The HP-41 System – 30 Years Old
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INTRODUCTION

The HP-41C Alphanumeric Scientific Calculator was announced just a little over 30 years ago on July 16, 1979. I was asked by the editor of the HP calculator newsletter, HP Key Notes, to write an article about the HP-41 in the August 1979 issue. Four years later in the August 1983 issue I wrote a follow up article.

The HP user community 30 years ago was a very prolific community and that is what I wrote about. Now 30 years later I once again write about this very popular machine, but in a "historical review" article - in an HP calculator newsletter.

The four versions of this machine are shown below.

HP-41C Coconut 7/16/79   HP-41CV Silverbird 12/15/80   HP-41C/CV Blanknut 3/24/81   HP-41CX Honeynut 10/1/83

Fig. 1 – Four versions of one of the most popular calculators HP has ever made. Over one million were sold.

The HP-41 astounded the world in 1979 because of its 17 segment alphanumeric display (see figure two) and four expansion ports. The machine was promoted as a system because of the many peripherals that HP provided for the calculator. These included an HP-IL module, a plug attach Card Reader, a Bar Code Wand, and a Thermal Printer/Plotter. The HP-IL module enabled a battery powered interface loop that allowed over 600 HP-IL devices to be connected and controlled at one time. A few of these include an HP-IL Thermal Printer/Plotter, an Impact Printer, an Acoustic Coupler, a Cassette Drive, a ThinkJet (later InkJet) Printer, a floppy disc drive, and a Graphics Plotter.

Fig. 2

HP-41 HARDWARE

The technical details of the four versions of the HP-41 and its peripherals may be obtained from the Internet if the reader is interested. Certain features, however, merit mention in this brief historical review.

The HP-41 was the first HP calculator to have a piezoelectric beeper or bender so that it could produce a narrow range of ten tones. The beep function is a four tone sequence and it alone probably sold more than a few machines. Tones were especially useful for alarms. Some customers used the audio tones to dial telephones, control photo enlargers (back in the days of film), and slide projectors (back in the days before power point).

The HP-41 hardware was continuously improved internally and externally. The most famous internal change was a design known as halfnut (not noticeable in figure one[1]). The change was to reduce the number of internal CMOS circuits to half their number. This would decrease the cost of manufacture. One of the most noticeable external changes was in a version that was called Blanknut (visible in figure one). This version was designed to be a regular HP-41, but it was keyboard overlay customizable by third party suppliers who sold their own applications software with the calculator as a package. Note that the program switch is covered by an easily removed piece of plastic.

The HP-41 keyboard utilized front sloping keys and a clean looking keyboard layout. The letters of the alphabet were printed in blue on the front sloping face of each key. Figures three and four show how the sloping face of the keys were changed after the first early machines with the taller framed keys. The early keys are often sought after by collectors.
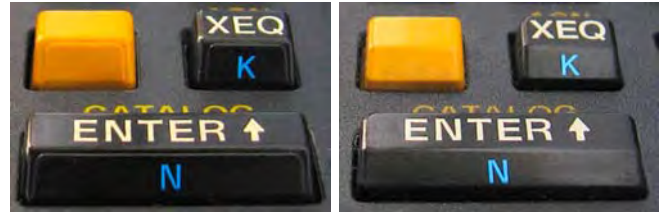

Fig. 3 - HP-41 early keys.   Fig. 4 - HP-41 later keys.

CALCULATOR INNOVATIONS

The HP-41 had many innovative features. The USER mode and key assignments provided the ultimate in user convenience. Any function or program could be assigned to almost any key. If the machine is in user mode your favorite program or function is just a single keystroke. The HP-41 system was designed for keyboard overlays. See **KEYBOARD OVERLAYS** below for details. If, however, you forgot what was assigned to a key you simply pressed and held the key and the display would tell you. If you held the key a bit longer it would "NULL" and not perform any operation at all.

Programming the HP-41 was easy and many owners wrote their own programs. The programs could be recorded on magnetic cards and the card itself labeled the top row keys which would run five programs when these top row keys were pressed - similar to the two predecessor machines the HP-65A and HP-67A. Even HP-67A program cards could be read by the HP-41 card reader and the programs could run on the HP-41. From this perspective the HP-41 was backward compatible.

While the HP-41 is not fully text oriented as most handhelds are today it was possible to use a great deal of text. Alpha sorting was possible and word games were very popular with HP-41 users.

The HP-41 was very day to day useful with such abilities as to automatically run a program when it was turned on, or to turn itself off when a program was finished (under program control). You could even set an alarm to run a program if needed – for data recording, for example.

LONG LIFE

The HP-41 enjoyed a product life of 12 years when the average scientific calculator at the time of introduction had a product life of about two years. The HP-41 product life was greatly extended by being expandable. In addition to the peripherals that plugged into its four ports hundreds of plug-in modules were produced for the HP-41. These included memory modules, applications program modules, a timer module, and even an infrared module for a wireless portable printer..

THIRD PARTY SUPPORT

HP intended its HP-41 vintage calculators (HP-41, HP-71, & HP-75) to be connected to the computer world, and its own instruments, with a series of dedicated HP-IL Interfaces. There was an RS-232C Interface, an HP Series 80 (computer) Interface, an HP-IB Interface, a GPIO Interface, 40 & 80 column

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1. *Astute HP-41 users will recognize the half nut in figure one (HP-41 CX). With the electronics changes was a display change that had a rounded corner "frame" around the display that indicated the major hardware redesign.*

Video Interfaces, and a universal HP-IL Interface Kit.

HP sponsored a third party program that encouraged other manufacturers to develop HP-41 accessories. Third parties built RAM Boxes and EPROM boxes using the card reader case. See figure five. Many of HP's own electrical measuring instruments had an HP-IL option including a digital multimeter and data acquisition control unit.

Fig. 5 – Memory expansion products.

Companies large and small built and sold products for the HP-41. Figure six shows a port light that plugged into any of the HP-41 ports. Pilots and others who "work in the dark" really appreciated this accessory. The same company offered a port extender that physically added seven ports. It fit nicely under the HP-41.

The HP-41 card reader was a very effective and low cost method of saving and sharing programs on chewing gum sized magnetic cards. Figure seven shows a third party magnetic card holder that had 40 slots that each could comfortably hold three magnetic cards. This meant that 120 magnetic cards would easily fit in your shirt pocket with your

Fig. 6 – HP-41 Port light. This was popular with pilots at night.

Fig. 7 – Most effective magnetic card holder.

HP-41. The list of third party products made for the HP-41 would require many pages just to summarize.

SOFTWARE SUPPORT

The HP-41 system required an extensive development effort and it was a complete effort. Not only did HP support the HP-41 with accessories and peripherals, but it also supported the machine with software and a newsletter called *HP Key Notes*.

The HP-41 was programmable in a simple key-stroke programming language that was eventually named Focal. HP encouraged its customers to contribute programs to a library that contained nearly three thousand programs. Today this is a small number compared to 100,000 programs for the iPhone. See an example of the August 1983 catalog edition in figure eight. The User's Library catalog was eventually bundled with a quarterly subscription of the *HP Key Notes* newsletter (printed inside), and it listed all software available for the HP-41 including HP's Solutions Books, and Program Application PACs. The catalog included sorted listings by Abstracts (in assigned numerical order), Author, and Application. The 10 major program categories were divided into subcategories for a total of 178 program categories.

Fig. 8- 8-1/2 x 11" HP $5 Catalog.

MEMORY EXPANSION

Any personal computational product that becomes a daily use tool requires an increasing amount of memory. HP offered a variety of RAM and ROM memory modules as well as a custom ROM program to put 4 KB or 8 KB of program code into one module.

An example of 1979 memory technology and 2009 memory technology is shown in figure nine. A 2 GB

USB thumb drive sits on top of an HP-41 8 KB memory module. In the same space two+ USB drives (RAM) are about the same size of one HP-41 (ROM) module. That is a memory module capacity increase of over 500 thousand times – for a much lower cost.

Fig. 9 – HP-41 memory module and USB thumb drive.

HP encouraged businesses, individuals, and even a calculator club to program and order custom ROMs that greatly expanded the program capability of the basic calculator. One of the largest orders HP received was for the PPC ROM that was programmed by hundreds of dedicated users to add 153 special highly modular "building block" routines in one 8 KB ROM module.

KEYBOARD OVERLAYS

The Blanknut version (see figure one) required the use of a custom keyboard overlay. Keyboard overlays were very popular with all versions of the HP-41. Figures 10 through 12 show a small sampling of HP-41 keyboard overlays.

Figure 10 shows a sampling of HP supplied overlays. A and B are typical PAC overlays for the math Pac and Stop Watch respectively. C is an overlay that has the standard keyboard notations on it which are covered by an overlay. The slots on the HP-41 are deep enough that three overlays may be "stored" on the keyboard at one time. The three slots for the overlay tabs on the bottom hold the overlay. The plastic slide between the USER and PRGM switches below the display hold the overlay at the top. This is one of the best and most convenient methods that any calculator has for overlay attachment. D is what HP called a rubber duck. It is a water resistant rubber film with key indentations and HP-41 notations on the top and plastic buttons under each key area to transfer the press to the key below.

Figure 11 shows a sampling of third party produced overlays. E is a typical overlay in the HP archetype. F shows how the fourth row has been cut to make the overlay symmetrical so both sides may be used.
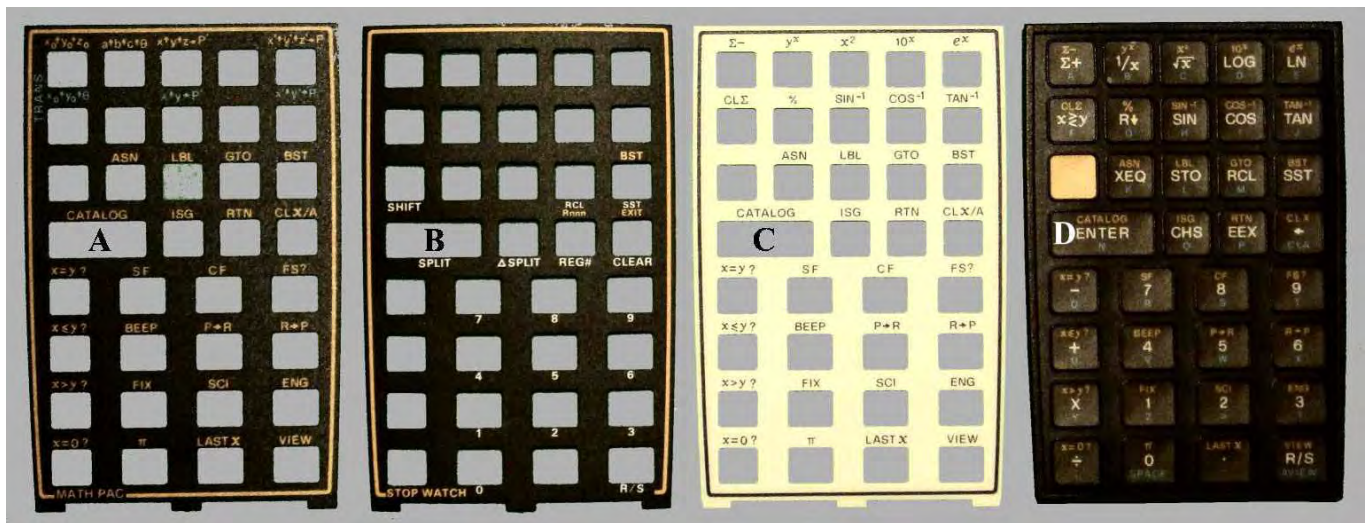

Fig. 10 – Typical keyboard overlays provided by HP for PACs (A and B) and general use (C and D).

This overlay is made of paper; all of the previous examples were made of plastic. A variety of colors were available. G is a clear plastic overlay. The shadowing doesn't show it well. H is a temporary paper "planer" overlay that is taped to the keyboard. These were available in pads and you considered them as a quick and easy method to identify your assigned keys for program development.

Figure 12 shows a sampling of overlays that had the keys opposite the double wide ENTER key cut so as to also have a double wide space. This made the overlay symmetrical and allowed both sides of the
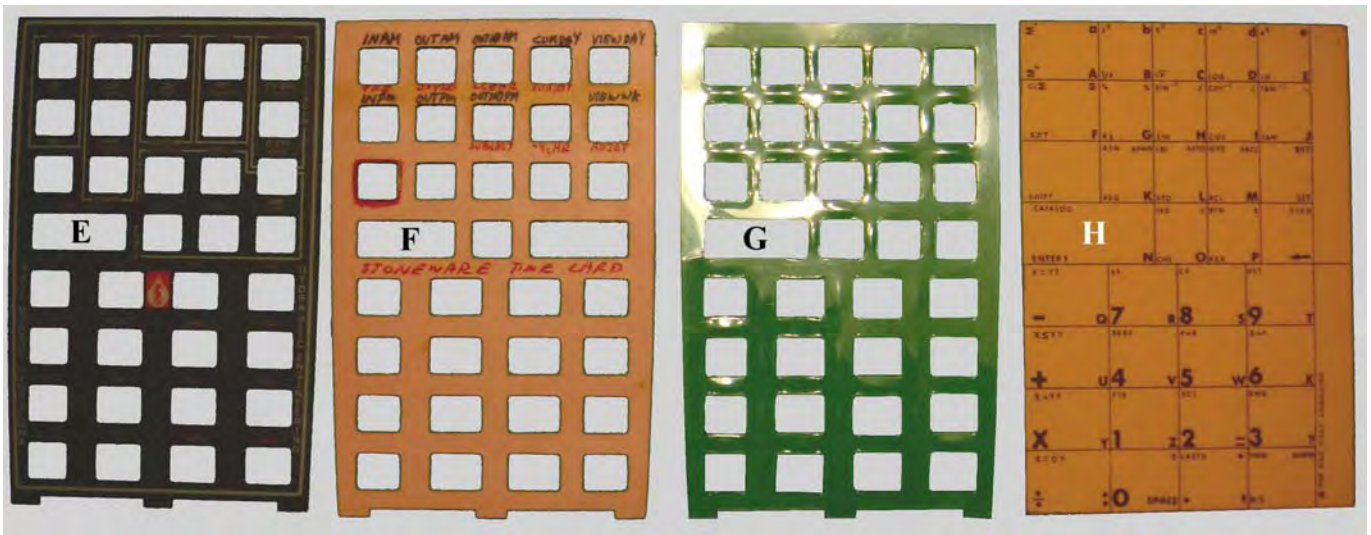
Fig. 11 – Typical third party HP-41 keyboard overlays. See the text for a description of these designs.

overlay to be used to effectively double the number (six) of overlays you may conveniently carry with your machine without anything "extra." Note the variety of color schemes and lines used to group and identify the key assignments.

Fig. 12 – Commercial overlays that were designed to be used double sided.

PROGRAM BARCODE

One of the many technologically advanced aspects of the HP-41 system was its ability to print and read programs in a simple low-reproduction cost barcode format. The HP-41 Wand, shown in figure 13, could be used to read printed barcode programs. HP's software support included collections of programs that not only described how the program works and the basis of the program, but also it included printed listings and barcode listings. HP published barcode standards and even had a recommended

Fig. 13 – HP-41 Optical Barcode Wand.

approved vendor to print barcode programs. These standards were conservative and the PPC ROM manual used a highly reduced barcode that increased the printed program density four times. The same program is used to print the barcode. The reduced barcode must be printed on glossy paper, but the shorter rows made scanning much easier. Reading, speed, density, and reliability were actually improved.

See examples in figures 14 and 15. These reproductions are half size of an 8-1/2 x 11 inch page.

SINE COSINE
EXPONENTIAL INTEGRALS
PROGRAM REGISTERS NEEDED: 18

HEWLETT PACKARD
SOLUTION BOOK:
HIGH–LEVEL MATH

ROW 1 (1 : 6)

ROW 2 (7 : 18)

Fig. 14- Two rows from a single page HP book listing.

MK
PROGRAM REGISTERS NEEDED: 61

ML
PROGRAM REGISTERS NEEDED: 64

Fig. 15- Two rows from a single page PPC ROM listing. Figures 14 and 15 were scanned and printed to the same scale (proportion). The density is increased four times.

CONCLUSION

The HP-41 system was a very popular calculator that is still used daily by many people 30 years later. Third party suppliers still build special peripherals (RAM boxes) for the HP-41. There are several people who repair and refurbish HP-41s, and even the card reader is easily and inexpensively brought up to specifications when magnetic card drive wheels deteriorate.

The HP-41 is a simple machine compared to today's HP 50g, but the power and simplicity the HP-41 offered is still able to handle many of the computational tasks technical people have to perform. Even an HP-41 Key chain – see figure 16 – is a daily reminder of a truly great calculator.

Happy 30th Anniversary HP-41.

Fig. 16 – HP-41 Key chain.