Chapter 1

Computer Hardware and Vocabulary

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CPU: The **CPU** is the Central Processing Unit. It resides on one or more chips inside the computer. Each chip is a grid of silicon wires encased in a plastic container about the size of a fingernail. Although there are other chips involved and this is an oversimplification, it works well to think of the CPU as the central component of your system. It functions the way your brain functions, coordinating the activities of the other devices. Although computers with vacuum tubes go back to 1946, the first microprocessor-- i.e. computer on a chip-- was invented by Ted Hoff from Intel Corp in 1971.

Another important chip-- the **RAM** chip-- is always blank when the electricity is off. When you start up a computer and begin to work, the information you type as well as the program that is in process all fit inside of RAM. When people refer to a 1.8 gig or 2 gig computer, they are referring to the size of the RAM capacity. RAM stands for Random Access Memory. A typical Mac or Windows computer now comes with two gigabyte of RAM; older Macs and PCs in the early 1990s came with 1 meg of RAM. In the mid 1980s, typical computers had about 1/8 of a meg of RAM (128K) and very primitive graphics. The first microcomputer in 1975 (Altair) had under 1K of RAM which is about 1/1,000th of a meg. Gordon Moore, former CEO of INTEL and mentor of Andrew Grove (TIME magazine Man of the year 12/97) gets credit for what is now called “Moore's Law” — chip power doubling roughly every 2 years and costs falling by 50%.

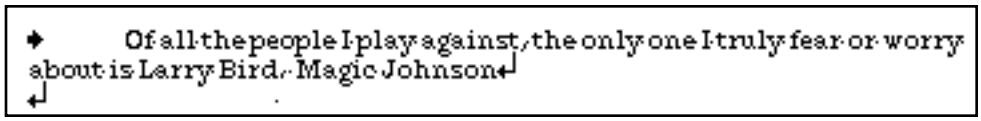
ROM chips are crucial to the computer, but not very interesting to us as consumers. A ROM chip typically contains “frozen” information (fairly technical, esoteric stuff) that the manufacturer wants accessible at all times. BASIC, however, was built into ROM on the Apple II

so that if you turned on that CPU without a disk drive, you could actually start programming. ROM stands for Read Only Memory. ROM chips are found not only in computers; many appliances and even toys contain ROM chips. In fact, the singing bass, Big Mouth Billie, contains a ROM chip.

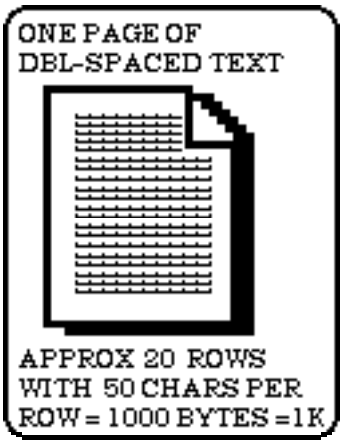
In order for the CPU and other chips to talk to other devices, an **Interface** board is used to connect the electronics of one machine to another. The board contains a printed circuit with a few special purpose chips. The innovation of the Mac Plus back in 1987 was that it had a SCSI Interface built-in, allowing for easy connection to hard disk drives. The technology rivalry between the East Coast (Rt. 128 beltway) and West Coast (Silicon Valley area) was symbolized by the pronunciation of the word SCSI. East Coasters wanted to pronounce it as "sexy" while West Coasters wanted “scuzzy.” As the Lakers proved more often in the 1980s, the West won and “scuzzy” became the accepted pronunciation. By the way, **SCSI**, which stands for Small Computer System Interface is increasingly another obsolete word, since USB, firewire, and Bluetooth are taking over as faster ways for data to travel.

One special interface board — the **Video Board** — connects the computer to the screen; it frequently has multicolored wires emerging from it, typically RGB for red, green and blue. Although most of us mixed the primary colors (red, yellow, and blue) to make other paint colors, it turns out that the primary colors for electron beams are red, green, and blue. Another important board — the **Motherboard** — is the main circuit board that all the RAM Chips, ROM Chips, and other Interface Boards plug into.

Both the computer chip and the disk drive store information that is coded electronically. The basic unit of information is the **Byte** which is equivalent to one character or one keystroke. For example, the word “Hello” is a 5 byte word. Because spaces are just as significant as letters, “New York” is one 8 Byte word, which is the way most New Yorkers say it anyway. In fact, it is very useful in teaching or learning word processing to realize that Space Bar and Return each constitutes 1 Byte; you might say that the computer alphabet has 29 letters: A-Z, Space Bar, Tab and Return. Use the “show invisibles” command in your word processor to see all of these 29 letters!



1000 BYTES = 1 **K**: How many BYTES on a piece of paper? Well, a good approach is to consider double-spaced text with wide margins. For example, you might have 50 characters across the page, with a total of 20 lines down. Therefore, we have 20 X 50 bytes or 1000 bytes on the page. Computer people refer to 1000 bytes as 1 **Kilobyte** and then abbreviate it as 1 **K**.



Just as 1000 bytes equals 1 kilobyte (1K), 1 million bytes (1000K) is 1 **Megabyte** (usually pronounced **MEG**) and 1 billion bytes (1000 megabytes) is 1 **Gigabyte**. Hard disks range from 40 meg to 80 gigabytes. CDs hold up to 650,000K, which we call 650 meg or over 1/2 a Gigabyte. In Spring of 1998, Bill Gates launched the TerraServer project — a database of satellite pictures (www.terraserver.com) of the world. The Web server contains over 1 terabyte ("of the terra") stored in a database of 173.6 million rows. One **Terabyte** contains 1,000 gigabytes (about 1500 CDs) or about 1 million floppy disks!

This chart summarizes basic computer literacy for various disks

• double density floppy disk	800K	800,000 bytes	.8 meg	
• high density floppy disk	1,400K	1,400,000 bytes	1.4 meg	
• typical hard disk drive	80,000,000K	80,000,000,000 bytes	80,000 meg	80 gig
• CD ROM disk	650,000K	650,000,000	650 meg	.5 gig

How is each byte coded? Although this topic is not particularly useful, many people find it interesting. The inside of a chip looks like a grid of horizontal and vertical wires. A junction point on a the grid is magnetized to be either ON or OFF.

Consider a 1 inch chip that has 100 horizontal wires and 100 vertical wires. It looks like a gigantic tic-tac-toe board with 10,000 different junction spots or intersection points. Imagine that each one can be TURNED ON or OFF with magnetism, behaving like a light bulb. Let us call each junction of wires a **Bit** and let us think of grouping the thousands of **Bits** into groups of 8.

Using groups of 8 **Bits** at a time, we have a picture that looks like this:

```
   |   |   |   |   |   |   |   |
  -·- -·- -·- -·- -·- -·- -·- -·-
   |   |   |   |   |   |   |   |
```

It turns out that we can design a code of ONs and OFFs so that each group of 8 **Bits** holds one letter or symbol of the English alphabet. How? Well, first let's figure out how many different patterns of ON and OFF we would find with 8 **Bits** lined up. If we had just a 2 bit computer, we might have 4 different patterns for the 2 spots:

```
ON-ON      · ·
ON-OFF     · o
OFF-ON     o ·
OFF-OFF    o o
```

If we had just a 3 bit computer, we might have 8 different patterns for the 3 spots:

```
ON-ON-ON       · · ·        OFF-OFF-ON     o o ·
ON-ON-OFF      · · o        OFF-OFF-OFF    o o o
ON-OFF-ON      · o ·        OFF-ON-ON      o · ·
ON-OFF-OFF     · o o        OFF-ON-OFF     o · o
```

Using the symbols 1 for ON and 0 for off simplifies the explanation:

```
A 2-bit computer has 4 patterns:  00  01  10  11
A 3-bit computer has 8 patterns: 000 001 010 011 100 101 110 111
A 4-bit computer has 16 patterns:
          0000 0001 0010 0011 0100 0101 0110 0111
          0001 1001 1010 1011 1100 1101 1110 1111
```

This system of 1's and O's is really the **Base Two** or **Binary** number system in math; the word **Bit** is an acronym of the phrase **BInary digiT.**

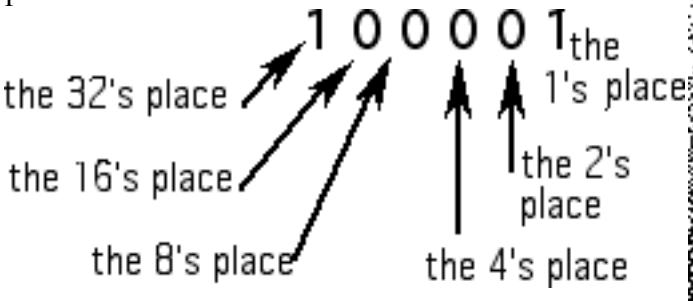
Here are the numbers from 1 to 14 written in **Base Two**:

```
0001 = 1    1000 = 8
0010 = 2    1001 = 9
0011 = 3    1010 = 10
0100 = 4    1011 = 11
0101 = 5    1100 = 12
0110 = 6    1101 = 13
0111 = 7    1110 = 14
```

Here is Larry Bird's uniform number (33) written as a BASE TWO number:

100001

Each position stands for a power of TWO instead of a power of TEN:



Now let's figure out how many patterns in an 8 bit computer? Since a 2 bit computer has 4 patterns and a 3 bit computer has 8 patterns, can you see that the number of patterns doubles as we add a bit. Can you figure out a good rationale for why it is so?

Take the 8 patterns for a 3 bit computer. Put a zero in front of each pattern or put a one in front of each pattern — you get the 16 patterns that for a 4 bit computer. The end result is that an 8 bit computer has 256 patterns. Each one is equal to one letter of the alphabet, a symbol on the keyboard or perhaps even a graphics character. Some of the 256 patterns may even be left unused. This provides another way to understand a Byte. A byte is made up of 8 bits and is a coded way of representing one letter of the alphabet.