Chapter 1

Personal Computer Background

Many discoveries and inventions have contributed to the development of the machine known today as the personal computer. Examining a few important developmental landmarks can help bring the whole picture into focus.

Personal Computing History

A modern digital computer is largely a collection of electronic switches. These switches are used to represent, as well as control, the routing of data elements called *binary digits* (bits). Because of the on or off nature of the binary information and signal routing used by the computer, an efficient electronic switch was required. The first electronic computers used vacuum tubes as switches, and although the tubes worked, they had many problems.

The tube was inefficient as a switch. It consumed a great deal of electrical power and gave off enormous heat—a significant problem in the earlier systems. Tubes were notoriously unreliable also; one failed every two hours or so in the larger systems.

The invention of the transistor, or semiconductor, was one of the most important developments leading to the personal computer revolution. The transistor was invented in 1948 by John Bardeen, Walter Brattain, and William Shockley (engineers at Bell Laboratories). The transistor, essentially a solid-state electronic switch, replaced the much less suitable vacuum tube. Because the transistor consumed significantly less power, a computer system built with transistors was much smaller, faster, and more efficient than a computer system built with vacuum tubes.

The conversion to transistors began a trend toward miniaturization that continues to this day. Today's small laptop (or palmtop) PC systems, which run on batteries, have more computing power than many earlier systems that filled rooms and consumed huge amounts of electrical power.

In 1959, engineers at Texas Instruments invented the integrated circuit (IC), a semiconductor circuit that contains more than one transistor on the same base (or substrate material) and connects the transistors without wires. The first IC contained only six transistors. By comparison, the Intel Pentium microprocessor used in many of today's high-end systems has more than 3.1 million transistors, and the successor to the Pentium, code named P6, will have more than 6 million transistors! Today, there are many ICs with transistor counts in the multi-million range.

In 1969, Intel introduced a 1K-bit memory chip, which was much larger than anything else available at the time. (1K-bits equals 1,024 bits, a byte equals 8 bits; this chip, therefore, stored only 128 bytes—not much by today's standards.) Because of Intel's success in chip manufacturing and design, Busicomp, a Japanese calculator-manufacturing company, asked Intel to produce 12 different logic chips for one of its calculator designs. Rather than produce the 12 separate chips, Intel engineers included all the functions of the chips in a single chip. In addition to incorporating all the functions and capabilities of the 12-chip design into one multipurpose chip, they designed the chip to be controlled by a program that could alter the function of the chip. The chip then was "generic" in nature: it could function in designs other than just a calculator. Previously, designs were hard-wired for one purpose with built-in instructions; this chip could read from memory a variable set of instructions, which controlled the function of the chip. The idea was to design almost an entire computing device on one chip that could perform different functions depending on what instructions it was given. The first microprocessor, the Intel 4004, a 4-bit processor, was introduced in 1971. The chip operated on 4 bits of data at a time. The 4004 chip's successor was the 8008 8-bit microprocessor in 1972.

In 1973, some of the first microcomputer kits based on the 8008 chip were developed. These kits were little more than demonstration tools and did little except blink lights. In late 1973, Intel introduced the 8080 microprocessor, which was 10 times faster than the earlier 8008 chip and addressed 64K of memory. This breakthrough was the one the personal computer industry was waiting for.

MITS introduced the Altair kit in a cover story in the January 1975 issue of *Popular Electronics* magazine. The Altair kit, considered to be the first personal computer, included an 8080 processor, a power supply, a front panel with a large number of lights, and 256 bytes (not kilobytes) of memory. The kit sold for $395 and had to be assembled. The computer included an open architecture bus (slots) that prompted various add-ons and peripherals from aftermarket companies. The new processor inspired other companies to write programs, including the CP/M (Control Program for Microprocessors) operating system and the first version of Microsoft BASIC.

IBM introduced what can be called its first *personal computer* in 1975. The Model 5100 had 16K of memory, a built-in 16-line-by-64-character display, a built-in BASIC language interpreter, and a built-in DC-300 cartridge tape drive for storage. The system's $9,000 price placed it out of the mainstream personal computer marketplace, dominated by experimenters (affectionately referred to as hackers) who built low-cost kits ($500 or so) as a hobby. The IBM system obviously was not in competition for this low-cost market

and did not sell well. The Model 5100 was succeeded by the 5110 and 5120 before IBM introduced what we know as the IBM Personal Computer (Model 5150). Although the 5100 series preceded the IBM PC, there was nothing in common between these older systems and the 5150 IBM PC released later. The PC it turned out was very closely related to the IBM System/23 DataMaster, an office computer system introduced in 1980.

In 1976, a new company, Apple Computer, introduced the Apple I (for $695). This system consisted of a main circuit board screwed to a piece of plywood. A case and power supply were not included. Only a handful of these computers were made, and they reportedly have sold to collectors for more than $20,000. The Apple II, introduced in 1977, helped set the standard for nearly all the important microcomputers to follow, including the IBM PC.

The microcomputer world was dominated in 1980 by two types of computer systems. One type, the Apple II, claimed a large following of loyal users and a gigantic software base that was growing at a fantastic rate. The other type consisted not of a single system, but included all the many systems that evolved from the original MITS Altair. These systems were compatible with each other and were distinguished by their use of the CP/M operating system and expansion slots that followed the S-100 (for slots with 100 pins) standard. All these systems were built by a variety of companies and sold under various names. For the most part, however, these companies used the same software and plug-in hardware.

The IBM Personal Computer

At the end of 1980, IBM had decided to truly compete in the rapidly growing low-cost personal computer market. The company established what was then called the Entry Systems Division, in Boca Raton, Florida, to develop the new system. This small group consisted of 12 engineers and designers under the direction of Don Estridge. The team's chief designer was Lewis Eggebrecht. The division developed IBM's first real PC. (IBM considered the 5100 system, developed in 1975, to be an intelligent programmable terminal rather than a genuine computer, even though it truly was a computer.) Nearly all these engineers moved from working on the System/23 DataMaster project, a small, office computer system introduced in 1980 (and the direct predecessor of the IBM PC).

Much of the PC's design was influenced by the DataMaster's design. In the DataMaster's single-piece design, the display and keyboard were integrated into the unit. Because these features were limiting, they became external units on the PC—although the PC keyboard layout and electrical designs were copied from the DataMaster. Several other parts of the IBM PC system also were copied from the DataMaster, including the expansion bus, or input-output slots, which included not only the same physical 62-pin connector, but also the almost identical pin specifications. This copying was possible because the PC used the same interrupt controller and a similar direct memory access (DMA) controller as the DataMaster. Expansion cards already designed for the DataMaster could then be easily "ported" to the PC. The DataMaster used an Intel 8085 CPU, which had a 64K address limit, and an 8-bit internal and external data bus. This

prompted the PC design team to use the Intel 8088 CPU in the PC, which offered a much larger 1M memory address limit, and had an internal 16-bit data bus, but only an 8-bit external data bus. The 8-bit external data bus and similar instruction set allowed the 8088 to be easily interfaced into the earlier DataMaster designs.

Estridge and the design team rapidly developed the design and specifications for the new system. In addition to borrowing from the System/23 DataMaster, the team also studied the marketplace, which also had enormous influence on the IBM PC's design. The designers looked at the prevailing standards, learned from the success of those systems, and incorporated into the new PC all the features of the popular systems—and more. With the parameters for design made obvious by the market, IBM produced a system that filled perfectly its niche in the market.

IBM brought its system from idea to delivery in one year by using existing designs and purchasing as many components as possible from outside vendors. The Entry Systems Division was granted autonomy from IBM's other divisions and could tap resources outside the company rather than go through the bureaucratic procedures required to use only IBM resources. IBM contracted out the PC's languages and operating system, for example, to a small company named Microsoft. (IBM originally had contacted Digital Research, which invented CP/M, but that company apparently was not interested in the proposal. Microsoft was interested, however, and since has become one of the largest software companies in the world.) The use of outside vendors was also an open invitation for the aftermarket to jump in and support the system. And it did.

On Wednesday, August 12, 1981, a new standard took its place in the microcomputer industry with the debut of the IBM PC. Since then, IBM has sold more than 10 million PCs, and the PC has grown into a large family of computers and peripherals. More software has been written for this family than for any other system on the market.

The IBM-Compatible Marketplace 14 Years Later

In the more than 14 years since the original IBM PC was introduced, many changes have occurred. For example, the IBM-compatible computer advanced from a 4.77 MHz 8088-based system to 100 MHz 486-based and 100 MHz Pentium-based systems—nearly *200 times faster* than the original IBM PC (in actual processing speed, not just clock speed). The original PC could have only two single-sided floppy drives that stored 160K each using DOS 1.0, whereas modern systems easily can have several gigabytes of hard disk storage. A rule of thumb in the computer industry is that available processor performance and disk storage capacity at least doubles every two to three years. Since the beginning of the PC industry this pattern has shown no signs of changing.

In addition to performance and storage capacity, another major change since the original IBM PC was introduced is that IBM is not the only manufacturer of "IBM-compatible" systems. IBM invented the IBM-compatible standard, of course, and continues to set standards that compatible systems follow, but it does not dominate the market

as before. As often as not, new standards in the PC industry are developed by companies and organizations other than IBM. Hundreds of system manufacturers produce computers compatible with IBM's systems, not to mention the thousands of peripheral manufacturers with components that expand and enhance IBM and IBM-compatible systems.

IBM-compatible systems have thrived not only because compatible hardware could easily be assembled, but also because the primary operating system was available not from IBM, but from a third party (Microsoft). This allowed other manufacturers to license the operating systems software from Microsoft and to sell their own compatible systems. The fact that DOS borrowed the best functions from both CP/M and UNIX probably had a lot to do with the amount of software that became available. Later, with the success of Windows and OS/2, there would be even more reasons for software developers to write programs for IBM-compatible systems. One of the reasons that Apple Macintosh systems will never enjoy the success of IBM compatibles is that Apple controls all the software and does not license it to others for use in compatible systems. It is fortunate for the computing public as a whole that IBM did otherwise. The competition between manufacturers and vendors of IBM-compatible systems is the reason that such systems offer so much performance and capabilities for the money compared to other non-IBM compatible systems.

The IBM-compatible market continues to thrive and prosper. New technology will be integrated into these systems and enable them to grow with the times. Because of both the high value these types of systems can offer for the money and the large amount of software available to run on them, IBM and IBM-compatible systems likely will dominate the personal computer marketplace for perhaps the next 10 years as well.

Summary

This chapter traced the development of personal computing from the transistor to the introduction of the IBM PC. Intel's continuing development of the integrated circuit led to a succession of microprocessors and reached a milestone with the 1973 introduction of the 8080 chip. In 1975, MITS introduced the Altair computer kit, based on the 8080 microprocessor. IBM jumped into the personal computer market with the Model 5100 in 1975.

In 1976, Apple sold its first computers, followed in 1977 by the enormously successful Apple II. Because of its success, the Apple II played a major role in setting standards and expectations for all later microcomputers.

Finally, in 1981, IBM introduced its Personal Computer to a microcomputer world dominated by the Apple II and the computers that evolved from the Altair, which used the CP/M operating system. The IBM PC, designed with the needs of the market in mind and with many of its components produced by outside vendors, immediately set the new standard for the microcomputer industry. This standard has evolved to meet the needs of today's users, with more powerful systems that offer performance levels not even imagined in 1981.