

The HP-67 and HP-97

Hewlett-Packard's Personal Computers

Craig A Pearce
2529 S Home Av
Brewyn IL 60402

Photo 1: The Hewlett-Packard HP-67 programmable calculator. Magnetic cards containing programs are inserted into the slot on the side of the unit. (Photo courtesy Hewlett-Packard Co.)

Manufactured by Hewlett-Packard, the HP-97 and its software compatible younger brother the HP-67 are considered by many to be two of the best programmable calculators available.

The HP-97 costs \$750, compared with \$450 for the HP-67. Both feature a full complement of mathematical functions and statistical functions for two sets of variables; additional features include: Reverse Polish

Notation; 26 data storage registers (one of which is used for indirect and relative addressing); register arithmetic; 224 program steps (all fully merged, with no 2 or 3 keystroke instructions); the ability to record programs or data on magnetic cards; a pause feature that opens the keyboard up for user input during a running program; and a smart card reader.

Smart Card Reader

One of the HP-67's most interesting features is its "smart" card reader. When a card is fed into the unit, the reader begins accepting 28 byte blocks of data from the cards. The first block tells the calculator if the card being read is a program card (which means the remaining bytes are to be read into program memory), or if the card contains numerical data that must be fed into the data registers. The card, if it is a program card, will also set the display mode (fixed, scientific, or engineering, zero through nine places showing), the trigonometry mode (degrees, radians or gradians) and the calculator's four user flags (on or off). If side 2 of the card (containing steps 113 through 224) is fed into the reader first, they will be placed in the correct position, just as if side 1 had been fed in first (containing steps 1 through 112). When a card like this exists (that is to say, a program is recorded with more than 112 steps, or more than one side of the card), the calculator displays the word "Crd" as a prompt to the user that the second side of the card is required.

The same holds true for the data card. Side 1 contains the contents of the 16 primary registers. If data is also present in the secondary ten registers, the user is again prompted with "Crd." The contents of these



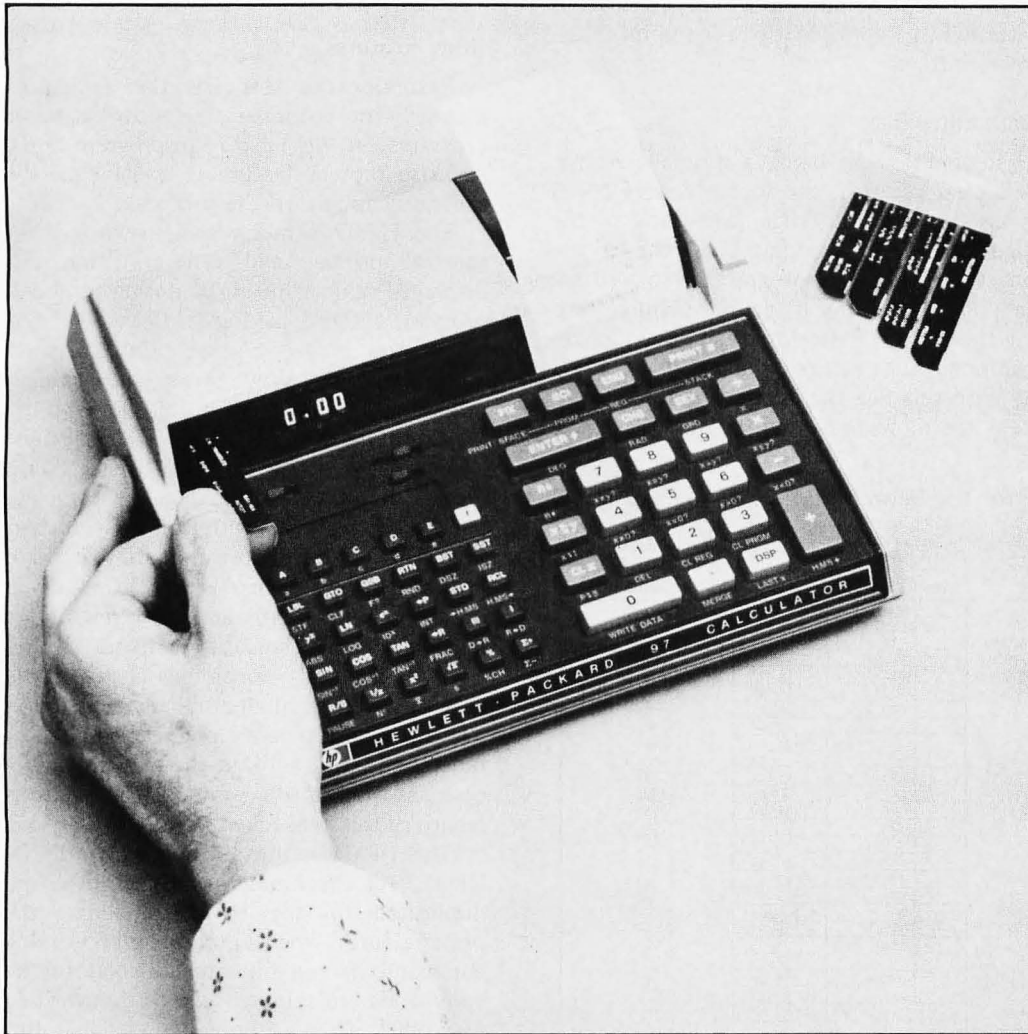


Photo 2: The Hewlett-Packard HP-97 programmable desk top calculator with printer. (Photo courtesy Hewlett-Packard Co.)

registers are contained on the second side of the data card.

A card may also contain data on one side and a program on the other. By placing data on side 1 and using a clever trick, the user can also get "Crd" when reading in one of these "half and half" cards. The card reader motor is under firmware control and will not switch on with a card present in the slot, if a program is running. However, the user does have the keyboard option of merging programs and data, or just feeding in 112 steps of program, under software control. Thus, with a 112 step card in the slot and a 224 step program running, all the user need do in order to feed in (overlay paging) those next 112 steps is to call for the keyboard active pause, which will cause the card reader to turn on and feed in that next card. Without

any user intervention the HP-97 or HP-67 can run 336 steps of program automatically.

The Active Pause

Another powerful feature of these calculators is the "active pause" feature. Pause gives the user the ability to momentarily stop a running program and display the answer currently on the screen for one second or so. It also unlocks the keyboard for user use and accepts any cards fed in at this point.

Normally, pressing any key on an HP programmable calculator causes the program to halt immediately. This is not the case during the pause feature. When pausing, any key, including one of the ten user definable label keys, can be pressed and that function will be carried out. After this the pause will be

extended an additional second, and the program will then continue. If a user definable key is pressed, that program is called as a subroutine (three levels of subroutines are available on the HP-97 and HP-67), and, if that subroutine ends with the "RTN" (return) command, program control is returned to the original pausing point in the main routine.

Data Entry Flag

In addition to being a general purpose, test clearable flag, the fourth flag (FLG 3) is also a data entry flag. When any of the digit keys is pressed, flag 3 switches to the on state. Thus the program, if so written, can sense the input of data, much like testing the status register on a full blown micro-computer, for keyboard input.

With this flag the user can define the ten keys for more than one function. A simple

example is the programming of the formula $\text{distance} = \text{rate} \times \text{time}$. Each of three keys can accept data input if the third flag is on; if the third flag is off, the key just pressed can calculate the unknown variable. This feature is indispensable when writing games.

Other Features

Naturally the user has the ability to manually or automatically record data or programs on the 1 by 7 cm program cards. A write protect feature is available on the cards by clipping off the corners.

The HP-97 comes with its own built in thermal printer, and can print out the displayed value manually or during a running program without halting it. Because of the 7 level key buffer, a single print command will not even slow down the running program. Of course, the buffer works in the manual mode as well. The HP-97 can also list the contents of the 4 level Reverse Polish Notation (RPN) stack and give a complete program listing with line number, mnemonics, and an on and off switchable key code as well. There is even a trace mode of operation for program debugging or for keeping a detailed record of a manual operation. A "Normal" position is also available to keep a record of all numbers entered during a manual problem along with all the key mnemonics, but without the final answer, in case the user might want just a keystroke record of the steps taken.

The HP-67 is the pocket version of the HP-97. All the functions of the HP-97 are duplicated on the HP-67, including the print features. When a program with printing commands is run on some calculators, the commands are skipped over as though they were NOP when no printer is available. But in the same situation the HP-67 will pause for 5 seconds and blink the decimal point to show that a print statement is being executed. At this point the user can either stop the program and hand copy the answer displayed or just let the program run, since 5 seconds is usually enough time to get the answer written.

Although of no use on the HP-67, the paper spacing key is provided so that full control is possible when a HP-67 program is run on an HP-97.

Both machines come with huge manuals containing some of the clearest, most detailed documentation in the programmable calculator market. A standard "PAC" of blank and prerecorded program cards is also provided. These prerecorded cards cover dozens of various applications and include their own manual of several dozen more detailed pages. The latter gives programming

Listing 1: Pinball Wizard, a game for the Hewlett-Packard HP-67 and HP-97 programmable calculators.

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
001	F PRAC	16 44			R ↓	-31	
	F π	16-24			DSP 0	-63 00	
	X ≥ Y	-41			RTN	24	
	f X=0?	16-43		060 *	LBL B	21 12	
	+	-55			RCL 1	36 01	
	f FRAC	16 44			f X=0?	16-43	
	STO E	35 15			GTO f a	22 16 11	
	5	05			1	01	
	0	00			STO - 1	35-45 01	
010	STO B	35 12			-	-45	
	1	01			PRINT X	-14	
	0	00			0	00	
	STO A	35 11			STO 0	36 00	
	X ²	53		070	5	05	
	STO C	35 13			STO 3	35 03	
	CLX	-51			* LBL f b	21 16 12	
	STO 0	35 00			f CLF 0	16 22 00	
	STO 1	35 01			DSP 0	-63 00	
	STO 2	35 02			3	03	
020	GTO f a	22 16 11			STO 7	35 07	
	* LBL f e	21 16 15			EEX	-23	
	RCL E	36 15			3	03	
	9	09			STO 6	35 06	
	9	09		080 *	LBL f c	16 21 13	
	7	07			f CLF 3	16 22 03	
	x	-35			RCL 3	36 03	
	f FRAC	16 44			f X=0?	16-43	
	STO E	35 15			GTO f a	22 16 11	
	RTN	24			f PAUSE	16 51	
030 *	LBL A	21 11			f P? 3	16 23 03	
	2	02			f P? 3	16 23 03	
	STO + 1	35-55 01			GTO f c	22 16 13	
	.	-62			1	01	
	2	02		090	STO - 3	35-45 03	
	5	05			DSP 1	-63 01	
	STO - 2	35-45 02			X ≥ Y	-41	
	RCL 1	36 01			* LBL f d	21 16 14	
	PRINT X	-14			GSB f e	23 16 15	
	* LBL f a	21 16 11			1	01	
040	2	02			2	02	
	CHS	-22			x	-35	
	STO I	35 46			f INT	16 34	
	RCL 0	36 00			3	03	
	5	05		100	-	-45	
	EEX	-23			f X=Y?	16-33	
	4	04			GTO f d	22 16 14	
	÷	-24			f X>0?	16-44	
	f INT	16 34			GTO E	22 15	
	STO + 1	35-55 01			f PAUSE	16 51	
050	RCL 0	36 00			f X=0?	16-43	
	f PAUSE	16 51			GTO 0	22 00	
	GTO (i)	22 45			f P? 3	16 23 03	
	* LBL C	21 13			f P? 3	16 23 03	
	DSP 2	-63 02		110	GTO 0	22 00	
	RCL 2	36 02			CHS	-22	
	f PAUSE	16 51			f X≠Y?	16-32	

REGISTERS								
0	1	2	3	4	5	6	7	8
score	games	\$\$\$	balls			bonus	targets	
S0	S1	S2	S3	S4	S5	S6	S7	S8
A 10 (constant)	B 50 (constant)	C 100 (constant)	D	E seed	I used			

tips and lists techniques about how certain of the prerecorded cards were written.

As with all of Hewlett-Packard's calculators, the units run on rechargeable nickel cadmium batteries, or from AC through an adapter that recharges the batteries whether the machine is in use or not. A carrying case is also standard with the machines.

For all owners who join, an extensive users' library of contributed programs is available. A user can send a favorite brainchild and get free programs and blank magnetic cards in exchange. Even for those who do not write programs the library is of great importance, since dozens of widely different programming areas are covered.

HP-65, 67 and 97 owners receive free issues of *Keynotes*, a newsletter edited by Henry Horn. *Keynotes* keeps the user up to date about all the changes or corrections to the several PACs of preprogrammed cards available, as well as listing some of the newer programs submitted between library catalog updates.

Unsupported Features

As with the HP-65 (and later the Texas Instruments' SR-52), HP-67 and 97 users have managed to locate and use quite a number of features that Hewlett Packard had not originally intended to document.

Through the efforts of Louis Cargile, a member of PPC, an independently run users' group, the limited alphanumeric codes of the machines (both can form: r, C, o, d, E), have been brought under user control along with the ability to view internal registers, create moving marquee type displays, animation and dozens of other ingenious outputs. Even the hexadecimal representations for all the internal codes have been mapped and printed in *PPC Journal*, the newsletter of PPC. These codes include the six unused codes, formally unavailable to the user. (The HP-97 and 67 use 8 bit instructions, but only a total of 250 different commands, thus leaving six unused.)

One clever program by Cargile is called "Iida/Gerald/Ella." Through the use of an alphabetic overlay of the keys it allows the user to spell out mathematical functions and commands to the units and carry on a running dialogue with them.

Example Program

Of course, the proof of the ability of these machines lies in how intricate a program can be run on them. I offer a version of a program I wrote, called "Pinball Wizard," which duplicates many of the features on a standard pinball machine

including dual flipper action, out hole bonus, and even an optional tilt feature for the wizards among you. It is playable on either the HP-67 or 97, but the keystrokes and codes shown in the program listing correspond to those of the HP-97. They can all be converted over to the HP-67 by using the manual's back pages, which list the various keystroke differences between the machines for example, the key sequence: **f** (a shift key) followed by **FRAC** (fractional truncation), will be converted to **g frac** on the 67.

As always, a card recorded on the 97 will show the corrected codes when read into a 67, and vice versa.

This article by no means explores all the intricate and complex programming capabilities of the HP-67 and HP-97, but I hope the reader now has a better idea of the sophistication these desk top wonders have to offer.

Listing 1, continued:

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
	GTO 0	22 00		170	f PAUSE	16 51	
	2	02			f PAUSE	16 51	
	CHS	-22			GTO f d	22 16 14	
	f X ² Y	16-32		*	LBL 1	21 01	
	GTO f d	22 16 14			f F? 0	16 23 00	
	GSB f e	23 16 15			GTO 1	22 01	
	3	03			f STF 0	16 21 00	
120	X	-35			DSP 9	-63 09	
	f INT	16 34			RCL A	36 11	
	f X=0?	16-43			GTO D	22 14	
	GTO f b	22 16 12		*	LBL 1	21 01	
	GTO f d	22 16 14		180	DSP 1	-63 01	
*	LBL E	21 15			f CLP 0	16 22 00	
	STO I	35 46			RCL A	36 11	
	GTO (i)	22 45			GTO D	22 14	
*	LBL 0	21 00		*	LBL 3	21 03	
	B	08			RCL C	36 13	
130	CHS	-22			RCL A	36 11	
	STO I	35 46			GTO 3	22 03	
	RCL 0	36 00		*	LBL 4	21 04	
	f X ² 0?	16-42			RCL E	36 06	
	GTO 0	22 00		190	2	02	
	1	01			5	05	
	STO + 3	35-55 03		*	LBL 3	21 03	
	DSP 0	-63 00			GSB f e	23 16 15	
	GTO f c	22 16 13			x	-35	
*	LBL 0	21 16			1	01	
140	1	01			+	-55	
	f F? 0	16 23 00			f INT	16 34	
	2	02			X	-35	
	STO x 6	35-35 06		200 *	GTO 9	22 09	
	RCL 0	36 00			LBL 5	21 05	
	f PAUSE	16 51			RCL B	36 12	
	EEX	-23			GTO 9	22 09	
	3	03		*	LBL 2	21 02	
	SFO - 6	35-45 06		*	LBL 6	21 06	
	STO + 0	35-55 00			EEX	-23	
150	RCL 0	36 00			3	03	
	f PAUSE	16 51			STO + 6	35-55 06	
	RCL 6	36 06			RCL C	36 13	
	f X ² 0?	16-42			GTO 9	22 09	
	GTO (i)	22 45		210 *	LBL 7	21 07	
	R ↓	-31			RCL A	36 11	
	f PAUSE	16 51			f DSZ (i)	16 25 45	
	GTO f b	22 16 12			GTO 9	22 09	
*	LBL 9	21 09			3	03	
	f F? 0	16 23 00			STO 7	35 07	
160	RCL A	36 11			1	01	
	f F? 0	16 23 00			STO + 3	35-55 03	
	x	-35			RCL C	36 13	
*	LBL D	21 14			GTO 9	22 09	
	STO + 0	35-55 00		220 *	LBL 8	21 08	
	RCL I	36 46			RCL A	36 11	
	RCL A	36 11			GTO D	22 14	
	=	-24					
	+	-55					

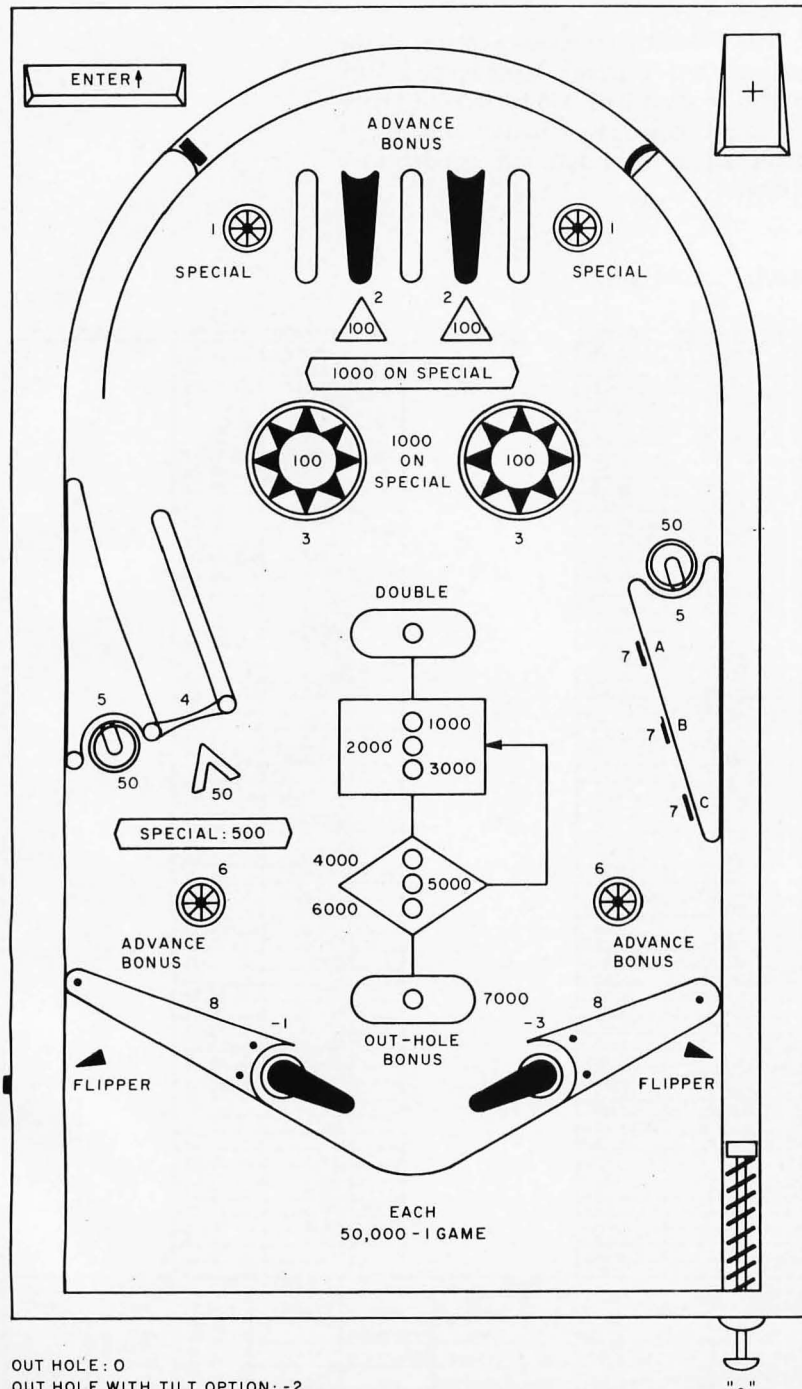
LABELS					FLAGS		SET STATUS		
A	25¢	CREDIT	RCL S	D used	E used	0 SPECIAL	TRIG		DISP
a	used	b used	c used	d used	e end# gener	1 -	ON OFF	DEG	FIX
out hole	1 SPECIAL	2 roll over	3 thumpers	4 spin. gate	2 -	0 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	GRAD	SCI	<input type="checkbox"/>
kick out	b bonus adv.	d drop targ.	s slibg-shot	9 used	3 used	1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	RAD	ENG	<input type="checkbox"/>
						2 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			n_0
						3 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>			

Note: PPC (not affiliated with the Hewlett-Packard Company) is an independently run users' group started for and by users of Hewlett-Packard programmable calculators. It is the largest calculator club in the world, with over 2500 members worldwide. The address is: PPC, Richard J Nelson, editor, *PPC Journal*, 2541 W Camden Pl, Santa Ana CA 92704.

Pinball Wizard:
A Game for the HP-67 and HP-97

This program duplicates the play of standard pinball machines including features like out hole bonus points, "Special" for higher scoring, two thumper-bumpers, a spinner gate, three drop targets for a free ball, bonus advance roll overs, kick out holes, two flippers, and a tilt option for putting the ball into play in two out of three chances. The program is meant to be left running at all times, with all input from the

Figure 1: Model pinball machine layout used in the game of Pinball Wizard (see listings 1 and 2).



OUT HOLE: 0
OUT HOLE WITH TILT OPTION: -2

user occurring during the active keyboard pause feature of the HP-67 or HP-97.

There are eight different scoring devices on the play field (see figure 1) and each device is given an identification number. When a score is made on a device, the display pauses twice, showing the amount of points just made to the left of the decimal point, and the device identification number to the right of the decimal point. The score to the left of the point is added to the player's total score, which will be displayed at the end of each round of play. The various devices are:

Device #1: Consists of two star roll overs (buttons) on the play field which, when hit, will add ten points to the player's score and switch on the "Special" scoring (which is indicated by turning on all the trailing zeroes after the device ID number). When this occurs, all devices so listed will score ten times higher than normal. Hitting device #1 repeatedly will alternately switch the Special scoring on and off.

Device #2: Consists of two top roll over lanes which score either 100 (or 1000 points if Special is lit), and advance the out hole bonus by 1000 points.

Device #3: Consists of two thumper (jet) bumpers. Each scores 100 points (or 1000 when Special is lit) whenever the "ball" strikes them. The ball can bounce between them up to ten times, so scores from 100 to 1000 (1000 to 10,000) can be made.

Device #4: This is a spinner gate that will score 50 (or 500 points for Special) each time it spins one turn. The gate can spin from one to 25 times.

Device #5: Consists of two kick out holes where the ball drops in, scores either 50 (or 500 points again depending on the state of Special), and is kicked back out.

Device #6: Consists of two bonus advance roll over stars and functions in the same manner as device number 2.

Device #7: Consists of three drop targets. Each time device 7 is hit, one target drops away and the player receives ten points added to his score. On the third hit, however, the player receives 100 points and is credited with a free ball. The targets are reset to try again. Special scoring increases the point value by ten times.

Device #8: Consists merely of two slingshot kickers giving a score of only ten points, whether or not Special is lit.

A "0" on the display means that the ball

has rolled past the flippers and through the out hole. At this point the player's score so far is shown on the display and the out hole bonus points accumulated during the game are added onto the player's score, 1000 points at a time. The display pauses for viewing each time. At the end of this scoring, the final total, is flashed once more and the display goes back to blinking the remaining number of balls (if any) in the game. If none remain, the final score is flashed. If Special was lit when the ball rolled out, the out hole bonus is doubled.

To shoot a ball, the player keys the decimal point (.) when the remaining number of balls left to play is flashed on the display.

Pressing key "A" adds two games to the "credit wheel" and deducts 25¢ from the player's cash register (no pun intended). The amount of money spent can be viewed by pressing key "C" during a pause at any time.

Pressing key "B" deducts a game from the credit wheel, and starts a new game.

Caveats

If a "-1" shows on the display, it means that the ball has reached the left flipper and requires the user to key in a "1" (pressing the left flipper button) in one second or the ball will roll out. Likewise, if a "-3" is displayed, the ball is at the right flipper, and requires an immediate input of the digit "3" from the user, or again the ball will roll out through the out hole.

When a "-2" appears on the display, it means the ball will miss both flippers, but the user has the option of keying in a "2" which effectly will "tilt" the machine, and, in two out of three cases, put the ball back in play. Be warned, however! If you should fail in the tilt attempt (that is, the machine has been tilted), you lose all collected bonus points and the next ball is immediately displayed, without a score review.

For each 50,000 points made, the player is credited with a free game. When a score over 50,000 is made, please refrain from pressing the "A" key.

Special note: If, on the first ball, before any score is made, you should lose the ball, it will be returned to you for reshooting, as in most pinball machines. (A failure at a tilt will not return the ball, however.)

Example of Play:

- Initialize game by inputting a seed number such that 0<seed<1. For this example, let's use 0.1541790869.
- Press: RTN R/S Display will flash "0."

- Obtain credit of two games and spend one quarter: press A . (A "2" will be displayed, confirming a credit of two games.)

- Start first game: press B . (A "1" is displayed to show that there is one game remaining. Next, 5 is flashed on the display to show that there are five balls left to shoot.)

- Shoot first ball: press . . See displayed:

```

50.5           (50 points on a kick out
                hole)
10.10000000   (10 points and Special is
                on)
1000.60000000 (device 6 advances bonus
                and gives player 1000
                points)
-2.00000000   (a tilt option has come
                up)

```

Try tilting the machine by inputting a 2 from the keyboard during the pause window. A flashing 4 will be displayed to show that there are four balls remaining to shoot. The machine was tilted and all bonus points were lost.

You can continue to play out this game in the same manner. Good luck.■

(Note: Pinball Wizard is reprinted with the permission of PPC.)

Listing 2: User instructions for Pinball Wizard.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter program				
2	Input seed (s) such that 0<(s)<1	seed	RTN	R/S	0 *
3	To obtain credit of 2 additional games (and spend 25¢): The number printed/paused, will show the number of games the player has credit for.		A		2 ***
4	To start one game (which is deducted from the credit register): The first number printed/paused will be the remaining games left. The next number flashed will be the remaining balls left to shoot.		B		1 *** 5 *
5	To shoot current ball, displayed, during a 1 second pause 'window': Scoring begins as described in the program description on the previous pages.				
6	When '-1' is displayed, to use the left flipper during a 1 second pause 'window', input: -OR-		1		
6	When '-3' is displayed, to use the right flipper during a 1 second pause 'window', input: -OR-		3		
6	When '-2' is displayed, to attempt to 'tilt' the machine and chance putting the 'ball' back in play, input: If the tilt was successful, the scoring will continue. If the machine 'tilted', the remaining number of balls will be flashed (if any) or the final score will be flashed, if the game is over.		2		
7	To shoot any remaining balls, go to step 5.				
8	If no balls remain, to start a new game, go to step 4.				
9	If no games remain on the 'credit wheel', go to step 3.				
***	--Indicates a printed number, on the 97 or a number paused for 5 seconds on the 67.				
*	--Indicates a number flashed (paused for 1 sec.)				