Non Aligned Movement:
Addressing Digital Divide
Manual on E-Readiness

TABLE OF CONTENTS
Computer Evolution Go!

SUPPLEMENT ON INFORMATION AND COMMUNICATION TECHNOLOGY

Chapter 1

Computer Evolution

Computer History and Development

Nothing epitomizes modern life better than the computer. For better or worse, computers have infiltrated every aspect of our society. Today computers do much more than simply compute: supermarket scanners calculate our grocery bill while keeping store inventory; computerized telephone switching centers play traffic cop to millions of calls and keep lines of communication untangled; and automatic teller machines (ATM) let us conduct banking transactions from virtually anywhere in the world. But where did all this technology come from and where is it heading? To fully understand and appreciate the impact computers have on our lives and promises they hold for the future, it is important to understand their evolution.

Early Computing Machines and Inventors

The abacus, which emerged about 5,000 years ago in Asia Minor and is still in use today, may be considered the first computer. This device allows users to make computations using a system of sliding beads arranged on a rack. Early merchants used the abacus to keep trading transactions. But as the use of paper and pencil spread, particularly in Europe, the abacus lost its importance. It took nearly 12 centuries, however, for the next significant advance in computing devices to emerge. In 1642, Blaise Pascal (1623-1662), the 18-year-old son of a French tax collector, invented what he called a numerical wheel calculator to help his father with his duties. This brass rectangular box, also called a Pascaline, used eight movable dials to add sums up to eight figures long. Pascal's device used a base of ten to accomplish this. For example, as one dial moved ten notches, or one complete revolution, it moved the next dial - which represented the ten's column - one place. When the ten's dial moved one revolution, the dial representing the hundred's place moved one notch and so on. The drawback to the Pascaline, of course, was its limitation to addition.

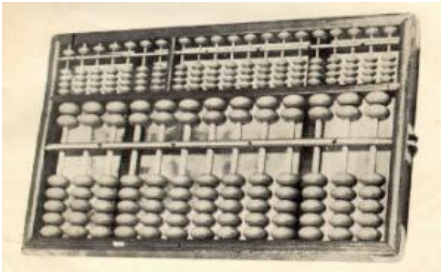

Figure 2. Abacus Device

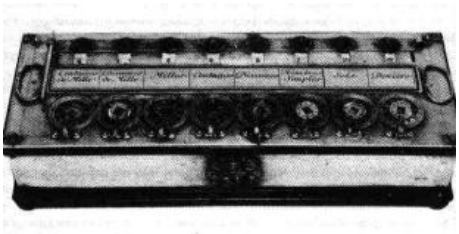

Figure 2. Pascaline

In 1694, a German mathematician and philosopher, Gottfried Wilhem von Leibniz (1646-1716), improved the Pascaline by creating a machine that could also multiply. Like its predecessor, Leibniz's mechanical multiplier worked by a system of gears and dials. Partly by studying Pascal's original

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notes and drawings, Leibniz was able to refine his machine. The centerpiece of the machine was its stepped-drum gear design, which offered an elongated version of the simple flat gear. It wasn't until 1820, however, that mechanical calculators gained widespread use. Charles Xavier Thomas de Colmar, a Frenchman, invented a machine that could perform the four basic arithmetic functions. Colmar's mechanical calculator, the arithometer, presented a more practical approach to computing because it could add, subtract, multiply and divide. With its enhanced versatility, the arithometer was widely used up until the First World War. Although later inventors refined Colmar's calculator, together with fellow inventors Pascal and Leibniz, he helped define the age of mechanical computation.

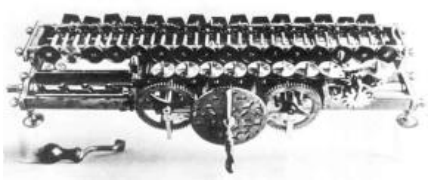

Figure 3. Leibniz Machine

The real beginnings of computers as we know them today, however, lay with an English mathematics professor, Charles Babbage (1791-1871). Frustrated at the many errors he found while examining calculations for the Royal Astronomical Society, Babbage declared, "I wish to God these calculations had been performed by steam!" With those words, the automation of computers had begun. By 1812, Babbage noticed a natural harmony between machines and mathematics: machines were best at performing tasks repeatedly without mistake; while mathematics, particularly the production of mathematics tables, often required the simple repetition of steps. The problem centered on applying the ability of machines to the needs of mathematics. Babbage's first attempt at solving this problem was in 1822 when he proposed a machine to perform differential equations, called a Difference Engine. Powered by steam and large as a locomotive, the machine would have a stored program and could perform calculations and print the results automatically. After working on the Difference Engine for 10 years, Babbage was suddenly inspired to begin work on the first general-purpose computer, which he called the Analytical Engine. Babbage's assistant, Augusta Ada King, Countess of Lovelace (1815-1842) and daughter of English poet Lord Byron, was instrumental in the machine's design. One of the few people who understood the Engine's design as well as Babbage, she helped revise plans, secure funding from the British government, and communicate the specifics of the Analytical Engine to the public. Also, Lady Lovelace's fine understanding of the machine allowed her to create the instruction routines to be fed into the computer, making her the first female computer programmer. In the 1980's, the U.S. Defense Department named a programming language ADA in her honor.

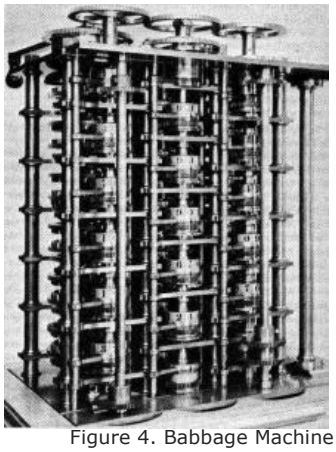

Figure 4. Babbage Machine

Babbage's steam-powered Engine, although ultimately never constructed, may seem primitive by today's standards. However, it outlined the basic elements of a modern general purpose computer and was a breakthrough concept. Consisting of over 50,000 components, the basic design of the Analytical Engine included input devices in the form of perforated cards containing operating instructions and a "store" for memory of 1,000 numbers of up to 50 decimal digits long. It also contained a "mill" with a control unit that allowed processing instructions in any sequence, and output devices to produce printed results. Babbage borrowed the idea of punch cards to encode the machine's instructions from the Jacquard loom. The loom, produced in 1820 and named after its inventor, Joseph-Marie Jacquard, used punched boards that controlled the patterns to be woven.

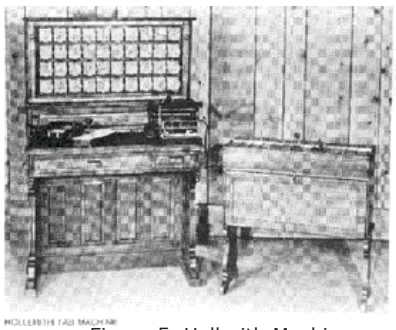

Figure 5. Hollerith Machine

In 1889, an American inventor, Herman Hollerith (1860-1929), also applied the Jacquard loom concept to computing. His first task was to find a faster way to compute the U.S. census. The previous census in 1880 had taken nearly seven years to count and with an expanding population, the bureau feared it would take 10 years to count the latest census. Unlike Babbage's idea of using perforated cards to instruct the machine, Hollerith's method used cards to store data information which he fed into a machine that compiled the results mechanically. Each punch on a card represented one number, and combinations of two punches represented one letter. As many as 80 variables could be stored on a single card. Instead of ten years, census takers compiled their results in just six weeks with Hollerith's machine. In addition to their speed, the punch cards served as a storage method for data and they helped reduce computational errors. Hollerith brought his punch card reader into the business world, founding Tabulating Machine Company in 1896, later to become International Business Machines (IBM) in 1924 after a series of mergers. Other companies such as Remington Rand and Burroghs also manufactured punch readers for business use. Both business and government used punch cards for data processing until the 1960's.

In the ensuing years, several engineers made other significant advances. Vannevar Bush (1890-1974) developed a calculator for solving differential equations in 1931. The machine could solve complex differential equations that had long left scientists and mathematicians baffled. The machine was cumbersome because hundreds of gears and shafts were required to represent numbers and their

various relationships to each other. To eliminate this bulkiness, John V. Atanasoff (b. 1903), a professor at Iowa State College (now called Iowa State University) and his graduate student, Clifford Berry, envisioned an all-electronic computer that applied Boolean algebra to computer circuitry. This approach was based on the mid-19th century work of George Boole (1815-1864) who clarified the binary system of algebra, which stated that any mathematical equations could be stated simply as either true or false. By extending this concept to electronic circuits in the form of on or off, Atanasoff and Berry had developed the first all-electronic computer by 1940. Their project, however, lost its funding and their work was overshadowed by similar developments by other scientists.

Five Generations of Modern Computers

First Generation (1945-1956)

With the onset of the Second World War, governments sought to develop computers to exploit their potential strategic importance. This increased funding for computer development projects hastened technical progress. By 1941 German engineer Konrad Zuse had developed a computer, the Z3, to design airplanes and missiles. The Allied forces, however, made greater strides in developing powerful computers. In 1943, the British completed a secret code-breaking computer called Colossus to decode German messages. The Colossus's impact on the development of the computer industry was rather limited for two important reasons. First, Colossus was not a general-purpose computer; it was only designed to decode secret messages. Second, the existence of the machine was kept secret until decades after the war.

American efforts produced a broader achievement. Howard H. Aiken (1900-1973), a Harvard engineer working with IBM, succeeded in producing an all-electronic calculator by 1944. The purpose of the computer was to create ballistic charts for the U.S. Navy.

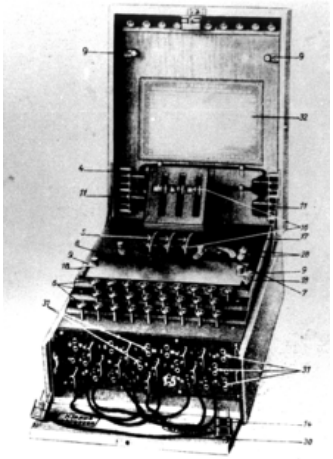

Figure 6. Colossus Machine

It was about half as long as a football field and contained about 500 miles of wiring. The Harvard-IBM Automatic Sequence Controlled Calculator, or Mark I for short, was an electronic relay computer. It used electromagnetic signals to move mechanical parts. The machine was slow (taking 3-5 seconds per calculation) and inflexible (in that sequences of calculations could not change); but it could perform basic arithmetic as well as more complex equations.

Another computer development spurred by the war was the Electronic Numerical Integrator and Computer (ENIAC), produced by a partnership between the U.S. government and the University of Pennsylvania. Consisting of 18,000 vacuum tubes, 70,000 resistors and 5 million soldered joints, the computer was such a massive piece of machinery that it consumed 160 kilowatts of electrical power, enough energy to dim the lights in an entire section of Philadelphia. Developed by John Presper Eckert (1919-1995) and John W. Mauchly (1907-1980), ENIAC, unlike the Colossus and Mark I, was a general-purpose computer that computed at speeds 1,000 times faster than Mark I.

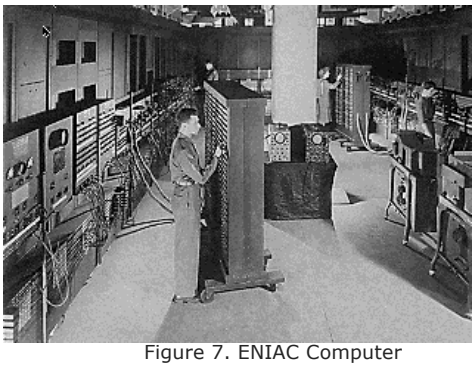

Figure 7. ENIAC Computer

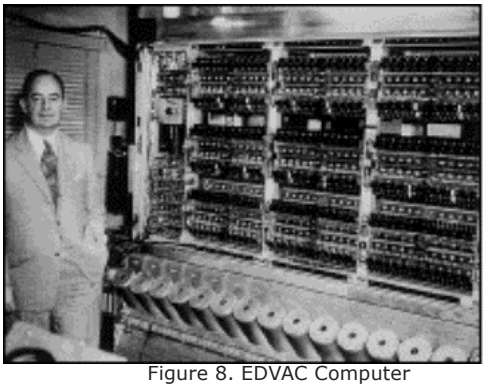

Figure 8. EDVAC Computer

In the mid-1940's John von Neumann (1903-1957) joined the University of Pennsylvania team, initiating concepts in computer design that remained central to computer engineering for the next 40 years. Von Neumann designed the Electronic Discrete Variable Automatic Computer (EDVAC) in 1945 with a memory to hold both a stored program as well as data. This "stored memory" technique as well as the "conditional control transfer," that allowed the computer to be stopped at any point and

then resumed, allowed for greater versatility in computer programming. The key element to the von Neumann architecture was the central processing unit, which allowed all computer functions to be coordinated through a single source. In 1951, the UNIVAC I (Universal Automatic Computer), built by Remington Rand, became one of the first commercially available computers to take advantage of these advances. Both the U.S. Census Bureau and General Electric owned UNIVACs. One of UNIVAC's impressive early achievements was predicting the winner of the 1952 presidential election, Dwight D. Eisenhower.

First generation computers were characterized by the fact that operating instructions were made-to-order for the specific task for which the computer was to be used. Each computer had a different binary-coded program called a machine language that told it how to operate. This made the computer difficult to program and limited its versatility and speed. Other distinctive features of first generation computers were the use of vacuum tubes (responsible for their breathtaking size) and magnetic drums for data storage.

Second Generation Computers (1956-1963)

By 1948, the invention of the transistor greatly changed the computer's development. The transistor replaced the large, cumbersome vacuum tube in televisions, radios and computers. As a result, the size of electronic machinery has been shrinking ever since. The transistor was at work in the computer by 1956. Coupled with early advances in magnetic-core memory, transistors led to second generation computers that were smaller, faster, more reliable and more energy-efficient than their predecessors. The first large-scale machines to take advantage of this transistor technology were early supercomputers, Stretch by IBM and LARC by Sperry-Rand. These computers, both developed for atomic energy laboratories, could handle an enormous amount of data, a capability much in demand by atomic scientists. The machines were costly, however, and tended to be too powerful for the business sector's computing needs, thereby limiting their attractiveness. Only two LARCs were ever installed: one in the Lawrence Radiation Labs in Livermore, California, for which the computer was named (Livermore Atomic Research Computer) and the other at the U.S. Navy Research and Development Center in Washington, D.C. Second generation computers replaced machine language with assembly language, allowing abbreviated programming codes to replace long, difficult binary codes.

Throughout the early 1960's, there were a number of commercially successful second generation computers used in business, universities, and government from companies such as Burroughs, Control Data, Honeywell, IBM, Sperry-Rand, and others. These second generation computers were also of solid state design, and contained transistors in place of vacuum tubes. They also contained all the components we associate with the modern day computer: printers, tape storage, disk storage, memory, operating systems, and stored programs. One important example was the IBM 1401, which was universally accepted throughout industry, and is considered by many to be the Model T of the computer industry. By 1965, most large business routinely processed financial information using second generation computers.

It was the stored program and programming language that gave computers the flexibility to finally be cost effective and productive for business use. The stored program concept meant that instructions to run a computer for a specific function (known as a program) were held inside the computer's memory, and could quickly be replaced by a different set of instructions for a different function. A computer could print customer invoices and minutes later design products or calculate paychecks. More sophisticated high-level languages such as COBOL (Common Business-Oriented Language) and FORTRAN (Formula Translator) came into common use during this time, and have expanded to the current day. These languages replaced cryptic binary machine code with words, sentences, and mathematical formulas, making it much easier to program a computer. New types of careers (programmer, analyst, and computer systems expert) and the entire software industry began with second generation computers.

Third Generation Computers (1964-1971)

Though transistors were clearly an improvement over the vacuum tube, they still generated a great deal of heat, which damaged the computer's sensitive internal parts. The quartz rock eliminated this problem. Jack Kilby, an engineer with Texas Instruments, developed the integrated circuit (IC) in 1958. The IC combined three electronic components onto a small silicon disc, which was made from quartz. Scientists later managed to fit even more components on a single chip, called a semiconductor. As a result, computers became ever smaller as more components were squeezed onto the chip. Another third-generation development included the use of an operating system that allowed machines to run many different programs at once with a central program that monitored and coordinated the computer's memory.

Fourth Generation (1971-Present)

After the integrated circuits, the only place to go was down - in size, that is. Large scale integration (LSI) could fit hundreds of components onto one chip. By the 1980's, very large scale integration (VLSI) squeezed hundreds of thousands of components onto a chip. Ultra-large scale integration (ULSI) increased that number into the millions. The ability to fit so much onto an area about half the size of a U.S. dime helped diminish the size and price of computers. It also increased their power, efficiency and reliability. The Intel 4004 chip, developed in 1971, took the integrated circuit one step further by locating all the components of a computer (central processing unit, memory, and input and output controls) on a minuscule chip. Whereas previously the integrated circuit had had to be manufactured to fit a special purpose, now one microprocessor could be manufactured and then programmed to meet any number of demands. Soon everyday household items such as microwave ovens, television sets and automobiles with electronic fuel injection incorporated microprocessors.

Such condensed power allowed everyday people to harness a computer's power. They were no longer developed exclusively for large business or government contracts. By the mid-1970's, computer manufacturers sought to bring computers to general consumers. These minicomputers came complete with user-friendly software packages that offered even non-technical users an array of applications, most popularly word processing and spreadsheet programs. Pioneers in this field were Commodore, Radio Shack and Apple Computers. In the early 1980's, arcade video games such as Pac Man and home video game systems such as the Atari 2600 ignited consumer interest for more sophisticated, programmable home computers.

In 1981, IBM introduced its personal computer (PC) for use in the home, office and schools. The 1980's saw an expansion in computer use in all three arenas as clones of the IBM PC made the personal computer even more affordable. The number of personal computers in use more than doubled from 2 million in 1981 to 5.5 million in 1982. Ten years later, 65 million PCs were being used. Computers continued their trend toward a smaller size, working their way down from desktop to laptop computers (which could fit inside a briefcase) to palmtop (able to fit inside a breast pocket). In direct competition with IBM's PC was Apple's Macintosh line, introduced in 1984. Notable for its user-friendly design, the Macintosh offered an operating system that allowed users to move screen icons instead of typing instructions. Users controlled the screen cursor using a mouse, a device that mimicked the movement of one's hand on the computer screen.

As computers became more widespread in the workplace, new ways to harness their potential developed. As smaller computers became more powerful, they could be linked together, or networked, to share memory space, software, information and communicate with each other. As opposed to a mainframe computer, which was one powerful computer that shared time with many terminals for many applications, networked computers allowed individual computers to form electronic co-ops. Using either direct wiring, called a Local Area Network (LAN), or telephone lines, these networks could reach enormous proportions. A global web of computer circuitry, the Internet, for example, links computers worldwide into a single network of information. During the 1992 U.S. presidential election, vice-presidential candidate Al Gore promised to make the development of this so-called "information superhighway" an administrative priority. Though the possibilities envisioned by Gore and others for such a large network are often years (if not decades) away from realization, the most popular use today for computer networks such as the Internet is electronic mail, or E-mail, which allows users to type in a computer address and send messages through networked terminals across the office or across the world.

Fifth Generation (Present and Beyond)

Defining the fifth generation of computers is somewhat difficult because the field is in its infancy. The most famous example of a fifth generation computer is the fictional HAL9000 from Arthur C. Clarke's novel, 2001: A Space Odyssey. HAL performed all of the functions currently envisioned for real-life

fifth generation computers. With artificial intelligence, HAL could reason well enough to hold conversations with its human operators, use visual input, and learn from its own experiences. (Unfortunately, HAL was a little too human and had a psychotic breakdown, commandeering a spaceship and killing most humans on board.)

Though the wayward HAL9000 may be far from the reach of real-life computer designers, many of its functions are not. Using recent engineering advances, computers are able to accept spoken word instructions (voice recognition) and imitate human reasoning. The ability to translate a foreign language is also moderately possible with fifth generation computers. This feat seemed a simple objective at first, but appeared much more difficult when programmers realized that human understanding relies as much on context and meaning as it does on the simple translation of words.

Many advances in the science of computer design and technology are coming together to enable the creation of fifth-generation computers. Two such engineering advances are parallel processing, which replaces von Neumann's single central processing unit design with a system harnessing the power of many CPUs to work as one. Another advance is superconductor technology, which allows the flow of electricity with little or no resistance, greatly improving the speed of information flow. Computers today have some attributes of fifth generation computers. For example, expert systems assist doctors in making diagnoses by applying the problem-solving steps a doctor might use in assessing a patient's needs. It will take several more years of development before expert systems are in widespread use.

Personal Computers History and Development

The personal computer (PC) has revolutionized business and personal activities and even the way people talk and think; however, its development has been less of a revolution than an evolution and convergence of three critical elements - thought, hardware, and software. Although the PC traces its lineage to the mainframe and minicomputers of the 1950s and 1960s, the conventional thought that was prevalent during the first thirty years of the computer age saw no value in a small computer that could be used by individuals.

A PC is a microcomputer, so named because it is smaller than a minicomputer, which in turn is smaller than a mainframe computer. While early mainframes and their peripheral devices often took up the floor space of a house, minicomputers are about the size of a refrigerator and stove. The microcomputer, whose modern development traces back to the early 1970s, and fits on a desk.

From the start, the creation of the computer was centered around the concept that a single unit would be used to perform complex calculations with greater speed and accuracy than humans could achieve.

The Transistor

On December 23, 1947, one of the most far-reaching technologies of the 20th Century was developed at Bell Laboratories by John Bardeen, Walter Brattain, and William Shockley - the transistor. But the transistor wasn't available to U.S. manufacturers until 1956, when a seven year-old antitrust law suit against AT&T, the owners of Bell Labs, was settled. The judgment required that AT&T give away licenses to manufacture the transistor to American companies. Following this decision, the transistor was used to replace thousands of vacuum tubes in computers and began the miniaturization of electronics. Because it drastically reduced the size and heat considerations of the large vacuum tubes, the transistor enabled the computer to become a viable tool for business and government.

The Computer Mystique

From the beginning, computers baffled the populous with their capability. In corporate and government offices and on university campuses, information processing departments sprouted up to serve the computer. The IBM 701, which was introduced in 1952 as a business computer, was comprised of several units that could be shipped and connected at a customer's location, rather than the earlier massive units that had to be assembled on site. In 1953, IBM began shipping the first mass-produced computer, the IBM 650. IBM introduced the first solid-state (transistorized) computer in 1959, the IBM 7090. Then in 1964, IBM culminated over $1 billion in research when it brought out the System/360 series of computers. Unlike other mainframes, the System/360 computers were compatible with each other.

By 1960, the computer was king. Companies hired armies of technicians and programmers to write its operating programs and software, fix it, and allocate the precious computer time. The capability of the machines was more than a mere mortal could fathom, but gathering raw data and "keying" it in so the computer could "crunch the numbers" was a complicated and time-consuming task.

Frustrations abounded, computer errors were called "glitches," and the phrases "garbage in/garbage out," "It's a computer mistake," and "Sorry, the computer's down and we can't do anything," were introduced into the lexicon.

On college campuses in the 1960s, students carried bundles of computer cards to and from class, hoping that their share of the valuable computer time would not be bumped or allocated to someone else. The term, "Do not fold, spindle or mutilate," was coined so people wouldn't disable the process of feeding the punched computer cards into punch card readers, where the intricate patterns of holes were decoded.

The computer mystique was reinforced in people every time they heard of some new accomplishment. In 1961, a computer calculated the value of pi to 100,000 decimal places. A computer could play checkers, and in 1967 a chess playing computer program was made an honorary member of the United States Chess Federation. Banks began printing checks with magnetic ink so they could be processed by the computers.

A Small Change in Thought

Until 1971, nobody even thought of a computer as anything but a big, fast, electronic brain that resided in a climate-controlled room and consumed data and electricity in massive quantities.

In 1971, an Intel 4004 chip containing 4004 transistors was programmed to perform complex mathematical calculations; the hand-held calculator was born. Suddenly, scientists and engineers could carry the computational power of a computer with them to job sites, classrooms, and laboratories; but the hand-held calculator, like the ENIAC before it, was not yet a computer. The microprocessor was developed by Robert Noyce, the founder of Intel and one of the inventors of the integrated circuit, and brought with it a change in the way people worked.

New Technologies and New Ideas

Small, hand-held calculators had provided an idea, or at least a "what if," to some people. Still, in the early 1970s, computers were used for number crunching and printing out long streams of green and white paper. IBM Selectric typewriters were the top of the line "word processors" and Xerox copiers churned out photocopies. Most people never imagined that a computer could process data in real time, be used to write letters, or fit on a desk.

In 1972, Intel brought out its 8008 chip, capable of processing 8-bits of data, enough to convey numbers and letters of the alphabet. In that same year, Xerox began working on a personal computer at their Palo Alto Research Center. For the next several years, a team of Xerox scientists worked on the "Alto," a small computer that would have become the first PC if only the development team had been able to convince someone of its usefulness.

Likewise, in 1972 Digital Equipment Corporation (DEC), a minicomputer manufacturing company headed by Kenneth Olsen, had a group of product engineers developing the DEC Datacenter. This PC incorporated not only the computer hardware but the desk as well. The DEC Datacenter could have put tremendous computing capability in the home or at work, but management saw no value to the product and halted its development.

In the end, none of the giant companies whose names had been synonymous with computers would introduce the PC to the world. There seemed to be no future in an inexpensive product that would replace the million dollar "Big Iron" that they were selling as fast as they could make them.

The people who eventually introduced the PC were rebels. Many had spent time in the bowels of the big companies and were frustrated by the lack of vision they encountered. They retreated into their own garages and attended meetings with other "computer nuts" who saw a much different future than the one laid out over the previous 30 years by the giants of the computer industry.

The PC is Born

In 1975, Rubik's Cube was put on store shelves and proved to many that the human brain was incapable of complex problem solving. But a ray of hope also appeared; the first PC was introduced. Micro Instrumentation and Telemetry Systems, Inc. (MITS) sold a kit for the MITS Altair 8800 that enabled computer hobbyists to assemble their own computers. It had no monitor, no keyboard, no printer, and couldn't store data, but the demand for it, like Rubik's Cube, was overwhelming.

The Altair proved that a PC was both possible and popular, but only with those people who would spend hours in their basements with soldering irons and wire strippers. The Altair, which looked like a control panel for a sprinkler system, didn't last, but it helped launch one of the largest companies in the computer world and gave a couple of young software programmers a start. In 1974, Bill Gates and Paul Allen wrote a version of BASIC for the Altair and started a company called Microsoft Corporation.

In 1976, another computer kit was sold to hobbyists - the Apple I. Stephen Wozniak sold his Volkswagen and Steve Jobs sold his programmable calculator to get enough money to start Apple. In 1977, they introduced the Apple II, a pre-assembled PC with a color monitor, sound, and graphics. It was popular, but everyone knew that a serious computer didn't need any of this. The kits were just a hobby and the Apple II was seen as a toy. Even the Apple name wasn't a serious, corporate sounding name like IBM, Digital Equipment Corporation, or Control Data.

But 1977 also brought competition. The Zilog Z-80 microprocessor, which had been introduced in 1975, was used in the Tandy Radio Shack TRS-80, affectionately called the "Trash 80." Apple, Commodore, and Tandy dominated the PC marketplace. The Apple II had 16K bytes of RAM and 16K bytes of ROM; Commodore Business Machines' Personal Electronic Transactor (PET) included 4K RAM and 14K ROM; and the TRS-80 had 4K RAM and 4K ROM.

Also in 1977, the Central Program for Microprocessors (CP/M) operating system was developed by Digital Research and Gary Kildall. From its introduction until 1980, CP/M was used in most PCs, but even that did not guarantee that a program or document could be written on one machine and read on another because each manufacturer used different floppy disk drives.

Apple introduced the floppy disk drive in 1978, allowing Apple II users to store data on something other than the cumbersome and unreliable tape cassettes that had been used up to that point. But despite the popularity of the three PCs, non-computer people still saw little reason to buy an expensive calculator when there were other ways to do the same things. In 1979, that all changed.

When VisiCalc was introduced for the Apple II, non-computer people suddenly saw a reason to buy a computer. VisiCalc, a spreadsheet program created by Dan Bricklin and Bob Frankston, allowed people to change one number in a budget and watch the effect it had on the entire budget. It was something new and valuable that could only be done with a computer. For thousands of people, the toy, the computer few could find a use for, had been transformed into a device that could actually do something worthwhile.

Microprocessors and high-tech gadgets were gradually worming their way into people's lives. In 1978, Sony introduced the Beta format video cassette recorder, and a year later the VHS video recorder and the Sony Walkman. And to remind everyone of how far we had to go, Star Trek: The Motion Picture came to theaters in 1979.

The Sinclair ZX-80 PC, which hit the market in 1980, used the same Z-80 chip as Commodore's PET and the Tandy TRS-80. The ZX-80 had 1K RAM and 4K ROM. Developed by British entrepreneur Clive Sinclair, the ZX-80 meant that people could enter the computer revolution for under $200. Its small size and price attracted people who had never thought about owning a PC.

The Commodore VIC-20, also introduced in 1980, had a color monitor and would eventually become the first PC to sell more than one million units. Even with all of the success the early PC manufacturers had in the late 1970s and early 1980s, the advances in microprocessor speeds, and the creation of software, the PC was still not seen as a serious business tool. Unknown to everyone in the computer industry; however, a huge oak tree was about to drop an acorn that would fall close to the tree and change everything.

Validation of the PC

Two events occurred in 1981 that would have a tremendous impact on the future of the PC. In 1980, IBM had started a secret project in Boca Raton, Florida called "Acorn." Thirteen months later, in 1981, IBM introduced the IBM PC, a product that validated the PC as a legitimate business tool. For many people, even those who prided themselves on being able to operate the "Big Iron," if IBM was making PCs then the small desk-top units were worthy of respect.

When the IBM PC hit the market, it was a compete system. Secretly, IBM had provided software developers with prototypes of their PC so they could develop an array of programs that would be available when the machine hit the streets. IBM also developed printers, monitors, and expansion cards for the PC and made it an open system so other manufacturers could develop peripherals for it.

The IBM PC used an Intel 8088 microprocessor, had 16K of RAM, was expandable to 256K, came with one 5.25-inch disk drive and room for a second, and was available with a choice of operating systems; CP/M-86 or IBM PC-DOS, which had been developed by Microsoft.

The second major event of 1981 was the introduction of the first luggable computer, the Osborne 1. This self-contained, suitcase-sized PC, developed by Adam Osborne, was not only the first portable PC, but also the first to be sold with software. The Osborne I came with BASIC, CBASIC, WordStar for word processing, and the SuperCalc spreadsheet program. Over the next two years, the Osborne Computing Company would go from nothing to a company with $70 million in annual revenue and then into bankruptcy.

Prior to 1980, the most common method of storing data was to connect an audio tape recorder to the PC and dump data to standard tape cassettes. Large word processors and some PCs had 8-inch disk drives, but in 1980 Al Shugart introduced the Winchester hard-disk drive.

The Race was On

Now that the PC had been validated, it began appearing on desk-tops in large and small companies to produce work schedules and payrolls, write letters and memos, and generate budgets. Software enabled people to do more in less time and business was promised the "paperless office" as an added benefit of the PC.

Managers attended classes and began writing memos and letters, but many felt that the work they could now do themselves on a PC was demeaning; it was the work that secretaries and clerks had always done. For some, having a PC on the desk meant that they now had to do the work, not just delegate it, and for others it meant they no longer supervised a person, but a machine.

There was also a strong fear factor. The PCs were expensive and many people were afraid they would damage the units or erase everything in one keystroke. People who had always worked with things they could see and understand were suddenly putting their faith in chips and hard drives that they not only couldn't see or touch, but they also didn't understand. Suddenly it was permissible to make a mistake in spelling or grammar; it could be changed and rewritten until it was correct. The whole thought process didn't set well with some, for others it freed them from the drudgery of using white correction-fluid to cover up mistakes on printed documents.

The early 1980s were a time of furious change in the computer industry. More than 100 companies were manufacturing PCs, each with its own unique features, each with its own software. When IBM entered the market in 1981, software companies knew that writing IBM compatible software would be profitable. Software for the Apple II had exploded to 16,000 titles and IBM would do the same. New software in the 1980s included WordStar, Lotus 1-2-3, Microsoft Word, and Word Perfect.

In 1981, Hayes Micromodem brought the MOdulator/DEModulator (MODEM) to the market for PCs. The modem had been invented at AT&T Bell Labs in 1960 to connect mainframes and minicomputers. Hayes' modem allowed PCs to communicate with each other and access CompuServe and The Source, the online services that started up in 1979. CompuServe showed people what to do with their 300 baud modems by offering them an array of services and databases to connect with.

In 1982 Compaq introduced the first IBM compatible machine. Until Compaq, most manufacturers feared IBM and would not bring out a machine that was compatible with the PC. Later the compatibles would be termed "clones."

Also in 1982, Tandy brought out the TRS-80 Model 16, which was based on the Motorola 68000 and Z-80 microprocessors. The Model 16 retailed for $5,000 and included 128K RAM, an 8-inch floppy disk drive, as well as the Xenix operating system, a derivative of UNIX.

In January, 1983 Time magazine anointed the PC as the "Man of the Year," a designation by the editors that the computer had been the most influential newsmaker of 1982. The magazine estimated 80 million PCs would be in use by the end of the century. Industry leaders included Texas Instruments, Timex, Commodore, Atari, Apple, IBM, and Tandy, with Osborne leading the way in the portable market. The individuals pushing the PC into the future were John Opel at IBM, Adam Osborne of Osborne Computers, VisiCalc creator Dan Bricklin, Jack Tramiel of Commodore, and Clive Sinclair who founded Sinclair Research.

The leading products of 1982 and their sales figures included the Timex/Sinclair 1000 - 600,000; Commodore VIC-20 - over 600,000, Atari 400 and Atari 800 - 600,000; Texas Instruments 99/4A - 530,000; TRS-80 Model III - 300,000; Apple II Plus - 270,000; IBM PC - 200,000; and Osborne 1 - 55,000. These computers ranged in price from the $99 Timex/Sinclair to the Osborne 1 at $1,795 with bundled software. In the opinion of Time, computers priced over $2,000 would appeal to a market of "...growing small businesses and big corporate clients..." Manufacturers of these higher end PCs included Altos, Corvus, Cromemco, Control Data, Digital Equipment, Hewlett-Packard, North Star, Olivetti, Tele Video, Toshiba, Xerox, and Zenith.

But in 1983 there was once again a wind of change blowing across the PC landscape.

The Mac Attack

In 1983, Apple brought out a machine that failed to sell but nonetheless showed consumers and manufacturers a new direction for the PC. The Lisa, an expensive PC with a graphical user interface (GUI), hit the market with a thud. At $10,000, it had few friends and even fewer buyers.

Also in 1983, IBM introduced IBM XT with a 10MB hard drive, three additional expansion slots, 128K RAM, and a 360K floppy drive. To many buyers, the 10MB storage capacity seemed large enough to last a lifetime.

Immediately after the failure of Lisa, Steven Jobs rethought the machine and in 1984, out came the Macintosh. The Macintosh was powered by Motorola's 68000 processor and came with 128K of RAM. It was so radically different from any other PC that it split the PC world into two halves that would not be rejoined for another decade. In addition to the GUI that made the computer an "intuitive" extension of the user, the "Mac" had its own operating system that was incompatible with IBM's MS-DOS system. Suddenly PC meant DOS-based and IBM compatible and Mac meant GUI and mouse.

The Mac was introduced to the world in an extravagant television commercial that was shown only once during half-time of the NFL Super Bowl. The commercial changed the advertising industry almost as much as the Mac changed computing.

Suffering from the failure of the Apple III and Lisa, Apple was literally saved by the Mac. People who hated computers loved the simplicity of Mac. The GUI allowed the user to click a mouse button on an icon to launch a program, print a document, or copy a file. No longer did users have to know combinations of keys or special codes to get the computer to do what they wanted it to do. The Mac was "user friendly."

Although not the first PC with a mouse or GUI (that distinction went to Xerox's $50,000 Star that came out in 1981 and immediately failed), the Mac did set the computer world on its ear because of its ease of operation and its operating system.

When Apple came out with the Apple LaserWriter in 1985 it was with Adobe Systems Inc.'s PostScript page description language. By 1986, with its what-you-see-is-what-you-get (WYSIWYG) display and printing, desk-top publishing was born. WYSIWYG meant that a person could format a document with special fonts and spacing and be assured that what came out of the printer would look like what they had created on the screen.

Adobe, founded in 1982 by John Warnock and Charles Geschke, turned the printed page into a graphic image. The bit map made each pixel on the screen a definable image that could be moved and changed without the limitations of a standard text format. PostScript changed the way people thought about fonts, page layout, and the visual impact of the documents they produced with their PC. Printers like the Apple LaserWriter and the Hewlett-Packard HP LaserJet made every document look like it had been professionally typeset and printed.

In 1985, the Commodore Amiga 1000, which featured multitasking, graphics, sound, and video in a windowing operating system, exposed people to multimedia. At the same time Toshiba came out with the T1100 laptop, Tandy introduced the Tandy 200 laptop, and AT&T introduced the UNIX PC. Intel took the microprocessor to a new level when it brought out the 386 microprocessor in 1985, proving that PCs were not only getting better, they were getting faster.

The 1980s were very active times for hardware manufacturers and software producers. Small software companies locked in with either IBM or Macintosh, but large companies like Microsoft were able to create new applications for both operating systems. While Aldus brought out PageMaker, and Lotus introduced Jazz, Microsoft announced Excel for the Mac, C 3.0, and finally shipped a long-awaited program called Windows.

Bill Gates, a founder of Microsoft, tried three times to interest IBM in Windows but was turned down each time. Although the Mac operating system had changed the interface between users and their PCs, many DOS users continued to hang on to their command line-driven MS-DOS operating system, and it would be several more years until the Windows concept caught on.

With the availability of hundreds of software programs, hard disk space became valuable real estate. The 10MB hard disk on the IBM XT began to fill up so hard drive manufacturers started the process of doubling their capacity.

As modems proliferated and the Hayes Smartmodem was accepted as the standard for modems, just about everyone either knew someone they could get online with, subscribed to an online service such as CompuServe, or wanted to access the 1000 host sites on the Internet.

But PCs that were connected to the outside world were also vulnerable to a new phenomenon called viruses. Once downloaded, these programs could attach themselves without warning to a PC's hard drive and gradually or in the blink of an eye destroy or overwrite files. Virus checkers then became the rage for anyone who received data over telephone lines.

By 1987 enough people were writing their own software and sharing it that the Association of Shareware Professionals was formed to market and protect the inexpensive software. In 1987 a new computer language, C++, stimulated the growth of object-oriented programming (OOP).

Out of the Box and Obsolete

For consumers, the late 1980s were a time of frustration. No sooner had they learned to run their new PC and Macs than a new, better, larger, faster model was on the shelf. New versions of software, printers, and modems made it impossible to have the latest of anything.

In 1990, Intel's 386 and Motorola's 68030 microprocessors were at the top, then in 1991 Intel brought out the i486SX 20 MHz chip and Motorola introduced the 68040. Less than a year later Intel introduced the 50MHz 486 chip and Tandy brought out its $400 CD-ROM drive for PCs. Then, just to make everyone wonder what was going on, in 1991 Apple and IBM agreed to share technology by integrating the Mac into IBM's systems and using the IBM Power PC chip.

In 1992, Apple brought out the Apple PowerBook, a laptop that made everyone wonder just how small a full-function computer could get. A year later everyone knew the answer when Apple introduced the Newton Personal Digital Assistant (PDA). The Newton was supposed to be able to recognize hand-written notes and Apple sold 50,000 of them in 10 weeks.

In 1993, Intel introduced the 60MHz Pentium chip, the next generation of chips. The Pentium; however, had a nasty mathematical bug and its acceptance was slowed. Apple discontinued the workhorse of its fleet, the Apple II, which, despite the mind boggling changes in the industry, had lasted 17 years.

Not only were hardware and software obsolete, people were also getting caught up in their own obsolescence. For years, employers had included the operating systems and software names in their advertising for clerical and secretarial positions. As companies used more temporary workers and included both IBM clones and Macintosh's in their operations, proficiency with only one slammed the door on employment opportunities.

Many people enrolled in classes to learn the latest software or update their computer skills. A good, well-rounded employee needed to know desktop publishing, two or more word processing programs, at least one spreadsheet program, and a graphics package. They had to be able to access the company local area network (LAN), send and receive E-mail using high-speed modems, and solve problems with hardware and software to maximize their output. Microprocessor-driven telephones, cellular phones, and pagers added to the complexity of the job, and repetitive motion syndrome from using keyboards hour after hour created an army of people wearing wrist braces.

Many people left a job where their day was spent working at a computer terminal or PC and went home to enjoy the quite, relaxing camaraderie they found in Internet chat rooms, by visiting the World Wide Web, or reading their favorite newspapers and electronic magazines (ezines).

From its inception in 1975, the PC has become a focal point of business, education, and home life. The microprocessor, an amazing technology when it had 4000 transistors on a single chip, is now even more amazing when it has over 3 billion transistors on an even smaller chip. In 1982, when Time magazine made the computer its "Man of the Year," the PC was still in its infancy. "Big Iron" still dominated the high-tech environment and having a personal computer was a luxury.

The creation and success of the PC would not have been possible without the elimination of the concept that a computer was a large, centralized, data processor and number cruncher. Today the PC is a communication channel more than it is a computational tool. Millions of people work in their "electronic cottages," either operating their own business from home or telecommuting to work. It is strange that one of the first Intel 4004 microprocessors ever made, continues to operate and lead the world to the outer edges of time and space. In 1972 one of the small chips was installed in the Pioneer spacecraft. Today it continues to operate over 5 billion miles from earth.

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