# Chapter 7
# Famous Technology Companies

**Key Topics**

Hollerith's Tabulating Machine
IBM 360
IBM Personal Computer
Microsoft
Motorola
Six Sigma

## 7.1 Introduction

This chapter considers the history of some well known technology companies. These include International Business Machines (IBM), Microsoft and Motorola. The origin of IBM goes back to the late nineteenth century with Hermann Hollerith's work on tabulating machines. This machine was designed to tabulate the results of the 1890 census in the United States. IBM has grown to become a major corporation and it has made a major contribution to the computing field. It is a world class professional company and is dedicated to quality and customer satisfaction.

Microsoft was founded in the mid-1970s and it was awarded a contract by IBM to develop the Disk Operating System (DOS) for the IBM PC. It has grown to become a major corporation and has developed operating systems such as Microsoft Windows NT, Windows 2000 and Windows XP.

Motorola was founded as the Galvin Manufacturing Corporation in 1928. Its initial business was the production of radios for cars and it became a world leader in radio and telecommunications. Motorola produces mobile phones and base stations for the mobile telecommunications field.

Apple was founded in the mid-1970s. It developed the Apple Macintosh in the mid-1980s. This introduced a friendly graphical user interface (GUI) which made the machine easy to use. The company also produced the iPod.

Other companies discussed in this chapter include HP, Oracle and Siemens.

## 7.2 International Business Machines

IBM is a household name today and the company has a long and distinguished history. In many ways, the history of computing is closely related to the history of IBM, as the company has played a key role in the development of the computers that we are familiar with today. The origins of the company go back to the late nineteenth century with the processing of the 1880 census of the United States.

The processing of the 1880 census took 7 years to complete as all the processing was done manually. The population of the United States was steadily increasing at this time, and it was predicted that the 1890 census would take in excess of 10 years to process. The US Census Bureau recognised that the current methodology for processing census results was no longer fit for purpose. Therefore, it decided to hold a contest among its employees in an effort to find a more efficient methodology to tabulate the census data. The winner was Hermann Hollerith who was the son of a German immigrant (Fig. 7.1).

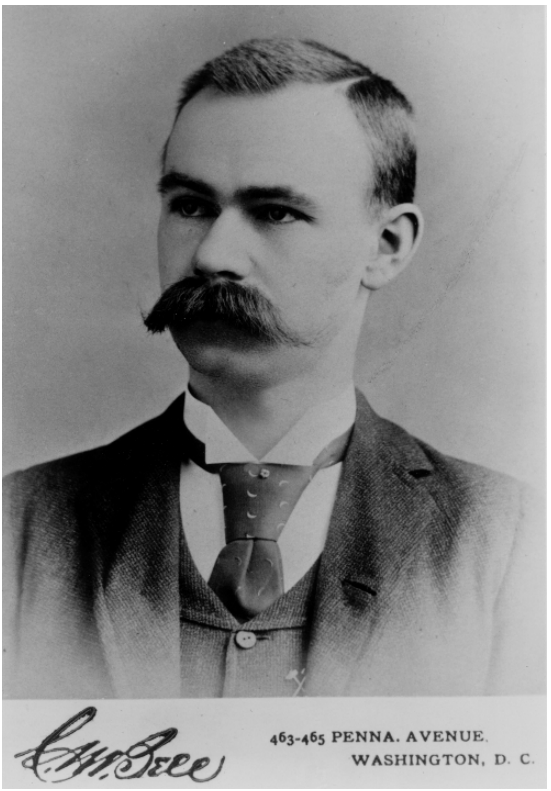


**Fig. 7.1** Hermann Hollerith
Courtesy of IBM archives.

**Fig. 7.2** Hollerith's Tabulator (1890)
Courtesy of IBM archives.

His punch card Tabulating Machine used an electric current to sense holes in punched cards, and it kept a running total of the data (Fig. 7.2). His machine used Babbage's idea of punched cards for data storage. The new methodology enabled the results of the 1890 census to be available within 6 weeks, and the population was recorded to be over 62 million.

### *7.2.1 Early Years*

Hollerith formed the Tabulating Machine Company in Washington, D.C., in 1896. This was the world's first electric tabulating-machine company, and it later merged with the International Time Recording Company to form the Computing Tabulating Recording Company (CTR) in 1911. Thomas Watson Senior became president of the Computing Tabulating Company in 1914 and at that time the company employed 400 people. Watson transformed the company over the following decades to become a global multinational. He was responsible for the famous "Think" signs that have been associated with IBM for many years. They were first used in the company in 1915.

Watson considered the motivation of the sales force to be an essential part of his job, and the sales people were required to attend an IBM sing along. The verses in the songs were in praise of IBM and its founder Thomas Watson Sr (Fig. 7.3). The company was renamed in 1924 to become International Business Machines (IBM). It employed over 3,000 people in 1924, and had revenues of US $11 million, with

**Fig. 7.3** Thomas Watson Sr
Courtesy of IBM archives.

a net income of $2 million. It had manufacturing plants in the United States and Europe. By 2005, IBM had revenues of $91.1 billion, net income of $7.9 billion, and it employed over 300,000 people.

IBM has evolved to adapt its business to a changing world and emerging trends in the information handling field. Its early products were designed to process, store and retrieve information from tabulators and time recording clocks. Today, the company produces powerful computers and global networks, and it is an industry leader in the development of computer systems to meet the needs of business and consumers.

IBM redesigned the existing punch card in the late 1920s to create the popular IBM punch card. It had 80 columns which was almost double the capacity of existing cards. The new design was patented, and it included rectangular holes. The company introduced a mechanism by which staff could make improvement suggestions in the 1920s. Many companies today now encourage their staff to make improvement suggestions to deliver better results.

The great depression of the 1930s affected many American companies and had a devastating impact on the lives of many Americans. However, surprisingly, its impact on IBM was minimal, and the company continued to grow. The policy of Thomas Watson Sr. and IBM was to take care of its employees, and IBM was one of the first corporations to provide life insurance and paid vacations for its employees. Watson kept his workers busy during the depression by producing new machines

even while demand was slack. He also won a major government contract to maintain employment records for over 26 million people.

Watson created a division in the early 1930s to lead the engineering, research and development efforts for the entire IBM product line. This was followed by the creation of a modern research and development laboratory, and also a centre dedicated to education and training in New York. The education and development of employees was seen as essential to the success of the business. IBM launched an employee and customer magazine called *Think* in the 1930s. This magazine included topics such as education and science.

IBM contributed to the defense of the United States during the Second World War. It placed all of its plants at the disposal of the US government, and it expanded its product line to include military equipment such as rifles. IBM commenced work on computing during the war years. This included work on the Harvard Mark I (also known as ASCC) machine completed in 1944. It was essentially an electromechanical calculator that could perform large computations automatically.

The machine was 50 feet long and eight feet high and weighed five tons. It performed additions in less than a second, multiplications in 6 seconds, and division in about 12 seconds. It used electromechanical relays to perform the calculations.

### *7.2.2 Early IBM Computers*

The company developed the Vacuum Tube Multiplier in 1943 and this was important in the move from electromechanical to electronic machines. It was the first complete machine ever to perform arithmetic electronically by substituting vacuum tubes for electric relays. The key advantages of the vacuum tubes is that they were faster, smaller, and easier to replace than the electromechanical switches used in the Mark I. They allowed engineers to process information thousands of times faster.

The company introduced its first large computer based on the vacuum tube in 1952. This machine was called the IBM 701, and it executed 17,000 instructions per second (Fig. 7.4). It was used mainly for government work and also for business applications. Transistors began to replace vacuum tubes in the late 1950s. Thomas Watson, Sr., retired in 1952 and his son, Thomas Watson, Jr., became chief executive officer the same year.

Thomas Watson, Jr**.** believed that the future of IBM was in computers rather than in tabulators (Fig. 7.5). He recognized the future role that computers would play in business, and realised that IBM needed to change to adopt to the new technology world. He played a key role in the transformation of IBM from its existing business model to a company that would become the world leader in the computer industry.

IBM introduced the IBM 650 (Magnetic Drum Calculator) in 1954. This was an intermediate sized electronic computer designed to handle widely diversified accounting and scientific computations. It was used by universities and businesses. The machine included a central processing unit, a power unit and a card reader.

**Fig. 7.4** IBM 701
Courtesy of IBM archives.

The IBM 704 data processing system was a large computer that was introduced in 1954. It included core memory and floating-point arithmetic, and was used for both scientific and commercial applications. It included high speed memory which was faster and much more reliable than the cathode-ray-tube memory storage mechanism employed in earlier machines. It also had a magnetic drum storage unit which could store parts of the program and intermediate results.

The interaction with the system was either by magnetic tape or punched cards entered through the card reader. The program instructions or data were initially produced on punched cards. They were then either converted to magnetic tape or read directly into the system, and data processing performed. The output from the processing was then sent to a line printer, magnetic tape or punched cards. Multiplication and division was performed in 240 microseconds.

The designers of the IBM 704 included John Backus and Gene Amdahl. Backus was one of the key designers of the Fortran programming language introduced by IBM in 1957. Fortran was the first scientific programming language and has been used extensively by engineers and scientists. Gene Amdahl later went on to found his own company in 1970 (i.e., the Amdahl Corporation[1]).

The first commercial computer with transistor logic (the IBM 7090) was introduced in 1958. It was designed for large-scale scientific applications, and it was over 13 times faster than the older vacuum tube IBM 701. It could perform 229,000

[1] Amdahl went on to rival IBM and became a threat to the success of IBM. At its peak, Amdahl had 22% of the mainframe market. The company bacame a wholly owned subsidiary of Fujitsu in 1997, and it is located in San Francisco.

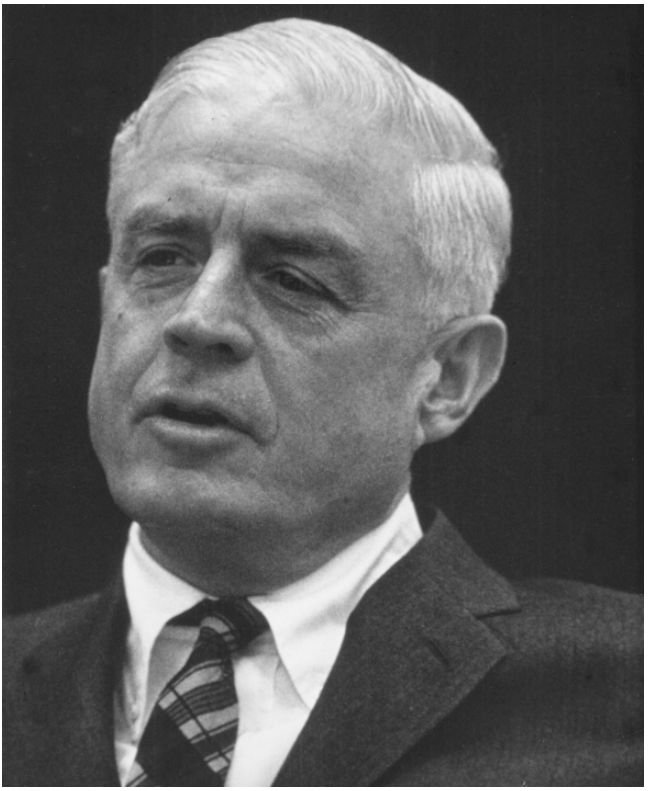

**Fig. 7.5** Thomas Watson Jr
Courtesy of IBM archives.

calculations per second. It used a 36-bit word and had an address-space of 32,768 words. It was used by the US Air Force to provide an early warning system for missiles and also by NASA to control space flights. It cost approximately $3 million but it could be rented for over $60 K per month.

IBM introduced the first computer disk storage system in 1957. This medium was called the Random Access Method of Accounting and Control (RAMAC), and it became the basic storage medium for transaction processing. The RAMAC's random access arm could retrieve data stored on any of the 50 spinning disks.

IBM contributed to the Semi-Automatic Ground Environment (SAGE) early warning system during the cold war. The US Air Force had commenced work on SAGE in 1954, and IBM provided the hardware for the system. The initial installation was completed in 1958, and the system was fully implemented in 1963. It remained operational until 1984.

There were 24 SAGE Direction Centers and three SAGE Combat Centers located in the US. Each centre was linked by long-distance telephone lines, and Burroughs provided the communications equipment that allowed the centers to communicate

with one another. This was one of the earliest computer networks. Each center contained a large digital computer that automated the information flow, and provided real time control information on aircraft and on weapons systems. It tracked and identified aircraft, and presented the electronic information to operators on a display device (cathode ray tub).

The IBM 1401 data processing system and the IBM 1403 printer were launched in 1959. The 1401 was an all-transitorised data processing system and it was aimed at small businesses. It included high speed card punching and reading, magnetic tape input and output and high speed printing. The 1403 printer was four times faster than any competitor printer. IBM introduced a program termed "Speak Up" to enhance staff communication in 1959. It opened the headquarters for its research division at York town Heights, New York in 1961.

### *7.2.3 The IBM System 360*

Thomas Watson announced the new System 360 to the world at a press conference in 1964 and said:

The System/360 represents a sharp departure from concepts of the past in designing and building computers. It is the product of an international effort in IBM's laboratories and plants and is the first time IBM has redesigned the basic internal architecture of its computers in a decade. The result will be more computer productivity at lower cost than ever before. This is the beginning of a new generation – not only of computers – but of their application in business, science and government.

The chief architect for the 360 was Gene Amhadl and the S360 project manager was Fred Brooks.[2]

The IBM 360 was a family of small to large computers, and it offered a choice of five processors and 19 combinations of power, speed and memory (Fig. 7.6). There were 14 models in the family. The concept of a "family of computers" was a paradigm shift away from the traditional "one size fits all" philosophy of the computer industry, as up until then, every computer model was designed independently. The family of computers ranged from minicomputers with 24 KB of memory, to supercomputers for US missile defence systems. However, all these computers had the same user instruction set, and the main difference was that the larger computers implemented the more complex machine instructions with hardware, whereas the smaller machines used microcode.

The S/360 Architecture potentially allowed customers to commence with a lower cost computer model, and to then upgrade over time to a larger system to meet their evolving needs. The fact that the same instruction set was employed meant that the time and expense of re-writing software was avoided. The machines had

[2] Fred Brooks is the author of "The Mythical Man Month". This is a well-known publication that considers the challenges of delivering a major project (of which software is a key constituent) on time, on budget and with the right quality.

**Fig. 7.6** IBM 360 Model 30
Courtesy of IBM archives.

different operating systems, with the smaller machines having a very basic operating system, the mid-range using an operating system called DOS, and the larger systems using an operating system called OS/360. The System 360 also gave significant performance gains, as it included IBM-designed solid logic technology. This allows denser and faster circuits than earlier transistors, and was over 1,000 times more reliable than vacuum tubes.

The S/360 was used extensively in the Apollo project to place man on the moon. The contribution by IBM computers and personnel were essential to the success of the project. IBM invested over $5 billion in the design and development of the S/360. However, the gamble paid off and it was a very successful product line. The System/360 introduced a number of new industry standards including:

- 8-bit Bytes
- Byte Addressable Memory
- 32-bit words
- Two's complement Arithmetic
- EBCDIC Character Set
- Microcoded CPUs
- IBM Floating Point Architecture.

IBM introduced the Customer Information Control System (CICS) in 1969. This is a transaction processing system designed for online and batch processing. It was originally developed at IBM's Palo Alto laboratory, but development moved to IBM's laboratory at Hursley, England from the mid-1970s. It is still developed and enhanced at Hursley.

It is used by banks and insurance companies in the financial sector for their core business functions. It can support several thousand transactions per second, and up to 300 billion transactions flow through CICS every day. It is available on large

mainframes and on several operating systems, including Z/OS, AIX, Windows and Linux. CICS applications have been written in Cobol, PL/1, C and Java.

The IBM System/370 was introduced in 1970. It was backwards compatible with the older 360 system, in that programs that ran on the 360 could still run on the 370. This made it easier for customers to upgrade from their System 360 to the System 370. The S/370 employed Virtual Memory.[3]

The floppy disk was introduced in 1971, and it became the standard for storing personal computer data. The IBM 3340 Winchester disk drive was introduced in 1973. It doubled the information density on disk surfaces and included a small light read/write head that was designed to ride on an air film that was $18 \times 10^{-6}$ inches thick. Winchester technology was employed up to the early 1990s.

IBM introduced the Systems Network Architecture (SNA) networking protocol in 1974, and this protocol provided a set of rules and procedures for communication between computers. It remained an important standard until the open architecture standards appeared in the 1990s.

It introduced the IBM 5100 Portable Computer in 1975 which cost under $20,000. This was a desktop machine and was used by engineers and scientists. IBM's Federal Systems Division built the flight computers and special hardware for the space-shuttle program.

IBM developed the Data Encryption Standard (DES) in the mid-1970s. DES provides a high degree of security during the transmission of data over communication channels. It specifies an algorithm that enciphers and deciphers a message. The effect of enciphering is to make the message meaningless to unauthorized discovery as the task of breaking the encryption algorithm is extremely difficult.

### *7.2.4 The IBM Personal Computer*

IBM introduced the IBM Personal Computer (or PC) in 1981 and this machine was intended to be used by small businesses and in the home (Fig. 7.7). Its price was $1,565 and it was the lowest price computer produced up to that date. It offered 16 kilobytes of memory (that was expandable to 256 kilobytes), a floppy disk and a monitor. The IBM Personal Computer became an immediate success and became the industry standard. The personal computer also led to a new industry of "IBM-compatible" computers. These compatible computers had all of the essential features of the IBM PC but were typically retailed for a much lower price. IBM introduced the IBM Personal Computer XT in 1983. This model had more memory, a dual-sided diskette drive and a high-performance fixed-disk drive. The Personal Computer/AT was introduced by IBM in 1984.

[3] Virtual Memory was developed for the Atlas Computer at Manchester University in England in the early 1960s. It allowed the actual memory space of a computer to appear much larger by using the space available on the hard drive. The Atlas computer was a joint venture between the Manchester University, Ferranti and Plessey.


**Fig. 7.7** IBM Personal Computer
Courtesy of IBM archives.

IBM had traditionally produced all of the components for its machines. However, it outsourced the production of components to other companies for the IBM PC. The production of the processor chip was outsourced to a company called Intel,[4] and the development of the Disk Operating System (DOS) was outsourced to a small company called Microsoft.[5] These two companies would later become technology giants.

The IBM token-ring local area network was introduced in 1985. This enabled personal computer users to share printers, files and information within a building. It is essentially a computer network in which all of the computers are arranged in a circle (or ring). There is a special data frame termed a token, and the token moves from computer to the next computer until it arrives at a computer that needs to transmit data. This computer then converts the token frame into a data frame for transmission. That is, the computer that wishes to transmit catches the token,

[4] Intel was founded by Bob Noyce and Gordon Moore in 1968.
[5] Microsoft was founded by Bill Gates and Paul Allen in 1975.

attaches a message to it, and then sends it around the network. The Token Ring network later became the IEEE 802.5 standard.

The Ethernet local area network was developed by Robert Metcalfe at Xerox and its performance was superiour to the IBM Token Ring network. Ethernet was first published as a standard in 1980, and it was later published as the IEEE 802.2 standard. Metcalfe formed the technology company 3-Com to exploit the Ethernet technology. IBM introduced the Advanced Peer-To-Peer Networking architecture (APPN) in 1984. This was widely used for communication by mid-range systems and it allowed individual computers to talk to one another without a central server.

IBM developed the Reduced Instruction Set Computer (RISC) architecture. This technology boosts computer speed by using simplified machine instructions for frequently used functions. It reduces the time to execute commands and is the basis of most workstations in use today. Early work on RISC architecture goes back to work done by IBM in the mid-1960s. Later work by IBM led to the design of the RS/6000 and the subsequent development of the Power PC architecture. The RISC System/6000 was introduced in 1990. It is a family of workstations that were among the fastest and most powerful in the industry. IBM introduced the next generation of personal computers termed the Personal System/2 (PS/2) in 1987. It included a new operating system called Operating System/2 (OS/2). The latter gave users of personal computers access to multiple applications, very large programs and data, and allowed concurrent communication with other systems. It was the first offering in IBM's Systems Application Architecture (SAA) which was designed to make application programs look and work in the same manner across different systems such as personal computers, mid-range systems and larger systems.

A research group at IBM developed a suite of Antivirus tools to protect personal computers from attacks from viruses. This led to the establishment of the High Integrity Computing Laboratory (HICL) at IBM. This laboratory went on to pioneer the science of computer viruses.

IBM researchers introduced very fast computer memory chips in 1988. These chips could retrieve a single bit of information in $2 \times 10^{-}8$ of a second. This was over four times faster than the existing generation of dynamic random access memory (DRAM) chips. IBM also introduced the IBM Application System/400 (AS/400) in 1988. This was a new family of easy-to-use computers designed for small and intermediate-sized companies. It became one of the world's most popular business computing systems.

A team of IBM researchers succeeded in storing a billion bits of information (i.e., a gigabit) on a single square inch of disk space in 1989. This was 15–30 times greater than the existing data density on magnetic storage devices. The amount of data that a gigabit can store is equivalent to approximately 100,000 A4 pages. IBM introduced a laptop computer in 1991 to give customers computing capabilities on the road or in the air.

IBM, Apple Computers and Motorola entered an agreement in 1991 to link Apple computers to IBM networks, and to develop a new reduced instruction set microprocessors for personal computers. IBM and Motorola completed development and fabrication of the PowerPC 620 microprocessor in 1994. The new open-systems

environment allowed both IBM AIX and Macintosh software programs to run on RISC-based systems from both companies.

The introduction of the personal computer represented a paradigm shift in computing, and it led to a fundamental change in the way in which people worked. It placed the power of the computer directly in the hands of millions of people. The previous paradigm was that an individual user had limited control over a computer, and the access privileges of the individual users were strictly controlled by the system administrators. The subsequent introduction of the client–server architecture led to the linking of the personal computers (clients) to larger computers (servers). These servers contained large amounts of data that could be shared with the individual client computers.

IBM had until then provided a complete business solution to its clients with generally one key business person making the decision to purchase the IBM computer system for the company. The personal computer market and the client–server architecture had now fragmented this traditional market, as departments and individuals could now make their own purchasing decisions. The traditional customer relationship that IBM had with its clients had been fundamentally altered. It took IBM some time to adjust to this changing world, and it incurred huge losses of over $8 billion in 1993. The company embarked on cost cutting measures as it worked to adapt to the new environment. This involved reducing its work force, rebuilding IBM's product line, and major cost reductions. IBM's strength in providing integrated business solutions proved to be an asset in adapting to the brave new world.

IBM faced further challenges to adapt to the rise of the Internet and to network computing. The internet was another dramatic shift in the computing industry, but IBM was better prepared this time after its painful adjustment in the client/server market. IBM's leadership helped to create the e-business revolution, and IBM actually coined the term "e-business". IBM outlined to customers and to its employees how the Internet had the ability to challenge older business models, and to transform the nature of transactions between businesses and individuals.

IBM created the world's fastest and most powerful general purpose computer in 1994. This was a massively parallel computer capable of performing 136 billion calculations per second. The increase in computational power of computers was becoming phenomenal. The Deep Blue computer programmed chess program defeated Garry Kasparov in 1997 (Fig. 7.8). Kasparov was then the existing world champion in chess, and the IBM victory showed that the computational power of computers could match or exceed that of man. It was also the first time that a computer had defeated a top-ranked chess player in tournament play. Deep Blue had phenomenal calculating power, and it could calculate 200 million chess moves per second.

IBM and the US Energy Department introduced Blue Pacific which was the world's fastest computer in 1998. It was capable of performing 3.9 trillion calculations per second and had over 2.6 trillion bytes of memory. An indication of its computability is given by the fact that the amount of calculations that this machine could perform in one second would take a person using a calculator over 63,000 years.

**Fig. 7.8** Deep Blue Processors
Courtesy of IBM archives.

The Year-2000 millennium bug generated significant customer demand in the late 1990s, as customers wished to ensure that their software was compliant and would continue to function correctly in the new millennium. January 1, 2000 went smoothly for most companies as they had converted their legacy software systems to be Year-2000 compliant.

IBM is a highly innovative company and is awarded more patents[6] in the United States than any other company. It earned over 3,000 patents in 2004. The company is a household name and it has a long and distinguished history. The history of computing is, in many ways, closely related to the history of IBM, as the company has played a key role in the development of the computers that we are familiar with today.

## 7.3 Microsoft

Microsoft was created by Bill Gates and Paul Allen in 1975 (Fig. 7.9). Steve Ballmer joined the company in 1980. The first real success of the company was with the Disk Operating System (DOS) for personal computers. IBM had originally intended awarding the contract for the operating system to Digital Research use a version of Digital's CP/M operating system on the forthcoming IBM Personal Computer. However, negotiations between IBM and Digital failed in 1981, and IBM awarded the contract to Microsoft to produce a version of the CP/M operating system for its personal computers.

[6] A patent is legal protection that is given to an inventor, and allows the inventor to exploit the invention for a fixed period of time (typically 20 years).

**Fig. 7.9** Bill Gates
Photo courtesy of Wikipedia.

Microsoft purchased a CP/M clone called QDOS to assist with this, and IBM renamed the new operating system to PC-DOS. Microsoft created its own version of the operating system called MS-DOS, and the deal with IBM allowed Microsoft to have control of its own QDOS derivative. This proved to be a major mistake by IBM, as MS-DOS became popular in Europe, Japan and South America. The flood of PC clones on the market allowed Microsoft to gain major market share through aggressive marketing of its operating system to the various manufacturers of the cloned PCs. This led to Microsoft becoming a major player in the personal computer market.

The company released its first version of Microsoft Word in 1983, and this would later become the world's most popular word processing package. Microsoft released its first version of Microsoft Windows in 1985, and this product was originally a graphical extension for its MS-DOS operating system. However, later that year, Microsoft and IBM commenced work on a new operating system called Operating System 2 (OS/2). This operating system was for the new IBM PS/2 personal computer. Microsoft introduced its integrated office products called Microsoft Works in 1987, and this product suite Included a word processor, spreadsheet, database and other office applications.

The company introduced its well-known Microsoft Office product in 1989, and this includes Microsoft Word, Microsoft Excel, and Powerpoint. Microsoft introduced Windows 3.0 in 1990, and this new operating system included graphical user interfaces. The company discontinued its work on OS/2, and focused instead

on improving Microsoft Windows. Windows (and its successors) became the most popular operating systems in the coming years. Microsoft's office suite gradually became the dominant office suite with a far greater market share than its competitors such as WordPerfect and Lotus 1-2-3. Microsoft released its Windows 3.1 operating system and its Access database software in 1992. Windows was the most widely used GUI operating system by 1993. Windows 95 was released in 1995, Windows NT in 1996, Windows 2000 in 2000, and Windows XP in 2001.

### *7.3.1 Microsoft Windows and Apple GUI*

Apple Computers had taken a copyright infringement lawsuit against Microsoft in 1988, and the legal arguments lasted 5 years. The final ruling in 1993 was in favour of Microsoft. Apple had sought to prevent Microsoft from using GUI elements that were similar to those in Apple's operating system. However, Apple lost the lawsuit and the subsequent appeal. It had claimed that the look and feel of the Macintosh operating system was protected by copyright including 189 GUI elements. However, the judge found that 179 of these had already been licensed to Microsoft (as part of the Windows 1.0 agreement), and that most of the 10 other GUI elements were not copyrightable.

The Apple Computer vs. Microsoft case generated a lot of interest in the computer science community. Some observers considered Apple to be the villain, as they were using legal means to dominate the GUI market and restrict the use of an idea that was of benefit to the wider community. Others considered Microsoft to be the villain with their theft of Apple's work, and their argument was that if Microsoft succeeded a precedent would be set in allowing larger companies to steal the core concepts of any software developer's work.

The court's judgment seemed to invalidate the copyrighting of the "look and feel" of an application. However, the judgement was based more on contract law rather than copyright law, as Microsoft and Apple had previously entered into a contract with respect to licensing of Apple's icons on Windows 1.0. Further, Apple had not acquired a software patent to protect the intellectual idea of the look and feel of its Macintosh operating system. Further, had Apple won then the development of X-Windows and other open-source GUIs would have been impeded.

### *7.3.2 The Browser Wars*

The world wide web was invented by Tim Bernards Lee in the early 1990s. Microsoft was initially slow to respond to the rise of the internet. However, in the mid-1990s it expanded its product suite into the world wide web with Microsoft Network (MSN). This product was intended to compete directly against America On-Line (AOL). The company developed some key internet technologies such as ActiveX, VBScript and JScript. ActiveX is an application programming interface built on the Microsoft Component Object Model (COM), and VBScript and Jscript

are script languages. The company also released a new version of Microsoft SQL Server that provided built-in support for internet applications. The company released a new version of Microsoft Office and Internet Explorer 4.0 (its internet browser) in 1997. This was the beginning of Microsoft dominance of the browser market. Netscape had dominated the market but as Internet Explorer 4.0 (and its successors) was provided as a standard part of the Windows operating system (and also on Apple computers) it led to the replacement of Netscape by Internet Explorer.

This led to a filing against Microsoft stating that Microsoft was engaged in anti-competitive practices by including the Internet Explore browser in the Windows operating system, and that Microsoft had violated an agreement signed in 1994. The court was asked to stop the anti-competitive practices of the company. The leaking of internal memos of the company on the internet caused a great deal of controversy in 1998. These documents went into detail of the threat that open source software posed to Microsoft and also mentioned possible legal action against Linux and other open source software.

Windows 2000 was released in early 2000 and included enhanced multimedia capabilities. The legal action taken by the US Department of Justice against Microsoft concluded in mid-2000, and the judgement called the company an "abusive monopoly". The judgment stated that the company should be split into two parts. However, this ruling was subsequently overturned on appeal. The company released Windows XP in 2001.

Microsoft launched its .NET initiative in 2002 and this is a new API for Windows programming. It includes a new programming language called C#. Microsoft also released a new version of the Visual Studio development product in 2002. Microsoft Vista is due to be released in 2007.

## 7.4 Motorola

Motorola[7] was originally founded as the Galvin Manufacturing Corporation in 1928. Paul Galvin and his brother Joseph purchased a battery eliminator business in Chicago. They incorporated Galvin Manufacturing Corporation later that year. The company initially had five employees and its first product was a battery eliminator. This was a device that allows battery-powered radios to run on standard household electric current. The company introduced one of the first commercially successful car radios in 1930. This was the Motorola model 5T71 radio and it sold for between $110 and $130. Paul Galvin created the brand name "Motorola" in 1930. The origin of the name is from "Motor" to highlight the company's new car radio, and the suffix "ola" was in common use for audio equipment at the time.

[7] This section is dedicated to the staff of the late Motorola plant in Blackrock, Cork, Ireland. Motorola set up a plant in Cork in the mid-1980s and at its peak it employed over 500 skilled software engineer and I was impressed by their professionalism and dedication to customer satisfaction. The plant developed the Operations and Maintenance Centre (OMC) which is a key part of the GSM system.

Motorola has come a long way since then and it is now a global leader in wireless, broadband and automotive communications technologies. It is internationally recognized for its innovation, excellence and its dedication to customer satisfaction. It has played a leading role in transforming the way in which people communicate, and the company has been a leader rather than a follower in technology. Its engineers have developed innovative products and services to connect people to each other.

Motorola's products have evolved over the years in response to changing customers' needs. Many of its products have been radio-related, starting with a battery eliminator for radios, to the first walkie-talkies, to cellular infrastructure equipment and mobile phones. The company was also strong in semiconductor technology,[8] including integrated circuits used in computers. This included the microprocessors used in the Apple Macintosh and Power Macintosh computers. The Power PC chip was developed in partnership with IBM. Motorola has a diverse line of communication products, including satellite systems and digital cable boxes.

The company is renowned for its dedication to quality and customer satisfaction. It defined and implemented the original Six Sigma$^{TM}$quality principles in 1983. Motorola was awarded the first Malcolm Baldridge National Quality Award granted by the US Department of Commerce in 1988 in recognition of its work on 6-sigma. The three commandments of six sigma philosophy are:

- The company needs to be focused on the Customer (and on Customer Satisfaction).
- Data must be gathered to provide visibility into performance with respect to the key goals and performance of the processes.
- Variation in processes needs to be eliminated (as variation leads to quality problems).

The use of Six Sigma by Jack Welsh within General Electric is well-known. Six-Sigma is a rigorous customer-focused, data-driven management approach to business improvement. Its objectives are to eliminate defects from every product and process, and to improve processes to do things better, faster and at a lower cost. It can be used to improve every activity and step of the business that is concerned with cost, timeliness and quality of results. It is designed to provide tangible business results directly related to the bottom line of the company. Motorola University provides training on six sigma.

### *7.4.1 Early Years*

Motorola was founded as the Galvin Manufacturing Corporation in 1928 and its first product was the battery eliminator. It introduced one of the first commercially

[8] Motorola's semi-conductor product sector became a separate company (Freescale Semiconductor Inc.) in 2003, as Motorola decided to focus on its core activities following a major re-structuring of the company.

successful car radios in 1930. This was the 5T71 radio and it was installed in most automobiles. The company entered the field of mobile radio communications in 1936 with the development of the Motorola Police Cruiser mobile receiver. This product was preset to a single frequency and allowed vehicles to receive police broadcasts. Motorola's roots are in radio technology, and its core expertise in radio enabled it to become a leader in mobile phone communications in the mid-1980s.

The company entered the home radio business in 1937 and its products included phonographs (for playing recorded music) and home radios. It developed a lightweight two-way radio system in 1940 that was used for communication during the Second World War. It introduced its first commercial line of Motorola FM two-way radio systems and equipment in 1941.

It introduced its first television for the home entertainment business in 1947. This was the Golden View model VT71 and it was priced under $200. The Galvin Manufacturing Corporation officially became Motorola, Inc., in 1947 and it introduced its well known logo in 1955.

It established a research centre in Arizona to investigate the potential of new technologies such as the transistor. It would become one of the largest manufactures of semi-conductors in the world. However, its semi-conductor product sector became a separate company (Freescale Semiconductor Inc.) in 2003. Motorola's first mass-produced semiconductor was a transistor intended for car radios. The company introduced a pager in 1956 that allowed radio messages to be sent to a particular individual.

Motorola's radio equipment (including a radio transponder) was used by Neil Armstrong on the Apollo 11 lunar module for two-way voice communication on the moon. A Motorola FM radio receiver was used on NASA's lunar roving vehicle to provide a voice link between the Earth and the moon.

Motorola presented a prototype for the world's first portable telephone in 1973. The DynaTAC (Dynamic Adoptive Total Area Coverage) used a radio technology called cellular. The company would spend $100 million in the development of cellular technology, and commercial services of DynaTAC commenced in 1983. The first DynaTAC phone became available to consumers in 1984 and weighed almost 2 lbs.

Motorola made a strategic decision in 1974 to sell off its radio and television manufacturing division. The television manufacturing division produced the Quasar product line. Quasar was sold as a separate brand from Motorola, and all Motorola manufactured televisions were sold as "Quasar". The Quasar division was sold to Matsushita who were already well-known for the Panasonic television brand. The Matsushita acquisition of Motorola's Quasar division was the beginning of the end of the manufacturing of televisions by US companies.

Motorola televisions were transistorized coloured models that contained all of the serviceable parts in a drawer beneath the television. However, they had quality problems. The new Japanese management succeeded in producing televisions with significantly higher quality than Motorola and they had 5% of the defects of Motorola manufactured televisions. Motorola's executives later visited the Quasar plant near Chicago and were amazed at the quality and performance improvements.

The Japanese had employed the principles of total quality management based on Deming and Juran, and had focused on improvements to the process. This had led significant cost savings as less time was spent in reworking defective televisions.

The Japanese quality professionals had recognized that the cost of poor quality was considerable, and their strategy was to focus on the prevention of defects at their source. This led to a dramatic reduction in the number of defects, and a corresponding reduction in the costs of correcting the defects. The Motorola executives were amazed at the correlation between cost and quality, and this motivated the six-sigma quality improvement programme in Motorola.

There were allegations that the acquisition by Matsushita of Quasar was nothing more than a Japanese strategy to avoid paying tariffs on television sets imported into the United States. The "Quasar" brand was considered to be domestically made even though Quasar's engineering and manufacturing division was being scaled down. The Quasar televisions produced consisted of Japanese parts as the company moved away from engineering in the United States and focused on assembly and distribution.

### *7.4.2 Six-Sigma*

The CEO of Motorola established the "Five Year Ten Fold Improvement Programme" as one of the top-10 goals of the company in 1981. This was a commitment by senior management to achieve significant quality and performance improvements to its products and services over the next 5 years.

The roots of six-sigma as a measurement standard goes back to the eighteenth century German mathematician Gauss. He introduced the concept of the normal distribution curve, and this curve is important in probability theory. It is also known as the Gaussian distribution or bell curve.

The curve has two parameters, and these are the mean (a measure of location or centre of the curve), and the standard deviation (a measure of variability from the mean). The mean is represented by the Greek letter $\mu$ (mu) and the standard deviation is represented by the Greek letter $\sigma$ (sigma). The properties of the standard deviation is given in Table 7.1.

Walter Shewhart was one of the grandfathers of quality and he worked on quality improvements by reducing product variation in the 1920s. He demonstrated that

**Table 7.1** Properties of sigma levels

| $\sigma$-Level | Area of Curve within Sigma Level |
|---|---|
| 1-sigma | 68.27% |
| 2-sigma | 95.45% |
| 3-sigma | 99.73% |
| 4-sigma | 99.993% |
| 5-sigma | 99.99994% |
| 6-sigma | 99.9999998% |

three sigma (or standard deviations) from the mean is the point where a process requires correction. The term "Six Sigma" was coined by a Motorola engineer called Bill Smith in the early 1980s, and it was used by Motorola both as a measure of process variability and as a methodology (Table 7.2) for performance and quality improvement. The application of the methodology by an organization leads to a change of culture in the organization.

Motorola engineers realized that the traditional quality levels of measuring defects in thousands of opportunities did not provide sufficient granularity for quality and performance improvements. The new Motorola standard allowed defects per million opportunities to be measured. Six-Sigma was a major success for Motorola, and the company made major savings following its introduction in the mid-1980s.

The objective of the 6σ programme was to improve the quality performance of all key operations in the business including manufacturing, service, marketing and support. The goal was to design and manufacture products that are 99.9997% perfect: i.e., 3.4 defects per million opportunities. The fundamental philosophy of the methodology is that every area of the organization can be improved. The steps involved in 6-sigma are summarized by the acronym DMAIC.[9] This stands for Define, Measure Analyse, Improve and Control. There is a step zero before you start and it is concerned with six-sigma leadership.

The methodology is based upon improving processes by understanding and controlling variation. This leads to more predictable processes with enhanced capability, and therefore more consistent results.

The participants on a six-sigma programme have an associated belt (e.g., green belt, black bet, etc.) to indicate their experience and expertise with the methodology. A Black Belt has received extensive training on six sigma and statistical techniques. Motorola was awarded the first Malcolm Baldrige National Quality Award in recognition of its efforts in 6σ. This Award was established by the US Congress to recognize the pursuit of quality in American business.

The use of six-sigma is not a silver bullet to success for any organization. Motorola paid the price for totally misjudging the transition from the analog cellular market to digital cellular.

**Table 7.2** Six sigma methodology

| Activity | Description |
|---|---|
| Define | Define the process. |
| Measure | Measure the current performance of the process. |
| Analyse | Analyse the process to identify waste. |
| Improve | Improve the process. |
| Control | Measure the improvements made to the process and repeat the cycle. |

[9] DMAIC was influenced by Demings "Plan, Do, Act, Check" cycle.

### 7.4.3 Cellular Technologies

The invention of the telephone by Graham Bell in the late nineteenth century was a revolution in human communication, as it allowed people to communicate over distance. However, its key restriction was that the physical location of the person to be contacted was required before communication could take place: i.e., communication was between places rather than people.

Bell Laboratories introduced the idea of cellular communications in 1947 with the police car technology. Motorola was the first company to incorporate the technology into a portable device that was designed for use outside of an automobile. The inventor of the first modern portable handset was Martin Cooper of Motorola, and he made the first call on a portable cell phone in April 1973 to the head of research at Bell Labs.

It took a further 10 years for Motorola to bring the mobile phone to the market, and it introduced the first portable mobile phone in 1983. It was called DynaTAC, and it cost $3,500 and weighed one pound. Today, there are more mobile phone users than fixed line users, and mobile phones weigh as little as 3 ounces.

Bell Laboratories developed the Advance Mobile Phone Services (AMPS) standard for analog cellular phone service. It used the 800 MHz cellular band, and it was used in the United States and other countries. It had a frequency range between 800 and 900 MHz. These frequencies were allocated by the Federal Communications Commission (FCC). Each service provider could use half of the 824–849 MHz range for receiving signals from cellular phones and half the 869–894 MHz range for transmitting to cellular phones. The bands are divided into 30 kHz sub-bands called channels. The division of the spectrum into sub-band channels is achieved by using frequency division multiple access (FDMA).

The signals from a transmitter cover an area called a cell. As a user moves from one cell into a new cell a handover to the new cell takes place without any noticeable transition. The signals in the adjacent cell are sent and received on different channels than the previous cell's signals and so there is no interference. Analog is the original mobile phone system but has been replaced by more sophisticated systems in recent years. These include GSM, CDMA, GPRS and UMTS. The old analog phones were susceptible to noise and static. They were also subject to eavesdropping.

Bell Labs constructed and operated a prototype cellular system in Chicago in the late 1970s and performed public trials in Chicago in 1979. Motorola commenced a second US cellular radio-phone system test in the Washington/Baltimore area. The first commercial systems commenced operation in the United States in 1983.

Motorola dominated the analog mobile phone market. However, it was slow to adapt to the GSM standard and it paid the price in loss of market share to Nokia and other competitors. The company was very slow to see the potential of a mobile phone as a fashion device.[10] However, in recent years the company has made painful

[10] The attitude of Motorola at the time seemed to be similar to that of Henry Ford: i.e., they can have whatever colour they like as long as it is black.

adjustments to position itself appropriately for the future. The company decided to focus on mobile phone technology and has sold off non-core businesses including its automotive and semi-conductor businesses. It has also become much more customer focused and has launched a series of stylish phones.

### *7.4.4 Semiconductor Sector*

Bell Labs invented the transistor in 1947 and its first commercial use was products for the hearing impaired. It invented an all-transistor computer in 1954. Motorola set up a research lab in 1952 to take advantage of the potential of semi-conductors, and by 1961 it was mass producing semi-conductors at a low cost. It introduced a transistorized walkie-talkie in 1962 as well as transistors for the Quasar televisions. It became the main supplier for the microprocessors used in Apple Macintosh and Power Macintosh personal computers. The power PC chip was developed in a partnership with IBM and Apple.

Motorola introduced the 8-bit 6,800 microprocessors in 1974 and this microprocessor was used in automotive, computing and video games. It contained over 4,000 transistors. It introduced a 16-bit microprocessor in 1979 and this was adopted by Apple for its Macintosh personal computers. It introduced the MC68020, the first true 32-bit microprocessor in 1984. This microprocessor contained 200,000 transistors on a 3/8 inch square chip.

Motorola went through a painful adjustment in the late 1990s and decided to focus on its core business of mobile communications. Its semiconductor business became a separate company called Freescale in 2004.

### *7.4.5 Motorola and Iridium*

Iridium was launched in late 1998 to provide global satellite voice and data coverage to its customers. It provides complete coverage of the earth, and this includes the oceans, airways and polar regions. No other form of communication is available in remote areas, and so the concept of Iridium is very valuable.

Iridium was implemented by a constellation of 66 satellites. The original design of Iridium required 77 satellites, and the name “Iridium” was chosen as its atomic number in the periodic table is 77. However, the later design required 66 satellites, and so Dysprosium which has an atomic number 66 would now be a more appropriate name. The satellites are in low Earth orbit at a height of approximately 485 miles, and communication between satellites is via intersatellite links. The satellite contains seven Motorola Power PC 603E processors running at 200 MHz. These machines are used for satellite communication and control.

Iridium routes phone calls through space and there are four earth stations. As satellites leave the area of an Earth base station the routing tables change, and frames are forwarded to the next satellite just coming into view of the Earth base station.

The Iridium constellation is the largest commercial satellite constellation in the world, and is especially suited for industries such as maritime, aviation, government and the military. Motorola was the prime contractor for Iridium, and it played a key role in the design and development of the system. The satellites were produced at an incredibly low cost of $5 million each ($40 million each including launch costs).

The first Iridium call was made by Al Gore. However, Iridium as a company failed and it went into bankruptcy protection in late 1999 due to:

- insufficient demand for its services
- High cost of its service
- Cost of its mobile handsets
- Bulky mobile handsets
- Competition from the terrestrial mobile phone networks
- Management failures.

However, the Iridium satellites remained in orbit, and the service was re-established in 2001 by the newly founded Iridium Satellite LLC. It is used extensively by the US Department of Defence.

## 7.5 Apple Computers

Apple was founded by Steven Wozniak and Steven Jobs (Fig.7.10) in 1976. Jobs and Wozniak were two college dropouts, and they released the Apple I computer in 1977. It retailed for $666.66. They then proceeded to develop the Apple II computer. This machine included colour graphics and it came in its own plastic casing. It retailed for $1299 and it was one of the first computers to come pre-assembled. The Apple II was a commercial success and Apple became a public listed company in 1980.

The Apple Macintosh was released in 1984 and this machine was quite different from the IBM PC in that it included a graphical user interface that was friendly and intuitive. This made the Macintosh a much easier computer to use than the standard IBM PC, as the latter required users to be familiar with its DOS operating system and commands. The introduction of the Mac GUI was an important milestone in the computing field.

Jobs got the idea of the graphical user interface for the Macintosh from Xerox's PARC research centre in Palo Alto in California. Apple intended that the Macintosh would be an inexpensive and user friendly personal computer that would rival the IBM PC and its clones. However, it was more expensive than its rivals as it retailed for $2,495, and initially the Macintosh had limited applications available. The IBM PC had spreadsheets, word processors and databases applications available.

Apple went through financial difficulty in the mid-1980s as its products were more expensive than rival offerings. Jobs resigned from the company in 1985, and he founded a new company called Next Inc. Microsoft and Apple signed a contract in the mid-1980s that granted Microsoft permission to use some of the Macintosh GUIs. This contract would lead to Apple losing all of the lawsuits over copyright

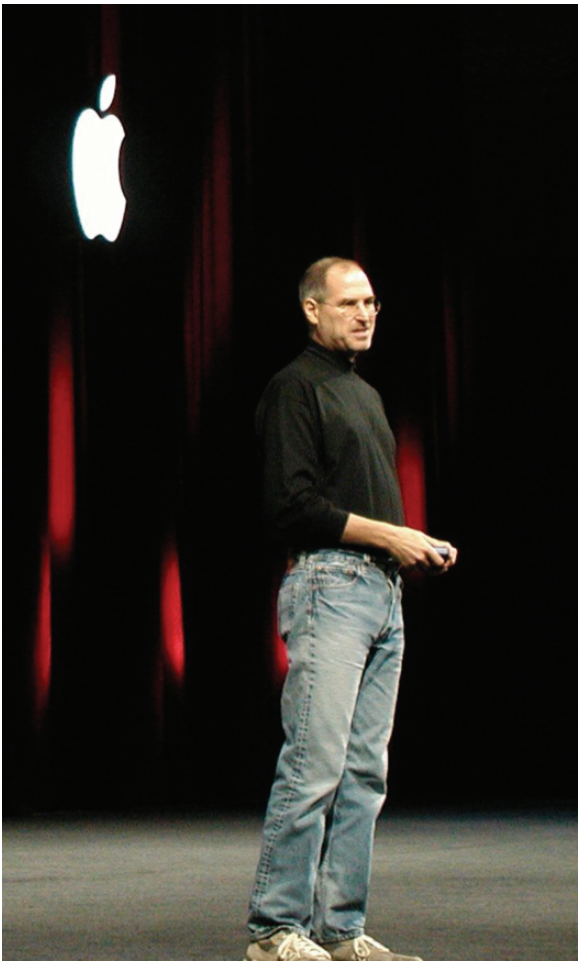

**Fig. 7.10** Steve Jobs
Photo courtesy of Wikipedia.

infringement against Microsoft that it took in later years. Apple Computers was sued by the Apple Corporation[11] in 1989 for violating the terms of their 1981 agreement that prohibited Apple Computers from building computers with the capability of producing synthesized music.

Apple released the Newton Message Personal Digital Assistant (PAD) in 1993. However, the Newton proved to be unsuccessful mainly due to reliability problems. IBM, Apple and Motorola entered an alliance in the early 1990s aimed at challenging the Windows and Intel architecture. The responsibilities of IBM and Motorola were to design and produce the new Power CPUs for the new desktop computers

[11] This was the Beatles recording company.

and servers. The responsibilities of Apple were to port its MacOS operating system to the new architecture.

The first Power PC processor was released by Motorola in 1993, and Apple released its power Macintosh desktop computer in 1994 based on the Motorola processors. Motorola developed processors with enhanced capabilities in the coming years, and this led to better and faster Power Macintosh computers. These include the Power Macintosh and PowerBook G3, G4 and G5. Apple took over Next Inc. in 1996, and this led to a return of Jobs to Apple. Jobs became the acting head of Apple in 1997 and he developed an alliance between Apple and Microsoft. The iMac was released in 1998 and this was a major commercial success. Apple released the iBook in 1999 and this was another major commercial success.

Apple released the iPod in 2001. This was a portable hard-disk MP3 player, and it had a capacity of 5 GB. The iPod could hold up to 1,000 MP3 songs. Apple released a software package (iTunes) that allowed MP3 files to be transferred from the Mac to the iPod.

Apple is a highly innovative company and has made major contributions to the history of computing.

## 7.6 Oracle

Oracle was founded in 1977 by Larry Ellison, Bob Miner and Ed Oates. Ellison came across a working prototype of a relational database, and he saw an opportunity to exploit and commercialise relational database technology. At that time there were no relational databases in the world, and the founding of Oracle changed business computing. The company was originally called Software Development Laboratories, and it changed its name to Oracle in 1983. The database product that Ellison, Milner and Oates created was called Oracle in memory of a CIA funded project code named Oracle that they had worked on in a previous company.

Today, Oracle is the main standard for database technology and applications, and Oracle databases are used by companies throughout the world. Oracle has grown over time to become the second largest software company[12] in the world. An Oracle database consists of a collection of data managed by an Oracle database management system. The release of Oracle V.2 in 1979 was a major milestone in the history of computing as it was the world's first relational database.

The concept of a relational database was described by Edgar Codd [Cod:70]. Codd was born in England and he worked for IBM in the United States. A relational database is a database that conforms to the relational model, and it may also be defined as a set of relations (or tables). A Relational Database Management System (RDBMS) is a system that manages data using the relational model, and examples include products such as Oracle and Microsoft SQL Server.

[12] Microsoft is the largest software company in the world.

A relation is defined as a set of tuples and is usually represented by a table, where a table is data organized in rows and columns. The data stored in a each column of the table is of the same data type. Constraints may be employed to provide restrictions on the kinds of data that may be stored in the relations. Constraints are Boolean expressions which indicate whether the constraint holds or not, and are a way of implementing business rules into the database.

Most relations have one or more key associated with them, and the key uniquely identifies the row of the table. An index is a way of providing quicker access to the data in a relational database. It allows the tuple in a relation to be looked up directly (using the index) rather than checking all of the tuples in the relation.

A stored procedure is executable code that is associated with the database. It is usually written in an imperative programming language, and it is used to perform common operations on the database.

Oracle is recognised as a world leader in relational database technology and its products play a key role in business computing.

## 7.7 Siemens

Siemens is a European technology giant and it employs approximately 475,000 people around the world. It is one of the world's leading electrical engineering and electronics companies, and its headquarters are in Munich and Berlin. Its annual sales are in excess of € 87 billion. The company operates in several segments including automation and control, power, transportation, medical, and information and communications. It was founded in 1847 by Werner von Siemens, and initially the focus of the company was in telecommunications with a product that improved upon the Wheatstone Telegraph. The company was involved in building telegraph networks in Prussia and Russia, as well as building an Indo-European[13] telegraph network in its early years. The company began laying the first transatlantic cable from Ireland to the United States in 1874. Siemens played a role in the introduction of facsimile telegraphy in the 1920s. This involved the scanning of photographs and it was employed on Siemens equipment from the late 1920s. It proved to be very popular with the press as it made it easier to transmit photographs. Siemens played a role in launching the world's first public telex network in work that it did with Deutsche Reichpost in 1933. This was achieved by technology to type and receive messages.

Siemens became the first company to succeed in manufacturing the ultra-pure silicon needed for semiconductor components. This was done in 1953 and was independent of the research being done in the United States. This technique was known as the floating-zone method, and the company was granted a patent for this

[13] The construction took 2 years and the route was over 11,000 km. It extended from London to Calcutta. It took 1 minute for a dispatch to reach Teheran, whereas it took 28 minutes to reach Calcutta.

invention in 1953. The company became involved in satellite communication for telecommunications from the mid-1960s.

Siemens has played an important role in the development of mobile phone technology. The company entered the mobile phone market in the early 1980s, and at that time there was a very expensive public mobile phone network[14] in place in Germany. Siemens supplied new mobile radio system equipment to Deutch Bundespost in the mid-1980s, and this technology allowed subscribers to be reached at their own numbers. It introduced its first mobile phone (C1) in the mid-1980s. It weighed 8.8 Kg or 19 pounds. Today, many mobile phones weigh less than 200 grams. Siemens made its first GSM call in the early 1990s.

Siemens has a number of joint ventures with companies such as Fujitsu, Nokia and Bosch. The joint venture with Fujitsu is now Europe's leading IT manufacturer. Fujitsu Siemens' portfolio ranges from high-performance servers, to PCs, notebooks, and so on. Nokia–Siemens Networks has world class research and development, and its mission is to advance the development of product platforms and services for the next-generation of fixed and mobile networks. Siemens is an innovative company and its products and services are familiar to consumers world-wide.

## 7.8 HP

Hewlett Packard was founded by Bill Hewlett and Dave Packard in 1939. They were both classmates at Stanford University, and graduated in engineering in 1934. Packard then took a position with General Electric, and Hewlett continued with graduate studies in Stanford/MIT. They built their first product in a Palo Alto garage, and this was an electronic test instrument used by sound engineers. Walt Disney Studios was an early HP customer.

The company began to grow during the early 1940s with orders from the US government. Hewlett and Packard created a management style for the company, and over time this became known as the HP way. The HP way was highly effective, and HP's corporate culture was later copied by several technology companies.

The HP way included a strong commitment by the company to its employees, and a strong belief in the basic goodness of people and in their desire to do a good job. It believed that if employees are given the proper tools to do their job that they would then do a good job. There was a firm conviction that each person had the right to be treated with respect and dignity.

The HP management technique was known as "management by walking around", and this is characterised by the personal involvement of management. This includes good listening skills by the manager, and the recognition that everyone in a company wants to do a good job. The HP way involves management by objectives: i.e., senior

[14] This network supported 11,000 users in Germany and was staffed by 600 staff who were responsible for switching the calls of the subscribers. The use of this network was the preserve of the super rich in Germany as the cost of phones and calls were prohibitive for the general public.

managers communicate the overall objectives clearly to their employees. Employees are then given the flexibility to work towards those goals in ways that are best for their own area of responsibility. The HP Way was refined further in the late 1950s, and the company objectives included seven areas. These are profit, customers, fields of interest, growth, people, management and citizenship.

HP also established an open door policy to create an atmosphere of trust and mutual understanding. The open door policy encouraged employees to discuss problems with a manager without fear of reprisals or adverse consequences. HP addressed employees by their first name and provided good benefits to its employees. This included free medical insurance and the provision of regular parties for employees. HP was the first company to introduce flexitime, and this was introduced in the late 1960s. The concept was based on trust and it allowed employees to arrive early or late for work as long as they worked a standard number of hours.

HP entered the microwave field during the Second World War and it later became a leader in the technology. It became a public quoted company in 1957, and set up two plants in Europe in the late-1950s.

It moved into the medical device sector in the 1960s and developed its first computer in the mid-1960s. HP's research laboratory was established in 1966, and it became a leading commercial research centre.

The company introduced the hand held scientific calculator in the early 1970s, and this invention made the slide rule obsolete. HP become a major player in the computer industry in the 1980s, and its product portfolio included desktop computers and mini-computers. It also introduced a set of inkjet and laser printers. It introduced a touchscreen personal computer in the early 1980s.

HP merged with Compaq in 2002, and the new company is known as HP. Today, HP has revenues of over $90 billion and employs over 150,000 people. The rise of HP and insight into its business practices, culture and management style that led to its success are described by David Packard in [Pac:96].

## 7.9 Miscellaneous

This section considers some miscellaneous technology companies including Philips, Amdahl and Sun Microsystems.

### *7.9.1 Amdahl*

Amdahl was founded by Gene Amdahl in 1970. Amdahl was a former IBM employee and had worked on the System 360 family of mainframe computers. The company launched its first product in 1975, and this was the Amdahl 470. This product competed directly against the IBM System 370 family of mainframes. Amdahl became a major competitor to IBM in the high-end mainframe market, and Amdahl gained 24% market share.

Amdahl worked closely with Fujitsu to improve circuit design, and Fujitsu's influence on the company increased following Gene Amdahl's departure from the company in 1980. Amdahl moved into large system multi-processor design from the mid-1980s. However, by the late-1990s it was clear that Amdahl could no longer effectively compete against IBM's 64-bit zSeries as Amdahl had only 31-bit servers to sell. The company estimated that it would take $1 billion to create an IBM-compatible 64-bit system.

Amdah became a wholly owned subsidiary of Fujitsu in 1997, and its headquarters are in California.

### *7.9.2 Philips*

Philips is a European technology giant and it was founded in Eindhoven, The Netherland in 1891. It was founded by Gerard Philips,[15] and initially the company made carbon-filament lamps. Today, it is a technology giant and it employs over 120,000 people, and has sales of approximately $27 billion. Its headquarters moved to Amsterdam in the late 1990s.

The company began manufacturing vacuum tubes and manufacturing radios in the 1920s. It introduced consumer products such as the electric razor in the 1930s, and introduced the compact cassette in the 1960s. By the mid-1960s it was producing integrated circuits, and its semiconductor sector played a key role in its business. Philips introduced the laser disc player in the late 1970s and it introduced the compact disk in 1982. It introduced the DVD in the late 1990s.

Philips sold off a majority stake of its semiconductor business to a consortium of private equity investors in 2005. The company has gone through a major process of change, and it plans to focus on health care, lifestyle and technology in the future.

### *7.9.3 Sun Microsystems*

Sun Microsystems was founded by four Stanford University graduates in 1982, and the company is a vendor of computers and software. Its headquarters are in Santa Clara in California.

Sun's products include computer servers and workstations based on its SPARC processors and Solaris operating system. The SPARC workstation was first introduced in the late 1980s. It has developed innovative technologies such as the Java platform, and has contributed to the development of open systems and open source software. The Java technology plays a key role in the portability of software, and allows developers to write applications once to run on any computer.

---

[15] Gerard Philips was a cousin of Karl Marx.

## 7.10 Review Questions

1. Discuss the contribution of IBM to computing.
2. Discuss the contribution of Motorola to mobile phone technology.
3. Discuss the controversy between Microsoft and Apple and the controversy between Microsoft and Netscape.
4. Describe the 6σ methodology.
5. Describe the HP Way.

## 7.11 Summary

This chapter considered the history of some famous technology companies including IBM, Microsoft and Motorola.

The origin of IBM goes back to Hermann Hollerith's work on tabulating machines. This machine was designed to tabulate the results of the 1890 census in the United States.

Microsoft was founded in the mid-1970s and it has grown to become a major corporation. It has developed operating systems such as Microsoft Windows NT, Windows 2000 and Windows XP.

Motorola was founded as the Galvin Manufacturing Corporation in 1928. Its initial business was in the production of radios for cars and it became a world leader in radio and telecommunications. Motorola produces mobile phones and base stations for the mobile telecommunications field.

Apple was founded in the mid-1970s. It has developed innovative technology including the Apple Macintosh in the mid-1980s. This introduced a friendly graphical user interface (GUI) which made the machine easy to use.

Other companies discussed in this chapter include HP, Oracle and Siemens.