Mental Model of the Hewlett Packard 12C Calculator

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Abstract

The HP 12C calculator has withstood the test of time. It was first introduced by Hewlett Packard in 1981, and is still considered the preferred calculator of use by many individuals in the business and financial world. It is a part of the HP 10C series, which also included the HP 15C calculator for advanced scientific functions and the HP 16C calculator for computer programming functions. Due to the HP 12C's popularity, the calculator remains in production today, with minor hardware updates throughout the years. It is considered Hewlett Packard's best selling product, although HP has never released official sales numbers. When compared to any other technological innovation of its time, very few, if any at all, are still as popular as the HP 12C. The following paper will explore the successful alignment of user and developer mental models of the HP 12C by analyzing the 5 usability metrics defined by Neilson in Usability Engineering.

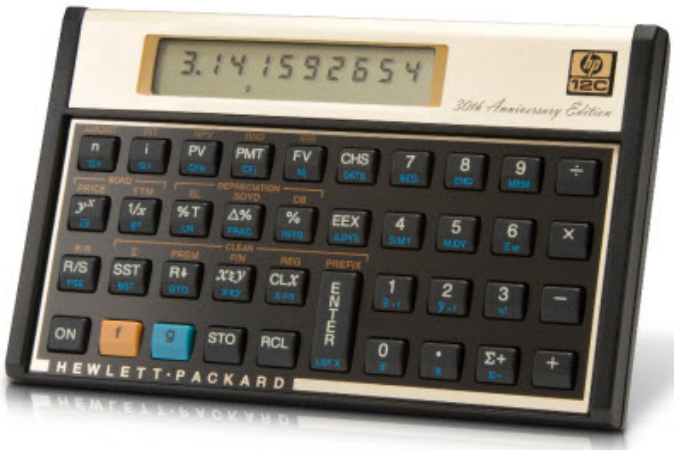

Figure 1: The 30th Anniversary Edition of the HP 12C

1 Introduction

The HP 12C calculator has withstood the test of time. It was first introduced by Hewlett Packard in 1981, and is still considered the preferred calculator of use by many individuals in the business and financial world. It is a part of the HP 10C series, which also included the HP 15C calculator for advanced scientific functions and the HP 16C calculator for computer programming functions. Due to the HP 12C's popularity, the calculator remains in production today, with minor hardware updates throughout the years. It is considered Hewlett Packard's best selling product, although HP has never released official sales numbers. When compared to any other technological innovation of its time, very few, if any at all, are still as popular as the HP 12C. The following paper will explore the successful alignment of user and developer mental models of the HP 12C by analyzing the 5 usability metrics defined by Neilson in Usability Engineering.

2 The Computational Environment of 1981

The computer landscape of 1981 was drastically different compared to today's landscape. In order to understand the initial success of the HP 12C calculator, it is beneficial to analyze the early stages of the personal computer revolution. The Altair 8800, the Apple II, and the Casio Mini Card LC-78 will be analyzed to acquire a sense of the computer environment of the 70's and early 80's, which will further the understanding of the HP 12C's seemingly eternal success.

The Altair 8800, developed around the popular Intel 8080 processor of the time, was introduced in 1975. It was one of the first computers marketed as a kit for hobbyists. At the time it was first introduced, it had no programming language other than machine language. A programmer would have to enter the machine language opcode manually by toggling a series of binary external switches, and use an enter switch to load the opcode into memory. This process was extremely inefficient and impractical for any type of real world application. Therefore, the Altair only appealed to self acclaimed computer hobbyists as a way to learn how to build a computer bit by bit (excuse the pun).

However, the Altair did boast an 8-bit Intel 8080 microprocessor, which had a clock speed of 2 MHz, making it one of the fasted processors of its time. Because it was a hobbyist computer, it also had a low price point of $439. These two factors opened up doors to outside visionaries like Bill Gates, who developed a version of BASIC for the Altair. This allowed a user to easily load programs into the Altair, like a mathematical operation. This drastically improved user efficiency, and thus was the inception of Microsoft.

Another computer product of the time, the Apple II, which was launched in 1977, was Apple's first mass-produced personal computer. It contained a 1 MHz CPU and 4 KB of RAM. Interestingly, the Apple II had a slower clock speed when compared to the Altair 8800, launched 2 years prior. What made the Apple II popular was its color graphical display, its mouse driven GUI, and expansion slots for third party devices, among other things. But the real driving factor for the Apple II's success was the development of third party software, including VisiCalc, the first spreadsheet software that was launched in 1979. Unlike the Altair, the Apple II was expensive, with an original retail price of $1298. Yet, it was cheap enough to get it into a few homes and offices.

These two personal computers were revolutionary for their time, and it wasn't until much later when personal computers became common in the home and workplace. The world of hand

held calculators developed in parallel with personal computers, yet experienced more success in the late 70's and early 80's with respect to popularity. In general, pocket calculators were cheaper and more mobile than personal computers. Manufacturers of pocket calculators in the 70's and 80's included HP, Canon, Texas Instruments, Mostek, Sinclair, Casio, Sanyo, and many others. Therefore, the competition was steep, whereas the personal computer environment was still blossoming.

The first credit card sized calculator, the Casio Mini Card LC-78, was released in 1978, and measured a mere 3.9 mm thick. It originally sold for $34. This attractively thin form factor parallels today's product design. But the functionality of the Casio Mini Card was limited to basic arithmetic operations. Users in the professional field needed calculators to compute specific functions to their fields of study. This is where the HP 12C calculator comes into play. The quantity of built in functions found in the HP 12C for financial applications made it a go to calculator for the business world. But this does not explain how it has withstood the test of time, as those functions became a commonplace when spreadsheet software and future calculators flooded the marketplace.

3 Industrial Design of the HP 12C

One aspect of the HP 12C that made it successful was the high quality look and feel of the device. As a financial calculator, it fits well in the formal setting of fortune 500 companies. By looking at Figure 1 on page one, one can admire the HP 12C's aesthetic quality. The color of the plastic casing is black with a golden metallic strip that spans the top. The two function buttons f and g are golden orange and baby blue respectfully. Sub-functionality for each button is indicated by similarly colored font, with the f function text above the button, and the g function text on the bottom half of the button. This makes it intuitive to select button sub-functionality. The top half of the button displays the first level functionality of the button in a larger font than the second level functionality. The developers of the HP 12C understood what functions the user would use more often, like integer values 0 through 9, enter, and clx (clears temporary register x), and made those first level functions. By making the first level function text on each button larger than the sub functionality text, the user can easily differentiate between first and second level functions.

The buttons stick out a substantial amount, and are beveled at the bottom, giving it a more pyramidal shape. This gives the calculator a good tactile response, which gives the user instant gratification. There is never any doubt if the button was pressed or not pressed.

4 Functionality of the HP 12C

What makes the HP 12C so popular is its built in financial functionality. These functions include common financial mathematical formulas like interest rate functions, bond functions, depreciation functions, statistical functions (mean, standard deviation, linear estimation etc.), real estate functions, and other miscellaneous financial related functions. With so much functionality, there is the risk of the user to experience information overload, and become lost in the options of button pressing. There are a total of 39 buttons on the HP 12C. As mentioned in the previous section, sub-functions exist by the use of the f and g buttons. These sub-functions are categorized in bond, depreciation, and clear functions. These 'submenus' hide less used functionality of the calculator, or more advanced functionality of the calculator, depending on how one looks at it.

5 Reverse Polish Notation

There is more to the calculator than functionality and good industrial design. It uses Reverse Polish Notation (RPN), as opposed to the more commonly used algebraic notation. RPN allows the user to input less keystrokes than algebraic notation. RPN works by the user inputting the operands, which is followed by the operator. For example to calculate 3 + 4, the following would be inputted into the calculator:

[3] [enter] [4] [+]

Contrast that with algebraic notation:

[3] [+] [4] [enter]

At first it may be unclear how RPN would reduce the number of keystrokes, as both examples use 4 keystrokes. But let us look at an example that requires knowledge of precedence (recall PEMDOS: Parentheses, Exponentiation, Multiplication, Division, Addition, Subtraction). Let us compute (1+2)*(3+4) in RPN:

[1] [enter] [2] [+] [3] [enter] [4] [+] [x]

Now let us compute the same thing in algaraic notation, without the use of parenthases:

[1] [+] [2] [enter], temporality store result in memory or write down

[3] [+] [4] [enter], temporality store result in memory or write down

[result1] [x] [result2] [enter]

RNP requires 9 keystroke, whereas algabraic notation requires at least 12 keystrokes, depending if the user stores the temporary values in memory or not. For algabraic notation, there's a disconnect between temporary values, where the user has to recall those temporary values. for RPN, the user can observe the result for each temporary step. Some calculators allow use of parenthases, where the user can directly input the algabraic equation as seen.

[( ] [1] [+] [2] [ )] [( ] [3] [+] [4] [ )] [enter]

This method still requires at least 11 keystrokes, but may be more intuitive to the user who is familiar with standard math expressions. All they have to do is copy how they would write it on a piece of paper. Therefore, the learnability of the algebraic method is faster than RPN, as RPN requires a bit of manipulation of how the user inputs data into the calculator. But, because RPN requires less keystrokes, the user can obtain the final result faster, making RPN more efficient. Many people who have learned how to use RPN tend to not forget how it works. This makes RPN very memorable.

6 Hardware of the HP 12C

7 Conclusion