

Chapter

1

The Future of PC Hardware

In this chapter, we will learn the following to World Class standards:

- **The Past of PC Hardware**
- **Key Innovators of Computing**

The Past of PC Hardware

The past of personal computing does not involve much of what we use today in the terms of hardware interface, but the concepts are still there. Computers are all about counting, however today as they churn through larger and larger numbers, their input and outputs show displays to consumers who demonstrate little concern for mathematics.

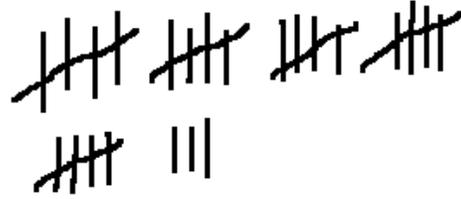


Figure 1.1 – Counting on a Wall

We surmise that we begin with scratches on a cave wall to count the number of days of continuous rain or the duration of days between full moons. Whatever the reason, we have a limitation of 20 digits if we use our fingers and toes, so without much trepidation, we figure that our ancestors began to compute a number on a flat surface and or a large rock wall which is as good as any to record their numbers.

A few thousand years ago, someone determined to create columns to create a system that has fewer digits but holds more data. The abacus is such a device where the first column represents 0 to 9, the second column symbolizes 0, 10 to 90, the third column signifies 0, 100 to 900. This is called the base ten numbering system. Different versions of the abacus were the cutting edge of technology right up to the 17 century where they are used throughout the period for adding and subtracting by students, business people and caregivers in the home.

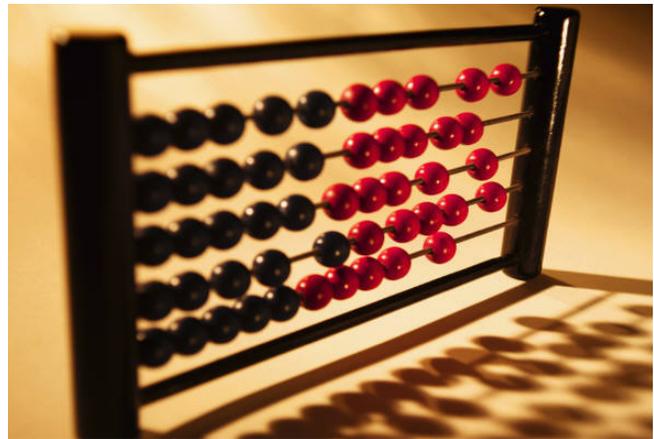


Figure 1.2– An Abacus for Adding

In this version of the abacus, there are beads that stand for 5 at the top and the 4 beads signify 1 at the bottom. When we move the beads to the center post, we count. In figure 1.3, the abacus is showing 15318, which is much more efficient than scratching that many notches on the surface of a wall or even trying to count them if we did. How do we display a zero on the abacus? We have in the hundred thousand column, when we did not slide a bead to the center post.

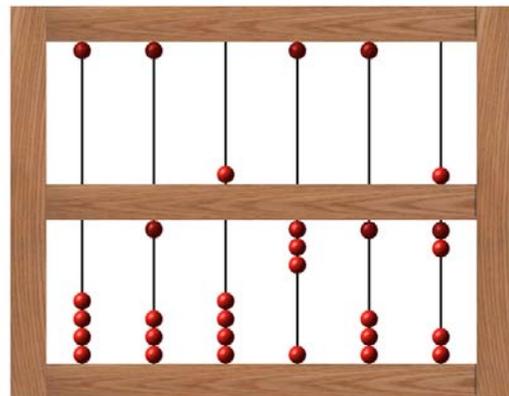


Figure 1.3– An Abacus for Adding

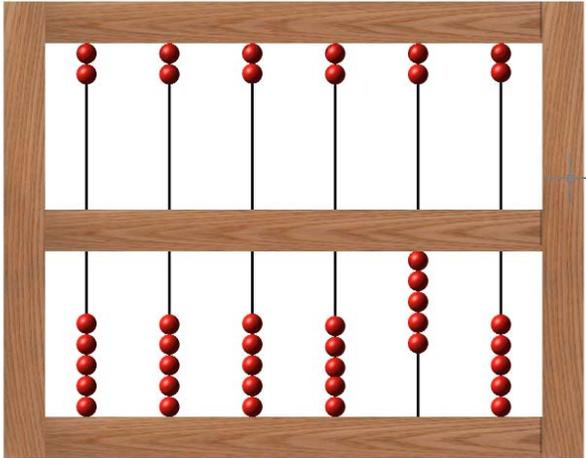


Figure 1.4– Moving Five to the Post

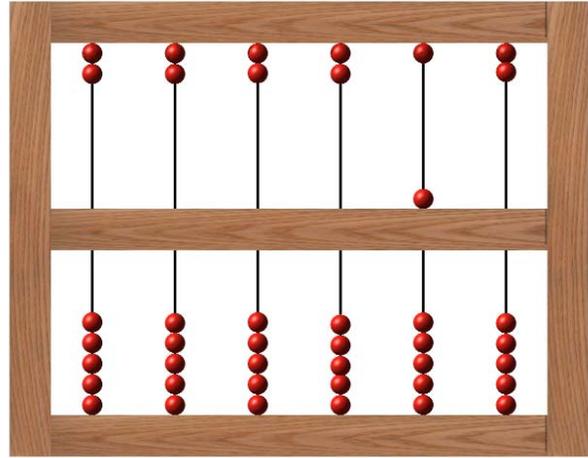


Figure 1.5– Substituting a Single Bead for 5

In another version of the abacus, we can have two five beads and five 1 beads so that we can count to five and then substitute a complete set of five beads for a single five bead. When we move two 5 beads to the center beam, we then can substitute the two fives for a single 1 in the next column.

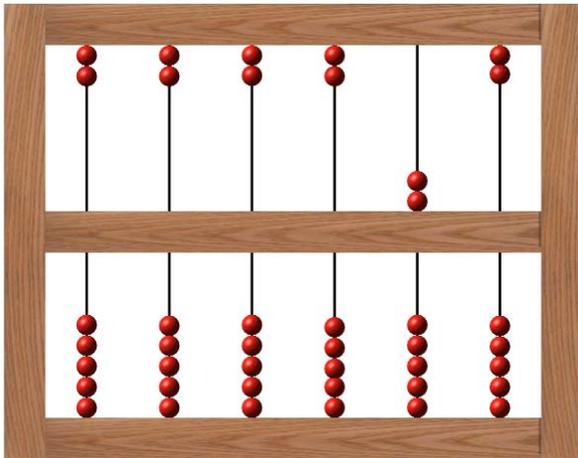


Figure 1.6– Moving Two 5 Beads to the Post

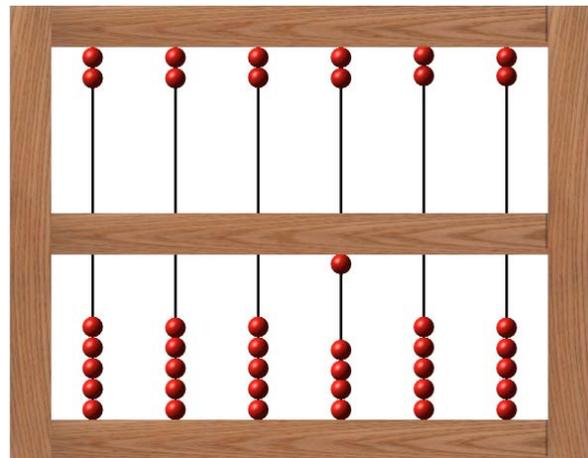


Figure 1.7– Substituting a Single Bead for 2

The abacus counting frame was an efficient system until people need to use the multiplication and division process. In 1614, an English mathematician named John Napier developed a system called Logarithms where we can add two converted numbers and obtain a new number that we convert again and we achieve multiplication. With a book of Logarithm tables written by Wilhelm Briggs, a person can add two converted numbers and take that number to get the answer for a multiplication problem. Or they can reverse the process and use subtraction and to achieve division.

For example if we take the number 2, in a logarithm table we get 0.30103. The number 3, we get from the table, 0.47712. We add the two converted numbers 0.30103 and 0.47712 to get 0.778151. When we look up this number up in the table, we see the number 6. In 1622, William Oughtred used the logarithmic scale to develop the slide rule where two opposing logarithmic scale are

stacked so that base 10 numbers can be multiplied. Below, we can see the 1 in the upper scale overtop the two of the lower scale. We follow the 3 on the upper scale and we can see that it is over the 6 of the lower scale.

$$2 \times 3 = 6$$

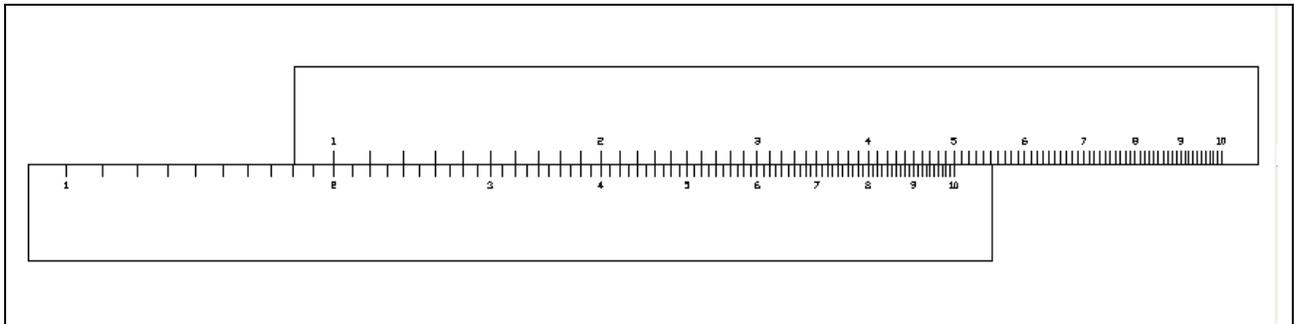


Figure 1.8– Adding on a Slide Rule Results in Multiplication

We can see in the above image that $2 \times 4 = 8$ and $2 \times 5 = 10$. With a little training, people could use these slide rules to multiply and divide numbers primarily on the job from the 17th century until the 1970's.

We can see in the next image that 2.25 times 4 will equal 9. In this example, we place the 1 from the top scale past the 2, two tenths and then half way to the next tenth. We follow the 4 on the upper scale and we can see that it is over the 9 of the lower scale.

$$2.25 \times 4 = 9$$

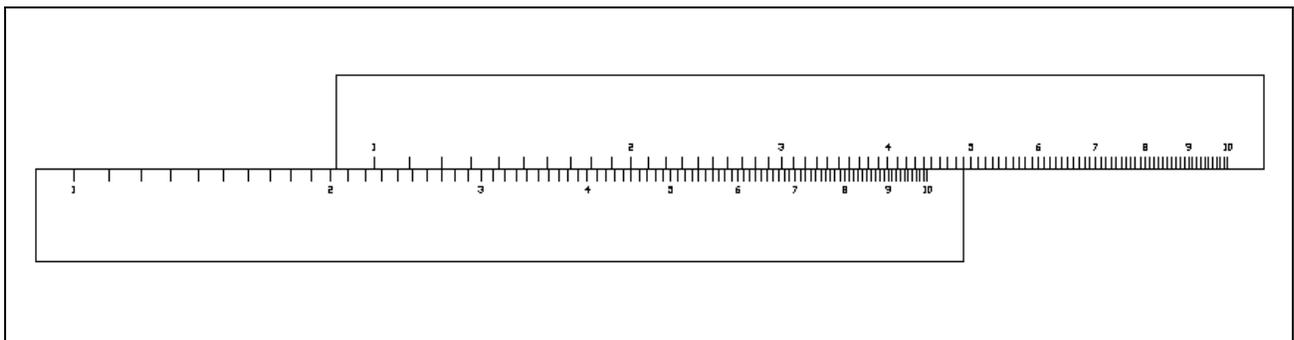


Figure 1.8– Adding on a Slide Rule Results in Multiplication

If you were not lucky enough to learn how to use a mainframe computer from anywhere from 1946 to the late 1970's, you were still using a slide rule to do your computations. By 1942, John Atanasoff and Clifford Berry had developed the first electronic binary calculator and computer at the Iowa State College. In using the last system, the slide rule, the user would have to utilize their best judgment to computer a three significant digit number. In many cases, this was sufficient, but both efficiency and accuracy are important in doing complex work. In the late 20th century, people using advanced weapons and manufacturing processes wanted more precision and faster solutions.

The binary number system used in the ABC computer is also a simple system like the base 10 that

has an ordered system where we can use fewer digits to hold more information. It evolved because a switch is either on which we will call 1 or off that we will call 0. There is no room for anything in between. This system is called base 2.

The system is similar to Base 10 except each column can only hold two numbers, 0 and 1. Let us say that we want to write the base 10 number 9 in base 2 or binary, so we have to know how a base two number is concatenated. The first column of the binary number is the one's column. We can only have two figures in a base 2 column, a one or a zero. If we need to count to two, we need to add another column to the left, the two column. In a two-digit binary number, we can count to three. For example 11 is one 2 and one 1, and 2 plus 1 equals 3. The next column is four, the fourth column is the eight column. We keep on doubling the number for each column to the left.

In the example shown, to obtain the base 10 number 9, we write a 1 in the eight column and 1 in the one column to get a total of nine. Each placeholder is called a bit. Below the 8-bit number for the corresponding base 10 number 9 is 00001001.

128	64	32	16	8	4	2	1	Total
0	0	0	0	1	0	0	1	9

Sometimes we want to convert a binary number to base 10. In our conversion from binary to base 10, we just write the binary number in the chart and add any column heading that contains a 1. In our example 10101011, we place the binary number in the table. Now, we add any column number that shows a number 1 in the binary figure.

128	64	32	16	8	4	2	1	Total
1	0	1	0	1	0	1	1	171

$$128 + 32 + 8 + 2 + 1 = 171$$

The total is 171. This technique works with any binary number conversion.

The first electronic computers and calculators were 8-bit machines called a byte and each number could hold figures from 0 to 255. This is not a large number, but this numeric system is still used to translate the letters of the alphabet on our keyboards to the web address on our servers and computers on the Internet.

By the mid 1970's, we had 16-bit microprocessors where a single 16-bit number could hold figures from 0 to 65535. By the mid to late 1980's, companies like Intel introduced true 32-bit microprocessors such as the 80486 chip. By the early 2000's, we now have 64 bit technology.

Binary	Range of Numbers
8 bit	0 to 255
16 bit	0 to 65535
32 bit	0 to 4,294,967,296
64 bit	0 to 18,446,744,073,709,551,616

The individuals playing video games have always taken advantage of the larger binary number since the enhanced display requires rendering of many colors and the software has the display changing quickly compared to that of a word processing program.

How can we calculate how high a certain length binary can count? On the Windows 7 operating system, we click on the Start button and we type calc in the test box. When the Calculator window appears on the desktop, we change select View on the Menu bar. We change the calculator to Scientific as we see in figure 1.9. Using the number pad on the keyboard, we type “2”.

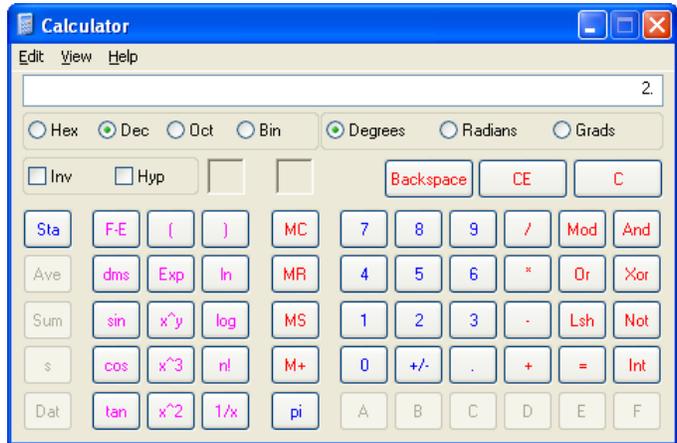


Figure 1.9– The Windows Scientific Calculator

We can compute 2^{64} by pressing the x^y button on the calculator. Next we type “64” as we see figure 1.10.

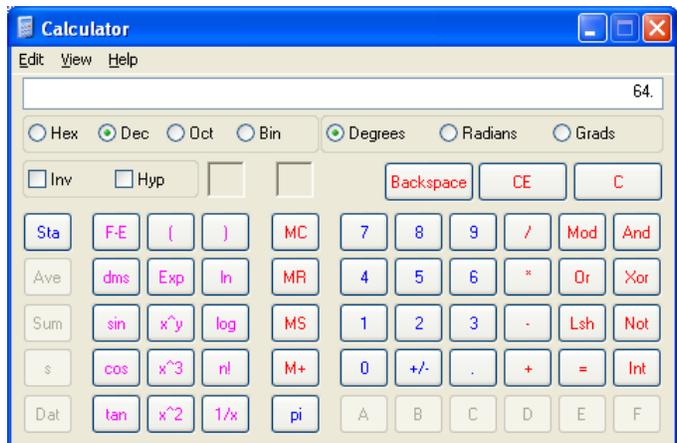


Figure 1.10– The Windows Scientific Calculator

Then we press the equal sign and we see 18,446,744,073,709,551,616 in the display. Can you compute how high a 128 bit number can count? Or a 256 bit number can count? The numbers are so large that a normal calculator will use scientific notation to display the value.

Binary	4 Significant Digits	$\times 10^N$
64 bit	1.845	10^{19}
128 bit		$10^{—}$
256 bit		$10^{—}$

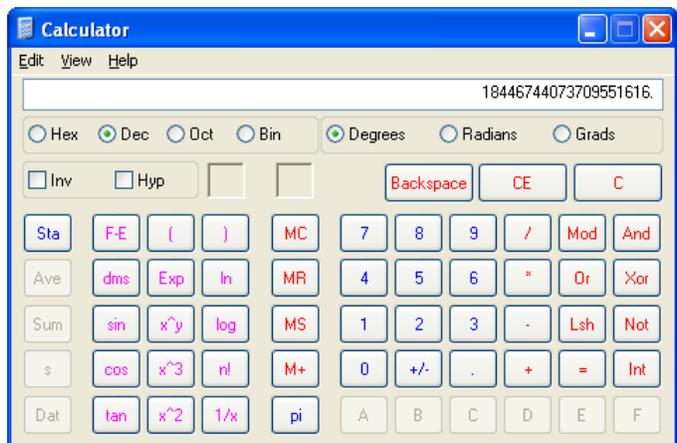


Figure 1.11– The Windows Scientific Calculator

So we have progressed from scratching numbers on a wall to electronically computing numbers in seconds that we would have to spend an hour to maybe even a lifetime to calculate. However, today, computers are much more than numbers. Computers take our input, process it and then produce an output. A typical personal computer will have applications that play games, music, videos, send a text message, send an email and file, write a school paper, make an accounting spreadsheet for work or doing taxes, or create an entertaining slide presentation. All machines have many modes of input such a movable pointing device, display touch screen and microphone. They have thin flat screen video output, speakers and the ability to print to paper or other media.

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