Chapter Three

History of the sound recording technology

In general, cultural objects can be divided into two categories: (1) Tangible and (2) Intangible. All the physical and visual forms of art such as paintings, statues, traditional crafts and carving belong to what is commonly known as “tangible culture” whereas beliefs, folklore, dance, songs, and literature are considered as “intangible phenomena”. Where the tangible and intangible objects are compared, it becomes clear that there are several methods of preserving tangible culture. These include scripting, photographing, and drawing etc. However, the only possible methods of preserving the intangible objects such as music, drama, dance, folklore is audio video recording. When Compared to the objects mentioned under the tangible culture category, uniqueness becomes the main characteristic feature of intangible objects. When music is understood as an intangible phenomenon, it can be said that the method of notation is the only way of preserving such objects other than recording. The basic structure of a song or a musical piece work can be demonstrated only in terms of notation. It is quite impossible to capture the fine features belonging to the composition, voices of singers, playing patterns and timbers of instruments, customs related to musical cultures and so on. Thus, the most appropriate method of preserving an intangible object is recording. However, before the scientific inventions and evolutions of proper recording technologies for preserving unique performances, valuable folk legends had been documented using historical conservation methods, like writing on leaves, pictorial inscriptions *etc*., especially to report and record these elements as historical incidents and resources for future research.

3.1 Meaning of Recording

Recording can be defined in many ways. One sense of the terms is ‘notifying or documenting some notes or statements’. Recording sounds using mechanical or electronic methods is quite deferent from notifying data or information. Recording method varies from visual to audible. There is a diverse range of recording medium including scripting, photographing, and drawing *etc*. Sound recording implies to preserve for listening again in future.

However, recording sound differs from preserving an object visually. In that sense, recording sound can be defined as a progression of codifying or storage of human speech or singing, sound pertaining to instrumental music or sound effects using electronic or mechanical methods. This can be understood as a result of the scientific revolution.

There are four kinds of sound recording technologies that have emerged so far since the evolution of sound recording. Similarly, as far as the methods and procedures are concerned four kinds of recording eras can be identified as Mechanical era, Electronic era, Magnetic era and Digital era that have continued from the early times to modern periods[1]. They are:

(1) Mechanical or acoustic recording
(2) Electronic recording.
(3) Magnetic recording
(4) Digital recording

3.2 Mechanical Sound Recording

Mechanical recording is also known as *acoustic sound recording*. That is the initial and practical method of recording sounds. Sound grooves on the recorded medium (wax or other medium) were produced by the mechanical vibrations of a needle, which was

connected as stylus to one end to the membrane and the other end to large horn that employed as a microphone. In this recording process, sound was recorded as a visual image into the membrane or the recording medium[2].

3.3 Electrical Sound Recording

Electrical recording emerged as a result, of scientific experiments and innovations. In the Electrical recording progression, sound is recorded using electronic devices such as microphones, amplifiers and other appropriate equipment such as electrical record cutters rather than phonograph horn that was used to record sound mechanically. This was initially experimented by the Colombia Record Company and the Victor Talking Machine Company in 1924[3]. The sound quality of electrical recordings did not have harsh sounds like in mechanical recordings and it improved the sound quality of recordings. However, the technology of electrical recording did not change the practice of live group performance.

Both Magnetic and Digital recording technologies can be considered as evolutionary and advanced methods of sound recording.

3.4 Types of Recording

Even though this technology is basically classified based on the time periods and its advanced features, the functionalities and the process of it permit one to discuss three major headings as follows:

1. Live recordings (Pre-production)
2. Track recording (Post-production)
3. Programming

3.4.1 Live Recordings (Pre-Production)

Sometimes, the musical performances are simultaneously recorded on specific mediums. All the recordings that were stored on the previous storage mediums such as wax were cut to such mediums at the same time of recording. However, this method is not employed very often and it is not considered to be a proper and practical method of recording of musical data. However, this is used to record live concerts and folk music performances especially, for preservation. The live beams of programs that are broadcast are employed the same method of recording[4].

3.4.2 Track Recording (Post-production)

With the introduction of magnetic recording with different track counts, the technique of track recording came into existence as a practical method of sound recording. According to this method, music is recorded using certain recording equipment (especially microphones) on its own track. Finally, all the recorded tracks are mixed once the recoding process is completed. This principle is commonly used presently due to its convenience and practical simplicity[5].

3.4.3 Programming

Programming is commonly used in the field of computing vocabulary. It is related to the field of computers. The concept was adopted in the field of music with regard to the gradual development of computer based music recording and production technologies. With the development of the digital music recording technology, which is based on software and MIDI devises, both composing music and recording came to be known as music programming. Storing programmed and manipulated data of music in a compatible medium by means of software and certain other equipment is called 'programming'. As a result, the position of 'sound engineer' is sometimes replaced with that of the 'music programmer'. There are two existing forms of recording. They are;

(1) Analog recording and

(2) Digital recording.

In analog recording method (Analog means that the electrical signals consist of continuous changes in electrical voltage rather than a discrete series of numbers as in modern digital format)[6], waves of sounds produced by human voices or acoustic musical instruments are recorded as physical texture on the medium. But when record the same analog data onto a tape medium it converts into electrical signals and are then stored on a tape. On the contrary, Digital Recording is a process of transcribing sounds or data into binary or numeric format (Is and 0s) while recording is taking place. The process of transforming analog signal to digital is performed by a converter called 'analog to digital converter' (ADC). In contrary to analog recording the most compensation of digital recording has duplicate number of copies without losing the sound quality as well as, copies can also be made of copies without the sound being degraded. This facility is highly supportive for editing purposes. However, both forms of recordings have their own distinctive characteristic qualities. When consider to both analog and digital forms digital is in advance as a format since its higher solidity. As far as both formats are concerned analog recording is like a painting while the digital is like a snap shot of a natural thing.

3.5 Sound Recording studio

The place where especially designed for capturing and recording sound is commonly known as recording studio. Normally recording studio consists of two rooms such as; control room and studio room. All necessary recording machineries and sound manipulation devises (sound mixer, amplifiers, recorders *etc.*) are located in the control room and the control room is utilized for sound recording and manipulation process while musical instruments, microphones (with stands), notation stands…etc. are housed in the studio room and also this space is used for musicians to perform.

As far as the functional usages are concerned, modern recording studios are classified under four headings such as: Professional studios (especially for commercial purposes), Audio-for-visual production environments (film and other media purposes), Project studios[7] (these types of studios are designed for personal use. Where the functional usages are concerned, modern home recording studies are fall into "project studios". However, with the development of computer based music recording technology, the concept of home recording studies was emerged. Accordingly, the above mentioned principles and concepts began to vanish and bed rooms, garages and other room spaces are utilized for recordings) and portable studios used by journalists[8].

Similarly, recording studios are classified under the technology in which is utilized as: (1). Analog studios, (2). Semi digital studios and (3). Fully digital studios[9].

Before the concept of studio emerged, specific rooms, covered spaces and locations were especially prepared and utilized according to the suitability for recording. But with the gradual development of recording technology, sound studios are came in to existence and expanded according to audio acoustic architectural concepts and principles and also compatible with modern recording technologies.

3.6 Early Attempts to Record Sounds

By inquiring into the history of sound recording one can assume that scientists have been making many efforts to record sounds. It is reported that, in the 16th century, a natural scientist named *Giovanni Battista Della Porta* had done some experiments with recording and reproducing sounds using a tube. He thought that he would be able to listen to his own voice just after speaking to the tube and covering it immediately. But the effort he made did succeed[10].

Another attempt to record sound was made by a Swiss watch maker named Smooth Nikola in 1796. He had tried to record sounds through a machine called “Musical box”. But it too failed like the former one. This can be considered as the first devise or the first method of recording sounds in the history[11].

3.7 History of Mechanical Sound Recording

3.7.1 Phonautograph by Leon Scott.

Leon Scott of France was the first person to record live sounds. The device invented by him to record sounds was known as *Phonoautograph*. It was invented around 1855-56. This machine had a horn shaped devise that worked as a microphone in order to direct sounds towards the diaphragm placed at the end. The stylus was attached to the diaphragm used to scratch out a wave line on a revolving cylinder according to the wave length that is passing through the horn. To record the sound wave, the cylinder was layered with lampblack that may be applied by holding it over a flame to accumulate carbon. He has recorded “*Au Clair de La Lune Pierrot repondit…*” using *Phonoautgraph*. However, due to the lack of sensitivity, this device was not sufficient enough to properly reproduce the recorded sound. By using this device only a very short sound track less than one second could be recorded. Even though it was not successful as a sound playback technology, it had a good demand as a scientific research object[12].

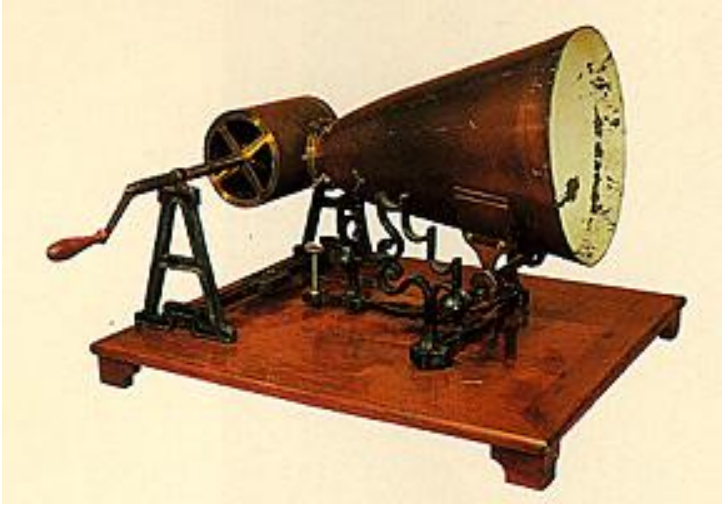

Figure 4: Phonoautograph of Leon Scott
(David Morton. Leon Scot's Phonoautograph - www.recording-history.org)

3.7.2 Graphophone by Alexander Graham Bell

More than two decades after the invention of *Phonautograph* by Leon Scott, in 1874, Alexander Graham Bell experimented on the ways of improving the aforementioned recording device in terms of a mechanism similar to the functional pattern of the human ear. Even though he started his research to develop his recording device *ear Phonautograph,* it was in 1886 that he was able to introduce the improved machine especially designed for dictation purposes. That instrument is now known as *Graphophone*[13]. He structured the entire machine in a similar manner to the ways in which the organs are positioned in the inner human ear. Like his contemporaries, he used cylindrical mediums for recording data as well. But the main deference between *phonautograph* and *graphophone* was the medium that was coated on the cylinder. Leon Scott coated the cylinder with lampblack whereas Bell used wax cylinders for his device. G*raphophone* was used for dictation purposes.

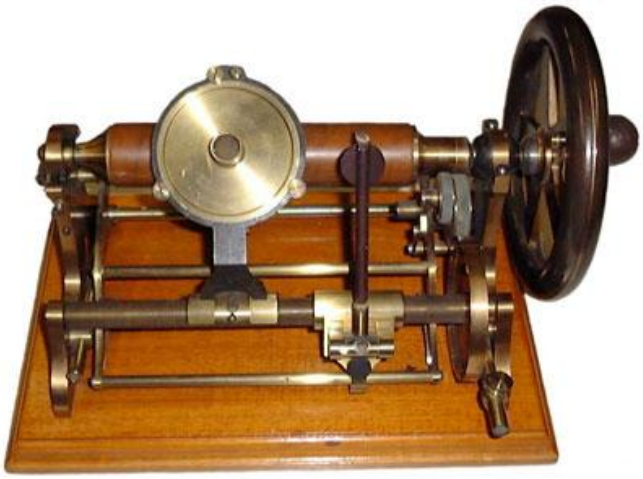

Figure 5: G*raphophone* of Alexander Graham Bell
(David Morton. Bell Graphophone - www.recording-history.org/HTML/phono_technology3.php)

3.7.3 Phonograph by Thomas Edison

In 1877, the well-known scientist Thomas Edison was able to discover a device for recording and playing back human voice for the first time in the world history. He had invented this device while he was experimenting with the ways of improving the telephone introduced by Alexander Graham Bell in 1876. This device is known as *Phonograph*. This is considered as the first ever recoding and play back machine in the world (it is reported that the principle which was applied to record sound on a soft material was first proposed by Jean Duhamel who was a French physician and mathematician)[14]. The recording medium was a "tin foil" which was wrapped around the cylinder; the cylinder was rotated via a hand crank during the recording and the playback. In this recording technology, he utilized the method of "vertical cut" (the "Vertical cut" is the early method that was used to cut recording discs by using stylus. This is also known as "Hill and dale" method. In this technology groves are cuts in varying depths on the disc and in the lateral cut recording the stylus that cuts side to side across a record)[15] to perform the recording on the tin foil[16]. He recorded and played back the short message "Mary had a little lamb" for the first time using Phonograph.

Even though the cylinder could produce adequate quality sound as a recording medium, the phonograph had a disadvantage of recording and reproduce music cylinders as in mass productions. That is the lack of a proper mechanism to record cylinders extensively. As a result, musicians, singers and instrumentalists faced many difficulties when recording the same music piece, because each one had to record individually in front of the recording horn to cut cylinders. Further, companies that manufactured cylinders had to face difficulties of sizes of the cylinders. The main differences of those cylinders were not similar to each other[17]. From *Phonoautograph to Graphophone* cylinders were employed as the recording medium. The main difficulty of using cylinders was duplication for the mass market. The solution was the disc recording technology.

Figure 6: Phonograph of Thomas Edison
(Tom Howe. *Thomas Edison Demonstrates the Cylinder Phonograph* (www.cedmagic.com/history/edison-cylinder-demo.html)

3.7.4 Gramophone by Emile Berliner

Disc recording technology was invented by Emile Berliner who was a German engineer immigrated to United States. He was able to overcome the notion of mass producing or the method of duplicating records to general public by inventing disc recording technology in 1887[18]. Contrary to the method of one by one recording procedure of Bell's cylinders, the newly invented disc recording technology of Berliner was able to easily produce thousands of copies by only one master disc. The term *phonograph* was not sufficient to refer to that devise. By that time, Edison had owned a patent for his device. Therefore, he called his machine *Gramophone*. Depending on the sound quality and higher range of volume, Gramophone was more popular among the public in the 1890s than both Phonograph of Edison and *Graphophone* of Bell. From its early days, the mediums of the discs were known as "recordings". These disc recordings were released to the mass market in differing recording speeds and different sizes. However, after 1912 all the records were played at the speed of 78 rpm (round-per- minute) as the slandered speed, but the sizes were generally between 10 inches (25 cm) and 12 inches (30 cm). The 78 rpm recording discs could produce only three and half minute time audio pieces (3.5 min)[19]. However, all the records until 1920s were basically recorded acoustically by using the method known as "Lateral cut" as opposed to Edison's "Vertical cut"[20] Even though in early days gramophone discs were originally manufactured in a hard, vulcanized variety of rubber known as ebonite, later these were produced by using the material called "Shellac" since the difficulty of pressing the material of ebonite[21]. However, some early recordings of Nicole Record Company were made of compressed cardboard with a reddish celluloid coating materials[22].

Figure 7: Gramophone of Emile Berliner
(Mary Bellis. *Picture of Gramophone*)
(http://inventors.about.com/od/gstartinventions/ss/gramophone.html)

3.8 Early Recordings Procedures

In earlier times, producing a recording cylinder or a disk was not an easy task at all. All entertainment based recordings were made in front of a recording horn. Sometimes, the recording horn of the phonograph or the gramophone was positioned in a neighboring room, with the recording horn poking through a window or a hole that was made especially for keeping the horn. Performers had to stand closer to the horn and had to play or sing very loudly to the recording horn. On the other hand, loud sounds also resulted in distortions and it affected the quality of the recording. However, there was no mechanism to avoid background noises and the distortions.

As mentioned the above, groups of singers crowding near the recording horn badly affected the instrument players and sometimes made difficulties to play properly and freely. Certain types of instruments such as pianos could not be used to record easily. Making such an earlier recording was not an easy task even for a well-trained and skilled

recording technician or a record artist. It was a delicate task or a function of him and he could tell the quality of the recording by seeing the way in which the recording session was going on. Not only that, some natural conditions such as humidity and air pressure also affected the quality of recordings[23].

With the invention of Vacuum Tube by Lee De forest, 1906 came as a year of great invention in the history of electronics. This invention has resulted in many electronic revolutions not only in the radio technology but also in the field of sounds recording[24]. As a result of the invention of Vacuum Tube, scientists could develop the method of electronic amplification which was available in the early periods of sound recording and reproduction with the uses of electronic microphones, amplification methods as well as electromagnetic disc recording devices. Consequently, aforementioned new technologies were adopted to cut master discs (For the first time, Western Electronic Company developed an electronic disc cutter in 1920 and experiments were done by Colombia Phonograph Company in 1924)[25]. The result of this was introducing high fidelity recording discs contrary to the quality of mechanically or acoustically recorded phonograph discs from 1924.

The next transitional phase in the history of recording industry was the introduction of "Long play" (LP) and "Extended play" (EP) discs into the field (Several materials such as; resin, plastic, Bakelite, were used to produce for EP and LP discs). The first long play (LP) microgrooves disc (33 1/3 rpm) were introduced by Colombia Phonograph Company in 1931 and in 1940, 45 rpm records were introduced by a Colombian in USA in 1948 and Seven inch 45 rpm was introduced by RCA Victor company in 1949 (But the first LP recording albums of LP and 45 rpm discs were issued by RCA Victor company respectively in 1950 and 1951 while they introduced their first stereo LP discs in 1958)[26].

3.9 History of Magnetic Sound Recording

3.9.1 Magnetic Recording

Due to some practical issues and certain technical reasons, scientists interested in sound recording were not satisfied with the previously invented recording technologies. As a result, they have attempted to find out new ways of advanced recoding technologies and devices other than the traditional Phonograph recording. Thus, it would not be incorrect to say that all the early recording devices originated as consequences of the development of telephone machineries.

As a consequence of the long procedure of the scientific research fundamental theories related to magnetism and electricity emerged within the time frame of 1820 to 1873. Magnetic Recording theory was invented by *Oberlin Smith* in 1888. But *Fenby* was generally referred to as the person who envisaged it in 1863[27]. In 1898, a telephone technician in Danish called *Valdermar Paulsen* was able to produce the first wire recording device with the aid of this theory. This was the first attempt made by a scientist to record sound on a steel wire as a practical form of "magnetic recording". Even though he failed in 1898 to obtain the patent for his invention he had obtained a patent for the prototype magnetic wire recording device known as "*Telegraphone*" around 1910[28]. The same method and process was followed by other inventers of "Recording sound on a tape" with certain modifications during 1950s.

Figure 8: Poulsen Telegraphone
(Tanya Robertson. *Poulsen Telegraphone*)
http://tanyarobertson.edublogs.org/files/2011/03/telegraphone-s5246s.gif)

According to the newly introduced knowledge, sounds were magnetically recorded on an ordinary steel wire (uncoated- which was known as *Piano wire* by *Poulsen* and his staff)[29]. In the initial stage, he tried to demonstrate that in the process of recording on a steel wire (using a short wire) it was wrapped around a metal cylinder which was hand-Cranked. That was a similar way of recording in the Edison's Phonograph. But in *Poulson's* machine, he used an electromagnetic "head" instead of stylus used in early times (especially in Phonographs) for recording and playing back sounds. The process used a microphone which generated electrical current, call the signal, corresponding to the pattern of sounds spoken to it. From the microphone the signal moved through a wire to a small electromagnet (recording head). That electromagnetic head would then radiate

a magnetic field that fluctuated rapidly, in synchronization with the incoming electrical signal. A piece of iron or steel that was held near the electromagnet would itself become magnetized, so *Poulsen* reasoned that by rapidly passing a long steel wire near the electromagnet, the wire would be magnetized along its length and would retain a record of the fluctuations[30]. Even though it produced a natural sound without any harsh effect, the volume was very low due to the lack of proper method for sound amplification. This technology of recording could be used to record sound, and to reproduce, and distribute speech. It also envisioned as a dictation machines in the same way it employed as a broadcast weather reports, home recorders as well as a broadcasting device as military massages[31]. Although the Patent of *Poulson's Telegraphone* was obtained by the "American *Telegraphone* Company" and sold these machines in 1905, it could not compete with the wax cylinder phonograph machines due to the fine and vociferate quality of sound.

After 1900 -1920s, a number of new firms interfered to produce recording devices and promote their business. During this period, *Curt Stille* had made improvements to develop the novel *Telegraphone* and other inventers have found ways to develop and invent some new devices. As a result, one scientist called *Karl Bauer* developed a machine called *Daily graph* around 1925. Daily graph was also a wire recorder with electronic amplifications. But it was a compact and properly designed machine that was especially used for office dictation purposes. It had the ability of recording messages directly from telephone lines. A removable cartridge was used in this machine as its recording medium. After several years, this device was modified by the telephone equipment manufacture ITT Company. The redesign *Daily graph* was called the *Textophone* in which was also a wire recorder employed as a telephone recorder in addition to dictation purposes[32].

Instead of recording sounds on a wire, methodology of recording sounds as an electrical audio signal on a paper tape or a celluloid tape was introduced by Fritz Pfleumber in 1928 using this technology. The German Company "*Allgemeine Elektrizitatsgesellschaft*" manufactured recording equipment named *Magnetophone* in 1930. Even though sound was recorded on a coated paper in its early ages in *Magnetophone*, the paper medium was transferred to a polyester magnetic tape medium in 1953. The sound quality of the *Magnetophone* was better than previously used devices such as wire recorders[33]. *Magnetophones* were really employed to record and broadcast war affiliated journalistic purposes during the World War II. However, these were especially used for music recordings. Models of HTS and K7 were two improved versions of machines which were available in 1945. In 1936, Sir Thomas Beecham and the Philharmonic Orchestra of London were invited to make some series of recordings during their European tour by *Allgemeine Elektricitats-Gesellschaft* (AEG). These were captured into tapes. However, because of the technological reasons, the quality of recording was not at a good level. However, they regularly tried to improve the quality of machines[34]. In that sense *Magnetophone* could be called the first reel-to-reel recording system in the 20th century.

Magnetic recording played an important role during the World War II due to the unique demands of the war time journalism. Consequently, many companies developed and introduced their new technologies and recording devices such as tape recorders during and after the war time. At that time, Germans and later British had made large number of tape recorders especially for varied purposes such as radio broadcasting, surveillance and dictation[35]. After sometimes magnetic recording became and played a leading role as a recording medium in the field of broadcasting as well as the standard for mastering music especially for Phonograph recordings. The medium of tape could be handled easily in remote locations in radio "spot" news reporting and recording. The medium of tape came in different types of formats such as: (1). Reel to reel, (2). Sound cartridge and (3). Cassettes that was introduced to mass market by Phillips in 1964.

Among these three mediums, "open reel to reel tape" was the predominant format of recording in early times and these came in different types of widths ranging 1/4" inches to 2' inch and also track formats ranging from 1/ 4 inch mono to discrete 32 track analog 2 inch tape[36]. In earlier times, these were used commonly for professional studio recordings. These open reel-to-reel tapes had the ability to handle easily while editing was in progress.

The sound cartridge system was initially introduced by RCA Victor (RCA) in 1958 as a storage medium especially as an easily transportable method. The tape was housed in a plastic cover measuring 5 x 7 1/8 x ½ inches. The width of the tape was 1/4 or 1 7/8 inches and the time duration was 60 minutes. All these cartridges were particularly used for dictation and other recording functions. After a few years, different types of cartridge formats entered market places for different purposes. These formats were: (1). Four track cartridge-1962 (2). *Orrtronics- Cousino* Audio-mate cartridge -1962 (3). Channel master cartridge -1964 and (4).Stereo eight track cartridge-1965. Among these, four track cartridges and Stereo eight track cartridges were specifically used for music recording. Some famous musicians released their songs using these mediums[37].

The medium of tape transformed the field of music and the culture of recording in a significant manner. The way or the process of recording resulted in many changes in this field. In early recordings such as mechanical, musicians had to alter according to the technology and it took a long time to record a song. The quality of the recording depended on the way in which it was recorded and the equipment that were used to record. With the introduction and the arrival of the new medium- the tape, the pattern of recording began to chance. The medium of tape could be easily handled than the disc medium both for recording and editing purpose.

The other specialty of handling tape is that it could be trimmed very easily in the editing process and two pieces of tapes with different recording on them could also be joined by splicing without any audible transition or degradation of the final product. In addition to that, using tapes for sound recording could make somewhat longer recordings than discs.

With such benefits the medium of tape became the slandered form of mastering music especially for phonograph recordings and in radio broadcasting[38]. In the next stage, multiple channel tape recordings led to the stereo revolution in the 1950s.

3.9.2 Technique of Splicing or Editing a Magnetic Tape.

The editing process of recorded tapes in this period was as creative as recording sounds. There were no highly developed tools for editing recorded sounds on a tape medium, whereas the only method which existed at that time was "tape splicing". This was completely a manual function similar to a physical surgery. Editing a tape or splicing allows a sound that occurred at one location in a recording to be moved to another fitting place in another location. However, there was a simple technique available to the recording technician to accomplish that task. Editing a tape using splicing technique was also considered as a different art. The process of editing followed three steps as follows;

1. Recording data on a tape,
2. Listening to the recorded tape and extracting sections of sound to be edited,
3. Cutting the proper location of the tape and spliced out as an edited version.

Equipment such as ruler, razor blade, splicing tape or glue and editing block or the splicing block were especially used for this task. Splicing block or the editing block is a rectangular strip that is made of aluminum to avoid magnetization of the bloc which may add noise to the tape. It has two slots: one is perpendicular cut and the other is diagonal cuts. Diagonal cut was extremely applied to the tape when the editing was being done, because it is much stronger than the perpendicular cut. However, some editors used different types of tape splicing techniques to combine tapes which generated different effects while playing the tape[39].

3.10 Multi-track Recording

The technology of multi-track recording marked an enormous chapter in the world recording industry as a creative tool and transformed the process of recording dramatically. Initially this also came under the magnetic recording in the recording medium. The multi-track recording was developed especially by audio engineers in Germany around 1940s[40]. The foremost multi-track feature was the stereophonic sound. In this process, tape was divided into multiple tracks simultaneously. Accordingly, instruments and vocal performances could be recorded individually on the tape and then it was possible to mix those separate tracks as the final production. Similarly, all the musicians did not need to be present at the same time. In comparison with the earlier recording process, they could record their individual music pieces separately at different times as per their convenience.

The next importance of this recording process was that it was possible to easily correct even a tiny mistake without re-recording the whole session unlike in the earlier phonograph recordings. As a result, music compositions became very complicated similar to other modern technological products. With regard to the newly introduced technological trend, music recording was not a basically improved version of studio performances as in the early stages. Music creator or the composer could construct a composition with the aid of a recording technician by adding some collection of components and could accumulate it as a complete and composite technological product.

As early as the 1940s, the well-known guitarist and the popular musician, Les Paul had installed an *Ampex* tape recorder which was able to record eight parallel multi-tracks on a two inchetape[41]. But this recording technique could only confer the recording from one monophonic tape recorder to another while playing along in real time. It had the facility of *"Sel-Sync"* which means that this circuitry allowed a recorded track to be played while a recording was being made on another track[42]. He also developed almost all the techniques and tricks which later became standards in multi-track sessions-headphone or

cue mixing, *Sel-sync* overdubbing, bouncing tracks, pre-laying effects and delays, and special varying speed operations[43].

In addition to the Les Paul's technique, the well-known commercial musician and the inventor of electronic instruments, Raymond Scott invented multi-track magnetic recording tape recorders in 1953. Accordingly, Scott's multi-track recording machine could record seven or fourteen parallel tracks on the same reel of tape. Moreover, in 1954 he has made a proto type eight –track recording machine and in 1955 Hugh Le Caine (1914-77) has invented a machine that could mix six separate tracks but synchronized tapes to one track[44] .

In the early and mid-1960s, two track (on standard 1/ 4" wide tape), three track (on 1/2" wide tape and four track) were well known among the popular musicians. By 1960s, all the famous music albums of popular groups such as *Beetles, Beach boys* were recorded in a creative way using multi- track recording facility.

However, with the popularity of multi-track recording, the 16 track, 24 track and 32 track recording machines are highly used today in the field of recording. Consequently, the multi-track recording was able to transform and revolutionize the recording industry considerably.

3.11 Digital Recording

As mentioned in the beginning of this chapter, the next revolutionary period of recording industry was the invention of the technique of digital recording. The sound or data are transformed into binary or numeric format while recording with the aid of an analog digital converter. In its initial stage, the system of digital recording has been subject to experimentation for recording television signals optically and reproducing them by scanning with the beam of light by Philips along with several other electrical firms in the 1970s. Initially, digitalized data were recorded on a reel to reel tape which was especially

manufactured for video recordings followed by Digital Audio Tape (DAT), whereas the DAT format was popularized only in studio workstations. However, the same principle of recording method could be successfully utilized to record audio data in digital audio form on a Compact disc. During the recording process, digitized audio data consists of electronic pulses that can be translated into pits of regular size of the disc and stored on the disc as pits. The principle of "Pulse Code Modulation" (PCM) was invented by Alec Reeves who was an English man in 1930s in 1967 the technical research Laboratory in Japan the NHK demonstrated an early studio-type digital tape recorder[45].

A few years after popularizing the digital based recording field, digital multi-track recording machines were produced for sound recording, especially for professional recordings and private and personal recording purposes. From its preliminary stages, video tapes were utilized as recording medium. A few years later, hard disc medium was introduced to the recording field as a method of recording medium rather than video tapes. In 1984, the first commercially available digitalized hard disc recording system was introduced by the British firm *AMS NEVE* Ltd.[46].

3.12 Computer-Based Recording

The use of computers has brought a revolutionary change in the field of recording system. Computer-based music technology originated in 1955 in America. However, the main purpose of using computers at that time was to compose music rather than to synthesize sound electronically. These tasks were mainly conducted by the composer Lejaren Hiller at the University of Illinois, in collaboration with Leonard Isaacson who was a mathematician at the slandered oil company. For their researches, they used an early mainframe computer *ILLIAC I* (Illinois Automatic Computer I) which was built in 1952. This computer was programmed by using codes punched onto Teletype paper tape. In 1962, he used IBM 7094 computer with software named ***MUSICOMP*****,** especially

developed for music. There were massive experiments with computer based music compositions were taking place in another places at that time[47].

In 1956, two computer engineers named Martin L. Klein and Douglas Bolitho used a computer called *Datatron* to automatically compose popular songs. In 1956, Max Mathews, a researcher at the Bell Laboratories, successfully demonstrated the computer generation of sound using a digital to analog converter (DAC) for the first time[48].

However, the development of computer technology made it interesting to develop electronically generated music synthesizing and composing music using the computer as a new "equipment". This resulted in developing computer-based music programming languages and methods for the direct synthesis of digital signals into audible sound. In 1957, Bell labs engineer, Max Mathews succeeded in programming a computer to synthesize a few notes of music. This is considered to be the first programming language written to generate sound directly from computer and was known as *MUSIC I*. This was followed by several improved versions MUSIC II (1958), MUSIC (1960). In addition to that, several composers and programmers developed new versions of the above mentioned programming languages and some newly improved languages such as *MUSIC N*, *MUSIC 360*, *MUSIC V* and *GROOVE*[49] .

Introducing MIDI (Musical instrument digital interface) technology in 1984 to compose, synthesize and record music with personal computers was a significant development in this field. Main features of MIDI were connecting and controlling synthesizers and linking computers to synthesizers. Similarly, analog instruments could be synthesized using this technology. As an advantage, the feature of MIDI is now employed in music recording composing and it helps obtaining musical data and sending from one place to another place while the instruments are being played or recorded. In the same way, this feature is normally used in multi-track recording[50].

The “Digital Audio Work Stations” (DAW) has been evolved recently years as a matured technology for synthesizing, recording, editing and playing back digital audio recordings while the data is directly stored in a hard disc medium. There are two types of Digital work Stations:

(1). Integrated Digital Work Stations
(2). Software-based Digital Work Stations

An integrated digital audio workstation consists of multifarious equipment such as mixing console, control surface, audio converter with a data storage device. Software based DAWs are mainly used with the computer. There are some major tools such as computer, sound card, compatible software and input devices for adding or modifying musical notes and monitors which are the essentialities of this system. Introducing software based DAWs highly popularized to integrated DAWs. Each and every software based DAWs has extensive MIDI recording, editing and play back capabilities[51].

In addition to that, technology and the recording equipment are now being transferred to human palms. These types of small and handy smart phone based digital work stations are known as Mobile Audio Workstations (MAWs). Among them, KDJ one mobile audio work station (See illustrations) is especially manufactured for both professional as well as for small scale recordings. It consists of all necessary features such as advance syntheses effects, sample manipulation and audio recording capabilities as tools that are relevant to a professional recording. Similarly, external Midi keyboard and microphones can be connected to the work station through standard jacks[52]. Some MAWs are greatly used by journalists and other researchers to record interviews and small scale music productions in addition to the above mentioned tools.

Whatever the nature of the technology would be, it can clearly be seen that the multi-track recording has been promoted as a qualitative, effective and creative method of

sound recording in these decades. Comparatively, computer based music recording has been influential in transforming the music recording culture as well. Function of musicians and the service of instrumentalists are not essential issues in this technology when creating a music composition than in previous recordings. There are various types of sound and rhythm samples, playing patterns of instruments and music effects which have been stored in modern Software and, music composers or producers can use them as per their wishes rather than obtaining the service of other instrumentalists. As a result, no live recording is needed in many cases. However, for mass productions, these types of practices can largely be seen in small scale home recording productions all over the world.

3.13 The Technological Background of Recording Sounds for Films

Adding sound effects to motion pictures is a different field which has a very long history, especially when compared to the historical evolution of "films" in general. None of the movies produced until 1927 contained sound effects due to the lack of a proper technology to embed sounds on motion pictures. As a result, the period was known as the “Silent era of films”. As a result, music was provided by musicians using “cinema organs” staying at the orchestra pit to avoid hash sounds effects that were emitted from machines as well as to fill the emptiness of situation. In some occasions, music was effectively utilized to give a functional emotion to the visualized action.

Various technologies were introduced by scientists in order to incorporate or to embed sounds into films to overcome such limitations in that era. The initial trends in this regard may be summed-up under three broad headings such as:

1. Mechanical sound recording
2. Photographic Sound recording and
3. Magnetic sound recording[53].

3.13.1 Mechanical Sound Recording

As a result, of the Mechanical sound recording principle, a variety of methods were introduced by synchronizing discs under different names implementing with some technological modifications by several inventers. Some of the noteworthy inventions are;

1. Kinetopscope by Edison in 1895
2. Chronophone by Leon Gaumaut in 1902
3. Camaraphone by E.E. Norton in and
4. Vitaphone by Warner Brothers in 1925

Edison's manufacturing company demonstrated the very first prototype moving image device *"Kinetoscope"* that was merely a "peep show" machine. A cylinder phonograph was synchronized with this machinery of which the sole purpose was to provide musical accompaniments to peep show. Even though this endeavor was unsuccessful as a commercial product, in later times, he has introduced a far developed version of this machine as *Kinetophone* in 1913 with maximum mechanical amplification along with image projection[54]. But it was far difficult to keep them synchronized sound and motion picture in a proper manner[55].

In the meantime, Leon Gaumont introduced his *Chronophone* in 1902. A single projector and two phonographs were attached to this machine by means if a series of single cables. A dial modification synchronized the motion picture and phonograph. He has filmed a variety of entertainments employing this synchronization technology. However, a developed version of this machine was introduced to the filed in 1907. That was utilized for Opera recitations and certain other dramatic programs. However, it was not promoted and popularized especially due to the issues of amplification and the higher instillation expenses[56].

The machine called *Camaraphone* was invented by E. E. Norton who was a former mechanical engineer of the American Gramophone Company. However, he had also to confront with common limitations and deficits such as the low level amplification, horrific synchronization and installation expenses. As a result, this method too was not succeeded[57].

As a developed method, only the *"Vitaphone"* introduced by Warner Brothers Company in collaboration with Western Electric was able to synchronize motion picture with disc sounds accurately. Accordingly, the dialogs, sounds and musical performances that belonged to films were recorded on discs. Subsequently, those discs were played with the synchronizing machines that were placed just beside the film projector. In order to obtain the proper sound quality, the 33 1/3 rpm EP discs were used to record the sound effects by using electrified recording techniques with wider frequency ranges. Later, the 45 rpm LP discs were applied[58]. The first film which was screened by using this technology was "Don Juan" (1926) of John Barrymore's though the "Jazz singer" that was screened in 1927 is considered as the world's first taking film. The former film became a hit at that time. However, the *Vitaphone* technology began to wane with the introduction of optical sounds on film strips.

3.13.2 Photographic Sound Recording

This method is also known as "optical sound" recording which was introduced by Lee De Forest in 1923 using the *Phonofilm* system. The technology of photographic sound was based on the method of sound on film instead of the use of discs[59]. Accordingly, the voice tracks were "photographed" into the films. Similarly, Lee De Forest's early invention "*Audion Tube"* was also resulted for the amplification of this device. According to this process, the sound waves were transformed into light waves and the light waves were then exposed to the sound negatives. This photographic imprint could be then condensed

or freezed and transferred to the picture track where it is printed as a sound strip and runs in continuous synchronization with the picture[60]. Likewise, the film is transferred to the projector, enabling the sound track to be decoded while the picture is moving on screen. This projector not only has a picture gate, but it also has a built-in sound gate. When the track goes through the sound gate, a fluctuation is caused in a beam of light and is fallen upon a photo-electric cell. These fluctuations are again transferred into sound waves through electrical pulses. Such sound waves are deployed to the audience by means of loud speakers. This system was introduced to the film industry in the 1930s by Fox's *Movietone* and RCA's *Phonophone*[61].

3.13.3 Magnetic Sound Recording

According to the nature of recording, both magnetic and optical sound recording methods are somewhat alike but the magnetic sound recording is considered to be better than the optical methods with regard to sound fidelity. In this mechanism, the sound waves input from a microphone imprint a recording upon the magnetized Ferrous Oxide surface of an acetate tape. Once the editing process is completed, the voice track is mixed relative to the picture[62].

As far as the abovementioned technologies are concerned, the magnetic recording method was accepted as the primary and most practical recording method since the 1950s. Similarly, sounds could be re-recorded without any degradation. On the other hand, with the development of mixing and other technological facilities, a different kind of "depth" was given to the picture by utilizing voices, music and other sound effects in effective ways. The introduction of *Cinemascope* in 1953 made it possible to engraft for fully synchronized magnetic tracks upon the print itself[63].

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[3] Morton, *Sound Recording; The life story of a technology*, xiv.

[4] Vishal, *Contribution of Audio- Visual Recording Studio for Promoting Indian Music*, 110-112.

[5] Ibid.,112-113.

[6] Hosken, *An Introduction to Music Technology*,128.

[7] Huber and E. Robert Runstein, *Modern Recording techniques*, 8-9.

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[16] Frayne, *History of Disc Recording. Audio Engineering*, 263.

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[19] Morton, *Sound Recording; The life story of a technology*, 36-41.

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[22] Kinner, *Gramophone companies first Indian* recordings. 21.

[23] Morton, *Sound Recording; The life story of a technology*, 26.

[24] Chanan, *Repeated Takes; A short history of recording and its effects on music*,38 ; Holmes, *Electronic and Experimental Music technology, music and culture*, 34.

[25] Morton, *Electrical Recordings*.

[26] Chanan, *Repeated Takes; A short history of recording and its effects on music*, 93; David L. Morton, *Sound Recording; The life story of a technology*, Xiv.

[27] Chanan, *Repeated Takes; A short history of recording and its effects on music*, 37

[28] Morton, *Sound Recording; The life story of a Technology*, 50-51.

[29] *Wire Recorders.*

[30] Morton, *Sound Recording; The life story of a technology*, 50.

[31] Holmes, *Electronic and Experimental Music technology, music and culture*, 34-35.

[32] Morton, *Sound Recording; The life story of a Technology*, 112.

[33] Holmes, *Electronic and Experimental Music technology, music and culture*, 35.

[34] Morton, *Sound Recording; The life story of a Technology*, 114-115.

[35] Ibid., 115-116.

[36] *Open reel to reel*.

[37] *Open reel to reel*.

[38] Morton, *Sound Recording; The life story of a Technology*, 144-145.

[39] Holms, *Electronic and Experimental Music technology, music and culture*, 124-126.

[40] Morton, *Sound Recording; The life story of a Technology*, 148.

[41] Holmes, *Electronic and Experimental Music technology, music and culture*, 163.

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[44] Holmes, *Electronic and Experimental Music Technology, Music and Culture*, 163.

[45] Morton, *Sound Recording; The life story of a Technology*, 170-172.

[46] Holms, *Electronic and Experimental Music Technology, Music and Culture*, 287.

[47] Ibid., 251-254.

[48] Ibid., 100-101.

[49] Ibid., 253 -254.

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[55] Morton, *Sound Recording; The life story of a Technology*, 71-72.

[56] Gomery, *The coming of Sound: Technological change in the American Film industry*, 54.

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[58] Morton, *Sound Recording; The life story of a Technology*, 74.

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[62] Scott, *Film: The medium and the maker*, 122-123.

[63] Ibid., 147.