Remembering The HP-35A[1]

Richard J. Nelson

In January of 2007 a major milestone occurred for Hewlett Packard. It marked the 35th anniversary of the scientific calculator, the HP-35A. I have recently moved and now I have all of my calculator materials together in one place for the first time in nearly a decade. As I unpack the 580 boxes of nearly 18,000 pounds of material I am reminded of those 35 years. This article is about remembering the HP-35A

In early 1972 I worked at Hi-Tek Corporation[2] in Santa Ana California as an EE doing maintenance engineering on military timing devices. My primary hobby at the time was amateur Radio as WA6OBM. A close friend, Leroy Sparks, was also into Amateur Radio and I would often stop by his Santa Ana "shack" after work and on week ends. Leroy repaired test instruments at the Fullerton Hewlett Packard Neely sales office, and in early January[3] 1972 he mentioned that HP had announced a new product, a scientific calculator called the HP-35A. Since he was an HP employee he could get a discount and he had ordered one[4]. The machine sold for just under 2,000 in 2007 dollars[5].

Spending $2,000 on a new device of limited family use for a father with three young children would be a difficult decision for someone today, but in the days when $2,000 would buy a new car[6] you could understand what a challenge it was. HP made it very easy for you to buy a machine. You contacted the HP sales force and a salesman would take your order. HP also started an order-by-mail campaign that gave you a true 15 day free trial. They would not cash your check until after the 15 day trial. I closely followed the HP-35A and I observed that they were in serious backorder on the machine. I eventually decided to take the leap and I ordered a machine. See the details of my order in Appendix A.

The HP-35A was an astounding product representing the state of the art in electronics. Many years later I

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1. *Common engineering practice for part numbers is to use a suffix letter to indicate revisions for released drawings. "A" is the initial release,"B" is the next revision, etc. AMF, a non-profit medical implant R & D foundation where I worked in 2007 uses this practice. HP used this engineering practice for their first consumer product but soon abandoned it. They used the HP-35A designation internally and not on sales literature. See figure A5 in Appendix A, figure C6 in Appendix C, and figure F1 in Appendix F..*

2. *Hi-Tek donated dedicated office and meeting space for the first PPC facilities after my garage proved too small.*

3. *The HP-35A Announcement date is January 4, 1972 making this date the official 35th year Anniversary date for the scientific calculator. This date may be found in an HP employee publication, The Hewlett-Packard Peninsulan dated August 1975. I picked up an issue while visiting the San Francisco Bay Area at the time. See Appendix C, figure C1, which reproduces an article titled "A 'superstar' quietly retires." The Peninsulan was published monthly for Hewlett-Packard People in Palo Alto, Mountain View, Cupertino, Santa Clara, and Sunnyvale. The Editor was Dennis Cresswell at Corporate Communications, 1819 Page Mill road, Building 18 in Palo Alto, CA 94304.*

4. *I don't remember if HP employees had to wait until adequate product was available during those days. I don't think so because Leroy received his HP-35A and seeing it really convinced me that I had to have one no matter how expensive it was. HP made it easy for people to order and for their first consumer product they did an astounding job of marketing and selling, what was to become, their first true consumer product.*

5. *The 2007 $2,000 cost ($ 1,961.59) of the $395 HP-35A is based on The Federal Reserve Bank of Minneapolis Consumer Price Index Calculator at:* **http://www.minneapolisfed.org/research/data/us/calc/**
CPI factor '72 →'07 = 4.916268; '74 → '07 = 4.168357

6. *A new Ford Pinto sold for $2,078 in 1972 according to:* **http://www.thepeoplehistory.com/70scars.html**

7. *Statek Corporation was a start up company with the objective of developing a low frequency, 32,768 Hz, tuning fork quartz watch crystal manufactured using a semiconductor lithographic wafer manufacturing process..*

met a "salesman" who called on Statek[7], where I worked at the time. We got to talking at the end of the day and he mentioned that he worked for Mostek back in "the days of the HP35A." I was very interested and he told me the following story. I wish that I had taken notes and that I could remember his name.

He had started a manufacturer's representative firm that represented, among other companies, Mostek Corporation in Carrollton Texas. As a Mostek Rep, HP contacted him regarding the manufacturing of what eventually became five hybrid circuits for the HP-35A. He sat in on many meetings between Mostek and HP engineers as they discussed the best way to divide the complex calculator circuit into manufacturable circuits with minimum interconnects. Once the "design" was finished there was one more "issue' to deal with. HP would not accept a single source supplier. Since Mostek represented the state of the art in hybrid circuit manufacturing that issue was going to be a challenge. In the end they agreed to transfer their technology to another company and HP would order circuits from both companies. The other company was American Microsystems Incorporated, AMI. See figure 1.

As it turned out, HP's policy of not depending on a single supplier for parts paid off. Both companies started building circuits. See the photo in figure 2 below. This was new territory technologically speaking, and both companies had difficulties. When it came time to deliver the five circuits required for each HP-35A, one company could only make three and the other two. As it turned out there were no duplicates and HP was able to get a full set of five hybrid circuits to start making HP-35A's. I am sure that these issues were well known within HP and they played a role in the comments made in the article shown in figure C3.

While I found the technical details the most interesting I could tell that he must have come away from the experience with a negative feeling. I probed further. He said that as Mostek's representative who

Ion Implant Sparks Tidy Front-End Business

By NAT SNYDERMAN

NEW YORK — Ion implantation is gaining favor in semiconductor factories and is generating a tidy little business for a handful of equipment suppliers virtually unknown a few years ago.

Considered a laboratory maverick until recently, ion implanters have evolved into sophisticated front-end production equipment which may one day compete with diffusion in microcircuit processing, notably in MOS.

National Semiconductor, Intersil and American Micro-systems are among the major IC producers which have installed ion implanters. Fairchild, Mostek and Hewlett-Packard have units on order.

A solid endorsement of the ion bombarding art will soon be given by IBM which has placed orders for three machines — two for East Fishkill and one for Manassas, Va. — reported to be a prelude to a push in MOS circuits. Made by the Ortec division of EG&G, the units will be delivered in April.

Equipment manufacturers estimate the total cost of the three systems IBM will buy from Ortec at $250,000 to $300,000.

Ion implantation has b technique for doping sem — generally thin-films formly over each wafer a ty from wafer to wafer. process, in this technolog ized, accelerated to hig barded onto the surface they penetrate and then

Device engineers have permits them to dope fine adjustments of

Electronic News, 4/24/72

Ion-Implant Production Accelerating at Mostek

DALLAS (FNS) — Mostek Corp., here, has ion-implanted more than 100,000 wafers of MOS/LSI circuits during the past 15 months, according to Bob Palmer, vice-president of the firm's Worcester, Mass., processing operation.

All of the wafers were implanted with a single machine purchased from "Accelerators, Inc., Austin, Tex. Another machine is on order from the same firm.

The new unit will offer both higher

Technology

The HP-35 employs MOS/LSI circuits using ion-implant processes.

Hewlett-Packard thinks they are the largest presently in volume production. Each circuit is equivalent to 6,000+ transistors — a total of 30,000 devices. They are made by Mostek especially for Hewlett-Packard (Dallas) and American Microsystems (Santa Clara, Calif.).

The HP 35 may well be one of the major developments of the current decade and the harbinger of things to come.

Electronic News, 2/14/72

Hewlett-Packard Introduces Electronic Pocket Calculator

PALO ALTO, Calif. — Hewlett-Packard Co. said it has introduced a new electronic pocket calculator called the HP-35.

William R. Hewlett, president, compared the nine-ounce battery-powered calculator to a "fast, extremely accurate electronic slide rule, with a solid-state memory similar to those used in computers." The HP-35 is approximately three inches wide, six inches long and one inch high and will sell for $395, according to Mr. Hewlett.

A major business publication, 1/5/72

Ion implantation as a processing tool will be used in one way or another by all manufacturers within a few years. Equipment will be refined and become less costly as more suppliers move into this market. Because of its ability to adjust thresholds, make depletion devices, make CMOS devices, etc., it is too useful a tool to ignore. Circuits made by ion implantation will be cost-competitive with most other technologies and offer some perfo

EDN/EEE, 9/15/71

Ion-Implantation Moves Ahead

Ion implantation technology contin to advance. This was borne out at the recent International Electron Devices Meeting in Washington, D.C. where, of the twelve papers presented on the subject, nine described applic cations other than the most common by known ones.

EDN/EEE, 12/15/71

Today ion implantation is big news.

Look what we started!

Two years ago you probably never heard of ion implantation. Today it's big news—helping turn bright ideas into profitable products.

MOSTEK was the first to use ion implantation in the volume manufacture of MOS/LSI, beginning in 1970. Since then we have made process and product innovations that have initiated an industry-wide movement towards implantation. Today you will find our implanted MOS circuits in an ever widening range of applications including: business and scientific calculators; electronic organs; credit verification terminals; industrial timers; computer peripherals; medical electronics; avionics; portable measuring instruments and modems. Looking ahead, implanted MOS is ideal for such new and exciting areas as utility meter reading, time keeping, and automotive electronics.

If you are considering using MOS in your products, check what implanted circuits can do for you, both technically —(lower power, higher speed, and operation over broad supply voltages)—*and* economically. Let MOSTEK recommend a custom approach or one of its standard implanted MOS circuits to meet your needs.

MOSTEK CORPORATION

1215 West Crosby Road
Carrollton, Texas 75006
(214) 242-0444

Regional Sales Offices: West: 11922 La Cienega Blvd., Inglewood, Calif. 90304 (213) 649-2888 East: 60 Turner Street, Waltham, Mass. 02154 (617) 899-9107
Midwest-Southeast: 515 S. W. Avenue, Jackson, Michigan 49203 (517) 787-1508
International: MOSTEK GmbH, 7 Stuttgart 80, Waldbuggstrasse 79, West Germany 0711-731305. System Marketing Inc., Center News Bldg., 1-3-11 Sotokanda, Chiyoda-ku, Tokyo, Japan. Far East: Imai Marketing Assoc., Inc., 525 W. Remington Dr., # 108, Sunnyvale, Calif. 94087 (408) 245-3511. Hong Kong: Astec Components Ltd., Alpha House, Flat "F" 13 Floor, 27 Nolan Rd., Kowloon, Hong Kong. Israel: Rasom Electronics, 60 Pinkas St., Tel Aviv, Israel.

Fig. 1 – Mostek ad in the April 24th 1972 issue of Electronics Magazine, page 34.

POCKET COMPUTATION from Hewlett Packard

WE'RE ON THE INSIDE!

The HP-35 pocket calculator is available *today*. A super slide rule, this electronic wonder challenges a computer in its problem-solving capability. People have talked about it for years, but HP made it work . . . a breakthrough product offering an unprecedented combination of size, multifunction capability, accuracy and speed. How is it practical? Through creative, MOS/LSI design, using ion-implanted, depletion-mode technology. A technology pioneered, proven and volume-manufactured by MOSTEK.

What kind of performance does implanted MOS/LSI provide? Here's a summary of the micro-processor developed for the HP-35:

Low Power: 90 mw (typical) for the sum of all five complex MOS arrays

Very Complex Chips: The arithmetic chip alone contains 3600 transistors

Immunity to Battery Voltage Variation: Specifications called for ±16.6%.

MOSTEK MOS circuits custom designed for Hewlett Packard.

This was exceeded with the micro-program storage chip operating from 3.5 to 30 V, typically.

Multi-Source Production Capability: MOSTEK pioneered the process; other sources are now following our lead.

MOSTEK's design team made implanted MOS work for Hewlett Packard. Can we do the same for you?

For more information, call Marketing Assistance at (214) 242-0444, or contact your nearest MOSTEK sales office listed below.

NOTE: The circuits utilized for the HP-35 are proprietary to Hewlett Packard and not available for general sale. For information on the pocket calculator, write: Advanced Products, Hewlett Packard, 10900 Wolfe Road, Cupertino, Calif. 95014.

MOSTEK®

MOSTEK Corporation, 1215 West Crosby Road
Carrollton, Texas 75006, (214) 242-0444

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REGIONAL SALES OFFICES: Western: 11922 La Cienega Blvd., Inglewood, Calif. 90304 (213) 649-2888 Eastern: 60 Turner Street, Waltham, Mass. 02154 (617) 899-9107 Central: 515 So. West Avenue, Jackson, Mich. 49203 (517) 787-1508

INTERNATIONAL: Europe: Mostek GmbH, 7 Stuttgart 80, Waldbuggstrasse 79, West-Germany 0711-731305; **Japan:** System Marketing Inc., Center News Bldg., 1-3-11 Sotokanda, Chiyoda-ku, Tokyo, Japan; **Far East:** Imai Marketing Assoc., Inc., 525 W. Remington Dr., # 108, Sunnyvale, Calif. 94087 (408) 245-3511; **Hong Kong:** Astec Components Ltd., Alpha House, Flat "F" 13 Floor, 27 Nolan Rd., Kowloon, Hong Kong; **Israel:** Rasom Electronics, 60 Pinkas St., Tel Aviv, Israel.

Fig. 2 – Mostek ad in the October 9th 1972 issue of Electronics Magazine, page 13

brought a new customer to Mostek he was entitled to a sales commission. Once the deal had been made, production was humming along, and he was receiving regular commission checks, a "problem" developed. The HP deal was very big and involved a large number of circuits and a large amount of money. Mostek had a corporate policy that a VP had to sign checks for $50,000 and up (that is nearly a quarter of a million in 2007 dollars) and when the commission reached this level human nature kicked in. "Why are we paying a Rep this amount of money" the VP asked? "We can open our own sales office and save money." Efforts were made to cut off the Rep, Mostek prevailed, and he eventually lost his contract dictated commissions.

I asked why he didn't make the commission a sliding scale with respect to quantity. He said that he did, but apparently it didn't slide down fast enough. The numbers were so large that no one involved ever expected to reach them. He made lots of money, but he could have made more if a "fight" didn't occur. I understood the issue because I had experienced a similar human nature greed situation while working previously at Hi-Tek.

HI-Tek was a small company that had a group that designed and manufactured parachute actuators for military pilots. The president decided that they needed to design the next generation actuator but he couldn't hire another engineer to do the job. A designer said that he would work over time and complete the design on his own time if he could get a percentage of the sales. They struck a deal and I watched him as he worked on the new design late evenings and on week ends for over a year. The new design went into production and was very successful. When the royalty checks reached a certain value the company felt that they just couldn't have a lowly designer making so much money. Greed drove a bitter "battle" that resulted in the designer leaving the company. I don't know the exact details of the "greed threshold", but I could personally relate to the Mostek Rep's situation.

The technical details of the HP-35A may be found many places on the Internet so I won't include them here. I will reproduce one brochure, however. It is dated 2/72 and it is the HP35A *Advance Technical Data* printed in blue and black on semi gloss heavy paper. See Figure 3. This brochure is especially interesting to study because it appears to be written by a person just as sensitive to technical issues as to marketing issues. It mentions that the machine has 35 keys. It uses technical terms like overflow and underflow. It talks about the approximately 3 x 5 inch front panel describing the keys as follows. "Each key has a "breakaway" or "overcenter" touch similar to the key action of a high quality electric typewriter." This *Advance Technical Data* brochure even includes a table of Operation Speeds. For example, Add and Subtract are 60 milliseconds and trigonometric operations are 500 milliseconds. Where else will you find operation speeds given for a calculator?

The HP-35A was an incredible machine. It out performed all methods then available for solving engineering and scientific problems available to an individual. Its 20 decade dynamic range was unbelievable and HP made a basic calculator design decision from the very beginning. If you can enter a problem into the machine all functions would work equally. In other words all functions operate over the full dynamic range. No other manufacturer of calculators does as good a calculating job as an HP calculator does. See appendix C at the top of page C3 for a typical example of how this dynamic range may be used.

I was lucky in that I had more of a connection to HP than the average person. I used HP test equipment and of course I had my friend Leroy. For most people their first exposure to the HP-35A was a "famous" promotional letter. See figure 4. The famous part is the Leibniz quote at the top of the letter. Most technical people have heard of it and there are many variations.

I remember sitting in my living room with all of the books of math tables that I had collected. The stack was over two feet high. I randomly picked values for any math function the HP-35A performed. WOW, I could replace all of these gigantic heavy books with this handheld marvel! I was very impressed.

HEWLETT hp PACKARD

HP 35

POCKET CALCULATOR
ADVANCE TECHNICAL DATA

A report on
the Hewlett-Packard

HP-35

A new shirt-pocket-sized answer machine to provide advanced mathematical capability

- *for the scientist*
- *for the engineer*
- *for anyone engaged in complex calculation who needs fast answers*

Development of the HP-35 is a new breakthrough from Hewlett-Packard research **and a long leap forward in pocket calculator capability.** It is about as small as a calculator can be made—while retaining fingertip operation and easy-to-read answers. Yet its computational power is extraordinary . . . and it costs only a fraction of the price of desk-top scientific calculators.

The HP-35 actually compresses most of this "big machine" capability into a nine-ounce unit that fits comfortably into a shirt pocket.

Advanced Technological Features

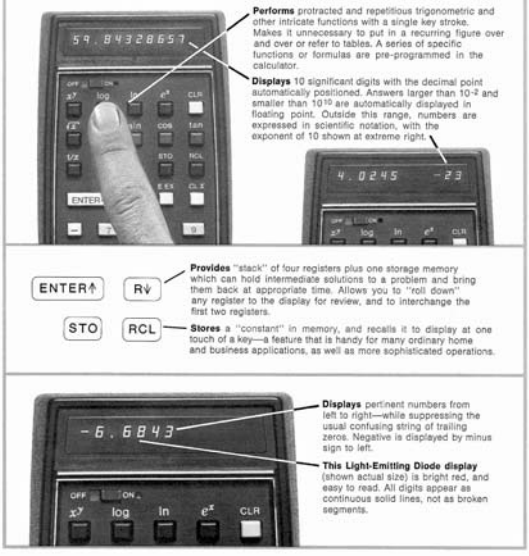
Large-Scale Integrated Circuits (LSI):
The HP-35 has especially designed MOS/LSI (Metal-Oxide-Semiconductor/Large-Scale Integration) circuits using a new low-power, high-performance ion-implant process. These circuits are believed to be the largest presently in volume production in the world. Each is equivalent to 6,000 transistors—a total of 30,000.

Light-Emitting-Diode Display (LED):
The bright, easily-read display in the HP-35 was designed specifically for this application by Hewlett-Packard, one of the world's leading producers of optoelectronic devices. Since the displays are made from semi-conductor materials, they—like transistors—do not wear out with time.

Tactile Feedback Keyboard:
The unique keyboard allows grouping of 35 easily-operated keys on a front panel approximately 3 x 5 inches. Keys are fully spaced for convenient fingertip operation. Each key has a "breakaway" or "overcenter" touch similar to the key action of a high quality electric typewriter.

Compact, Contoured Case:
The HP-35 has been designed to take substantial punishment in field use. Its sculptured, shirt-pocket case is made possible through a combination of modern packaging techniques and high-density integrated circuit electronics.

Provides a unique combination of advanced mathematical capability plus shirt-pocket portability—*and it's as easy to use as an adding machine.*



Performs protracted and repetitious trigonometric and other intricate functions with a single key stroke. Makes it unnecessary to put in a recurring figure over and over or refer to tables. A series of specific functions or formulas are pre-programmed in the calculator.

Displays 10 significant digits with the decimal point automatically positioned. Answers larger than 10^{-2} and smaller than 10^{10} are automatically displayed in floating point. Outside this range, numbers are expressed in scientific notation, with the exponent of 10 shown at extreme right.

ENTER↑ R↓ — **Provides** "stack" of four registers plus one storage memory which can hold intermediate solutions to a problem and bring them back at appropriate time. Allows you to "roll down" any register to the display for review, and to interchange the first two registers.

STO RCL — **Stores** a "constant" in memory, and recalls it to display at one touch of a key—a feature that is handy for many ordinary home and business applications, as well as more sophisticated operations.

Displays pertinent numbers from left to right—while suppressing the usual confusing string of trailing zeros. Negative is displayed by minus sign to left.

This Light-Emitting Diode display (shown actual size) is bright red, and easy to read. All digits appear as continuous solid lines, not as broken segments.

HEWLETT-PACKARD HP-35

A scientific-language pocket calculator that combines slide rule portability with the precise accuracy and problem-solving power of a small computer.

Yet you can compute complex transcendental functions with 10-digit accuracy in less than half a second. As easy to use as an adding machine.

Description

The HP-35 is a 35-key, pocket-sized scientific and engineering calculator. It performs logarithmic, trigonometric, and mathematical functions with a single keystroke and eliminates the need to refer to log or trig tables. It displays up to 10 significant decimal digits and automatically positions the decimal point throughout its 200-decade calculating range (10^{-99} to 10^{99}). It combines the portability and convenience of the slide rule with the problem-solving power of a desk-top scientific calculator. However, it provides answers in a fraction of the time required for slide rule calculation —with unprecedented 10-decimal place accuracy.

Single Keystroke Functions

A series of specific functions or formulas are pre-programmed into the HP-35 to provide its unique capability for performing trigonometric and exponential functions with a single keystroke. This feature makes it unnecessary to refer to tables for the values of these functions:

Arithmetic: Add, subtract, multiply, divide and square root.

Trigonometric: Sin x, Cos x, Tan x, Arc Sin x, Arc Cos x, Arc Tan x.

Logarithmic: Log_{10} x, Log_e x, and e^x.

Other functions: x^y, $1/x$, π and data storage and positioning keys.

Special Features

Operational Stack and Memory
The HP-35 is provided with an "operational stack" of 4 registers, plus a memory register for constants. The stack is used for solving either simple or complex problems that require intermediate values. It holds the intermediate results and at the appropriate time, automatically brings them back for further processing. This eliminates the need for scratch notes or the re-entry of intermediate answers.

Stack control keys permit the contents of any register to be shifted to the display for review. Examples of how the stack actually functions will be included later in this report.

Automatic Decimal Point Positioning
The HP-35 allows values to be entered in either floating point or scientific notation. Answers larger than 10^{-2} and smaller than 10^{10} are displayed in floating point with the decimal properly positioned. For values outside this range, answers are displayed in scientific notation, with the exponent of 10 shown at the right of the display.

Blanked Digits
Displays pertinent numbers from left to right. Insignificant trailing zeros are automatically blanked for easier reading of the display. Example: ½ is displayed as .5 with no trailing zeros.

Overflow-Underflow and Improper Operations
Overflow and underflow are indicated by the HP-35's closest answers: $9.99\ldots \times 10^{99}$, and zero, respectively. Improper operations, such as the square root of a negative number, are indicated by a flashing display.

Battery Power or AC Line Operation
A battery pack, consisting of nickel-cadmium rechargeable batteries, provides typically five hours of operation under normal use. When operating on the battery pack, the HP-35 automatically provides positive indication of low battery power. Five to 10 minutes of operating time remain after this warning signal is flashed. An adapter is provided for AC operation (115 or 230 volts). The unit can be operated on AC while the battery pack is being charged.

Consult your telephone directory for the number and address of your local HP Sales Office, or contact (in the U.S.)

East	Paramus W120 Century Road Paramus, New Jersey 07652	(201) 265-5000
Midwest	Skokie 5500 Howard Street Skokie, Illinois 60076	(312) 677-0400
South	Atlanta Post Office Box 28234 Atlanta, Georgia 30328	(404) 436-6181
West	North Hollywood 3939 Lankershim Boulevard North Hollywood, Calif. 91604	(213) 877-1282
(in Canada)	Pointe-Claire, Quebec 275 Hymus Boulevard Pointe-Claire, Quebec Canada	(518) 561-6520
(in Europe)	Geneva Hewlett-Packard S.A. Rue du Bois-du-Lan 7 CH-1217 Meyrin 2 - Geneva Switzerland	(022) 41 54 00

(for areas not listed)
Hewlett-Packard Intercontinental
3200 Hillview Avenue
Palo Alto, California 94304
Telephone: (415) 493-1501
TWX 910-373-1260
Telex 034-8461
Cable HEWPACK, Palo Alto

HEWLETT hp PACKARD

General Specifications:

SPEED OF OPERATION:
Typical times for operations are:

Add, Subtract	— 60 milliseconds
Multiply, Divide	— 100 milliseconds
Square Root	— 110 milliseconds
Logarithmic & Exponential	— 200 milliseconds
x^y	— 400 milliseconds
Trigonometric	— 500 milliseconds

POWER:
AC—115 or 230 V, ± 10%, 50 to 60 Hz, 5 watts.
Battery—500 mw derived from Nickel-Cadmium rechargeable Battery Pack. Meets specifications established by the Radio Technical Commission for Aeronautics, regarding radio frequency interference of devices carried on commercial aircraft.

WEIGHT:
Calculator — 9 ounces
Recharger — 5 ounces
Shipping weight — approx. 2 lbs.

DIMENSIONS:
Length — 5.8 inches
Width — 3.2 inches
Height — 0.7 to 1.3 inches

TEMPERATURE OPERATING RANGE:
0° C to 40° C (32° F to 104° F)

ACCESSORIES INCLUDED:
- AC Adapter and battery recharger (115/230V).
- Soft leather case with belt loop.
- Safety travel case of molded plastic, which holds both calculator and recharger and is compact enough to fit most standard attache cases.
- Self-adhesive owner name tags for the unit and accessories.
- Operating manual.

Certification and Warranty

The Hewlett-Packard Company certifies that every HP-35 Pocket Calculator is thoroughly tested and inspected and found to meet its published specifications before it is shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. Bureau of Standards to the extent allowed by the Bureau's calibration facility.

Hewlett-Packard Pocket Calculator Products are warranted against defects in materials and workmanship. This warranty applies for one (1) year from the date of delivery. We will repair or replace components which prove to be defective during the warranty period, provided the defective units are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damage.

5952-6000(22) Printed in U.S.A. 2/72

Fig. 3 – This HP-35A Advance Technical Data brochure is dated 2/72. The four pages are printed on semi gloss paper in black & blue. This obviously shows the very first version of the HP-35A. Note HP offices listed.

Leroy and I continually showed each other things that we could do with our latest and greatest toy. Leroy was single and I had a family to support. To him it was a technical curiosity bought with discretional income. To me, it was an important tool I used in my job bought with vital family funds.

When you have a fast convenient way to solve problems you naturally look for problems to solve. One of the things I noticed with many of the HP-35A users I came to know was that they would keep three by five index cards with formulas and equations written on them. Certain problems required an irritation process to get an answer. Since you had to press the "loop" steps yourself by pressing the same sequence of keys over and over again it became a challenge to work out the most efficient stack manipulation sequence possible to reduce the number of loop keys to press. If you spent two extra keystrokes to better load the stack to save one keystroke "in the loop" and the loop required ten iterations for an answer, you saved eight keystrokes. In essence, the equations on the index cards graduated into "program steps" for problem solving.

When I mentioned this to my friendly HP sales person he told me an interesting story about a fellow in another sales district. This person had developed an extensive set of problem solving notes, and that HP was negotiating with him to buy them and put them into a book. See figure B5. A year or two later, after I started the HP-65 User's Club, this fellow joined the club and I heard the story first hand in correspondence.

HEWLETT hp PACKARD

ADVANCED PRODUCTS • 10900 Wolfe Road, Cupertino, California 95014, Telephone 408-257-7000

"It is unworthy of excellent men
to lose hours like slaves
in the labor of calculation."

Gottfried Wilhelm Leibniz (1646-1716)

If you concur in this 300-year-old opinion, meet the first pocket calculator that speaks your language.

We've christened this tiny, nine-ounce brainchild the HP-35 Pocket Calculator. I like to think of it as an electronic slide rule. But as the enclosed literature will indicate, comparing this new working tool to a slide rule or ordinary calculator simply does not do it justice.

The HP-35 offers a whole lot more in terms of advanced mathematical capability than any hand-held calculator we know about. In fact...

...it comes close to being a computer that fits in your shirt pocket.

It's as portable as your faithful slide rule. But it's easier to use. It does more, does it faster, does it without reference to cumbersome tables, without the need to write down intermediate results. It gives you answers with the accurate 10-place precision that's especially welcome when you're running out a close calculation, and even keeps track of the decimal.

The HP-35 has just gone into production after many months of exhaustive tests and refinements. During this introductory period, available production is being allocated under my supervision.

However, we'd be pleased to have you try this remarkable little answer machine at our expense--so that you can evaluate its extraordinary capabilities. The price is just $395, and you can take your choice of several purchase and payment options.

To do so, simply fill out and mail the card enclosed. You are welcome to "shirt-pocket-test" the HP-35 for 15 days while you determine for yourself how many hours, errors, and dollars it will save you.

Sincerely yours,

Alexis Sozonoff
Advanced Products Manager

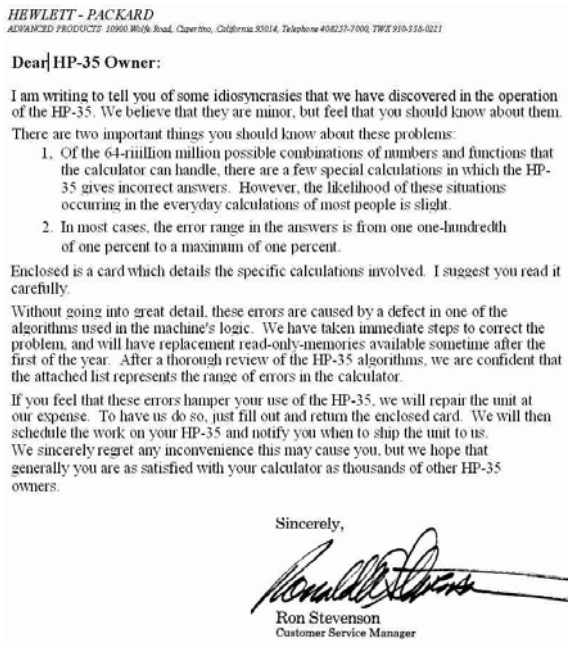
AS:c
Encl.

Fig. 4 – HP-35A promotional letter with its famous Leibniz quotation.

If my memory serves his name was Lee Skinner and he lived in Arizona or New Mexico. Lee was very happy that HP had paid him $600 (2,950 dollars in 2007 dollars) for his "index card problems." He wasn't very happy, however, when he saw the HP-45 Math Pac and he contacted HP. He said that he had sold them his material for the HP-35A math Pac, but not for the HP-45 Math Pac.

Most people know that when you buy a manuscript you are free to use it as you wish. HP, legally, did not have any obligation to pay for another use of his material. Besides, it was many months later and the people he dealt with originally were no longer around. How, HP asked, do we know that this is your material? Lee replied, "It is quite simple, many of the numbers used in the problems are my numbers; my phone number, my address, etc." In the end, HP paid him another $600 – and I am sure with a stronger legal agreement – and all ended well. This is an example of the HP early HP calculator users knew and respected.

By the fall of 1972 my computational life was very exciting. HP was advertising "every where" in newspapers and magazines – 220 as mentioned in the article in figure C2. HP was sending mailers for accessories and the factory was cranking out machines at a rate of 2,000 per week according to the article in figure C1. That would be 3.88 million dollars in 2007 dollars. Then clouds formed on the horizon, and I received the letter shown in figure 5. It described an HP-35A ROM bug. The Errors this bug caused



HEWLETT - PACKARD
ADVANCED PRODUCTS 10900 Wolfe Road, Cupertino, California 95014, Telephone 408/257-7000, TWX 910-338-0221

Dear HP-35 Owner:

I am writing to tell you of some idiosyncrasies that we have discovered in the operation of the HP-35. We believe that they are minor, but feel that you should know about them.

There are two important things you should know about these problems:

1. Of the 64-million million possible combinations of numbers and functions that the calculator can handle, there are a few special calculations in which the HP-35 gives incorrect answers. However, the likelihood of these situations occurring in the everyday calculations of most people is slight.
2. In most cases, the error range in the answers is from one one-hundredth of one percent to a maximum of one percent.

Enclosed is a card which details the specific calculations involved. I suggest you read it carefully.

Without going into great detail, these errors are caused by a defect in one of the algorithms used in the machine's logic. We have taken immediate steps to correct the problem, and will have replacement read-only-memories available sometime after the first of the year. After a thorough review of the HP-35 algorithms, we are confident that the attached list represents the range of errors in the calculator.

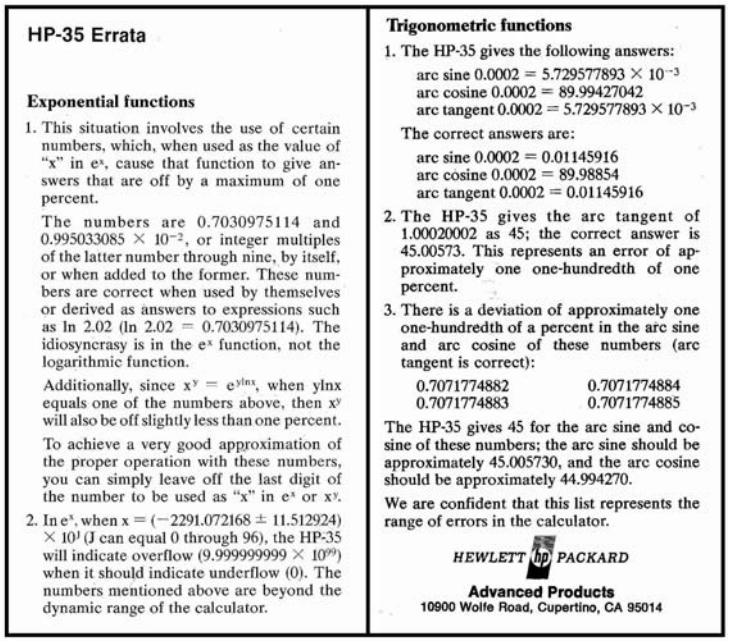
If you feel that these errors hamper your use of the HP-35, we will repair the unit at our expense. To have us do so, just fill out and return the enclosed card. We will then schedule the work on your HP-35 and notify you when to ship the unit to us.

We sincerely regret any inconvenience this may cause you, but we hope that generally you are as satisfied with your calculator as thousands of other HP-35 owners.

Sincerely,

Ron Stevenson
Customer Service Manager

Fig. 5 – Letter I received from HP reporting a bug in the ROM. I sent my machine if for repair.



HP-35 Errata

Exponential functions

1. This situation involves the use of certain numbers, which, when used as the value of "x" in e^x, cause that function to give answers that are off by a maximum of one percent.

   The numbers are 0.7030975114 and $0.995033085 \times 10^{-2}$, or integer multiples of the latter number through nine, by itself, or when added to the former. These numbers are correct when used by themselves or derived as answers to expressions such as ln 2.02 (ln 2.02 = 0.7030975114). The idiosyncrasy is in the e^x function, not the logarithmic function.

   Additionally, since $x^y = e^{y \ln x}$, when ylnx equals one of the numbers above, then x^y will also be off slightly less than one percent.

   To achieve a very good approximation of the proper operation with these numbers, you can simply leave off the last digit of the number to be used as "x" in e^x or x^y.

2. In e^x, when $x = (-2291.072168 \pm 11.512924) \times 10^J$ (J can equal 0 through 96), the HP-35 will indicate overflow ($9.999999999 \times 10^{99}$) when it should indicate underflow (0). The numbers mentioned above are beyond the dynamic range of the calculator.

Trigonometric functions

1. The HP-35 gives the following answers:
   arc sine $0.0002 = 5.729577893 \times 10^{-3}$
   arc cosine $0.0002 = 89.99427042$
   arc tangent $0.0002 = 5.729577893 \times 10^{-3}$
   The correct answers are:
   arc sine $0.0002 = 0.01145916$
   arc cosine $0.0002 = 89.98854$
   arc tangent $0.0002 = 0.01145916$
2. The HP-35 gives the arc tangent of 1.00020002 as 45; the correct answer is 45.00573. This represents an error of approximately one one-hundredth of one percent.
3. There is a deviation of approximately one one-hundredth of a percent in the arc sine and arc cosine of these numbers (arc tangent is correct):

0.7071774882	0.7071774884
0.7071774883	0.7071774885

   The HP-35 gives 45 for the arc sine and cosine of these numbers; the arc sine should be approximately 45.005730, and the arc cosine should be approximately 44.994270.

We are confident that this list represents the range of errors in the calculator.

HEWLETT hp PACKARD
Advanced Products
10900 Wolfe Road, Cupertino, CA 95014

Fig. 6 – 3-1/4 x 5-3/4 inch card explaining the errors that came with the letter in fig. 5. The left side is the front.

were described on the card that came with the letter as shown in figure 6.

I sent my machine in for repair and the process, from scheduling to return, worked exactly as HP promised. HP accomplished the only recall in calculator history with style and grace.

There are web sites dedicated to this ROM bug. A technical one is located at:

http://www.jacques-laporte.org/HP35%20bug.htm

Exactly when the bug was found I don't remember or have, at this time, documentation to determine the date. I have heard of several descriptions of what the bug was. The one that is technically descriptive, as described by HP, is that the bug was caused by a six bit programming error. I have this description scribbled on one of my note pages. What does this mean?

The "official" end of life date for the HP-35A is unclear but it was certainly in late July, or early August 1975 making the product life three years and six or seven months. See figures 7 and C1.

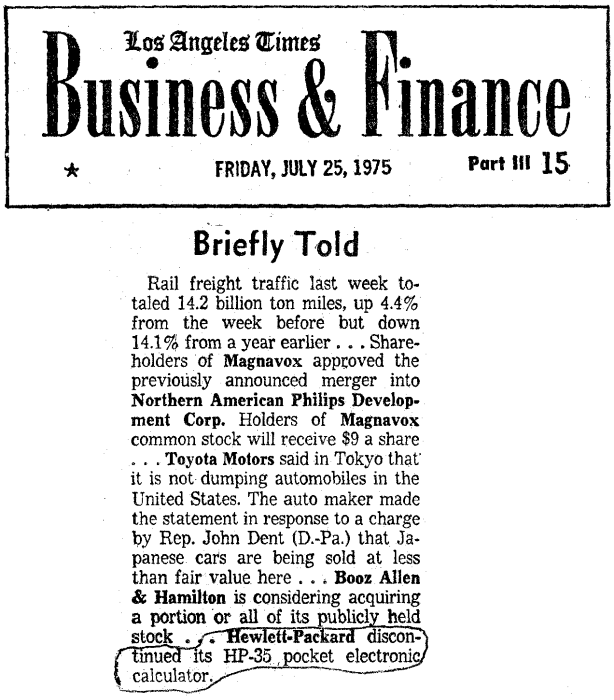
HP promoted the HP-35A with lots of colorful literature. Some of this literature is found in Appendix B. Other classic HP brochures may also be found on the HHC 2007 Web site.

I hope that everyone will remember to bring their HP-35A with them to HHC 2007 so we may pick a good representative for each of the different types and that we will be able take an HP-35A group photograph.

Appendix C includes copies of three HP internal publications related to the HP-35A. Most of the formal regular publications – HP Journal, HP65 Key Note, HP Keynotes, etc. - may be found on Jake Schwartz's CD's as listed at:

http://www.pahhc.org/ppccdrom.htm

Jake has spent endless hours scanning these publications and he has provided a great service to the HP User Community. See figure 7 for the label of the US and HP publications CD. International publications are on another CDs including one dedicated to the UK *Datafile*. Refer to the link above.



Los Angeles Times

Business & Finance

★ FRIDAY, JULY 25, 1975 Part III 15

Briefly Told

Rail freight traffic last week totaled 14.2 billion ton miles, up 4.4% from the week before but down 14.1% from a year earlier . . . Shareholders of **Magnavox** approved the previously announced merger into **Northern American Philips Development Corp.** Holders of **Magnavox** common stock will receive $9 a share . . . **Toyota Motors** said in Tokyo that it is not dumping automobiles in the United States. The auto maker made the statement in response to a charge by Rep. John Dent (D.-Pa.) that Japanese cars are being sold at less than fair value here . . . **Booz Allen & Hamilton** is considering acquiring a portion or all of its publicly held stock . . . **Hewlett-Packard** discontinued its HP-35 pocket electronic calculator.

Fig. 7 – The Los Angeles Time mentions the discontinuance of the HP-35A in late July 1975.

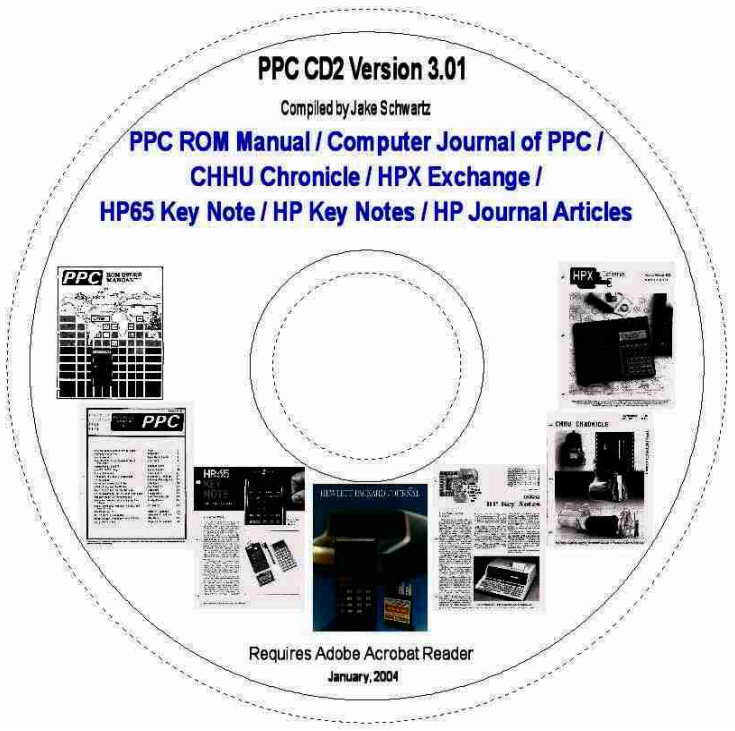


Fig. 8 – US User Community and HP calculator publications on Jakes PPC CD number 2.

Appendix C includes a description of scanned internal documents with descriptions. Appendix D shows two internal APD memos to HP field sales offices. The first memo, figure D1, explains when and why the raised tactile dot was removed from the five key of the HP-35A, HP-80 and later calculators.

The second memo describes field service calculator repair. Initially all calculator repair work was done at APD. As the product line expanded, however, HP followed its normal policy of having the machines repaired at field offices. To do this they had to document the machine with enough technical detail for it to be repaired. The field repair memo is 10 pages reproduced four pages to a page. Three introduction paragraphs explain the Appendix content.

The HP-35A inspired tens of thousands of technical users to excellence. I remember using it every day for many years – until I bought the HP-65 for 3,313.84 dollars in 2007 dollars.
Thanks HP for the memories.

X < > Y,

Richard

Appendix Descriptions

Appendix A – RJN HP-35A Order and Shipping Documents – 2 pages.

Fig. A1 – This is what you received if you responded to an HP-35A published ad or direct mailer. Page A1.

Fig. A2 – Order form for Richard's HP-35A. Page A1.

Fig. A3 – Shipping label of Richard's HP-35A. Page A1.

Fig. A4 – Notice of shipment of Richard's HP-35A. Page A2.

Once the HP-35A was introduced HP began advertising it strongly in technical publications, magazines, news papers, and in direct mailings. See Appendix B for a few selected examples.

If you were interested you sent HP a form and they "put you on a list" because they almost immediately went into backlog. Figure A1 shows that I "qualified" for a 15-day Free Trial Examination of an HP-35A calculator.

HEWLETT hp PACKARD
Advance Products
Dept. 103-J
10900 Wolfe Road
Cupertino, California 95014

IMPORTANT: When using your purchase order, please include this dept. number

EVALUATION REQUEST FORM

Product: HP-35 Pocket Calculator

Terms: 15-Day Free Trial Examination

This is to authorize shipment to Mr. R. J. Nelson, of the Model HP-35 Pocket Calculator, including leather carrying case and recharger, @ $395. It is understood that Mr. Nelson may examine and evaluate the HP-35 for 15 days without obligation on his part or that of his company. And, if not completely satisfied, he may return the unit and accessories within 15 days for full credit.

Authorized by: RK.

Ship to: Mr. R. J. Nelson
2541 W. Camden Pl.
Santa Ana, CA 92704

If above is not correct shipping address, please make necessary changes.

Payment Options (CHECK ONE):

☐ BILL MY COMPANY for $395.00 plus $4.95 shipping and handling charge and any applicable state or local taxes. Please indicate bank information below.

BANK NAME _____ BANK LOCATION OR PHONE NO. _____

☐ BILL MY CREDIT CARD for $395.00 plus $4.95 shipping and handling charge and any applicable state or local taxes. If desired, I can use deferred payment plans as available thru my charge card.

CHARGE TO: ☐ American Express ☐ BankAmericard ☐ Master Charge

MY COMPLETE CARD NO. IS: _____

If using MASTER CHARGE, please include 4-digit bank number appearing on card just above your name ☐☐☐☐

If your name and address on charge card do not correspond to that shown above, indicate changes:

NAME APPEARING ON CREDIT CARD _____

STREET ADDRESS _____ CITY, STATE, ZIP _____

☐ CASH PAYMENT: Check is enclosed for $395.00 plus applicable state and local taxes. Hewlett-Packard pays shipping and handling. Same 15-day return privilege applies.

NOTE: To order more than one unit, please specify quantity here ____ and enclose company purchase order.

AUTHORIZING SIGNATURE (If billed to credit card, must be signed by cardholder) _____ TITLE _____

BUSINESS PHONE NO. _____ COUNTY _____

Fig. A1 – This is what you received if you responded to an HP-35A published ad or direct mailer.

My HP-35A file also contains a Xerox copy (an actual Xerox) of my "rubber" check and the order form I sent to HP. See Fig. A2.

The form says to send $395 plus $4.95 shipping if you are billed. The last option is for cash and HP paid the shipping. Every penny counted and I did not have a credit card.

Note that the California sales tax in 1972 was 5%. The sales tax today is closer to 8.5% depending on the city or county where you live.

RICHARD J. NELSON
PASTORA B. NELSON
2541 W. CAMDEN PLACE (714) 557-6614
SANTA ANA, CALIFORNIA 92704

191
May 3 1972
90-2313
1222

PAY TO THE ORDER OF HEWLETT PACKARD $ 414.75

Four Hundred Fourteen and 75/100 DOLLARS

BANK OF AMERICA
BRISTOL - MC FADDEN BRANCH
1550 SOUTH BRISTOL STREET
SANTA ANA, CALIF. 92704

MEMO HP-35

⑆122231319⑆ 09110 0261 21

HEWLETT hp PACKARD
Advanced Products Department 104
10900 Wolfe Road
Cupertino, California 95014
May 3, 1972

IMPORTANT: When using your purchase order, please include this dept. number

☒ **I'd like to "shirt-pocket-test" your HP-35 on the job for 15 days**

Please ship me the HP-35 Pocket Calculator, complete with leather carrying case and recharger, at $395.00. I have checked below the payment option I prefer . . . but I understand that if I'm not completely satisfied, I may return the unit and accessories within 15 days for full credit.

CHECK ONE PAYMENT OPTION:

☐ **BILL MY COMPANY** for $395.00, plus $4.95 shipping and handling charge.*

☐ **BILL MY COMPANY ON YOUR DEFERRED PAYMENT PLAN** *(available only if purchased for business or commercial use)*: $395.00 plus a finance charge which will be no more than the maximum rate allowed in my state (not to exceed an Annual Percentage Rate of 18%). This will be divided into 15 equal monthly installments. The $4.95 shipping and handling charge plus applicable state and local taxes will be paid with the first installment.*

☐ **BILL MY CREDIT CARD** for $395.00, plus $4.95 shipping and handling charges.* *If desired, I can use deferred payment plans as available through my charge card.*

☐ American Express
☐ BankAmericard
☐ Master Charge

CARD NO. _____
If using MASTER CHARGE, please indicate the 4-digit number appearing on the card just above your name ☐☐☐☐

☒ **CASH PAYMENT.** Check for $395.00 is enclosed, plus applicable state and local taxes. Hewlett-Packard pays shipping and handling. Same 15-day return privilege applies.

*APPLICABLE STATE & LOCAL TAXES WILL BE ADDED TO YOUR BILLING.

SHIP TO: (If address is other than shown below)

Richard J. Nelson — ELX ENG
NAME — TITLE
HI-TEK CORP
FIRM
2220 S. ANNE ST.
STREET
SANTA ANA CA 92704
CITY — STATE — ZIP

$395.00 + .05 = 19750

395 + 19.75 = 414.75

R. J. Nelson
SIGNATURE (If billed to credit card, must be signed by cardholder) — TITLE

(714) 540-3520 — ORANGE
BUSINESS PHONE NO. — COUNTY

NOTE: To order more than one unit, please specify quantity here ____ and enclose company purchase order.

Fig. A2 – Order form for Richard's HP-35A.

I sent in my order and waited . . . and waited. The wait was the most difficult part. Eventually I received a shipping notice from HP. See Fig A4.

On July 31, 1972, just under 12 weeks after I ordered, my HP-35A arrived – at 9:50 in the morning.

HEWLETT hp PACKARD
10900 Wolfe Road, Cupertino, California 95014, Phone 408 • 257-7000

TO
S CUST ORD # -
HP ORD # 220601077
RICHARD NELSON
HI-TEK CORP
2220 S. ANNE ST
SANTA ANA, CALIF 92704

7-31-72
RCVD UPS
9:50 Am

PACKING SLIP ENCLOSED

9320-2199

Fig. A3 – Shipping label of Richard's HP-35A.

HEWLETT hp PACKARD

ADVANCED PRODUCTS 10900 Wolfe Road, Cupertino, California 95014, Telephone 408257-7000, TWX 910-338-0221

Dear Customer:

I am pleased to tell you that your HP-35 has been shipped separately and should arrive soon.

Your invoice is enclosed. You may use the extra copy provided to notify us if delivery is not made within ten days or if there are any difficulties with your unit upon arrival.

Please take a few moments to look through the first two sections of the operating instructions. The HP-35 is extremely easy to use, and in a very few minutes you will realize how quickly and simply you can make calculations that would otherwise have been impossible with any other portable calculator.

We hope you will take full advantage of the trial period to explore fully the power, versatility, and convenience of your HP-35 at work, at home, or while traveling. We are confident that you will become an enthusiastic member of the growing family of HP-35 users.

Sincerely,

Ron Stevenson
Advanced Products
Customer Service Manager

RS:kj

P.S. Naturally, no payment is due until the end of your trial period. If you have prepaid or charged to a credit card, a copy of an invoice showing a zero balance is included.

Fig. A4 – Notice of shipment of Richard's HP-35A.

PLEASE REMIT TO

HEWLETT hp PACKARD
ADVANCED PRODUCTS
P.O.BOX 38289
SAN FRANCISCO CA 94138

PLEASE DIRECT ALL INQUIRIES TO

ADVANCED PRODUCTS
10900 WOLFE ROAD
CUPERTINO CA 95014

PHONE (408) 257-7000

PLEASE PAY ON THIS INVOICE
NO STATEMENT WILL BE ISSUED

DUPLICATE

INVOICE

SHIP TO
RICHARD NELSON
HI-TEK CORP
2220 S. ANNE ST
SANTA ANA, CALIF 92704

M/F

INVOICE TO
RICHARD NELSON
HI-TEK CORP
2220 S. ANNE ST
SANTA ANA, CALIF 92704

PAYMENT DUE 30 DAYS FROM INVOICE DATE EXCEPT AS INDICATED BELOW

ORDER DATE	CUSTOMER ORDER NUMBER	GOVERNMENT CONTRACT NUMBER	HP GSA	HP PURCH
11MAY2				

SHIP DATE	SHIPPED VIA	B/L NUMBER	INV. DATE	INVOICE NO.
7/27/72 PPD BEST			7/28/72	07-4684
CASH				220601077

ITEM NO.	PRODUCT NUMBER	DESCRIPTION	QUANTITY SHIPPED	UNIT PRICE	AMOUNT
0100	35A	POCKET CALCULATOR	1	395.00	395.00
	SERIAL NO:	1143A38208			
	04	PLUS 5.00% TAX			19.75
		CASH PAYMENT			414.75

THANK YOU FOR YOUR ORDER

PLEASE SEND INVOICE COPY OR REFERENCE NO. AND REMIT 0.00

ALL CLAIMS FOR LOSS OR DAMAGE IN TRANSIT MUST BE MADE AGAINST THE CARRIER. PRICES F.O.B. FACTORY UNLESS OTHERWISE SPECIFIED. SELLER REPRESENTS THAT THESE GOODS WERE PRODUCED IN COMPLIANCE WITH ALL APPLICABLE REQUIREMENTS OF SECTIONS 6, 7 AND 12 OF THE FAIR LABOR STANDARDS ACT, AS AMENDED, AND OF REGULATIONS AND ORDERS OF THE UNITED STATES DEPARTMENT OF LABOR ISSUED UNDER SECTION 14 THEREOF.

Fig. A5 Invoice shipped with Richard's HP-35A.

Several things are worth noting. As previously mentioned the payment was not expected until after the 15 day trial period. The serial number of the HP-35A is noted on the invoice. This is a fairly early machine. Also note the HP-35A designation as the "Product Number."

The new 35th anniversary machine, the HP35s, product number is now called a manufacturing number and is: MFG#F2215AA#ABA.

If you study the paper work in the figures you will also notice an important historical distinction. The first HP calculator team started as the Advanced Products Department at 10900 Wolfe Road in Cupertino CA. When you hear of APD it was originally the Advanced Products Department.

As the department grew from the original 14 people, see figure C5, to over 700 people by the time the HP-35A was discontinued, APD became known as the Advanced Products Division. It is unclear to me the HP definition of division. Does it have to do with size, sales, or products? When does a Department become a Division?

The 700 employee number is also interesting because I remember when HP moved to Corvallis after they moved into new larger facilities in Cupertino I was told the idea was that the company wanted to keep a division as a small working group on the order of 600 people. When the number increased much beyond that number the "division" would be split. The Corvallis facility also used a new more efficient building design with a "half floor" between two floors to provide access to plumbing and electrical distribution. The new calculator "department" was having an impact on HP Corporate and APD was a little like a "tail wagging the dog" by influencing everything from people management to selling methods.

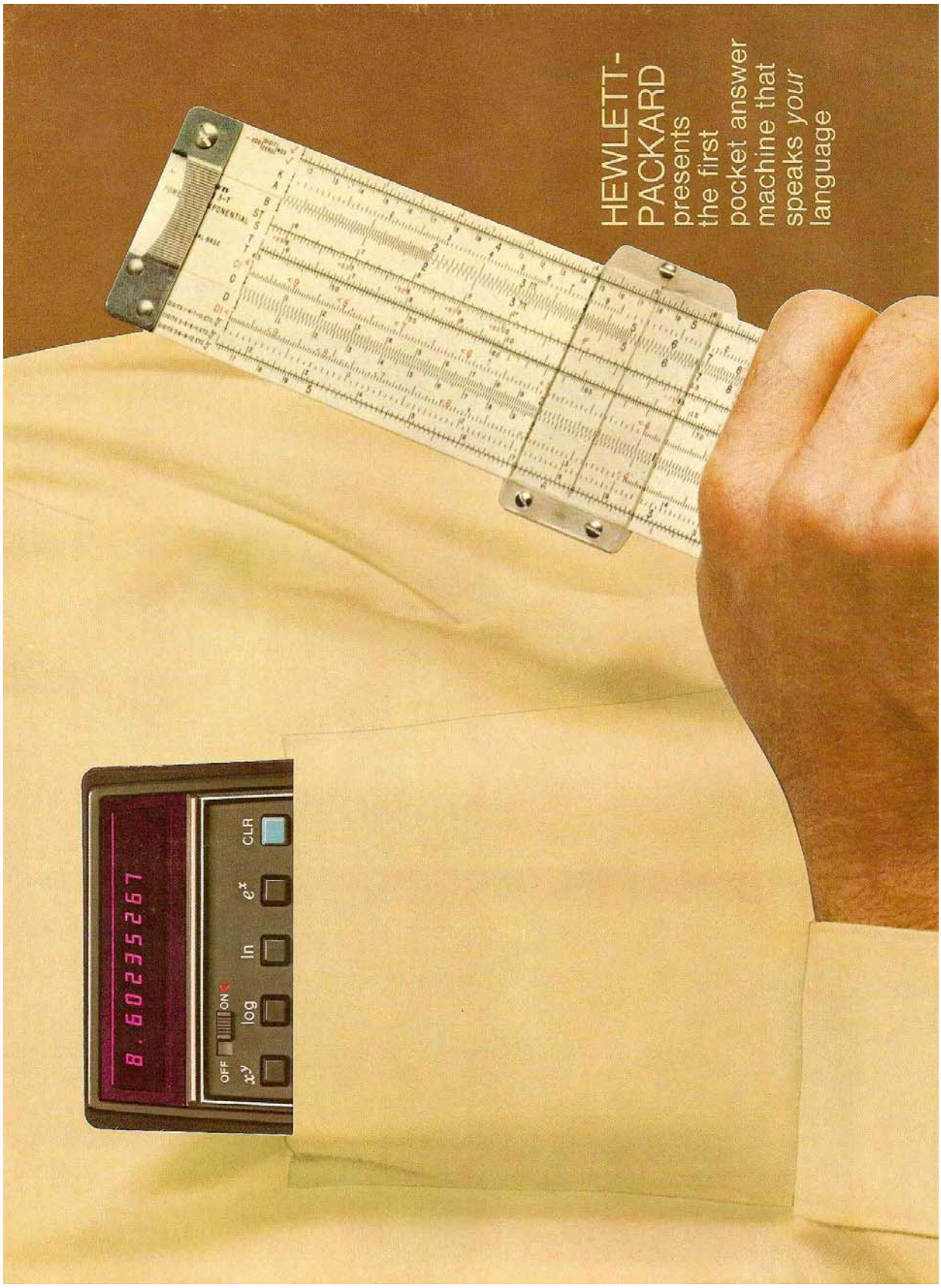


Fig. B1 – Undated six page full color brochure. The front page has a cutout window and opens to show the HP-35A full size. Note the red dot. The unseen label at the bottom of the machine says Hewlett•Packard.

Figure B1 shows an early version of the HP-35A with a "red dot" to the right of the on-off switch. Figure B2 shows a later version of the HP-35A which doesn't have the "red dot." There are at least four versions of the HP-35A and some collectors claim that there are six or more. We should be able to settle this question as to how many different HP-35A's there are at HHC 2007 if everyone brings their machines.

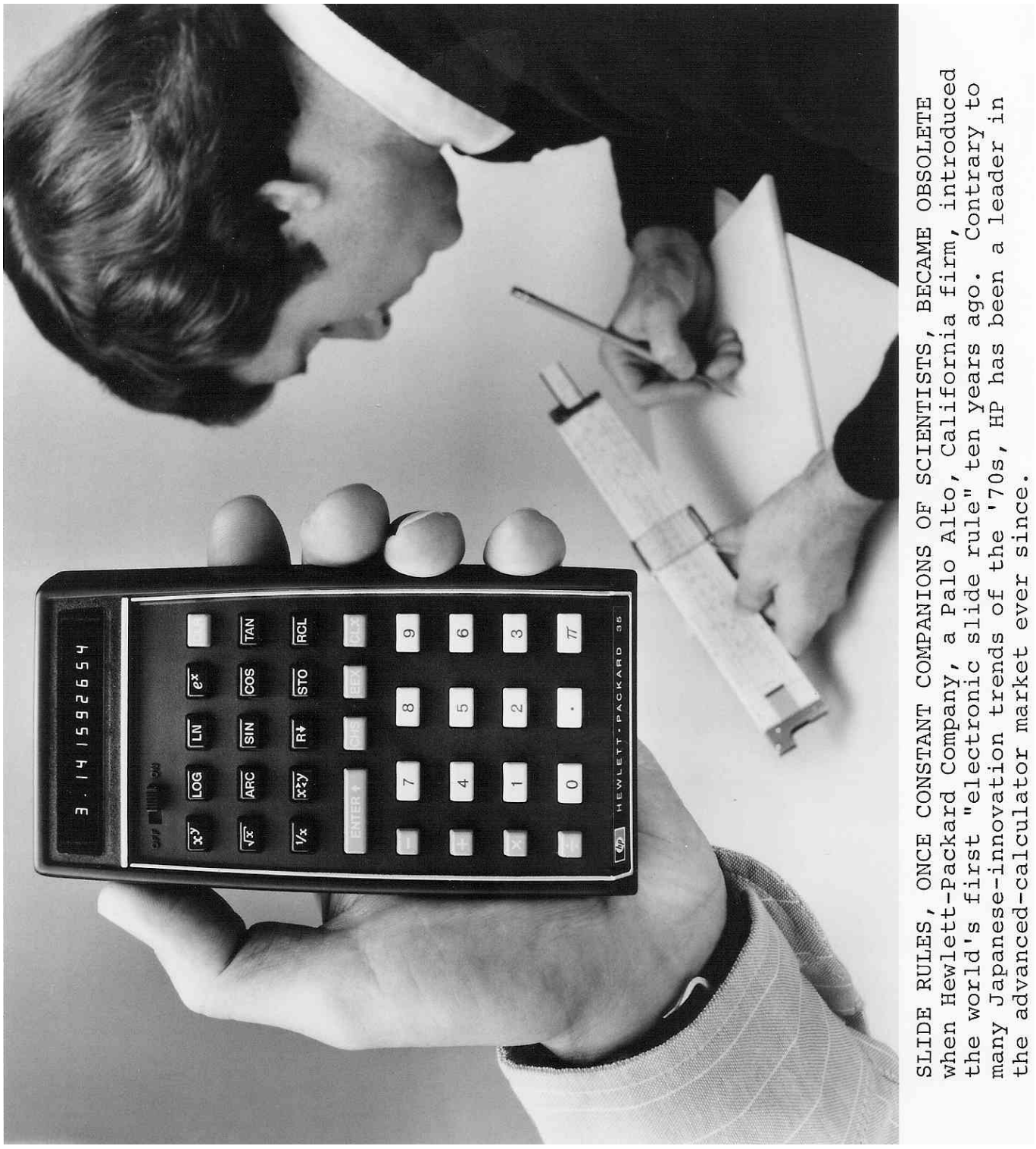


Fig. B2 – Undated – ten year anniversary? - HP-35A Press release photo. This is a later version that doesn't have the "red dot." Note the label at the bottom that says Hewlett•Packard 35.

The Hewlett-Packard HP-35 Scientific Pocket Calculator

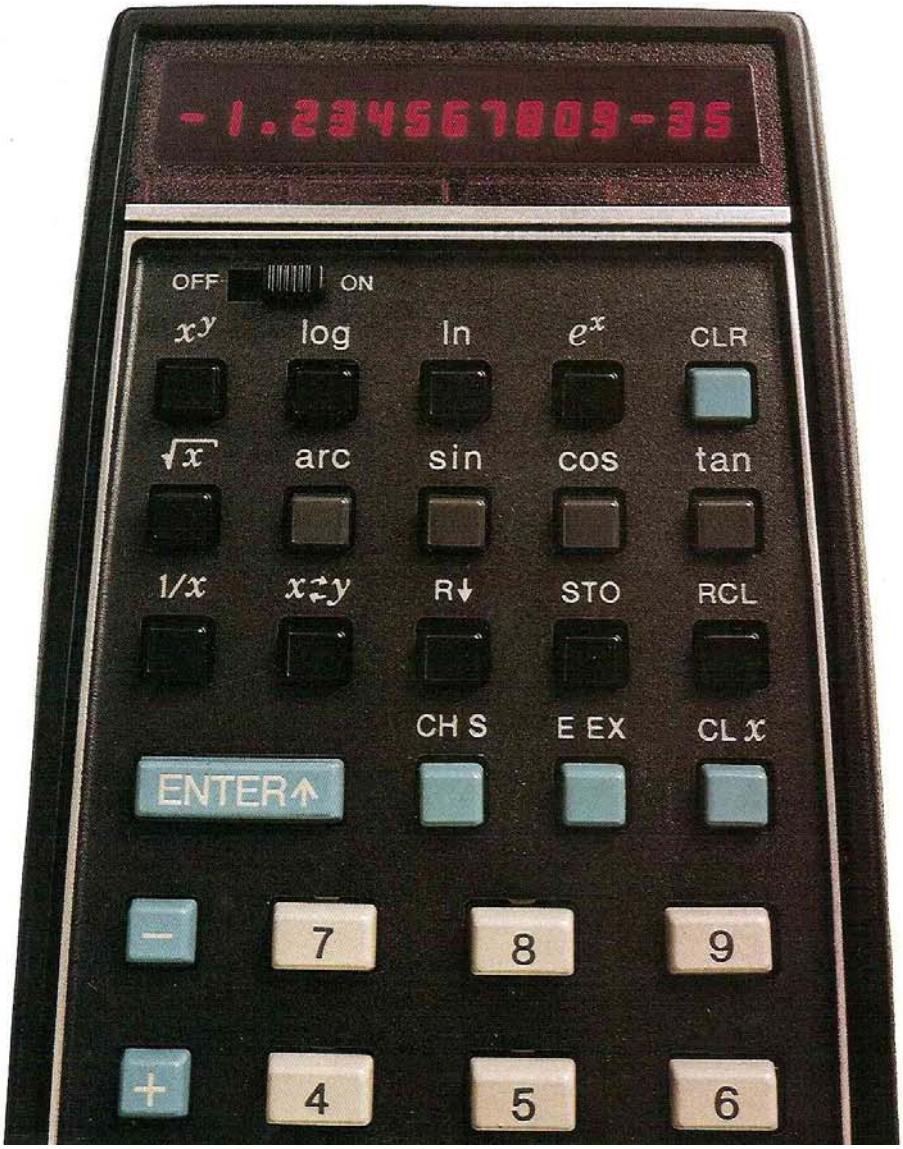


Fig B3 – Four page brochure (7/73) using the marketing cut-off-the-image technique to get the readers attention.

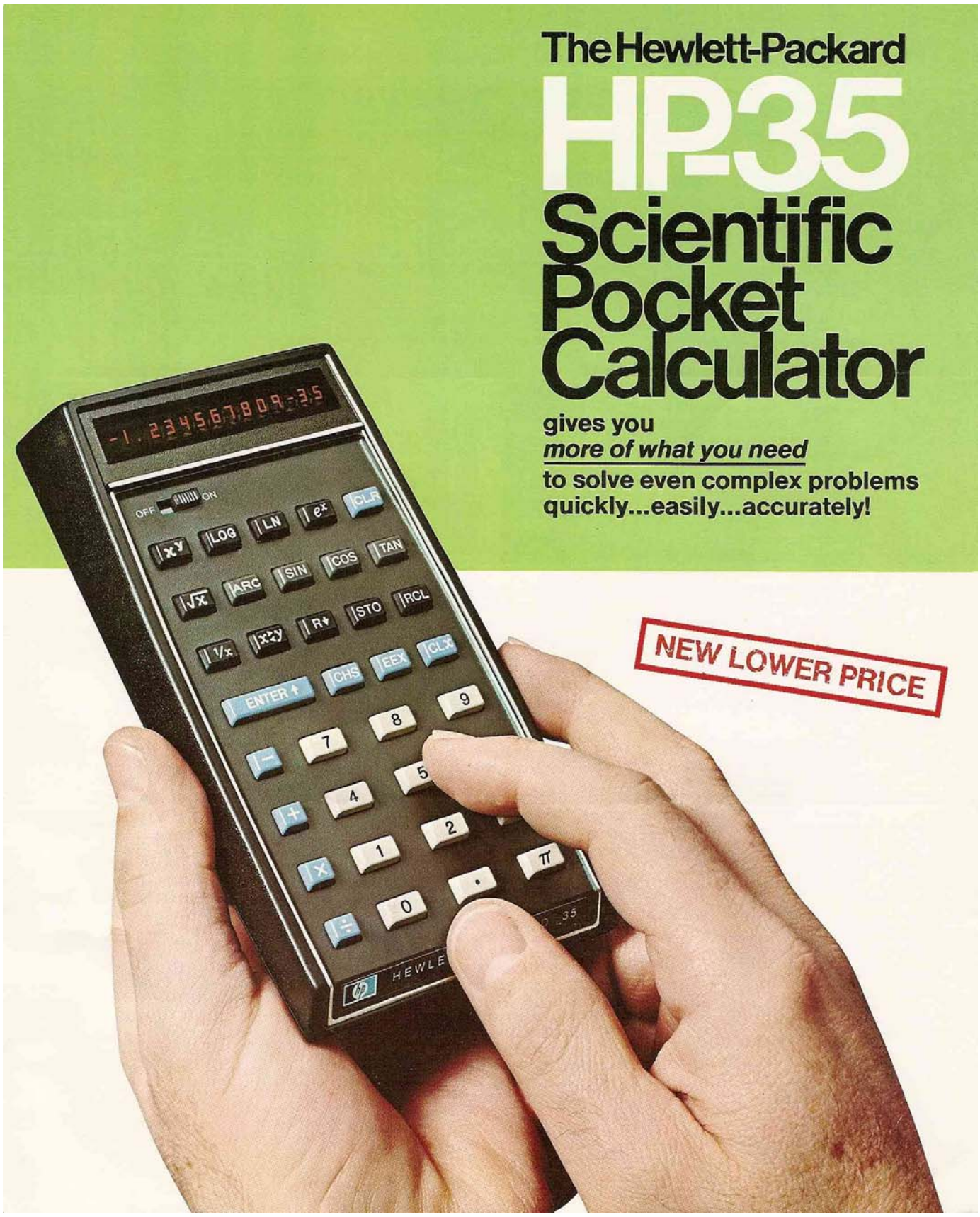
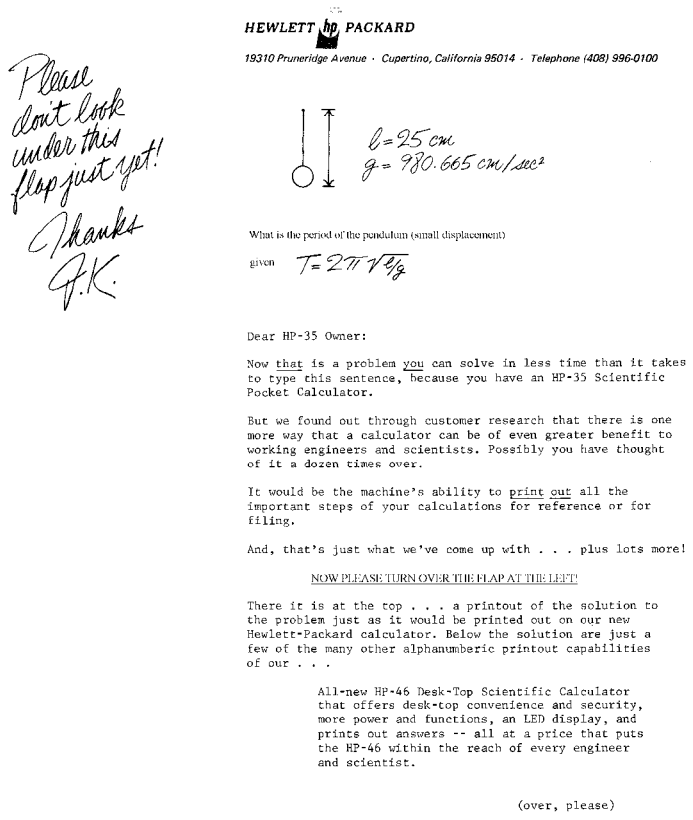


Fig. B4 – Four page flyer (3/74) promoting the last of the HP-35A's.

When you bought an HP-35A you were put on HP's mailing list and you received mailings for future machines. I received the letter below for the HP-46 which was introduced in 1973. I don't think that this machine sold very well. It is not shown on Rick Furr's HP Calculator poster. It was manufacturer by HP in Loveland Colorado and it didn't have much to do with APD. Obviously APD shared their mailing list with another HP division.



Please don't look under this flap just yet!
Thanks
F.K.

HEWLETT hp PACKARD

19310 Pruneridge Avenue · Cupertino, California 95014 · Telephone (408) 996-0100

$l = 25$ cm
$g = 980.665$ cm/sec²

What is the period of the pendulum (small displacement)
given $T = 2\pi\sqrt{l/g}$

Dear HP-35 Owner:

Now that is a problem you can solve in less time than it takes to type this sentence, because you have an HP-35 Scientific Pocket Calculator.

But we found out through customer research that there is one more way that a calculator can be of even greater benefit to working engineers and scientists. Possibly you have thought of it a dozen times over.

It would be the machine's ability to print out all the important steps of your calculations for reference or for filing.

And, that's just what we've come up with . . . plus lots more!

NOW PLEASE TURN OVER THE FLAP AT THE LEFT!

There it is at the top . . . a printout of the solution to the problem just as it would be printed out on our new Hewlett-Packard calculator. Below the solution are just a few of the many other alphanumberic printout capabilities of our . . .

All-new HP-46 Desk-Top Scientific Calculator that offers desk-top convenience and security, more power and functions, an LED display, and prints out answers -- all at a price that puts the HP-46 within the reach of every engineer and scientist.

(over, please)

Fig. B5a – Promotional letter for the new HP-46, first page. The script at the top left is on a flap that when turned over shows an adding machine tape of problems.

Your HP-35 is the one for your pocket; the HP-46 is the one for your desk. Let's look at the HP-46's great capabilities:

First of all, it has 9 storage locations which can be utilized and printed out individually or simultaneously. And the HP-46 will . . .

- Convert polar to rectangular (and vice versa)
- Set degree, radian or grad modes and convert angles from one mode to another
- Print out the number of entries in a summation, the standard deviation, and the mean -- all in one stroke!
- Recall the argument of a function after the function has been executed
- Raise y to the power x; e to the power x
- Calculate common or natural log and anti-log
- Calculate sine, cosine, tangent, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$
- And perform many other mathematical functions

One of the best features "programmed" into the HP-46 is the price. You might expect a machine of its capabilities to run well above a thousand dollars. But the HP-46 is only $815. That includes the printout feature and LED display.

TRY IT FOR 15 DAYS!

Would you like to try the HP-46 at your own place of work under actual firing line conditions? It can be done. See the enclosed card for details of our 15-day trial examination. When you receive the HP-46, place it anywhere in your lab or department and let everyone try it out.

Once you try the HP-46 Desk-Top Scientific Calculator, you'll wonder how you ever got along without it!

Drop the card in the mail today.

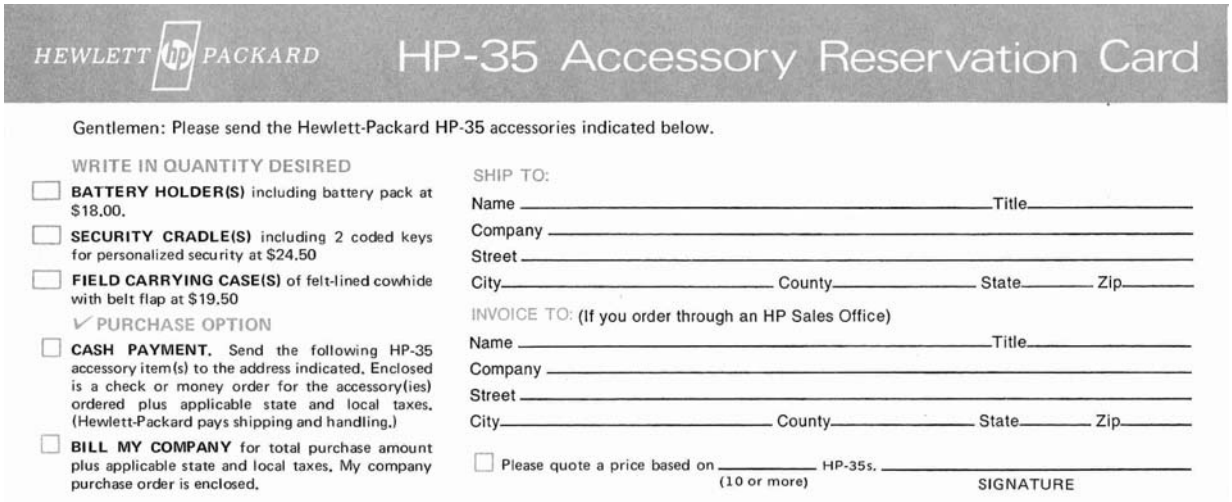
Cordially,

Tom Kelley

Tom Kelley, General Manager
Calculator Products Division

TK:c

Fig. B5b Promotional letter for the new HP-46, second page.



HEWLETT hp PACKARD **HP-35 Accessory Reservation Card**

Gentlemen: Please send the Hewlett-Packard HP-35 accessories indicated below.

WRITE IN QUANTITY DESIRED

☐ **BATTERY HOLDER(S)** including battery pack at $18.00.

☐ **SECURITY CRADLE(S)** including 2 coded keys for personalized security at $24.50

☐ **FIELD CARRYING CASE(S)** of felt-lined cowhide with belt flap at $19.50

✓ PURCHASE OPTION

☐ **CASH PAYMENT.** Send the following HP-35 accessory item(s) to the address indicated. Enclosed is a check or money order for the accessory(ies) ordered plus applicable state and local taxes. (Hewlett-Packard pays shipping and handling.)

☐ **BILL MY COMPANY** for total purchase amount plus applicable state and local taxes. My company purchase order is enclosed.

SHIP TO:

Name _____ Title _____

Company _____

Street _____

City _____ County _____ State _____ Zip _____

INVOICE TO: (If you order through an HP Sales Office)

Name _____ Title _____

Company _____

Street _____

City _____ County _____ State _____ Zip _____

☐ Please quote a price based on _____ HP-35s. _____
(10 or more) SIGNATURE

Fig. B6 – Here is an HP direct mailing piece to promote HP 35A Accessories. Note the back order implication.

HEWLETT hp PACKARD

19310 Pruneridge Avenue, Cupertino, California 95014, Telephone 408 996-0100

Dear HP-35 Owner:

In the relatively short time since the popular HP-35 scientific calculator came onto the market, we've answered thousands of requests for help in using the calculator to most efficiently solve many common but complex mathematical problems.

Now, we've put the most important of these solutions together in a handy new book, the "HP-35 Math Pac". This 169-page handbook gives anyone who uses mathematical formulae the keys to the full power of the HP-35 scientific calculator.

This valuable spiral-bound handbook gives you fully documented routines that enable you to step through even the most complicated formulae easily. With the "HP-35 Math Pac", you save time because you don't have to figure out how to solve a difficult equation. Nor do you have to remember the keystroke sequences...the handbook provides a permanent record, reducing the chance of making an error.

The "Math Pac" can also show you how to use Hewlett Packard's "RPN" (Reverse Polish Notation) and powerful operational stack in new and more efficient ways in all your problem solving.

The "HP-35 Math Pac" is divided into seven major sections that provide solutions to well over 100 useful equations. Here's a list of the sections:

Machine Related Operations	Numerical Methods
Number Theory and Algebra	Finance
Geometry and Trigonometry	Appendix (Questions and Answers)
Statistics	

Included in these sections are keystroke sequences for problems like Triangle Solution, Linear Regressions, Hyperbolic Functions, Complex Trigonometry, Complex Arithmetic, Vector Operations, Chi-Square and Correlation Coefficient, Roots of Numbers and Polynomials, Numerical Integration, Conversion Routines of many types, Iterative Solutions to Equations, Compound Interest Calculations, and many more.

With this handbook you'll be able to save calculation time, because you won't have to figure out how to solve a problem or reformat an equation to fit your application. You'll also be more confident of your answers because you will have less chance for error in stepping through your math problems.

Let us help you use the full power of your HP-35. Invest $10.00 to get expert help in solving your math problems. Simply fill out the coupon below, enclose it and your check in the postage paid envelope provided and send it to HP today.

Sincerely,

Dan Scheel

Dan Scheel
Sales Manager

9320-2300 *Just clip this coupon, put it into the postage-paid envelope, enclose your check and drop it in the mail today.* 5952-6043D

☐ , I'd like to begin using all the power of my HP-35 right away!

Please send____copies of the "HP-35 Math Pac," at $10.00* plus tax per copy. (00035-66001)

Enclosed is my check for $_____ (please include your state and local taxes)

*Domestic U.S.A. Prices

HEWLETT hp PACKARD
ACCESSORY SALES DEPARTMENT
19310 Pruneridge Avenue
Cupertino, CA 95014

RICHARD NELSON 194ZF
HI-TEK CORP
2220 S ANNE ST
SANTA ANA CA 92704

Please print clearly, this is your shipping label.

Fig B7 – HP-35A Math Pac promotional letter. Note the play on words text. This Pac has an interesting history. See the text at the bottom of page 3 for the story of its history.

Appendix C – Internal HP-35A Related Publications – Page 1 of 6 pages.

The following article, see foot note 3 on page 1, is dated August 1975 and it announced the retirement of the HP-35A. I had thought for many years that the HP-35A held its price throughout its life. Exploring my HP-35A file, however, shows that the price had been officially reduced. I would like to see a price Vs. time plot/table for each of HP's calculators. Which models best held their price over their official life? As I unpack my calculator materials I will eventually get to the boxes of HP calculator t-shirts that I have saved. I wonder if I have one with an HP tiger on it? All are new and have not been worn or washed.

HP-35 replaced in product line

A 'superstar' quietly retires

Advanced Products Division in Cupertino is retiring the HP-35 – the machine that sparked the current revolution in sophisticated scientific and business pocket calculators just three-and-a-half years ago. Introduced on January 4, 1972, it was the first of the now popular electronic slide rules, and it established new standards of speed and accuracy in personal computation devices.

APD has introduced even more sophisticated models since then, and has sold more than a million pocket calculators throughout the world. Replacing the 35 in the division's product line is the HP-21 – which, thanks to evolving technology, performs more functions for a lower price.

Since introduction of the 35, APD employment has increased from a handful of people to over 700. Bob Schaeffer, having just returned from Singapore, was one of the first to join the group that was to become the fledgling division.

As production manager, Bob recalls many problems in stepping up production to higher volumes than HP had experienced with any other product. "The original outside market survey predicted the 35 would sell, at its maturity, at the rate of 2,000 a month," Bob remembers. "I think we actually reached that level within the first few months." It wasn't long before the schedule called for 2,000 per week.

Linda Waxler was another member of that small team that began producing calculators in a crowded corner of the Data Systems plant. She described those first few months as a hectic time, but one in which morale was always high and a certain spirit caught hold that is still evident today.

Bob tells of some employees who were so eager they climbed over the partition that enclosed their work area so they could start to work earlier. "Somehow this group spirit got going and our people were just unbelievable – unbeatable! They could do anything."

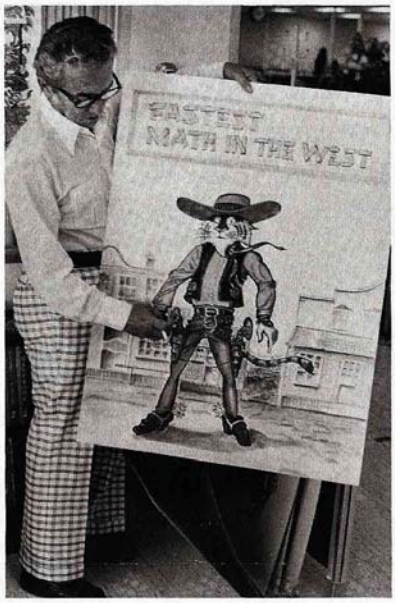
The pocket calculator team soon won the reputation of being "tigers" on the job. And that spirit, together with Bob's wartime experience with the "Flying Tigers" of the 23rd Fighter Group, gave birth to the friendly tiger that became an APD symbol.

The tiger started appearing on posters, publications and tee-shirts. Clyde Coombs, a "Flying Tiger" buff, ordered patches that were sewn onto shirts and smocks, and they seemed to inspire even greater loyalty and initiative.

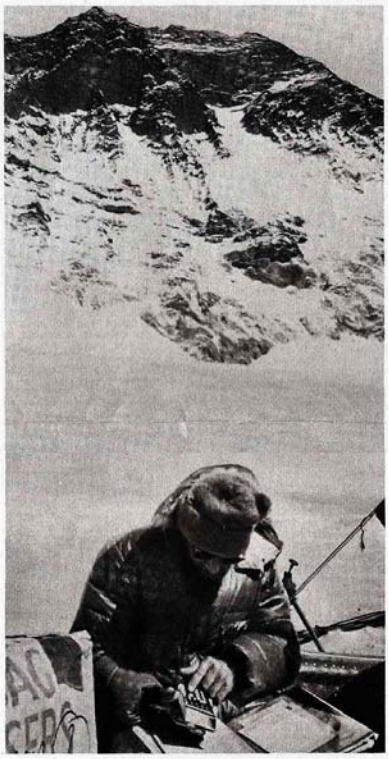
Such spirit is all the more remarkable considering the range of problems that had to be solved – most of which had no precedent within HP. Sharon Butterfield was doing the order processing, and had her hands full as orders flooded in for the HP-35. Eventually she, and others who came on board later, worked out an ingenious computerized system.

Gerry Inman, who joined Bob in the production area, is an accomplished Finn sailor after hours—and although he intended to try out for the Olympics, he couldn't spare the time away from his work. Every job seemed to require super-human effort – to handle the orders, produce the products, keep up with the demand for parts, accommodate the growing numbers of people, and to move into the present buildings in Cupertino. According to Bob, "Many of the people who joined us have made somewhat the same statement that I have. That is, I've never worked so hard in my life, but I've never had so much fun either. There was just no such thing as an eight-hour day."

It's a little different now. The spirit is still evident, but the work is more routine, more organized, more systematic. In a sense, retirement of the HP-35 signals the end of an era, and the division's move to Corvallis, Oregon, in the near future will bring even greater change. But the tiger is a nearly invincible animal, and the indomitable APD spirit will undoubtedly survive.



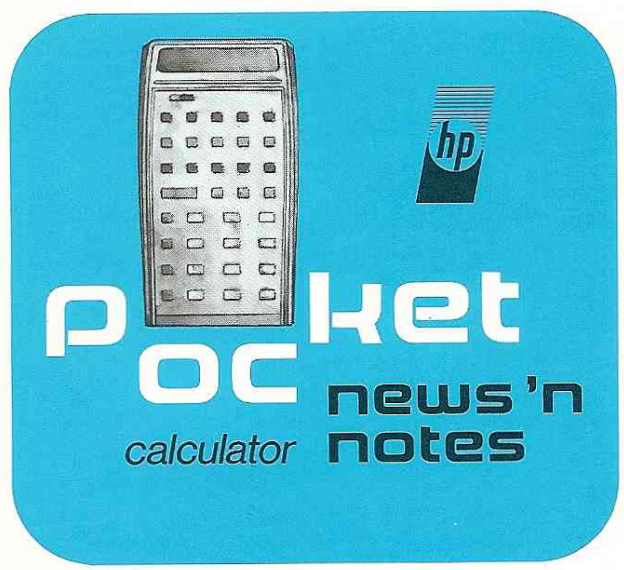
Bob Schaeffer shows one of the early tiger posters extolling the virtues of the HP-35.

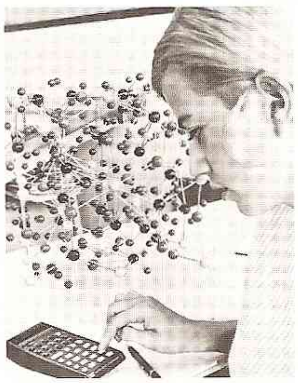


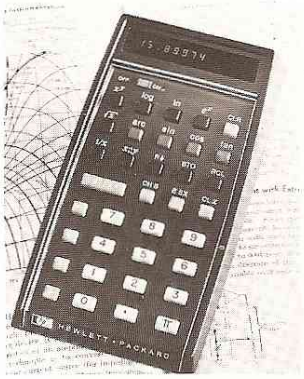
Some of the thousands of HP-35s that were sold were involved in high adventure. This one was carried high upon the rugged slopes of Mt. Everest. One survived a trip through a snowblower in freezing temperatures, others helped navigate sailing vessels on the high seas. But mostly, the HP-35 faithfully performed calculations for students and professionals in science, engineering and business.

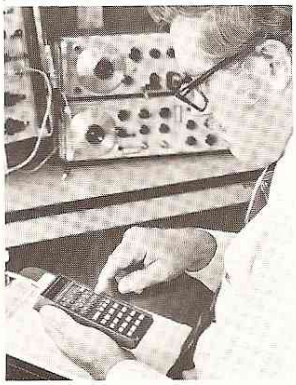
Fig. C1 - The Peninsulan was published monthly for Hewlett-Packard People in Palo alto, Mountain View, Cupertino, Santa Clara, and Sunnyvale. This August 1975 issue article describes a bit of history of the HP-35A.

I didn't know that this publication existed until I visited the Palo Alto HP facility in 1975. Free copies were available to be picked up in the lobby. Is this publication still being published 32 years later?









We've had an overwhelming response—

Frankly, the response to our announcement of the HP-35 back in January caught us a bit by surprise. In fact, the order rate now is about three times what we had anticipated. Demand for the unit is so great that we are now quoting 12-week delivery.

Since you already have your HP-35, you can appreciate the great degree of interest this powerful little calculator has generated. Since the introductory press conference at the beginning of the year, more than 220 magazines and newspapers have chosen to feature the HP-35 on their pages. More than 70 million people learned about the calculator through this channel.

We originally thought that the HP-35 would be bought primarily by people in the scientific and engineering communities, but we have received a large number of orders from bankers, contractors, insurance brokers, doctors, statisticians, and others outside the highly technical professions. It seems the HP-35 is more versatile than even we thought.

Interestingly, about half of our orders have come from individuals, purchasing their HP-35's with personal funds. This percentage is changing, though, as more and more companies and corporations begin to order the calculators in quantities of 50, 100 and more. To accommodate quantity purchasers, we have established a discount schedule for such orders.

Remarkable as the HP-35 may be, it is only one of a full line of advanced computational products that Hewlett-Packard offers. The Model 9810 and the new Model 9820 are among the most advanced programmable scientific calculators on the market, and the HP 3000 system, introduced late last year, is a multi-programming computer based on a radical new design for small central processors. With products like these in our line, HP is in a unique position to offer customers a full range of problem solvers for many applications.

Our vigorous research and development effort in the field of computation is an example of our continuing commitment to the production of devices like the HP-35 that represent substantial contributions to the state of the art.

As far as we can tell, the HP-35 remains the only machine of its kind on the market. Although other manufacturers have introduced pocket machines with one or another features of the HP-35, no one has yet announced a unit that comes close to being competitive.

If you are interested in quantity discount schedules or in our other computational products, please call one of our regional offices.

Alex Sozonoff
Manager
Advanced Products Department
Hewlett-Packard Company

Fig. C2 - The cover of one of two undated issues I have of an APD HP 1972 internal publication. I can only surmise the 1972 date from the context of the articles.

Figure C2 shows the first page of a four page internal publication of the APD. I didn't copy the other three pages because in terms of "remembering" the HP-35A they contain mostly promotional descriptions for accessories, showing "Hello" in the numeric only display, and calculating how many cubic inches in a "Cosmic Cube" a million light years on each edge. This problem demonstrated the dynamic range of the machine.

My second issue, however, has some additional information worth sharing. Figure C4 is the cover page. Note that the "masthead" has moved from the left to the right side. This is probably something that only an ex-publisher would immediately notice.

The article mentions fiscal sales. For HP that is to the end of October of the year. The article also mentions large quantity orders. A 100 piece order would sell each machine at a discount. At a 15% quantity discount this means that one order is $33,575 dollars. In 2007 dollars that is a single $165,064 calculator order.

The article implies that the Owner's Manual was revised within the first year. I haven't checked my HP-35A manuals for a revision history to check this.

Another interesting fact related to sales is at the bottom where there is the implication of a quota for HP sales people to sell at least 15 machines each. Having HP sales people sell the calculators was still common through 1975 at the end of the product life of the HP-35A. At this juncture the trend was changing very rapidly and with the introduction of the HP-65 it was difficult to get an HP sales person to take your calculator order. Years later I remember an HP Representative telling me that HP had come from calculator sales being 95% field sales and 5% retail to 5% field sales and 95% retail.

Figure C5 shows page four of the newsletter and the people of the APD. You may put a face to the signatures in figures A4, C2, and C6. Older HHC attendees may remember at least one HP person nearly twenty years later at HHC 1991 – Sharon Butterfield. She was still with HP calculators having moved to Corvallis after starting at Cupertino. See figure C5.

One other article, on page five of this Pocket news 'n notes issue is worth including. Here it is.

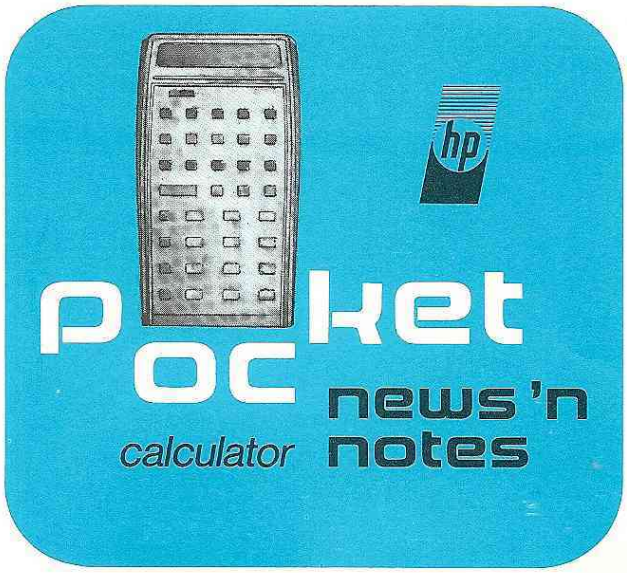
"**No Competition - yet**"

"As far as we know, no competitor has officially announced a portable scientific calculator that resembles the HP-35. We do know that several companies are working to bring a similar machine to market. Two of the more serious projects are in the works at Compucorp and Sharp. Either or both of these units could be announced at any time, but delivery capability is still uncertain."

"Any competition will probably have a hard time generating high production rates, since MOS/LSI and LED manufacturers are running at full capacity and will be for some time to come. Competitors will have to go through what we're going through now."

Fig. C3 – HP APD "Pocket news 'n notes" article describing the competition.

It helps to remember that TI joined the pocket scientific calculator market in 1974 with the SR-50. See Appendix E for an (internal?) HP Comparison of the HP-35A to the TI SR-50.



How things are going

You all know of the tremendous acceptance the HP-35 has enjoyed in the scant six months it has been on the market. In fact, we were overwhelmed by the order rate, which, if it holds, will bring fiscal 1972 sales to a total some three times our initial expectations.

The exceptional efforts of all of you, the nature of the product and widespread publicity combined to make this one of the most successful HP product introductions ever.

Surprisingly, we've found that the makeup of this initial market is much broader than we had anticipated. Many people outside the highly technical areas are buying the HP-35. Also, a large percentage of customers is buying the calculators with personal rather than corporate funds.

Volume purchase agreements have been signed with several corporate customers, and others have bought HP-35's in blocks of 50 and 100. Keep the volume orders coming.

Unfortunately, delivery is now 12 weeks, a situation we don't like any better than you do. In this business, it takes time to get all vendors into high-volume production. We've been working very hard to help our vendors to get into high gear to meet our demand.

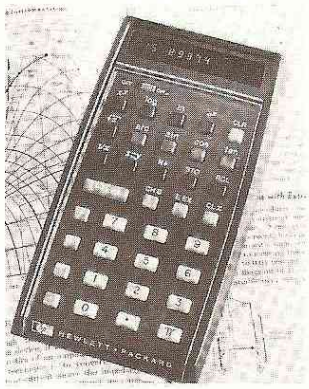
We hope to be able to quote four weeks delivery by the end of the fiscal year, but in the meantime, we are beginning to send letters to customers half-way through the announced delivery time.

The letter expresses our appreciation for his patience, and lets the customer know we're still thinking about him. This should also cut the number of people who call wondering where their unit is.

The new, more readable manual is out, and will be included with all units shipped from now on. A copy of the new version will be sent to every customer who has already taken delivery of an HP-35.

As you can see, we're putting all the pieces together to make sure our marketing, production and customer service match the high standard of the HP-35 product. We're building a substantial base for the future of this exciting product line.

Thanks again for your support in the U.S. sales introduction plan. Most sales engineers have sold their 15 units and the calculator sales people are running hard. The consensus from field management is that, even though the plan created some immediate problems, the long run benefit to HP more than compensates for the initial difficulties. Besides, hasn't it been a lot of fun.



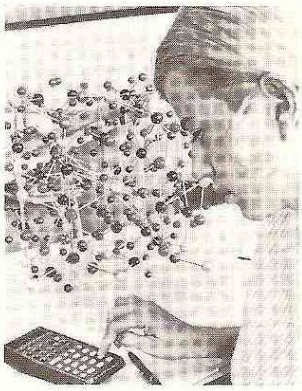


Fig. C4 - The cover of the second of two issues I have of an HP 1972 internal publication. I can only surmise the 1972 date from the context of the articles.

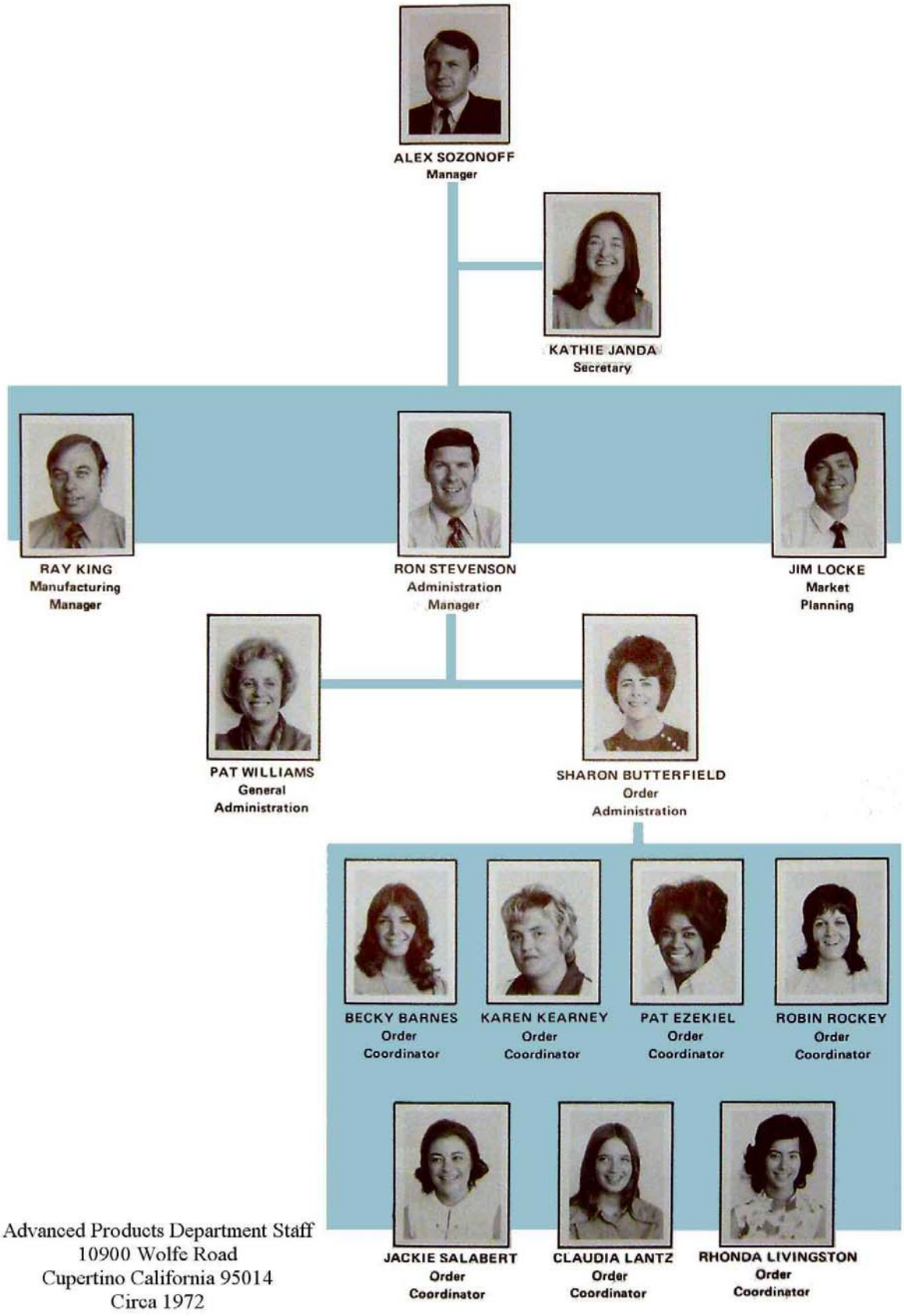


Fig. C5 – Page four of the second of two issues I have of an HP 1972 internal APD publication. This is the earliest staff of the APD.

Historically speaking the following memo helps to put the HP-35A project into perspective. The HP Board of directors had a meeting to discuss the HP-35A and figure C7 outlines the meeting agenda.

The HP board presentation included a report that summarized the calculator market. One sentence was especially interesting in paragraph A on page 3. "It is expected that the U. S. calculator industry is ready to react vigorously to the domination of the Japanese, not only in the world calculator market, but also domestically (70% of market share). The industry does not like to be reminded of another possible 'transistor radio' case where this market was almost entirely taken over by the Japanese."

The next page estimated the potential market for the 35A as having a total universe of around 3,000,000 customers broken into: 33.5% Accredited Engineers, 14% Scientists, 4% Math and Engineering oriented students and 48.5% other occupations (Economists, Architects, Draftsmen, etc.).

The report described the "Plan of fiscal '72. During fiscal '72, we plan to sell a minimum of 12,000 model 35A's in the U. S. for a sales revenue of 4.5 million or a 0.4% penetration into the universe described earlier."

Other interesting statements in the report. Life cycle of 24-30 months. *The life cycle was 42 months.* Potential entries into the market like WANG, Tecktronics, Monroe, and CDC. The fact that Systron-Donner had a scientific pocket calculator on their drawing boards was mentioned. A major competitor for the model 35A was expected to appear within 4-6 months after introduction.

The market from 1969 through 1975 was presented. The Casio "mini" was mentioned to reach 60K machines for all of 1971. Based on a recently released Casio History news release Casio has just produced their 1 billionth calculator. According to their time line the "mini" sold 1 million units in the first ten months of 1972. See the link at:

http://www.casio-intl.com/news/2007/cal_one_billion.html

HEWLETT hp PACKARD

CUPERTINO DIVISION • 11000 Wolfe Road, Cupertino, California 95014. Telephone 408-257-7000.

FROM Alex Sozonoff DATE October 5, 1971

TO Bill Terry
Bill Hewlett
Ray King
Paul Stoft
Tom Osborne
Tom Whitney
Ralph Lee
Bob Boniface

SUBJECT

Attached is a summary of the 35A presentation to the "Board of Directors" of September 17. The financial plan, although updated, is subject to adjustments.

A more detailed plan is being prepared in the form of a "Reference Manual" and will be available next month. We are hoping to make our first test mailings around November 15th but our engineering program may require going "safe" until the last days of December. We will make a final decision concerning the introduction date around November 1st.

Best regards,

AS:aa
Attachment

Fig. C6 – Internal HP board meeting memo for a meeting to discuss the final stages of releasing the HP-35A. Note the date. See figure C5 for photos of Alex Sozonoff and Ray King. Long time HP users will recognize many of the famous calculator people on the distribution list.

A. INTRODUCTION

B. GENERAL
- Definition
- Impact of "minicalculator" on the overall U.S. calculator market
- Pricing characteristics and trends
- Major present manufacturers and expected future entries

C. HP's minicalculator involvement and marketing plan FY '72

D. Medium and Long Term Plans

E. Technical Description of Model 35A: Tom Whitney

F. Manufacturing Plan: Ray King

"BREAK"

DISCUSSION

Fig. C7 – HP Board Meeting agenda. Attached to the memo is a 17 page document titled "Summary of Model 35A Pocket Calculator Presentation to the Board of Directors on 17 September 1971."

Introduction

My HP-35A file contained two internal memos given to me by a retiring HP salesman on the east coast, and these are reproduced in this appendix. The memo in figure D1 explains what happened to the center tactile "bump" HP used on the five key for orientation of 10 key users on the HP-80 and HP-35A.

The second memo is much longer and it describes the factory-to-field service transition. Imagine only paying $16/hr as a shop rate – figure D4 paragraph 10. The HP-35A ROM bug is described in figures D4 and D5 paragraph 13. The factory bug correction occurred on machines with serial number prefix of 1302A and later - mid January 1973.

Figure D5 also mentions the HP-35A Sales Amplifier publication which provides the high points of the machine for the field sales force to use when working with customers. There are two attachments. The first (D6 & D7) is an HP-35A repair logic tree. The second attachment (D8 – D11) is a list of 18 typical questions and answers to be used to support customers.

HEWLETT hp PACKARD

ADVANCED PRODUCTS • 10900 Wolfe Road, Cupertino, California 95014, Telephone 408 257-7000

FROM: Chuck Comiso, APD Marketing
DATE: April 12, 1973

TO: Calculator Sales Force Worldwide
SUBJECT: Pocket Calculator "5" Key

It has been brought to our attention that there is some uncertainty as to whether there should or should not be a small bump on the "5" key. Originally, this bump was put on the HP-35 to act as a "homing key" similiar to what appears on adding machines in order to allow faster operation without looking down at the keyboard. However, as surmized from our customer responses on its value, we found that many people asked that it be removed due to the fact that, in actuality, it really was not that useful and, in some cases, irritated their fingers.

In order to enhance visibility, we thickened the lines used to imprint the numbers on the keys. By doing so, the position of the bump on the "5" key made it difficult to read the number. Therefore, the decision was made, with the advent of the HP-80 in January, to remove this bump not only on the HP-80, but also on the HP-35. We completed using the remaining supply of made-up keys for the HP-35, and upon depletion of that supply, went into production of the "no bump, larger line" HP-35. Currently, both calculators are being produced in this manner.

If you have any customer inquiries on this, please make them aware of the fact that the bump has been removed and their machine is not defective if it has no bump.

CTC:kl

Fig. D1 – Memo that"5" Key tactile bump is removed.

Certainly serious collectors should distinguish one version category as 1972 versions with the "5" key bump and later 1973 versions without the "5" key bump.

HEWLETT PACKARD

EASTERN SALES REGION • P.O. Box [illegible], Century Road, Paramus, New Jersey 07652, Telephone 201-265-5000

FROM: Pete Johnson - ERRC
DATE: February 7, 1973

TO: Paul George, Lexington
George Tamaki, Paramus
Matt Tausz, King of Prussia
Ralph Holmes, Rockville
Ed Popp, Baltimore
Ted Majkowski, Syracuse
Mani Pires, Rochester
Fred Buckingham, Endicott
Bill Yoo, New Haven
Tom Coyne, Woodbury
Frank Martin, Albany
SUBJECT:

This memo was distributed for local Paramus use. The reference to Sherry Hoff should be deleted and the equivalent person in your area substituted.

Regards,

PCJ:sg

Attachment

Fig. D2 – Moving HP-35A repair to field offices.

recommended to customers due to the lack of special service fixtures, additional information and test procedures available to them beyond this point.

Servicing Information

1. Customer troubleshooting confined to attached "Trees".
2. Units in ESR being sent for repair should be addressed as follows:

   → Hewlett-Packard Company
   Eastern Regional Repair Center
   W120 Century Road
   Paramus, New Jersey 07652

3. Complete instrument should be sent unless otherwise stated in Troubleshooting "Tree". Complete instrument is: calculator, recharger and battery pack contained in safety travel case with service card.
4. Other Than Complete Instrument Return:
   (a) unit in warranty - service card indicating calculator serial number must be included.
   (b) unit out of warranty - known defective items (eg. recharger, battery) should not be sent in, but replaced directly through instrument sales--not via repair channels.
5. Instrument Warranty: one (1) year, entire calculator and accessories. (NOTE: S/N 800 and below--warranty questionable. These are demo or give-away units.)
6. Repair Warranty:
   (a) unit in warranty - warranted through end of normal instrument warranty period, no extension as a result of any repairs.
   (b) unit out of warranty - ninety (90) days.

Fig. D3 – Moving HP-35A repair to field offices Cont'd.

7. Turn-around Time: normally two (2) working days at ERRC. In the event of overload or special problems, units will be transshipped to division for back-up service.

8. Shipping Charges:

(a) unit in warranty - to HP, customer pays all charges; from HP, HP pays.
(b) unit out of warranty - customer pays both ways.

9. Information About Units In Repair:

(status, quotes, charges, etc.) contact Carol Fedewicz, Ext. 223.

10. Repair Charges:

(a) unit in warranty - none, unless obvious customer abuse, then individual parts price plus $16/hour labor.
(b) unit out of warranty - not determined as of this writing. Expect to have fixed price repair established shortly.

11. Service Contracts: none yet; this is being studied.

12. Request For Information Not Contained In Manual:

(schematics, parts list, failure rate, problem areas, sales volume, number of units in warranty, etc.) not at liberty to disclose.

13. "Bug Units or Error Units":

modifications to be done by division only on schedule established with customer. ERRC may do this in special cases only. "Error free" units to ship starting January 1973; prior to that all units require modifications which will be done free until November 1, 1973, thereafter customer pays. Modification TAT by division will be five (5) days. First units will be recalled February 1973, updated units warranted for ninety (90) days.

Fig. D4 – Moving HP-35S repair to field offices Cont'd

To Identify "Error Free" Units

(a) serial prefix 1302A and higher are "error free"
(b) to check other prefixes for modification, perform following key functions:

[CLR]
[2.02]
[Ln]
[e^x]

Display should now read [2.02]. If it reads [2.], unit is not modified.

As further information becomes available or changes occur, you will be notified.

For your general information only, pages 6 through 9 of the "35 Sales Amplifier" are attached. Any questions you receive of the type in the Sales Amplifier should be referred to Sherry Hoff.

Regards,

PCJ:sg

Attachments: "Troubleshooting Trees" cc: All
"35 Sales Amplifier" cc: B. G. & Y. V.

P. S. MODEL "80" REFER INQUIRIES TO SHERRY HOFF. ALL SERVICE UNTIL FURTHER NOTICE IS BY ADVANCED PRODUCTS DIVISION ONLY.

Fig. D5 – Moving HP-35S repair to field offices Cont'd

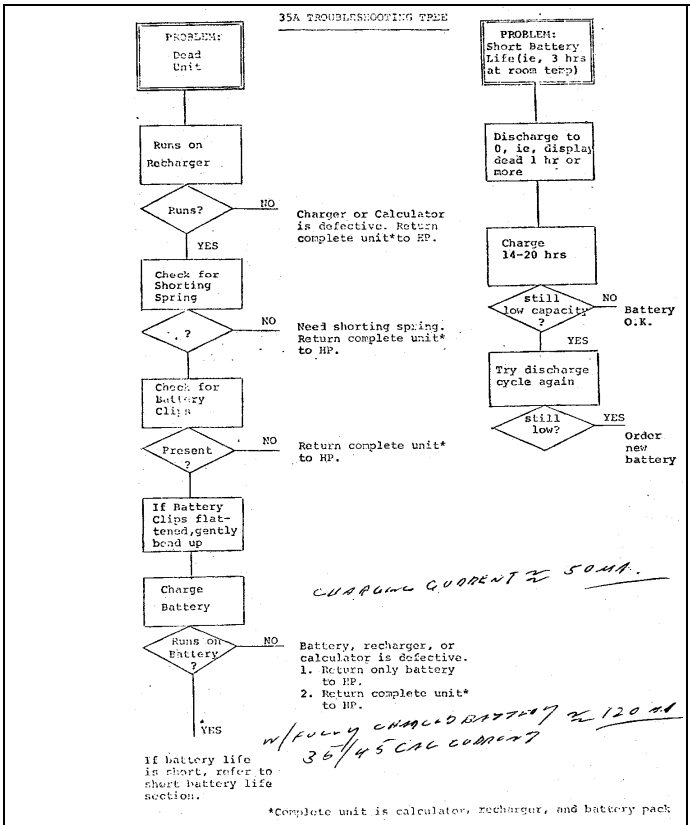


Fig. D6 – D2 memo Logic Tree attachment.

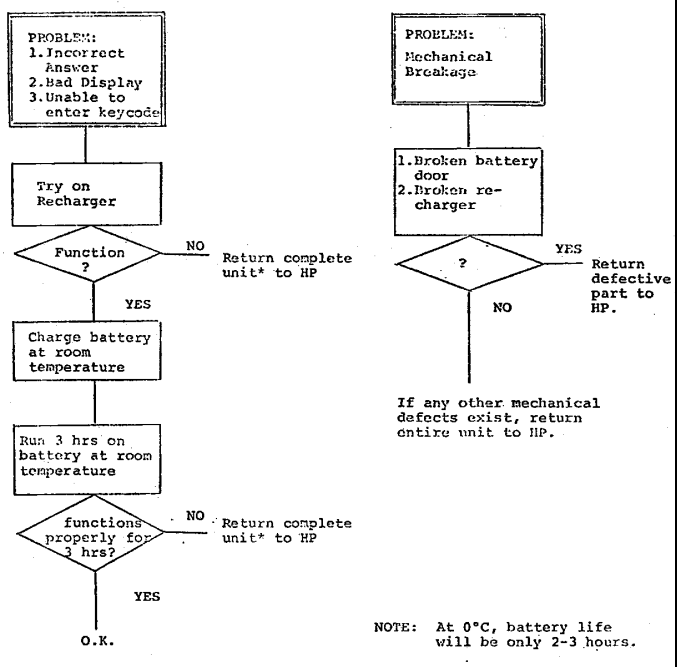


Fig. D7 – D2 memo Logic Tree attachment Cont'd

ANTICIPATING SOME PROSPECT QUESTIONS REGARDING THE OPERATION OF THE MACHINE...AND EXPLANATIONS

1. Question: Why does the HP-35 give different answers when taking tangents close to 90°? Example:

   Tan of +89: 57.28995965
   Tan of -89: -57.28996033

   How is "tangent" calculated?

   Answer: The trig functions (sin, cos, tan) are all resolved to positive angles lying within the unit circle. Therefore, there can be a difference in magnitudes of trig functions of opposite sign arguments but within the stated accuracy of the HP-35. Tangent is calculated by $\frac{\sin}{\cos}$.

2. Question: Why does 5^3 show 124.9999998 instead of 125?

   Answer: 5^3 is formed by $e^{3 \ln 5}$. The ln operation can produce about 1 count of error and the exp operation can produce another 2 counts of error in the answer. The exponential operation amplifies any error.

3. Question: Why does the calculator operate in degrees instead of radians?

   Answer: Degrees were chosen as the trig units to span a greater user application. Store $180/\pi$ and use as a constant multiplier.

4. Question: What is Reverse Polish Notation?

   Answer: A logical notation for a series of arithmetic operations in which no grouping symbol is used. This notation was developed by a Polish logician, Jan Lukasiewicz in 1929. For example, the expression Z=A(B+C) is represented in Polish notation as BC + A x Z=, where this expression is read from left to right. Note that the operator follows the operands.

Fig. D8 – D2 attachment HP-35S Anticipated Q & A.

Questions and Answers

5. Question: What is the advantage of so-called "reverse Polish notation" versus algebraic notation?

   Answer: "Reverse Polish notation" is easier for the designer to program because no key strokes have to be remembered and combined with the automatic stack in the HP-35 is easier for the user in chain operations. It also provides uniformity with transcendental functions such as trig, $\sqrt{\ }$, etc. It is the same sequence used with pencil and paper.

6. Question: How come you don't have a constant multiplier or divider?

   Answer: The storage registers accessed by [STO] and [RCL] are used as a constant multiplier, divider, or even addend. Press [RCL], [X] and a multiplication by the contents of the storage register is accomplished.

7. Question: How come answers for transcendental functions are not monotonic?

   Answer: The transcendental functions are all performed by single precision itterative algorithms. Therefore, there is some dither error in the last significant digit of the answer.

8. Question: What is the true accuracy of the HP-35?

   Answer: Since many of the transcendental functions vary wildly with small charges in argument, such as tangent close to 90°, we have referred the accuracy to the input argument. This we have stated as so many counts of error in the argument for the various functions. Also, since we do not have small argument resolution for trig functions, there is an additional error of $+1 \times 10^{-10}$ absolute in the answer. The spec on the elementary operations is ±1 count in the 10th significant digit in the answer.

9. Question: Numbers between .01 and .1--what happened to 10th significant digit?

Fig. D9 – HP-35S Anticipated Q & A Cont'd.

Questions and Answers

10. Question: Why do I lose storage data when machine is switched off and also when I punch [CLR]?

    Answer: When the machine is switched on, all registers are cleared including the storage. Pressing [CLR] executed the same turn-on program.

11. Question: Why do I lose one of my stack registers when doing a trig function?

    Answer: The trig functions, being more complex, have to save an intermediate result in the stack so it pushes T off the end.

12. Question: I don't understand the "operational stack."

    Answer: The "operational stack" is one that automatically moves data up and down as you perform operations and enter data doing a lot of housekeeping for you. It allows the user to perform problems of considerable complexity.

13. Question: What happens when I enter the decimal points in more than one position?

    Answer: Only the first one counts.

14. Question: How come I cannot enter [CHS] and then [π].

    Answer: [π] is a complete data entry including its sign. Its sign can be altered by pressing [π], [CHS].

15. Question: How come I cannot [CHS] of my exponent after I have entered the exponent?

    Answer: Since the entry is free field, i.e., mixed floating point and scientific, a digit entry into the exponent field sets the sign of the exponent.

Fig. D10 – HP-35S Anticipated Q & A Cont'd.

Questions and Answers

16. Question: When you take log of certain powers of ten (i.e. 10^6), how come I have an extra digit? Example: 6.000000001.

    Answer: The log calculation is performed by computing the ln of the number, then dividing by ln 10. Also see questions 2, 7.

17. Question: How come by entering four numbers in each register of stack (i.e., 1, 2, 3 and 4), I duplicate last number?

    Answer: The proper way to enter four numbers in the stack is as follows:

    [1], [ENTER↑]
    [2], [ENTER↑]
    [3], [ENTER↑]
    [4],

    Note: No last [ENTER↑]

18. Question: How come if I switch unit OFF and ON rapidly, unit does not turn on?

    Answer: A short time delay of one second is necessary for the power turn-on synchronizing circuit to discharge.

Fig. D11 – HP-35S Anticipated Q & A Cont'd.

HP-35A Competition

The first competition for the HP-35A was the TI SR-50 Announced in 1974. Any competition for the HP-35A has to qualify as a scientific calculator. It must calculate trig functions, logs and have a reciprocal function.

According to: http://www.datamath.org/Sci/WEDGE/sr-50.htm the SR-50 was introduced January 15th 1974. This is a full two years after the HP-35A. I found a weak photocopy copy of an "SR-50 HP Analysis" and it is reproduced in Appendix E. Part A of this analysis describes WHAT THE SR-50 DOES HAVE. Part B describes WHAT THE HP-35 HAS THAT THE SR-50 DOES NOT HAVE. I am not sure when Casio produced their first scientific calculator but it was well after TI's first.

The last page of the analysis, page 6, includes a table comparing the SR-50, HP-35A, and HP-45. The HP-45 was introduced in May 1973. One particular item is worth noting. The SR-50 calculated hyperbolic functions. Quiz question. What was the first HP scientific calculator that was able to calculate hyperbolics?

I remember a Statek engineer (now president of Statek) who was a die hard TI user. Whenever a new Hp calculator was announced I would show it to him and he was never interested. Then one day I showed him a new machine and his eyes lit up. "Why", I asked, "does this machine appeal to you? It calculates Hyperbolics" he said.

SR-50 HP ANALYSIS

A. WHAT THE SR-50 DOES HAVE

1. Deg-Rad Switch: Nice feature since machine can work in either mode; it also lets user know whether he is in degrees mode or radians mode.

   The HP-35 works in degrees only but problems stated in radians can be converted to degrees by: [DATA] [↑] [180] [↑] [π] [÷] [X]

2. [d/r] key - converts degrees to radians and radians to degrees depending on position of D-R Switch.

   This operation can be accomplished on the HP-35 by the following:

   Convert degrees to radians:

   DATA [↑] [180] [↑] [π] [÷] [÷]

   Convert radians to degrees:

   DATA [↑] [180] [↑] [π] [÷] [X]

3. SR-50 is algebraic: (Well, sort of.)

   Problem: 3 x 5 = 15

   Keys 3 [X] 5 [=] 15 This is algebraic.

   Problem: 3 x sin 30° = 1.5

   Keys 3 [X] 30 [sin] [=] This is half algebraic, half Polish.

   A truly algebraic machine would have parentheses (), and an arrow (↑) for exponentiation.

4. [N!] - Nice feature if and when you need it; good for statistics and data analysis.

5. [$\sqrt[x]{y}$] [x^y] - Nice feature. Can be accomplished on the HP-35 by [1/X]

6. Hyperbolic functions - Nice feature. (These were on the Model 9100 and (HP) experience was that few people used them.) They can be calculated fairly simply on the HP-35 and the formulas are:

$\sinh X = \frac{1}{2}(e^X - e^{-X})$

$\cosh X = \frac{1}{2}(e^X + e^{-X})$

$\tanh X = \frac{\sinh X}{\cosh X} = \frac{(e^X - e^{-X})}{(e^X + e^{-X})} = \frac{(1 - e^{-2X})}{(1 + e^{-2X})}$

$\sinh^{-1} X = \log (X + \sqrt{X^2 + 1})$

$\cosh^{-1} X = \log (X + \sqrt{X^2 - 1})$

$\tanh^{-1} X = \frac{1}{2} \log (1 + X) - \frac{1}{2} \log (1 - X)$

7. [Σ] key - Nice feature. It adds running totals in memory; does the same thing as M+ on most other calculators. Does not do what $\Sigma+$ does on the HP-45, or HP-80. Can be accomplished on the HP-35 by:

[RCL] [+] [STO]

8. Displayed accuracy is better (SR-50 has a guard digit), e.g.,

$2^{12} = 4096$ SR-50 answer - 4096

HP-35 answer - 4095.99997

B. WHAT THE HP-35 HAS THAT THE SR-50 DOES NOT HAVE

1. Consistent, unambiguous data entry and processing via "left to right rule."

This leads to CONFIDENCE in getting the right answer and in the machine.

a. Every problem is the same on the HP system. No need to restructure.

b. All intermediate answers shown. You can follow substeps with reassurance.

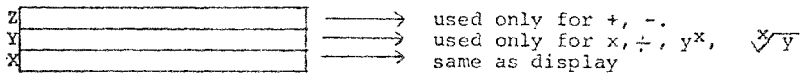
EXAMPLES:

Problem	HP Solution	TI Solution
(a x b) + (c x d)	[a][↑][b][×][c][↑][d][+]	[a][×][b][+][c][×][d][=]
(a + b) x (c + d)	[a][↑][b][+][c][↑][d][+][×]	[a][+][b][=][STO][c][+][d][=] [×][RCL][=]
(a + b) ÷ (c + d)	[a][↑][b][+][c][↑][d][+][÷]	[a][+][b][=][STO][c][+][d][=] [÷][RCL][x⇔y][=]

Note how complex and potentially confusing the TI solutions are. This can lead to a lack of confidence in getting the proper answer from the SR-50. Also, the user must figure out where to begin the problem, and what's stored in memory, and may have to rearrange the probelm to solve it. Note also the last example problem - would you expect the keystroke sequence to be [÷][RCL][X⇔Y] or would you expect [÷][X⇔Y][RCL] or something else?

2. The HP-35 has simple data processing rule. Can I operate?
   If yes → perform that operation.
   If no → enter↑. - [illegible]

3. HP HAS A FOUR REGISTER STACK.
   TI has "3" operating register:



   This is not really 3 registers - it's only 2½.

4. For HP-35 - [x≥y] works on contents of x, y registers.
   for the SR-50 - [x≥y] works only for x, ÷, y^x, $\sqrt[x]{y}$.
   This is a serious handicap when trying to manipulate data.

5. The HP-35 has [R↓] key - the user can access any piece of data in the machine. There is no way on the SR-50 to see the contents of the z-register.

6. The HP-35 will run on AC Recharger without battery pac in place, the SR-50 will not, i.e., if batteries go bad the SR-50 is useless even on AC.

7. The HP-35 can perform exceedingly complex calculations with ease, without having to write down and re-enter intermediate answers. The SR-50 will not do this problem without writing down on intermediate answer on paper.

$$\sqrt{(2 + 3) \times (4 + 5)} + \sqrt{(5 + 6) \times (7 + 8)}$$

8. Try 6,666, 666, 666 [1/x] on the SR-50.
   Display .000 000 000 1
   Real answer is 1.5×10^{-10}
   Multiply by 1000 on the SR-50 and get .000 000 15

9. The SR-50 can't clear X (CLX on HP-35) for a calculated number; only for an entered number.
   Thus, correcting a wrong result must be done with the "clear" key - losing all other data values in the machine (except memory).

10. The HP-35 displays intermediate answers in doing a problem. See examples in B.1. above. In those cases where intermediate answers are of value, extra keystrokes are required on the SR-50. An intermediate answer in those examples is (c x d) or (c + d).

Comparison: SR-50 vs HP-35 and HP-45

	SR-50	HP-35	HP-45
PRICE	$169.95 + $3.95 = $173.90	$225.00	$325.00
DATA ENTRY	INCONSISTENT, AMBIGUOUS, MUST REMEMBER HIERARCHY	CONSISTENT, UNAMBIGUOUS, LEFT TO RIGHT RULE	
DATA PROCESSING	ALGEBRAIC LOGIC 12 PAGES IN THE MANUAL	SIMPLE RULE: CAN I OPERATE? YES - PERFORM; NO - ENTER ↑ ADDING MACHINE LOGIC 3 PAGES IN THE MANUAL	5 PAGES IN THE MANUAL
OPERATING REGISTERS	2½	4	4
DISPLAY:			
NOTATION CONTROL	SWITCHES TO SCIENTIFIC NOTATION @ 10^{-10} UNLESS EE IS PRESSED.	SWITCHES TO SCIENTIFIC NOTATION 10^{-2}.	CONTROLLED BY FIX/SCI
DIGIT ENTRY	RIGHT JUSTIFIED AND MOVING	LEFT JUSTIFIED AND FIXED	LEFT JUSTIFIED AND FIXED
EEX	NEED TO ENTER MANTISSA FIRST	IF NO MANTISSA, ASSUMES "1"	IF NO MANTISSA, ASSUMES "1"
$X \lesseqgtr Y$	WORKS ONLY FOR Y^X, $\sqrt[X]{Y}$, X, ÷	WORKS ON X,Y REGISTERS	WORKS ON X,Y REGISTERS
ERROR INDICATOR	FLASHING ARGUMENT	FLASHING 0'S	FLASHING 0'S
ADDITIONAL FEATURES	1 MEMORY, HYPERBOLIC FUNCTIONS, $\sqrt[X]{Y}$, n!, Σ (SAME AS M+) DISPLAYED ACCURACY (GUARD DIGIT) DEG - RAD SWITCH DEG - RAD CONVERSION	1 MEMORY R↓	FIX/SCI, 9 MEMORIES WITH ARITH. CAPABILITY, R↓, n!, x^2, R⇄P, $\bar{x}$, S, ⇆D.MS, %, Δ% CM/IN KG/LB, LTR/GAL GRAD, 10^X LAST X DEG - RAD MODE DEG - RAD CONVERSION
BATTERY OPERATION	AC USELESS W/O BATTERY, FAST RECHARGE	AC WILL RUN W/O BATTERY	AC WILL RUN W/O BATTERY

Appendix F – Assorted HP-35A Documents – Page 1 of 1 page.

HP produced a substantial amount of HP-35A documentation. Here is a selected sample.

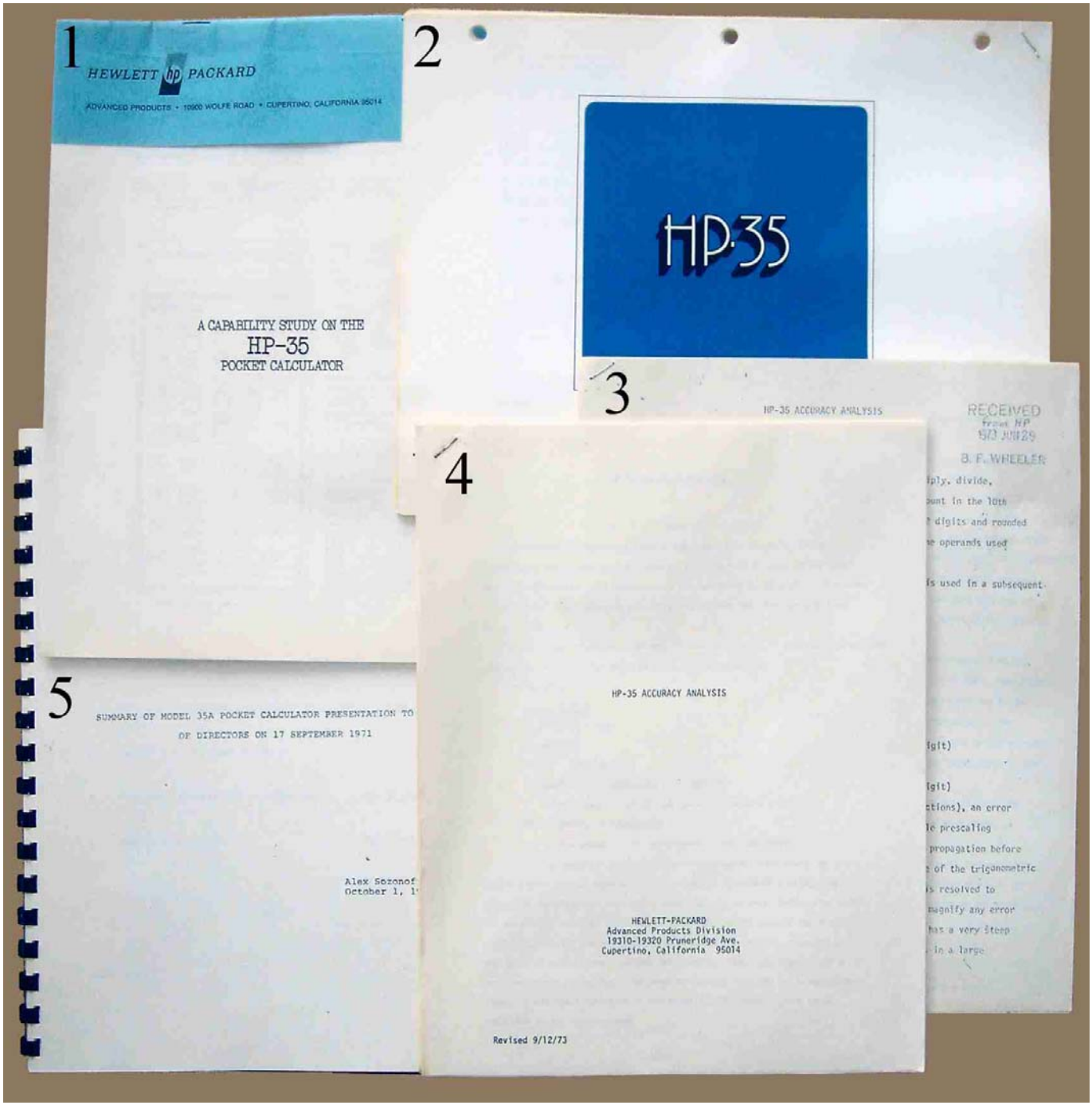


Fig. F1 – Five HP-35A related publications. ***1.*** *9 pp of black and red colored ink showing basic problem solving and specifications.* ***2.*** *13 pp of black and blue colored ink showing basic problem solving and specifications.* ***3.*** *16 pp photocopy. This is the famous HP-35A Accuracy analysis. First edition? no date.* ***4.*** *17 pp same as 4 but dated.* ***5.*** *20 pp photocopy of HP Board Meeting information as described in appendix C page C6. I comb bound the pages.*