidence interval

Figure 6

In other words, the probability is C that the confidence interval (between μ min and μ max) contains the average height of all female mathematics teachers in the United States. For the interval shown in Figure 5, the probability is 95% that the interval [63.7662, 65.2338] contains the average height of all female mathematics teachers in the United States.

Press PLOT to see a graphical illustration of the confidence interval (see Figure 6). The distribution curve is shown along with the critical T's. You can imagine that 95% of the area under the curve is between these critical T's. The sample mean, μ min and μ max are included on a separate scale that lines up μ min and μ max with the critical T's.

According to the National Center for Health Statistics, the average height for females in the US was 63.8 inches (5' 3.8"). Does this height fall within the confidence interval we just computed?

The HP 39/40gs Statistics and Inferential Aplets work together seamlessly to help students compute and visualize confidence intervals. For more information on the Inferential Aplet, visit www.hp.com/calculators and navigate to the HP 39gs or HP 40gs. From there, choose the link to our Learning Modules!
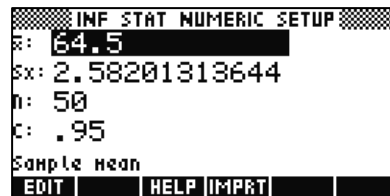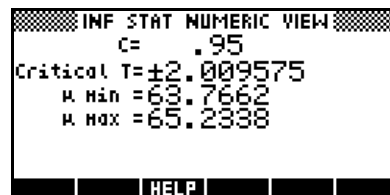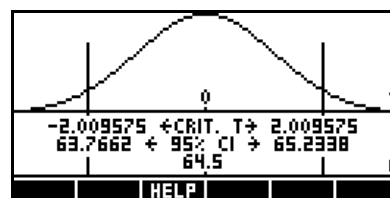
South San Antonio ISD finds HP 39gs calculators ease math challenges

HP 39gs calculator frees algebra teacher to teach

"The HP 39gs calculator is so easy to use, it practically teaches by itself. So it's now easier for me to teach algebra—because I don't have to teach how to use the calculator."
—Joel Gaines, Math Teacher, South San Antonio Independent School District

HP customer case study: HP 39gs calculator's easy-to-use interface makes it easy for math students to grasp algebraic concepts

Industry: Education

Objective:
Improvements in students' math achievement; more effective teaching

Approach:
Incorporate graphic calculator into algebra curriculum

IT improvements:
- Ease of use means students up to speed quickly
- Minimal number of steps to perform operations
- Single button to switch between function views
- Two-way infrared port simplifies transmission of e-lessons

Business benefits:
- Frees up classroom time for teaching
- Easier for students to grasp relationship between functions
- Less risk of student frustration
- Calculator projection software makes leading lessons easy
- Customizable e-lessons support specific lessons, curricula
- Flexible and powerful for most secondary school math and science classes

Math is a top priority for the South San Antonio Independent School District: it's outlined in the lead sentence in its vision and goals statement for student learning to improve achievement in math and science.

The district also believes that technology should be used to increase the effectiveness of student learning, as well as teachers' ability to teach.

For two years, now, math teacher Joel Gaines has taken that guidance and run with it. He's equipped his eighth-grade algebra students with HP 39gs calculators, partially made possible with a grant from HP.

The calculator that 'teaches by itself'

Gaines is a believer in the role technology can play in the classroom. But, he says, it has to be good technology. "Put a device with batteries in front of kids, and they just take off," he says. "But the technology has to be easy to use and understand. If it's not easy to use they get frustrated."

Given this perspective, it's no surprise that the first thing Gaines noticed about the HP 39gs calculator is how easy it is to use. "I handed the calculator out, and

by the time we started class the next day, the students were already doing things with them. I was planning to take some time to show them how to use it, but I didn't need to. It was amazing."

Students are also less likely to make "human operator"-type mistakes with the HP 39gs calculator. "Some calculators make it hard to correct yourself if you get into the wrong mode by accident," Gaines says. "All the students in the room enter the same numbers, but for three or four kids, the graphs won't work." At that point, Gaines adds, the teacher has only two choices: stop the lesson to try to help the kids who got into trouble, or ask those kids to look onto a neighbor's calculator. These types of problems are virtually non-existent with the HP 39gs calculator. "It's so much easier to correct user mistakes."

Switch views with one easy button

The calculator's ease of use has also proven to be a classroom time-saver. "With other calculators I've tried, I've had to take a few minutes out of every class period to teach the students how to use the calculator on that day's lesson," Gaines says. "With the HP calculator, the students just grab their calculators and go." It leaves more time for lessons and reduces the chance that distractions will interfere with Gaines' ability to cover the day's academic work.

The calculator's ease of use, Gaines says, is based in part upon the simplicity of its interface: in most cases, users can execute operations by using only a single button. "A lot of other graphic calculators take three or four steps to move between graph, numeric, and symbol views," he explains. "With the HP 39gs calculator, you do it with one easy button." This is nice enough from a functionality standpoint, but even more important, it helps the students grasp algebraic concepts. "It's easier for the students to see how different functions relate to one another."

The calculator's split screen capability—the HP 39gs screen measures 131 x 64 pixels—also lets the students perform comparisons easily, Gaines adds.

Another time-saver Gaines appreciates comes courtesy of the calculator's two-way infrared port. As a classroom device, one of the HP 39gs calculator's features is its support for e-lessons (HP Aplets):

electronic lessons adapted from textbooks that teachers can use as learning tools. Teachers can also create their own Aplets, and Gaines occasionally does just that. Then, at the start of class, he uses the calculator's infrared* data communications capability to transfer the custom Aplet from his calculator to several students' calculators; they in turn pass along the e-lessons until the entire class has it. "It takes only a minute and everyone's ready to go," he says.

Freed to focus on teaching

Another teaching aid Gaines finds useful is a software application that comes with the calculator; it allows teachers to project a replica of the calculator onto an interactive whiteboard or screen. "It makes it easy to lead the class through lessons step by step," Gaines says.

South San Antonio is making progress on its goal of improving its students' math performance: last year, for instance, Gaines' own algebra students scored substantially higher on their standardized tests than the previous class. The boost in scores was influenced by many factors, of course. But the HP 39gs calculator probably played a part, Gaines says, because it made it easier for him to teach. "Because the calculator is so easy to learn and use, I can focus on teaching algebra," he says. "It might only be a few minutes a day, but over the course of a year, it really adds up."

To learn more, visit www.hp.com/calculators