

Improving Keystroke Efficiency in HP's Recent Business Calculators

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The intention of this paper is to suggest alternate keyboard and function arrangements for the 17bII+ (silver) and recently-introduced 20b which would significantly reduce keystroke counts (and thus, in my opinion, increase keystroke efficiency) by adding a second shift key and removing some of the menus without altering functionality. Call this the “32SII effect” – whereby in 1991 the switch from a single to two shifts from the 32S to the 32SII increased clutter (from 2.730 to 3.622 functions/key) but reduced the average keystroke count (from 3.120 to 2.869 keystrokes/function) and reduced the number of functions in menus (from 276 to 125) all while actually incorporating roughly 70 additional functions to the machine. (For detailed analyses of most of the HP calculator keyboards with respect to clutter and keystroke efficiencies, consult <http://www.pahhc.org/keyboards.htm> on the web.)

How Did We Get Here?

Through the 1970s, all HP calculator functions were accessible on the keyboard. When the number of functions exceeded the number of keys (such as in the HP80 or HP45), a shift key was added in order to add an additional “key plane”, which effectively doubled the number of potential function positions. Again when the function count reached its limit, more shift keys and key planes were added until a maximum of three shifts were utilized in the HP65, 67 and 34C scientific machines. Following this, with the release of the HP41 series, a step back was taken to reduce keyboard clutter, utilizing the ALPHA keys to spell out functions which would not otherwise fit. While clutter was reduced (from 3.257 to 2.641 functions/key) between the HP67 and the HP41C, the keystroke counts skyrocketed (from 2.285 to 6.213 keystrokes/function) and thus keystroke efficiency plummeted.

Then the 18C came along with soft key menus and things changed. However, the 18C woefully underutilized the keyboard function positions and as a result, requiring many more keystrokes than essentially necessary for many functions. Was it to avoid intimidating business/financial users? Then why did the 12C with significantly more keyboard clutter (2.128 functions/key) than the 18C (1.431 functions/key) sell well and has continued to do so for over a quarter century? Also, the HP10bII (in its third iteration) with two shifts and two shifted key planes remains on the price list.

You wouldn't add shifted functions above blank keys, so why add softkey menus when all the shifted key positions are not fully utilized? The menu concept is really great, but it can be overused (which we might refer to as “menu madness”). It wouldn't be necessary for shift-key overkill like in the 67, 34C or 50g; just two shift keys would be sufficient. The second shift key was first introduced with the HP65 scientific (which actually had three) and has been prevalent on scientific and graphing machines ever since. With the HP20S, 21S and 32SII Pioneer machines in 1989 to 1991, two shifts were employed but for some reason was avoided on any of the business/financial Pioneers - the 10B, 14B and 17B. The change in key types from the beveled Voyager and Nut series keys (with shifted functions on key fronts) to flatter ones (having function labels only above keys) on the Pioneer and Charlie series did contribute to the appearance of increased clutter. However, the return of the beveled keys in the 35s and the latest 17bII+ (silver) was a positive step in my opinion, permitting a second shift while reducing function label “crowding”.

The Pros and Cons of Menus and Shifted Functions

When the HP calculator design team decided to build successors to the HP35A in both scientific and business disciplines, they realized that the number of functions required would exceed the 35 keys on the keyboard. Even if they had considered using any sort of calculator menu scheme, the chosen LED technology of the day did not support alphanumeric display characters and thus using shifted keyboard functions were the logical choice.

The negative side of shifted functions is that they increase keyboard clutter (defined as the average number of functions per key and computed as the total number of keyboard functions divided by the total number of keys). However the positive aspects are that (1) the function keystroke counts (defined as the average number of keystrokes per function) would be relatively small; and (2) all calculator functions are always visible to the user and therefore can be found without requiring guessing their location.

For menus, of which there are three major types in HP calculators –

- Softkey menus (like that in the 17bII+ and 50g) which use the top row of keyboard keys and bottom row of the LCD to label them
- “Counted” menus (like that in the 35S) which number the functions in the display and use the numeric keypad to select them
- “Sequential” menus (like that in the 20b) which reveal a single function at a time and require navigation via the up- and down-arrow keys and INPUT to select them

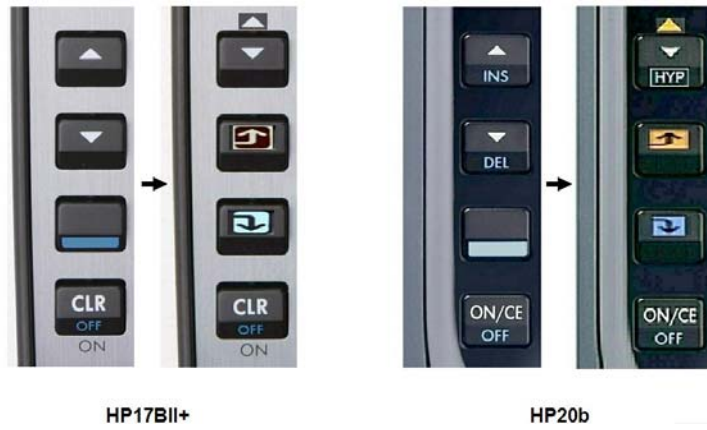
there is also an up side and a down side. The use of menus can provide an almost unlimited number of functions to the user while minimizing keyboard clutter (unless the menu labels are placed on shifted function positions). However, menu-based function keystroke counts are usually very high and the concealment of functions in menus can require some users to have to “hunt” for the correct menu in order to access the function desired.

Let us assume that minimizing function keystroke counts (and thus increasing keystroke efficiency) is a desired attribute. In addition, let us also assume that business/financial calculator users who have some familiarity with either the HP12C or HP10bII are not intimidated by keyboards containing two shift keys and corresponding functions located in two shifted key planes.

Adding the Second Shift Key

In the Pioneer-series machines (which have the exact same 37-key keyboard arrangement as in the current 17bII+ and the 20b), all eleven models had at least one shift key located toward the bottom left of the keyboard. In many of those machines, the up- and down-arrow keys were located immediately above the single shift key (as is the case for the 17bII+ and the 20b). The HP20S, 21S and 32SII had two shift keys with the second shift just above the first. In those, the up- and down-arrow functions had to be relocated elsewhere. For our experimental discussion, we could relocate the arrow keys onto the primary and a shifted position of the original up-arrow key, as shown in Figure 1.

For the 17bII+, the next order of business would be to complete the population of the original (blue) shifted key plane. With so many positions available, we can “expose” all the functions of the Math, Printer and Modes menus here. Next, in the spirit of the HP42S calculator, the top row of keys could be given functions from the “Main” menu, which would serve the dual purpose of providing access to the main-menu functions and also acting as soft keys when a menu was selected. Likewise as in the 42S, the



HP17bII+

HP20b

Fig. 1 – Adding a second shift key and rearranging the up- and down-arrow keys in the HP17bII+ and HP20b keyboards.

“EXIT” function would then turn off the soft-key menu, allowing an optional second numeric value to be displayed when desired. Next, the functions in the second shifted key plane would consist of former menu functions which could be placed in proximity to each other. With the number of positions available, it was realized that the FIN ICNV PER, FIN ICNV CONT, BUS (and its handful of submenus), and CALC menus (totaling ten in all) could be eliminated. Lastly, in the spirit of the HP32SII and HP48SX which highlighted keyboard function names leading to menus (in order to differentiate them from “regular” functions), those menu functions here have been highlighted by placing a rectangular box around them. The cumulative result is shown in Figure 2.

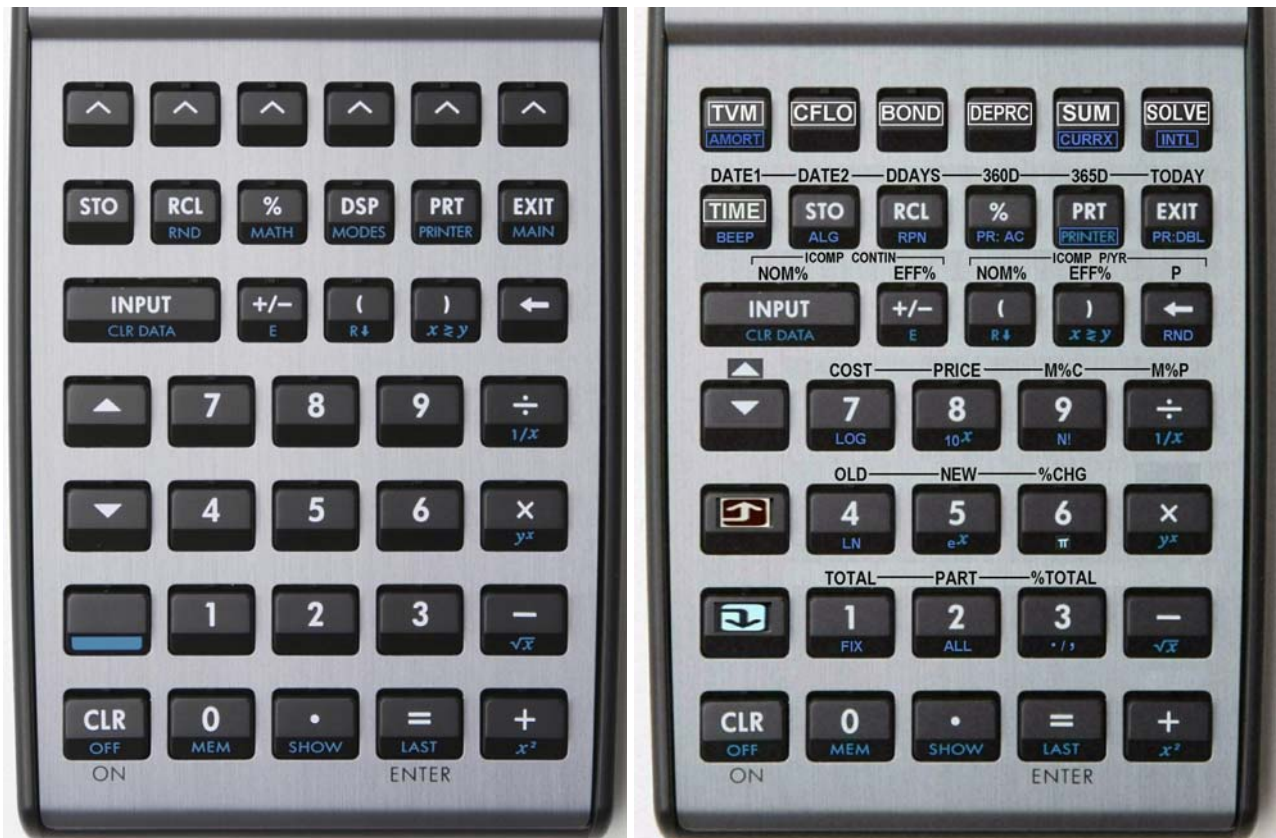


Fig. 2 – HP17bII+ and proposed HP17bII++ keyboards

Likewise for the HP20b, the second shifted key plane was added, with:

1. All the Math-menu functions brought out at the bottom, near the other existing math functions;
2. All the Mode-menu functions placed where they would fit, with some of them made into toggle buttons;
3. Several other business-related menus exposed, including %Change, Part%Total, Date, BreakEven, IConv and Markup functionality; and finally
4. The functions which activate menus were highlighted with a rectangular box around them

A comparison of the keyboards in the 20b and the proposed 20bII is shown in Figure 3.



Fig. 3 – H20b and proposed HP20bII keyboards

Enhancing The 17bII+ ALPHA Menus and LCD Softkey Menu Labels

Still another enhancement to the 17bII+ comes from the late great HP42S: That is the turning on of the up- and down-arrow annunciators to indicate that an active menu contains additional menu pages. By doing this and utilizing the arrow keys to advance forward and backward between menu pages, the sixth function position in every menu may be used for a real purpose, instead of resorting to the “MORE” or “OTHER” label. This small change simplifies the ALPHA softkey menus quite a bit, allowing the number of secondary “letter” menus to be reduced from 6 to 5 and the number of “symbol” submenus reduced from 7 to 6. Figure 4a shows the revised ALPHA letter scheme and Figure 4b shows the revised symbol scheme. An example of keystroke saving is shown in Figure 5. If the dollar sign (“\$”) is desired, under

the original scheme, the “ABCDE” key would be pressed, followed by the “OTHER” key, then the “MORE” key and finally the “\$” key. Under the revised scheme, the “SYMBL” key would navigate to the

ABCDE	FGHI	JKLM	NOPQ	RSTUV	WXYZ		ABCDE	FGHIJ	KLMNO	PQRST	U - Z	SYMBL
A	B	C	D	E	OTHER		A	B	C	D	E	(space)
F	G	H	I	(space)	OTHER		F	G	H	I	J	(space)
J	K	L	M	(space)	OTHER		K	L	M	N	O	(space)
N	O	P	Q	(space)	OTHER		P	Q	R	S	T	(space)
R	S	T	U	V	OTHER		U	V	W	X	Y	Z
W	X	Y	Z	(space)	OTHER							

Fig. 4a – ALHPA letter-menu scheme of the HP17bII+ (left) and the HP17bII++ (right). By using the up- and down-arrow keys to navigate between menu pages, the menu is reduced by a full page.

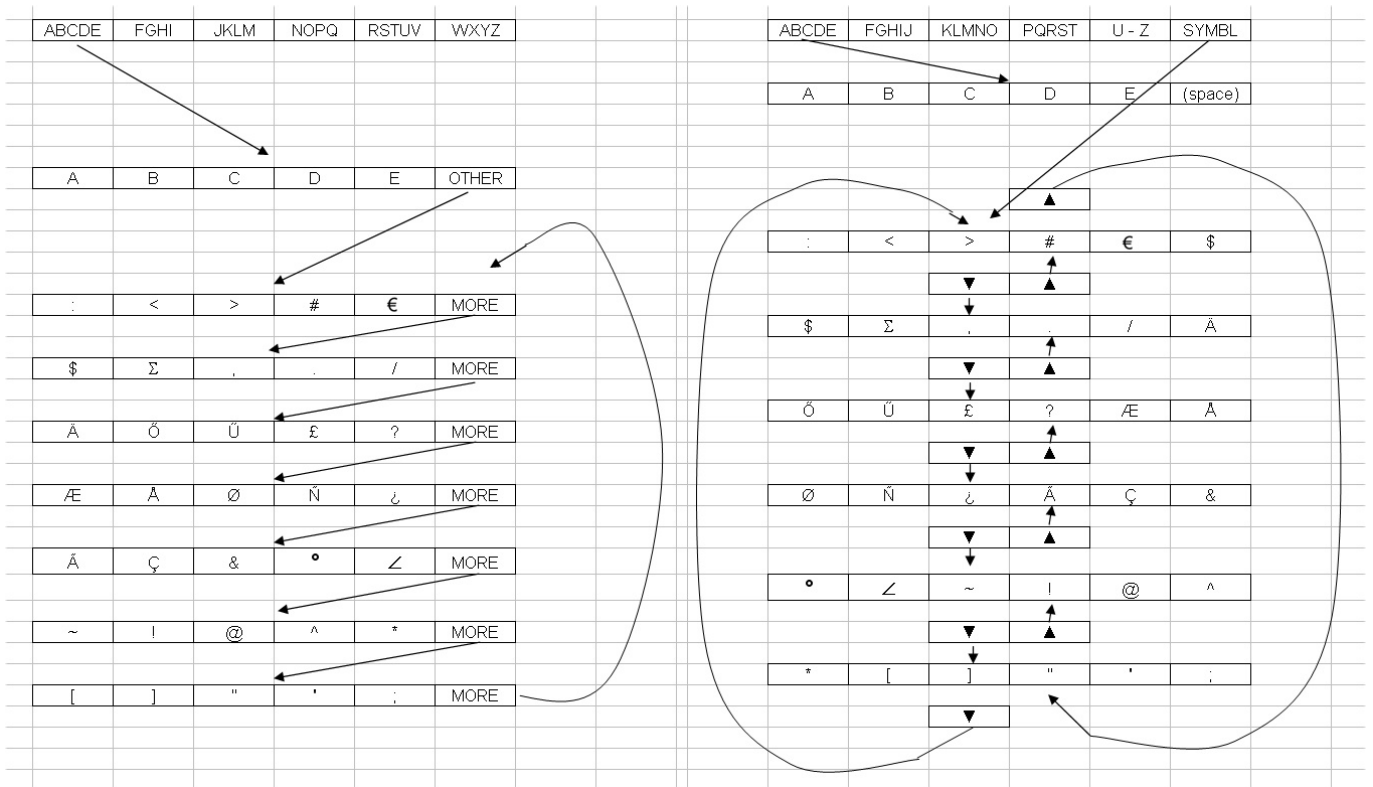


Fig. 4b – ALHPA symbol-menu scheme of the HP17bII+ (left) and the HP17bII++ (right). By using the up- and down-arrow keys to navigate between menu pages, this menu is also reduced by a full page.

first symbol page, whose sixth key is the “\$”. This would reduce the keystrokes from 4 to 2. Another distinct advantage of allowing the arrow keys to navigate between menu pages is that one can go both forward and backward between the pages, whereby the old “MORE” scheme requires cycling forward all the way through the pages in order to reach an earlier page.

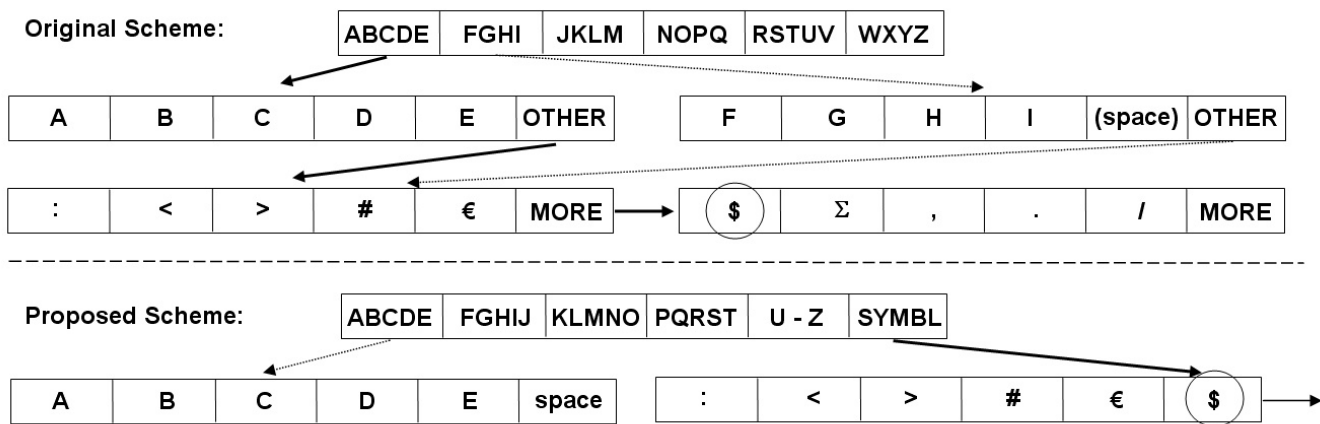


Fig. 5 – Original and proposed scheme to reach the “\$” key in the ALPHA menu tree. A reduction from 4 to 2 keystrokes may be achieved using this method.

Finally, a really useful tidbit from the HP48/49/50 series which could be adopted here would be the “marking” with a short horizontal bar above any LCD softkey label which further activates submenus. This distinguishes them from menu labels which simply execute functions. An overall comparison between the full 17bII+ and 17bII++ is shown in Figure 6.



Fig. 6 – Original and proposed HP17bII+ and HP17bII++

Further Enhancing The 20b: Reducing the Depth of the STATS Menu

Finally, one additional idea might slightly simplify the extremely complex 20b STATS menu. As the menu is entered, the first thing encountered is a set of choices for “2-Vars”, “1-Var” or “1-Weight” statistics. The INPUT key is required to be pressed to cycle through these choices until the desired one is reached, whereby pressing the down-arrow moves on to the next set of choices to select “Descriptive”, “Predictions” or “Sums”. One way to perhaps reduce the keystroke count here would be to replace the initial “sequential” menu of three choices with a “counted” menu a la the HP35S. When the STATS menu was selected, the top line of the LCD could turn on the alphanumeric message indicating to press 1, 2 or 3 for the particular choices. Then, only one key press would advance the user to the next level. And again, if the next sequential menu of three choices (or only two if only 1-variable data was selected initially) was replaced with a counted menu, that would also only require a single keypress. From either level, pressing “ON/CE” would then exit to the higher-level menu (or exit STATS entirely if at the first level). Since the top line of the display can only show approximately 8 alpha characters at a time, the menu message string would be scrolled across the display. Figure 7 shows an example of this feature.

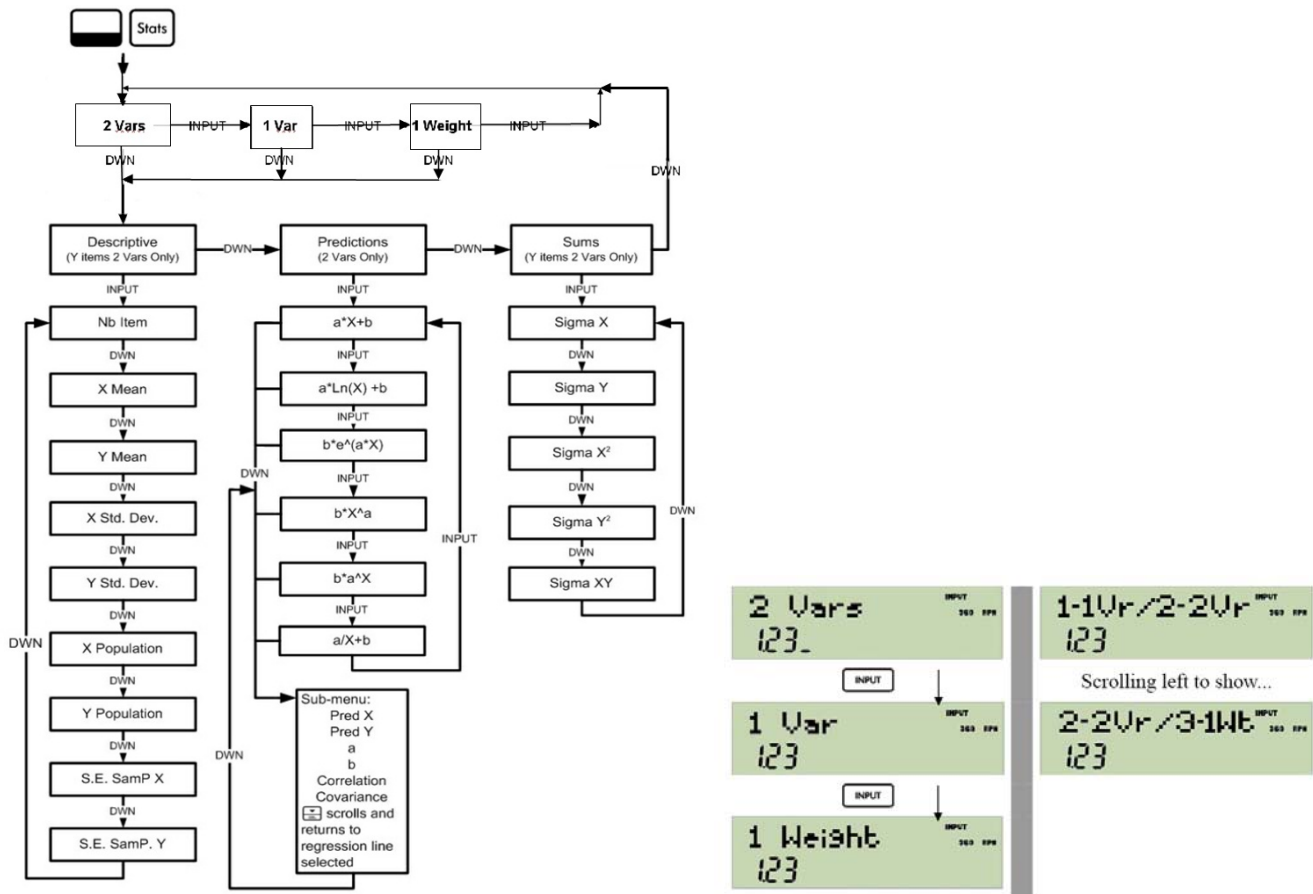


Fig. 7 – Original HP20b STATS Menu diagram (left) plus original and suggested 20bII initial “counted” menu (right). Instead of using INPUT to go between choices, the user presses keypad keys 1, 2 or 3. The text would be scrolled across the top line of the LCD, since it all cannot fit at the same time. Using this method for the top two levels of the STATS menu, as many as 4 keystrokes could be saved.

The Final Tallies

By applying the aforementioned improvements to the 17bII+ and 20b calculator keyboards and displays, a significant number of menus would be eliminated without removing any functionality. In addition, the average keystroke counts for both machines would be reduced and the overall ease of use could be considered to be increased in both cases. Although the clutter is increased in them, the keyboards would not have been made so complex as to bewilder a savvy user. Table 1 shows the changes in both machines with respect to counted keystrokes, menus, clutter, etc. It is hoped that improvements like these will be considered when future business calculators are on the drawing board.

Category	HP17BII+	proposed HP17BII++	Category	HP20b	proposed HP20bII
# menus	36	26	# menus	28	18
# menu fcns	245	196	# menu fcns	143	105
# primary keys	34	33	# primary keys	35	34
tot # primary fcns	27	26	tot # primary fcns	31	30
tot # shift keys	3	4	tot # shift keys	2	3
tot # 2-key shifted fcns	33	68	tot # 2-key shifted fcns	34	70
tot # 3-key sequences	40	40	tot # 3-key sequences	50	50
tot # 4-key sequences	10	20	tot # 4-key sequences	40	40
tot # 5-key sequences	0	2			
# menu functions	245	196	# menu functions	143	105
tot # Menu keystrokes	614	399	tot # Menu keystrokes	500	370
tot # functions	355	352	tot # functions	298	295
Keyboard Clutter (# fcns per key)	1.324	2.486	Keyboard Clutter (# fcns per key)	1.919	2.811
Keystroke Count	867	771	Keystroke Count	909	850
Keystroke count per function	2.442	2.190	Keystroke count per function	3.050	2.881

Table 1 – Counts of various keyboard metrics for the original and updated HP17bII+ (left) and HP20b (right). Although the clutter is increased in both, the number of menus is each reduced by ten, the number of menu functions moved to the keyboards is 49 and 38 respectively, and the total keystroke counts are reduced by 96 and 59 respectively.