INTRODUCTION OF MEDIA
Electronic aids to music have been a major component of the Western educational process for many years. However the application of high technology has only recently begun in India. Today there is an environment which is ripe for the spread of electronics into the field of music and music education. Applications as diverse as desktop publishing, electronically assisted education (audio/video cassettes), radio and TV programs and a host of electronic gadgets have already entered the field of music.

3.1 **HISTORICAL BACKGROUND OF MEDIA**

We can appreciate the present situation by having a firm understanding of the development of both Indian music and the Indian electronics industry. The music of India is an ancient system which is quite different. Furthermore the pedagogic process is essentially an apprenticeship. All of this must be seen so that we can appreciate the application of modern technology by India's indigenous electronics industry.

This highly developed system requires many years of formal training. This is in the form of an apprenticeship. For many millennia the craft has been passed from teacher to disciple in a process known as guru-shishya-parampara. Although this is still considered the traditional mode of education, in practice the student receives a large amount of information through the electronic media. A clear picture of this media can be seen by looking at the rise of high technology in the country.

The development of India's electronic and technological infrastructure is interesting. This allowed India to develop an indigenous electronics industry which was unconnected to the world markets. Although this industry was never able to come up to world standards, it did create an environment in which indigenous approaches could be developed for purely Indian musical needs.

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52 chandrakantha.com/articles/electronic.../el_aids_music_ed.html
Before we look at these devices which are relevant only to Indian music let us first look at the power of traditional analog approaches. Established analog technologies already have shown profound effect on the system of education. Analog technologies are commonly used in radio, TV, and tape recorders. Until recently the only radio and TV in India were the government owned "Akashavani", otherwise known as "All India radio" and "Dooradarshan" (TV). The government has a sustained interest in promoting traditional Indian music. One of the efforts has been occasional broadcasts of educational programs on Indian music.

Some of the most significant effects have been from the "National Programs". These are performances given by India's top artists which are aired all over the country. An artist may perform something on national TV and within a week, other musicians around the country are doing similar things. What makes this so important is that it introduces a fundamental change in the way musical information is transferred. Previously the only process for transmission of musical material has been from guru to disciple. This is a vertical flow of information known as "Taleem". The use of the electronic media creates a horizontal flow of information which cuts across traditional pedagogic lines.

We may summarize the history of electronics and Indian music quite simply. The music of India is an ancient modal form that is fundamentally different from the Occidental system. For thousands of years the musical material traveled along a simple linear path from teacher to disciple. Cross linkages were rare until relatively recently. The major increase in this horizontal flow of musical information began with the advent of the electronic media. The development of an indigenous electronics industry, essentially cut off from the larger world markets, has had interesting effects on musical electronics.

53 chandrakantha.com/articles/electronic.../el_aids_music_ed.html
3.2 **MICROPHONES**

A microphone is a device for converting acoustic power into electric power that has essentially similar wave characteristics. Microphones convert sound waves into electrical voltages that are eventually converted back into sound waves through speakers. They were first used with early telephones and then radio transmitters. Microphones started with the first articulate telephone transmitter, developed almost simultaneously by Elisha Gray and Alexander Graham Bell\(^\text{54}\). This was the liquid transmitter of 1876. This transmitter would be classified as a variable-resistance device. In 1876, Emile Berliner invented the first microphone used as a telephone voice transmitter. In 1878, the carbon microphone was invented by David Edward Hughes, and later developed during the 1920s. Hughes's microphone was the early model for the various carbon microphones now in use.

With the invention of the radio, new broadcasting microphones were created. The ribbon microphone was invented in 1942 for radio broadcasting. In 1964, Bell Laboratories received patent for the electro-acoustic transducer, an electret microphone. The electret microphone offered greater reliability, higher precision, lower cost, and a smaller size. It revolutionized the microphone industry, with almost one billion manufactured each year. During the 1970’s, dynamic and condenser microphones were developed, allowing for a lower sound level sensitivity and a clearer sound recording.

Microphones are transducers that produce an electrical image of the sound, i.e., they produce a voltage or a current which is proportional to the sound signal. The most common microphones for musical use are dynamic, ribbon, or condenser microphones. Besides the variety of basic mechanisms, microphones can be designed with different directional patterns and different impedances. The design is very simple. It comprises of a thin membrane which vibrates in response to sound pressure. This movement is subsequently translated into an electrical signal. Most microphones in use today for audio use electromagnetic induction (dynamic microphone), capacitance change (condenser microphone, pictured right), piezoelectric generation, or light modulation to produce the signal from mechanical vibration.

DIFFERENT TYPES OF MICROPHONES

55 inventors.about.com/od/infostartinventions/a/microphone.htm
3.2.1 **History:** Wireless telegraphy had been invented in 1895 by Nikola Tesla\(^\text{56}\). The telephone transmitter was the only available microphone in 1900. Consequently, it was used in early radio modulation experiments. Since telephone transmitters could handle a maximum of only about one-half ampere, only very low-power radio transmitters could use this form of microphone. As radio power was increased, new forms of microphones had to be developed.

One of the first alternatives was to use multiple microphones with a common mouthpiece. Multiple microphones had their various problems, one of which was that short circuit in one microphone would render the whole group inoperative.

Back in 1879 and 1881, Edison and Dolbear had introduced condenser transmitters\(^\text{57}\). They were not practical at the time for telephone use, but now, with the search for high-power microphones, they were reintroduced. As early as 1900, Fessenden had transmitted and received intelligible speech at a distance of one mile\(^\text{58}\). By 1906 he had built a high-power radio transmitter and two microphones to match that could handle up to 15 amperes of current without burning up. One was a condenser type. The other was a water-cooled carbon granule type he called his "trough transmitter". J. Berliner made a high-current carbon microphone that was air cooled by a fan mounted under the microphone, and an adjustable stand to go with it.

The Bell System improved the vacuum tube and developed circuitry for not only repeaters but also amplifiers and radio\(^\text{59}\). World War I created immediate demands for improved communications. Vacuum tubes not only helped meet these demands, but also put the microphone back into a simple circuit that no


\(^\text{57}\) tenwatts.blogspot.com/2006_12_01_archive.html

\(^\text{58}\) [www.hammondmuseumofradio.org/Fessenden-bio.html](http://www.hammondmuseumofradio.org/Fessenden-bio.html)

\(^\text{59}\) [users.belgacom.net/gc391665/microphone_history.htm](http://users.belgacom.net/gc391665/microphone_history.htm)
longer required bulky, complex, high-current designs. Standard telephone transmitters could be used again, regardless of the radio transmitter power.

Western Electric developed specific microphones to be used with their SCR-68 Army aircraft radio transmitter. This was an early form of noise-cancelling or "close talking" microphone. The Magnavox Company produced a noise-cancelling microphone for the Navy to be used aboard its "mammoth NC planes"\(^{60}\). This same microphone was supplied to General Electric with a spray shield cover.

### 3.3 Public Address Systems

Around 1915, Western Electric supplied a very simple "loudspeaking outfit" under two names, "Shawphone" and "Chau-Phone". The Shawphone was used for very small paging applications, while the Chauphone was for chauffeur-driven cars. Both used the 318W hand microphone with a 182 horn and a six-volt battery. After World War I, the radio industry grew by leaps and bounds. Radio amateurs were introducing the public to radio. Companies like Magnavox and Western Electric were introducing the populace to "public-address systems", or sound-reinforcement systems as we know them today.

Magnavox, had developed a good horn-type speaker and some small amplifiers\(^{61}\). Their experience during the war with special microphones gave them the expertise to manufacture a telephone for noisy areas. They also produced a sound system called "Telemegaphone". This was a complete system consisting of a large 18-inch horn speaker, a control box, a six-tube amplifier, and a model ST-4 four-button carbon microphone. This system, plus an additional horn, was used to broadcast President Wilson’s speech to 50,000 people assembled in the San Diego Stadium in 1919.

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\(^{60}\) users.belgacom.net/gc391665/microphone_history.htm

\(^{61}\) users.belgacom.net/gc391665/microphone_history.htm
Western Electric had been experimenting with "loud-speaking" systems since 1907. In 1912, they developed a high-efficiency transmitter and horn-type speaker to be used between the test desk and the frame room of a telephone central office to expedite servicing. The microphone used evolved into the No 360BW transmitter with a 4A horn attached. A few other special public-address experiments were performed. One, in particular, used a water-cooled carbon microphone to transmit speech 120 miles over 12-gauge wire to loudspeakers addressing a group of 300 people. Three very large public-address setups were used by the Bell System using Western Electric equipment for addressing a very large number of people. The first & second event used a new-type double-button carbon microphone and the third event used the condenser microphone that the Bell system was using in its acoustic research program.

Radio amateurs in the late Teens were becoming entertainers. Some of the more experienced and knowledgeable amateurs were playing records and using microphones with their rigs. This made radio more popular, and the general public was looking for receivers to get in on this new phenomenon. So the year 1920 ushered in the commercial broadcast era. Since now, there were advanced tube-type circuits; microphones reverted to the simple single-button carbon types that were plentiful in the telephone industry.

The early radio station used the candlestick telephone for a microphone. The typical transmitter element at this time was the Western Electric No 323. At first it was used as-is, talking into it as one would use a telephone. With the receiver off-hook, the speaker was on the air. As time passed, the receiver was removed, along with the hook switch and contacts, leaving the microphone "on" at all times. In this case the volume and on-off function were controlled by the engineer. In some applications the short mouthpiece was replaced with a brass

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62 en.wikipedia.org/wiki/Telegraphy
63 ezinearticles.com/?History,-Growth-And...Of-Modern...
megaphone six inches long. This allowed the announcer or performer to work at greater distances from the microphone.

The next step was to provide entertainers with a microphone that would allow them to stand and perform. For this application, the constructor took the transmitter of the candlestick telephone, replaced the short mouthpiece with the megaphone, slid this combination into a felt-lined bakelite sleeve about eight inches long, and put small eyebolts on each end to suspend it from above.

3.4 **AMPLIFIER**

![Diagram of how amplifiers work]

The basic concept of an amplifier: A smaller current is used to modify a larger current.

Generally, an **amplifier** or simply **amp**, is any device that changes, usually increases, the amplitude of a signal. The "signal" is usually voltage or current. The relationship of the input to the output of an amplifier — usually expressed as a function of the input frequency — is called the transfer function of the amplifier, and the magnitude of the transfer function is termed the gain.

The amplifier generates a completely new output signal based on the input signal. You can understand these signals as two separate circuits. The **output**
circuit is generated by the amplifier's **power supply**, which draws energy from a battery or power outlet. If the amplifier is powered by household alternating current, where the flow of charge changes directions, the power supply will convert it into direct current, where the charge always flows in the same direction. The power supply also **smoothes** out the current to generate an absolutely even, uninterrupted signal. The output circuit's **load** (the work it does) is moving the speaker cone.

The **input circuit** is the electrical audio signal recorded on tape or running in from a microphone. Its load is modifying the output circuit. It applies a **varying resistance** to the output circuit to re-create the voltage fluctuations of the original audio signal. In popular use, the term usually refers to an electronic amplifier, often as in audio applications to operate a loudspeaker that is being used in a PA system to make the human voice louder or play recorded music.

The term "power amplifier" is a relative term with respect to the amount of power delivered to the load and/or sourced by the supply circuit. In general a power amplifier is designated as the last amplifier in a transmission chain (the **output stage**) and is the amplifier stage that typically requires most attention to power efficiency. The essential role of the transistor amplifier is to magnify an input signal to yield a significantly larger output signal. The amount of magnification (the "forward gain") is determined by the external circuit design as well as the active device. Applications are numerous, some common examples are audio amplifiers in a home stereo or PA system, RF high power generation for semiconductor equipment, to RF and Microwave applications such as radio transmitters.

In most amplifiers, this load is too much work for the original audio signal. For this reason, the signal is first boosted by a **pre-amplifier**, which sends a stronger output signal to the **power amplifier**. The pre-amplifier works the
same basic way as the amplifier: The input circuit applies varying resistance to an output circuit generated by the power supply. Some amplifier systems use several pre-amplifiers to gradually build up to a high-voltage output signal.

3.5 **ALL INDIA RADIO (AIR) & DOORDARSHAN**

Sound broadcasting started in India in 1927 with the proliferation of private radio clubs\(^{64}\). The operations of All India Radio began formally in 1936, as a government organisation, with clear objectives to inform, educate and entertain the masses. When India attained Independence in 1947, AIR had a network of six stations and a complement of 18 transmitters. The coverage was 2.5% of the area and just 11% of the population. Rapid expansion of the network took place post Independence.

AIR today has a network of 232 broadcasting centres with 149 medium frequency (MW), 54 high frequency (SW) and 171 FM transmitters. The coverage is 91.79% of the area, serving 99.14% of the people in the largest democracy of the world. AIR covers 24 Languages and 146 dialects in home services. In External services, it covers 27 languages; 17 national and 10 foreign languages.

All India Radio, officially known as Akashvani is the radio broadcaster of India and a division of Prasar Bharati (Broadcasting Corporation of India), an autonomous corporation of the Ministry of Information and Broadcasting, Government of India. Established in 1936, today, it is the sister service of Prasar Bharati’s Doordarshan, the national television broadcaster. All India Radio is one of the largest radio networks in the world. The headquarters is at the Akashwani Bhavan, New Delhi. Akashwani Bhavan houses the drama section, the FM section and the National service. The Doordarshan Kendra (Delhi) is also located on the 6\(^{th}\) floor of Akashvani Bhavan.

\(^{64}\) Sound broadcasting started in India in 1927 with the proliferation of private radio clubs.
The **Doordarshan** is the public television broadcaster of India. It is one of the largest broadcasting organizations in the world in terms of the infrastructure of studios and transmitters. Recently, it has also started Digital Terrestrial Transmitters. On September 15th 2009, Doordarshan celebrated its 50th anniversary.

Doordarshan had a modest beginning with the experimental telecast starting in Delhi on 15 September 1959 with a small transmitter and a makeshift studio. The regular daily transmission started in 1965 as a part of All India Radio. Up until 1975, only seven Indian cities had a television service and Doordarshan remained the sole provider of television in India. Television services were separated from radio in 1976. Each office of All India Radio and Doordarshan were placed under the management of two separate Director Generals in New Delhi. National telecasts were introduced in 1982.

With the introduction of All India Radio & Doordarshan, carnatic music along with folk music and other entertainment along with the News, entered the common households. Now everyone could hear good music in the privacy & luxury of his home. The quality of transmission was very good and music became part of the common man’s life.

AIR & DD are important agents of publicity & public relations. They give wide coverage to moral, cultural, spiritual, social & educational features and music is being used as a suitable vehicle to convey the messages to the common man. AIR begins the day with devotional music. All religions are represented. Choir, choral music & group singing in many languages are becoming popular & innovations and new methods adopted in vocal and instrumental music are proofs of fresh experiments. Music with deep rooted traditions as well as with modern adaptations are broadcast. Folk music as well as classical dance music is also broadcast.
Music lessons broadcast by AIR falls within the reach of many interested in learning the pieces. Rare compositions are brought to light & biographies of composers, musical quiz and references to lakshana granthes provide enough material for a student of music to improve his knowledge. Musical features as opera presentations and musical discourses as ‘Kaalakshebham’s’ give an insight into the nature and structure of them and enable one to know of the ragas & tunes used to illustrate different emotions. The concerts is a boon, especially the RTP because it is a guide to those interested in cultivating creative music, especially to present the raga image correctly and to improvise swara groupings. Programs of layavinyaasam can be treated as classes in tala.

In doordarshan, we have the extra advantage of visual publicity to the art and the artists. When one is ‘face to face’ with the musician, the enjoyment is more. The tala rendition can be watched better. The instrumentalists’ style of playing, special techniques used by them all can be watched & compared to other musicians’ techniques for a better understanding. Thus the Rasio & Television established a great link between the public & musicians, giving them great publicity & popularity.

The tea shops, often the center of entertainment where people used to gather to chat, also started having the radio and played music. Here mostly devotional music which was semi carnatic and light music was popular because Akashavani’s carnatic music timings were generally late night.

### 3.6 Studio Recording

In the era of acoustical recordings (prior to the introduction of microphones, electrical recording and amplification), the earliest recording studios had very basic facilities, being essentially soundproof rooms that isolated the performers from outside noise. During this era it was not uncommon for recordings to be
made in any available location, such as a zamindar’s hall using portable acoustic recording equipment.

In this period, master recordings were made using a direct-to-disc cutting process. Performers were typically grouped around a large acoustic horn (an enlarged version of the familiar phonograph horn). The acoustic energy from the voices and/or instruments was channeled through the horn's diaphragm to a mechanical cutting lathe located in the next room, which inscribed the signal as a modulated groove directly onto the surface of the master cylinder or disc.

Following the invention and commercial introduction of the microphone, the electronic amplifier, the mixing desk and the loudspeaker, the recording industry gradually converted to electric recording, and by 1925 this technology had replaced mechanical acoustic recording methods for such major labels as RCA Victor and Columbia, and by 1933 acoustic recording was completely disused.

Electrical recording was common by the early 1930s, and mastering lathes were now electrically powered, but master recordings still had to be cut direct-to-disc. Studios in this period were primarily designed for the live recording of symphony orchestras and other large instrumental ensembles. Engineers soon found that large, reverberant spaces like concert halls created a vibrant acoustic signature that greatly enhanced the sound of the recording, and in this period large, acoustically "live" halls were favored, rather than the acoustically "dead" booths and studio rooms that became common after the 1960s.

Because of the limits of the recording technology, studios of the mid-20th century were designed around the concept of grouping musicians and singers,
rather than separating them, and placing the performers and the microphones strategically to capture the complex acoustic and harmonic interplay that emerged during the performance. Modern sound stages still sometimes use this approach for large film scoring projects today.

Electric recording studios in the mid-20th century often lacked isolation booths, baffles, and sometimes even speakers, and it was not until the 1960s, with the introduction of the high-fidelity headphones that it became common practice for performers to use headsets to monitor their performance during recording and listen to playbacks.  

It was difficult to isolate all the performers -- a major reason that this practice was not used was simply because recordings were usually made as live ensemble 'takes' and all the performers needed to be able to see each other and the ensemble leader while playing. The recording engineers who trained in this period learned to take advantage of the complex acoustic effects that could be created through "leakage" between different microphones and groups of instruments, and these technicians became extremely skilled at capturing the unique acoustic properties of their studios and the musicians in performance.

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68 Recording Studio Design - by Philip Richard Newell
69 Studio Acoustics - ~Michael Rettinger
The use of different kinds of microphones and their placement around the studio was a crucial part of the recording process, and particular brands of microphone were used by engineers for their specific audio characteristics. The smooth-toned ribbon microphone developed by the RCA company in the 1930s and the famous Neumann U47 condenser microphone were some of the most widely used from the 1950s. These models are still widely regarded by audio professionals as some of the best microphones ever made. Learning the correct placement of microphones was a major part of the training of young engineers, and many became extremely skilled in this craft. Well into the 1960s, in the classical field it was not uncommon for engineers to make high-quality orchestral recordings using only one or two microphones suspended above the orchestra.

In the 1960s, engineers began experimenting with placing microphones much closer to instruments than had previously been the norm. The unique sonic characteristics of the major studios imparted a special character to many of the most famous popular recordings of the 1950s and 1960s, and the recording companies jealously guarded these facilities. There were several other features of studios in this period that contributed to their unique "sonic signatures".

Special equipment was another notable feature of the "classic" recording studio. The biggest studios were owned and operated by large media companies like RCA, Columbia and EMI, who typically had their own electronics research and development divisions that designed and built custom-made recording equipment and mixing consoles for their studios. Likewise, the smaller independent studios were often owned by skilled electronics engineers who designed and built their own desks and other equipment.

70 Recording Studio Design - by Philip Richard Newell
During the 1950s and 1960s the sound of recordings was further defined by the introduction of proprietary sound processing devices such as equalizers and compressors, which were manufactured by specialist electronics companies. With the introduction of multi-track recording, it became possible to record instruments and singers separately and at different times on different tracks on tape, although it was not until the 1970s that the large recording companies began to adopt this practice widely, and throughout the Sixties many classics were still recorded live in a single take.\(^{71}\)

In the mid 20th century, recordings were analog, made on ¼” or ½” magnetic tape, with multitrack recording reaching 8 tracks in the 1950s, 16 in 1968, and 32 in the 1970s. Such tape is the 2” analog, capable of containing up to 24 individual tracks. Generally, after an audio mix is set up on a 24-track tape machine, the signal is played back and sent to a different machine, which records the combined signals to a ½” 2-track stereo tape, called a *master*.\(^{72}\)

Before digital recording, the total number of available tracks onto which one could record was measured in multiples of 24, based on the number of 24-track tape machines being used. Most recording studios now use digital recording equipment, which limits the number of available tracks only on the basis of the mixing console's or computer hardware interface's capacity.

Analog tape machines are still well sought, for some purists label digitally recorded audio as sounding too harsh, and the scarcity and age of analog tape machines greatly increases their value, as does the fact that many audio engineers still insist on recording only to analog tape. This harshness is incorrectly attributed by some of them to the belief that digital recording will sample a sound wave many times per second allowing an illusion of solid sound.

\(^{71}\) *Studio Acoustics* - ~Michael Rettinger  
\(^{72}\) *Music, Physics and Engineering* - by Harry F. Olson
waves to be created, where in contrast analog tape captures a sound wave in its entirety\textsuperscript{73}.

However, others simply argue that the lack of high frequency noise and the higher fidelity of the digital medium make the recorded higher frequencies more prominent, which results in such perceived harshness in contrast to analog recording. Still others point to problems of early digital recordings caused by the inexperience of sound engineers with the new medium as the cause for critics to the digital systems. Finally, another possibly relevant effect derives from the fact that, since CD-quality audio uses a sampling rate of 44.1 kHz, no frequencies above the Nyquist frequency of 22050 Hz are acceptable for recording\textsuperscript{74}.

Radio studios are very similar to recording studios, particularly in the case of production studios which are not normally used on-air. This type of studio would normally have all of the same equipment that any other audio recording studio would have, particularly if it is at a large station, or at a combined facility that houses a station group. Additional outside audio connections are required for the studio/transmitter link for over-the-air stations, satellite dishes for sending and receiving shows, and for webcasting or podcasting.

### 3.7 **Sound Recording and Reproduction**

It is the electrical or mechanical inscription and re-creation of sound waves, such as spoken voice, singing, instrumental music, or sound effects. The two main classes of sound recording technology are analog recording and digital recording. Acoustic analog recording is achieved by a small microphone diaphragm that can detect changes in atmospheric pressure (acoustic sound waves) and record them as graphic sound waves on a medium such as a

\textsuperscript{73} Principles of Digital Audio - by Ken C. Pohlmann

\textsuperscript{74} Recording Studio Design - by Philip Richard Newell
phonograph (in which a stylus senses grooves on a record) or magnetic tape (in which electrical current waves from the microphones are converted to electromagnetic fluctuation (flux) that modulate an electric signal.\textsuperscript{75}

Analog sound reproduction is the reverse process, with a bigger loudspeaker diaphragm causing changes to atmospheric pressure to form acoustic sound waves. Electronically generated sound waves may also be recorded directly from devices such as an electric guitar pickup or a synthesizer, without the use of acoustics in the recording process other than the need for musicians to hear how well they are playing during recording sessions.

Digital recording and reproduction uses the same analog technologies, with the added digitization of the sonographic data and signal, allowing it to be stored and transmitted on a wider variety of media. The digital binary numeric data is a representation of the periodic vector points in the raw analog data at a sample rate most often too frequent for the human ear to distinguish differences in quality. Digital recordings are not necessarily at a higher sample rate, but are often considered higher quality because of less interference from dust or electromagnetic interference in playback and less mechanical deterioration from corrosion or mishandling the storage medium. A digital audio signal (when converted) resembles an analog signal, unlike a pure binary digital signal which would only be perceived as a buzzing noise by the human ear.

After the Edison phonograph itself, arguably the most significant advances in sound recording were the electronic systems invented by two American scientists between 1900 and 1924\textsuperscript{76}. In 1906 Lee De Forest invented the "Audion" triode vacuum-tube, electronic valve, which could greatly amplify weak electrical signals, (one early use was to amplify long distance telephone in

\textsuperscript{75} Princples of Digital Audio - by Ken C. Pohlmann
\textsuperscript{76} Music, Physics and Engineering - by Harry F. Olson
1915) which became the basis of all subsequent electrical sound systems until the invention of the transistor. The valve was quickly followed by the invention of the Regenerative circuit, Super-Regenerative circuit and the Superheterodyne receiver circuit, all of which were invented and patented by the young electronics genius Edwin Armstrong between 1914 and 1922. Armstrong's inventions made higher fidelity electrical sound recording and reproduction a practical reality, facilitating the development of the electronic amplifier and many other devices; after 1925 these systems had become standard in the recording and radio industry.

3.8 **Wire & Wax Recording**

The first practical sound recording and reproduction device was the mechanical phonograph cylinder, invented by Thomas Edison in 1877 and patented in 1878. The invention soon spread across the globe and over the next two decades the commercial recording, distribution and sale of sound recordings became a growing new international industry, with the most popular titles selling millions of units by the early 1900s. In early productions, the recordings were on the outside surface of a strip of tinfoil wrapped around a rotating metal cylinder\(^7\). By the 1880s **wax cylinders** were mass marketed. These had sound recordings in the grooves on the outside of hollow cylinders of slightly soft wax. These cylinders could easily be removed and replaced on the mandrel of the machine which played them. The cylinder records would commonly wear out after they were played a few dozen times. They then used a mechanism which left their surface shaved smooth so new recordings could be made on them. In 1890 Charles Tainter patented the use of hard carnauba wax as a replacement for the common mixture of paraffin and beeswax used on phonograph cylinders. The development of mass-production techniques enabled cylinder recordings to

\(^7\) History of Audio Recording - Mathew Warnock
become a major new consumer item in industrial countries and the cylinder was the main consumer format from the late 1880.

In 1920 the first practical magnetic sound recording system, the magnetic wire recorder was introduced. Magnetic wire recorders were effective, but the sound quality was poor, so between the wars they were primarily used for voice recording and marketed as business dictating machines. In the 1930s radio pioneer Guglielmo Marconi developed a system of magnetic sound recording using steel tape. Because of the high recording speeds required, they used enormous reels.

3.8.1 Wire recording is a type of analogue audio storage in which the recording is made onto thin steel or stainless steel wire. The first wire recorder was the Valdemar Poulsen Telegraphone of the late 1890s. They were most famously introduced as consumer technologies after World War II. Consumer wire recorders were marketed for home entertainment or as an inexpensive substitute for commercial office dictation recorders. However, the introduction of consumer magnetic tape recorders around 1948 quickly drove wire recorders from the market.

Poulsen's original telegraph one and indeed all very early recorders placed the two poles of the record/replay head on opposite sides of the wire. The wire was thus magnetised transversely to the direction of travel. This method of magnetization was quickly found to have the limitation that as the wire twisted, the output from the head fell to almost zero.

The development was to place the two poles on the same side of the wire so that the wire was magnetised along its length or longitudinally. Additionally, the poles were shaped into a 'V' so that the head wrapped around the wire to some

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78 Sound Recording: The Life Story of a Technology - by David Morton, David L Morton Jr
extent. This increased the magnetising effect and also increased the sensitivity of the head on replay because it 'collected' more of the magnetic flux from the wire. This system was not entirely immune to twisting but the effects were far less marked. The longitudinal method survives into magnetic tape recording to this day.

Compared to later tape recorders, wire recording devices had a high media speed, made necessary because of the use of the solid metal medium. The wire reels were recorded or listened at nominally 24 inches per second (610 mm/s), making a typical one-hour reel 7,200 feet (approx. 2195 m) long. This enormous length was possible on a spool of under 3 inches in diameter because the wire was nearly as fine as hair\textsuperscript{79}. Since the wire was pulled past the head by the take up spool, the wire speed increased as the diameter of the spool increased.

Wires also came in different lengths, such as 15 or 30 minutes. After recording or playback, the reel had to be rewound, because, unlike the later tape recorders, the take up reel on most wire recorders was not removable. In practice, the fine wire easily became tangled and snarls were extremely difficult to fix. Editing could be accomplished by cutting the wire and tying the ends together, with the knot sometimes welded with the tip of a lit cigarette\textsuperscript{80}.

The audio fidelity of wire recording made on one of these post-1945 machines was comparable to a 78-rpm record or one of the early tape recorders. The Magnecord Corp. of Chicago briefly manufactured a high fidelity wire recorder intended for studio use, but soon abandoned the system to concentrate on tape recorders.

Some wire recorders were also used in aircraft cockpit voice recorders and flight data recorders beginning in the early 1940s, mainly for recording radio

\textsuperscript{79} History of Audio Recording - Mathew Warnock
\textsuperscript{80} Sound Recording: The Life Story of a Technology - by David Morton, David L Morton Jr
conversations between crewmen or with ground stations. In this capacity, being somewhat more resilient than magnetic tape, wire recorders survived somewhat later, being manufactured for this purpose through the 1950s and remaining in use somewhat later than that. There were also wire recorders made to record data in satellites and other unmanned spacecraft of the 1950s to perhaps the 1970s.

3.9 FILM RECORDING
In the 1920s, the early talkies featured the new sound-on-film technology which used photoelectric cells to record and reproduce sound signals that were optically recorded directly onto the movie film. The introduction of talking movies, spearheaded by The Jazz Singer in 1927 (though it used a sound on disk technique, not a photoelectric one), saw the rapid demise of live cinema musicians and orchestras. They were replaced with pre-recorded soundtracks, causing the loss of many jobs. The American Federation of Musicians took out ads in newspapers, protesting the replacement of real musicians with mechanical playing devices, especially in theatres.

J.F. Madan and J.J. Madan of Madan Theates Ltd., Calcutta had received their sound equipment from America and they started producing as well as exhibiting sound films in India. They released a two reeler sound film in their talkies cinema, Elphinstone Picture Palace, Calcutta, in 1929. The first Talkie Feature film shown in India was Universal's Melody of Love in English, which celebrated its premiere at Elphinstone Picture Palace in Calcutta in 1929.

3.10 GRAMOPHONE RECORDS - 78 RPM – HAND WINDING, EP, LP
A gramophone record (also phonograph record, or simply record) is an analogue sound storage medium consisting of a flat disc with an inscribed modulated

81 Talking Pictures - Milestones in Sound - from Widescreen Museum
82 Sound in Films - by Alberto Cavalcanti
spiral groove starting near the periphery and ending near the center of the disc. Gramophone records were the primary medium used for commercial music reproduction for most of the 20th century. They replaced the phonograph cylinder as the most popular recording medium in the 1900. Gramophone records remain the medium of choice for some audiophiles, and specialist areas such as electronics. The normal commercial disc is engraved with two sound bearing concentric spiral grooves, one on each side of the disc, running from the outside edge towards the centre. Since the late 1910s, both sides of the record have been used to carry the grooves. The recording is played back by rotating the disc clockwise at a constant rotational speed with a stylus (needle) placed in the groove, converting the vibrations of the stylus into an electric signal (see magnetic cartridge), and sending this signal through an amplifier to loudspeakers.

The terms LP record (LP, 33, or 33½ rpm record), EP, 16½ rpm record (16), 45 rpm record (45), and 78 rpm record (78) each refer to specific types of gramophone records. Except for the LP and EP (which are acronyms for Long Play and Extended Play respectively), these type designations refer to their rotational speeds in revolutions per minute (rpm). LPs, 45s, and 16s are usually made of polyvinyl chloride (PVC), and hence may be referred to as vinyl records or simply vinyl.

Early disc records were made of various materials including hard rubber. From 1897 onwards, earlier materials were largely replaced by a rather brittle formula of 25% "shellac" (a material obtained from the secretion of a southeast Asian beetle), a filler of a cotton compound similar to manila paper, powdered slate, and a small amount of a wax lubricant. Unbreakable records, usually of celluloid (an early form of plastic) on a pasteboard base, were made from 1904 onwards, but they suffered from an exceptionally high level of surface noise.
In the 1890s the early recording formats of discs were usually seven inches (nominally 17.5 cm) in diameter. By 1910 the 10-inch (25.4 cm) record was by far the most popular standard, holding about three minutes of music or entertainment on a side. From 1903 onwards, 12-inch records (30.5 cm) were also commercially sold, mostly of classical music or operatic selections, with four to five minutes of music per side.

Such records were usually sold separately, in plain paper or cardboard sleeves that may have been printed to show the producer or the retailer's name and, starting in the 1930s, in collections held in paper sleeves in a cardboard or leather book, similar to a photograph album, and called record albums. Empty record albums were also sold that customers could use to store their records in.

These gramophone records also were very popular among common men who patronized the local tea shops. The music played there throughout the day was loud, appealing to the masses, but had a background in carnatic music since in those days most music had carnatic origin. Thus, unknowingly, these people started appreciating some aspects of carnatic music.

3.11 **VINYL RECORDING**

The Vinyl microgroove was invented by a Hungarian engineer Peter Carl Goldmark. The vinyl microgroove record was introduced in the late 1940s, and the two main vinyl formats — the 7-inch single turning at 45 rpm and the 12-inch LP (long-playing) record turning at 33 1/3 rpm — had totally replaced the 78 rpm shellac (sometimes vinyl) disc by the end of the 1950s. Vinyl offered improved performance, both in stamping and in playback, and came to be generally played with polished diamond styli, and when played properly (precise tracking weight, etc.) offered longer life.

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83 Sound Recording: The Life Story of a Technology - by David Morton, David L Morton Jr
Vinyl records were advertised as "unbreakable". They were not, but were much less brittle and breakable than shellac. Nearly all were tinted black, but some were colored, as red, swirled, translucent, etc.

While a 78 rpm record is brittle and relatively easily broken, both the microgroove LP 33⅓ rpm record and the 45 rpm single records are made from vinyl plastic that is flexible and unbreakable in normal use. However, the vinyl records are easier to scratch or gouge, and much more prone to warpage. 78s come in a variety of sizes, the most common being 10 inches (25 cm), and 12 inches (30 cm) in diameter (sometimes 6–8 inches in the UK), and these were originally sold in either paper or card covers, generally with a circular cutout allowing the record label to be seen. The Long-Playing records (LPs) usually come in a paper sleeve within a colour printed card jacket which also provides a track listing. 45 rpm singles and EPs (Extended Play) are of a 7-inch (17.5 cm) diameter, the earlier copies being sold in paper covers.

The earliest rotation speeds varied widely. Most records made in 1900–1925 were recorded at 74–82 revolutions per minute (RPM). In 1925, 78.26 rpm was chosen as the standard because of the introduction of the electrically powered synchronous turntable motor. Thus these records became known as 78s (or "seventy-eights"). After World War II, two new competing formats came on to the market and gradually replaced the standard "78": the 33⅓ rpm (often just referred to as the 33 rpm), and the 45 rpm. The 33⅓ rpm LP (for "long play") format was developed by Columbia Records and marketed in 1948.

RCA Victor developed the 45 rpm format and marketed it in 1949, in response to Columbia. Both types of new disc used narrower grooves, intended to be played with a smaller stylus—typically 0.001" (25 µm) wide, compared to

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84 History of Audio Recording - Mathew Warnock
0.003" (76 µm) for a 78—so the new records were sometimes called Microgroove.

Eventually the 12" (300 mm) 33 1/3 rpm LP prevailed as the predominant format for musical albums and the 7" (175 mm) 45 rpm disc or "single" established a significant niche for shorter duration discs, typically containing one song on each side. The 45 rpm discs typically emulated the playing time of the former 78 rpm discs, while the LP discs provided up to one half hour of time per side (though typically 15 to 20 minutes). The 45 rpm discs also came in a variety known as Extended play (EP) which achieved up to 10-15 minutes play at the expense of attenuating (and possibly compressing) the sound to reduce the width required by the groove.

From the mid-1950s through the 1960s, in the U.S. the common home "record player" or "stereo" would typically have had these features: a three- or four-speed player with changer (78, 45, 33 1/3, and sometimes 16 2/3 rpm); a combination cartridge with both 78 and microgroove styluses; and some kind of adapter for playing the 45s with their larger center hole.

**3.12 Radiogram**

Radiogram is a now old-fashioned piece of furniture that combined a valve radio and record player. The word Radiogram is formed by a combination of the words radio and gramophone. Radiograms reached their peak of popularity in the late 1950's, supported by a rapidly growing interest in records. Originally they were styled in polished wood to blend with the furniture styles of the 1940s and 1950s. Later models took on the modern lines and plastic finish of the 1960s. When valve radio development ended in the early 1960's and transistors began to take over radiograms became obsolete. By the late 1970s they had been relpaced by more compact equipment. Since radiograms were
manufactured in such huge numbers they are not as rare or valuable as TV sets or table radios from the same period.

3.13 **MAGNETIC RECORDING**

*Magnetic tape* is a medium for magnetic recording generally consisting of a thin magnetizable coating on a long and narrow strip of plastic. Nearly all recording tape is of this type, whether used for recording audio or video or for computer data storage. It was originally developed in Germany, based on the concept of magnetic wire recording. Paper-based tape was first used but was soon superseded by polyester and acetate backing due to dust drop and hiss. Acetate was more brittle than polyester and snapped easily. This technology, the basis for almost all commercial recording from the 1950s to the 1980s, was invented in the 1930s by German audio engineers, who also discovered the technique of AC biasing, which dramatically improved the frequency response of tape recordings\(^\text{85}\).

Tape recording was perfected just after the war by American audio engineer John T. Mullin with the help of Crosby Enterprises (Bing Crosby), whose pioneering recorders were based on captured German recorders, and the Ampex company produced the first commercially available tape recorders in the late 1940s. Magnetic tape revolutionized the broadcast and recording industries. In an age when all radio (and later television) was live, it allowed programming to be prerecorded. In a time when gramophone records were recorded in one take, it allowed recordings to be created in multiple stages and easily mixed and edited with a minimal loss in quality between generations. It is also one of the key enabling technologies in the development of modern computers. Magnetic tape allowed massive amounts of data to be stored in computers for long periods of time and rapidly accessed when needed.

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\(^{85}\) *Music, Physics and Engineering* - by Harry F. Olson
Today, many other technologies exist that can perform the functions of magnetic tape. In many cases these technologies are replacing tape. Despite this, innovation in the technology continues and tape is still widely used. 

Magnetic tape brought about sweeping changes in both radio and the recording industry. Sound could be recorded, erased and re-recorded on the same tape many times, sounds could be duplicated from tape to tape with only minor loss of quality, and recordings could now be very precisely edited by physically cutting the tape and rejoining it. Within a few years of the introduction of the first commercial tape recorder, the Ampex 200 model, launched in 1948, American musician-inventor Les Paul had invented the first multitrack tape recorder. Tape enabled the radio industry for the first time to pre-record many sections of program content such as advertising, which formerly had to be presented live, and it also enabled the creation and duplication of complex, high-fidelity, long-duration recordings of entire programs. It also, for the first time, allowed broadcasters, regulators and other interested parties to undertake comprehensive logging of radio broadcasts. Innovations like multitracking and tape echo enabled radio programs and advertisements to be pre-produced to a level of complexity and sophistication that was previously unattainable and tape also led to significant changes to the pacing of program content, thanks to the introduction of the endless-loop tape cartridge.

3.14 **Reel-to-Reel Tape or Spool Tape**

Reel-to-reel, open reel tape recording is the form of magnetic tape audio recording in which the recording medium is held on a reel, rather than being securely contained within a cassette. In use, the supply reel or feed reel containing the tape is mounted on a spindle; the end of the tape is manually pulled out of the reel, threaded through mechanical guides and a tape head assembly, and attached by friction to the hub of a second, initially empty take-
up reel. The arrangement is similar to that used for motion picture film. The reel-to-reel format was used in the very earliest tape recorders. The great advantage of tape for studios was twofold – it allowed a performance to be recorded without the 30 minute time limitation of a phonograph disc, and it permitted a recorded performance to be edited. For the first time, audio could be manipulated as a physical entity.

The performance of tape recording is greatly affected by the width of the tracks used to record a signal, and the speed of the tape. The wider and faster the better, but of course this uses more tape. These factors lead directly to improved frequency response, signal-to-noise ratio, and high frequency distortion figures. Tape can accommodate multiple parallel tracks, allowing not just stereo recordings, but multi-track recordings too. This gives the producer of the final edit much greater flexibility, allowing a performance to be remixed long after the performance was originally recorded. This innovation was a great driving force behind the explosion of popular music in the late 1950s and 1960s. The first multi-tracking recorders had four tracks, then eight, then sixteen, twenty-four, and so on. It was also discovered that new effects were possible using multi-tracking recorders, such as phasing and flanging, delays and echo, so these innovations appeared on pop recordings shortly after multi-tracking recorders were introduced.

For home use, simpler reel-to-reel recorders were available, and a number of track formats and tape speeds were standardised to permit interoperability and prerecorded music.

3.15 **The Cassette Tape or Compact Cassette**

The Compact Cassette, often referred to as audio cassette, cassette tape, cassette, or simply tape, is a magnetic tape sound recording format. Although it

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86 [www.knowledgerush.com/.../Reel-to-reel_audio_tape_recording/](http://www.knowledgerush.com/.../Reel-to-reel_audio_tape_recording/)
was originally intended as a medium for dictation, improvements in fidelity led the Compact Cassette to supplant reel-to-reel tape recording in most non-professional applications. Its uses ranged from portable audio to home recording to data storage for early microcomputers. The word cassette is a French word meaning "little box."

Compact Cassettes consist of two miniature spools, between which a magnetic tape is passed and wound. These spools and their attendant parts are held inside a protective plastic shell. Two stereo pairs of tracks (four total) or two monaural audio tracks are available on the tape; one stereo pair or one monophonic track is played or recorded when the tape is moving in one direction and the second pair when moving in the other direction. This reversal is achieved either by manually flipping the cassette or by having the machine itself change the direction of tape movement.

The cassette's popularity grew further as a result of portable pocket recorders and hi-fi players such as Sony's Walkman, which used a body not much larger than the cassette tape itself, with mechanical keys on one side, or electronic buttons or display on the face. The transistor radio defined small music, then the portable CD player in the 1990s, and the MP3 player. The durability of the cassettes and ease of copying helped even poor people to use it. The portability of the cassette and cassette recorders allowed the common man the luxury of listening good music inexpensively at leisure. The introduction of pre-recorded

87 en.wikipedia.org/wiki/Compact_Cassette
music helped students of music learn new songs easily from the cassettes using the portable recorder. Also many used these recorders to record music from concerts etc, but here the quality was not good due to lack of good directional microphones.

Cassette technology created a booming market for pop music in India, drawing criticism from conservatives while at the same time creating a huge market for legitimate recording companies and pirated tapes. In some countries, particularly in the Third World, cassettes still remain the dominant medium for purchasing and listening to music.

Tape length is usually measured in minutes of total playing time. The most popular varieties are C46 (23 minutes per side), C60 (30 minutes per side), C90, and C120. The C46 and C60 lengths are typically 15–16 µm thick, but C90s are 10–11 µm and C120s are just 9 µm thick, rendering them more susceptible to stretching or breakage.

3.16 **HI-FI OR HIGH FIDELITY**

**High fidelity** or hi-fi reproduction is a term used by home stereo listeners and home audio enthusiasts to refer to high-quality reproduction of sound or images that are very faithful to the original performance. Ideally, high-fidelity equipment has minimal amounts of noise and distortion and an accurate frequency response. The term hi-fi for expensive high-quality home-audio electronics was largely replaced with high-end audio.

The introduction of electronic amplification, microphones, and the application of quantitative engineering principles were applied to the reproduction of sound. Acoustically-recorded disc records with capriciously peaky frequency response were replaced with electrically recorded records. Engineers applied waveguide

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88 *Principles of Digital Audio* - by Ken C. Pohlmann
technology to the design of the interior folded horn to produce a smooth frequency response which complemented and equalled that of the electrically recorded Victor Orthophonic records.

Meanwhile, the rise of radio meant increased popularity for loudspeakers and tube amplifiers, so there was an anomaly of a period of time during which radio receivers commonly used loudspeakers and electronic amplifiers to produce sound, while phonographs were still commonly purely mechanical and acoustic. Later, electronic phonographs became available, as stand-alone units or designed to play through consumer's radios.

The development of Sound film in the 1930s led motion picture companies to develop amplification and loudspeaker systems to fill movie theaters with good quality sound at a reasonable volume\textsuperscript{89}. To achieve this result, they employed loudspeakers with separate sections for low and high frequencies ("woofers" and "tweeters"), connected via an audio crossover network, and more carefully engineered enclosures. This development exposed the public to better fidelity than home equipment was capable of at the time. Some movie stars purchased movie theater sound equipment for use in their homes but the cost and size put them out of reach for anyone of modest means.

After World War II, several innovations created the conditions for a major improvement of home-audio quality:

- Reel-to-reel audio tape recording, based on technology found in Germany after the war, helped musical artists distribute recordings with better fidelity.
- The advent of the 33⅓ RPM Long Play (LP) microgroove vinyl record, with low surface noise and quantitatively-specified equalization curves. Classical music fans, who were opinion leaders in the audio market

\textsuperscript{89} Introduction to Loudspeaker Design - by John L. Murphy
quickly adopted LPs because, unlike with older records, most classical works would fit on a single LP.

- FM radio, with wider audio bandwidth and less susceptibility to signal interference and fading than AM radio, though AM could be heard at longer distances at night\(^{90}\).
- Better amplifier designs, with more attention to frequency response and much higher power output capability, allowing audio peaks to be reproduced without distortion.

In the 1950s, the term high fidelity began to be used by audio manufacturers as a marketing term to describe records and equipment which were intended to provide faithful sound reproduction. While some consumers simply interpreted high fidelity as fancy and expensive equipment, many found the difference in quality between "hi-fi" and the then standard AM radios and 78 RPM records readily apparent and bought 33 LPs, such as RCA's New Orthophonics and London's ffrrs, and high-fidelity phonographs. Audiophiles paid attention to technical characteristics and bought individual components, such as separate turntables, radio tuners, preamplifiers, power amplifiers and loudspeakers. Some enthusiasts assembled their own loudspeaker systems. In the 1950s, hi-fi became a generic term, to some extent displacing phonograph and record player. In the late 1950s and early 1960s, the development of the Westrex single-groove stereophonic record led to the next wave of home-audio improvement, and in common parlance, stereo displaced hi-fi\(^{91}\). Records were played on a stereo. In the world of the audiophile, however, high fidelity continued and continues to refer to the goal of highly-accurate sound reproduction and to the technological resources available for approaching that goal.

\(^{90}\) History of Audio Recording - Mathew Warnock
\(^{91}\) Music, Physics and Engineering - by Harry F. Olson
A very popular type of system for reproducing music from the 1970s onwards was the integrated music centre which combined phonograph, radio tuner, tape player, preamp and power amplifier in one package, often sold with its own separate, detachable or integrated speakers. These systems advertised their simplicity; the consumer did not have to select and assemble the individual components. Purists generally avoid referring to these systems as high fidelity, though some are capable of very good quality sound reproduction.

When high fidelity was limited to monophonic sound reproduction, a realistic approximation to what the listener would experience in a concert hall was limited. The general clarity of the sound, however, was not any less than with stereophonic sound reproduction. Researchers quickly realized that the ideal way to experience music played back on audio equipment was through multiple transmission channels, but the technology was not available at that time. It was, for example, discovered that a realistic representation of the separation between performers in an orchestra from an ideal listening position in the concert hall would require at least three loudspeakers for the front channels. For the reproduction of the reverberation, at least two loudspeakers placed behind or to the sides of the listener were required. Stereophonic sound provided a partial solution to the problem of creating some semblance of the illusion of performers performing in an orchestra by creating a phantom middle channel when the listener sits exactly in the middle of the two front loudspeakers. When the listener moves slightly to the side, however, this phantom channel disappears or is greatly reduced. The advances made in signal processors to synthesize an approximation of a good concert hall can now provide a somewhat more realistic illusion of listening in a concert hall.

In addition to spatial realism, the playback of music must be subjectively free from noise to achieve realism. The compact disc (CD) provides at least 90 decibels of dynamic range, which is about as much as most people can tolerate.
in an average living room. This therefore requires the playback equipment to provide a signal-to-noise ratio of at least 90 decibels\textsuperscript{92}.

Audio equipment must be able to reproduce frequencies high enough and low enough to be realistic. Many adults over 25 or 30 can hear up to, at most, 15 kHz. A few younger people can hear up to 19 kHz. There is relatively little music below 50 Hz, loud bass below 30 Hz is rare, and music below 16 Hz is almost non-existent. CDs are capable of reproducing high frequencies up to 22.05 kHz and low frequencies down to 10 Hz. The equipment must also provide no noticeable distortion of the signal or emphasis or de-emphasis of any frequency in this frequency range. Except for spatial realism, good modern equipment can easily satisfy all of these requirements at a relatively moderate cost\textsuperscript{93}.

Many, on first hearing a “good system” complained at the scratchiness of the music. The highs had never been prominently recorded or reproduced before. The handbooks on stereo and hi-fi concur that sound reproduction is a subjective thing, and each person should tailor his system to please himself. This is fine if the aim is to please the listener. But if the aim is to achieve optimum fidelity rather than a pleasing sound, then restriction is placed on the selection of the equipment, control settings of the pre-amplifier and the acoustic layout of the room used for reproducing the music. Faithfulness is indeed the most limiting, the most constricting of all aims in sound reproduction. Once the mind adjusts to the unreal, it takes a lot of convincing to accept real fidelity.

3.17 **Modern equipment**

Modern hi-fi equipment usually includes digital audio signal sources such as CD players, Digital Audio Tape (DAT) and Digital Audio Broadcasting (DAB)

\textsuperscript{92} Theory of the Film: Sound - by Bela Balazs
\textsuperscript{93} Principles of Digital Audio - by Ken C. Pohlmann
or HD Radio tuners, an amplifier, a preamplifier, and loudspeakers. Some modern hi-fi equipment can be digitally connected using fibre optic TOSLINK cables, universal serial bus (USB) ports (including one to play digital audio files), or WiFi support\textsuperscript{94}.

One modern component that is making fast gains in acceptance is the music server consisting of one or more computer hard drives that hold music in the form of computer files. Resolutions which exceed CD quality are capable with lossless files and appropriate playback equipment. If the hi-fi system includes components such as a projector, television, satellite decoder, DVD player, surround sound amplification and multi-channel loudspeakers, then it is often called home cinema or a home theatre system.

### 3.18 DIGITAL RECORDING

The invention of digital sound recording and the compact disc brought massive improvements in the durability and sound quality of consumer recordings. The CD initiated another massive wave of change in the consumer music industry, with vinyl records effectively relegated to a small niche market.

The most recent and revolutionary developments have been in digital recording, with the invention of the first purely electronic consumer recording format -- the MP3 digital music file -- accompanied by the invention of solid-state computerised digital audio players like the iPod. New technologies such as Super Audio CD and DVD-A continue to set very hi-fi digital standards\textsuperscript{95}.

The field covers many areas, from Hi-Fi to Professional audio, Internet radio and Podcasting. Technological developments in recording and editing have transformed the record, movie and television industries in recent decades. Audio editing became practicable with the invention of magnetic tape recording, but

\textsuperscript{94} Sound Recording: The Life Story of a Technology - by David Morton, David L Morton Jr
\textsuperscript{95} Principles of Digital Audio - by Ken C. Pohlmann
the use of computers has made editing operations faster and easier to execute, and the use of hard-drives for storage has made recording cheaper. We now divide the process of making a recording into tracking, mixing and mastering. Multitrack recording makes it possible to capture sound from several microphones, or from different 'takes' to tape or disc with maximum headroom and quality, allowing maximum flexibility in the mixing and mastering stages for editing, level balancing, compressing and limiting, and the addition of effects such as reverberation, equalisation, flanging and many more.

3.19 The Digital Shift

Digital audio has emerged because of its supreme usefulness to sound recording, manipulation, mass-production and distribution. The modern day distribution of music across the internet through on-line stores depends on digital recording and digital compression algorithms\textsuperscript{96}. "Dematerialization" of the music software into computer files has significantly reduced costs of distribution. However, it has brought about the rise in music sharing through peer to peer networks, which is illegal in many countries as copyright infringement. The Recording Industry claims that music sharing is severely harming the profitability of their business.

Analogue audio music storage & reproduction have been based on the same principles upon which human hearing are based. Sounds begin and end as mechanical energy wave forms in air, are captured in said wave form, and transformed into an electrical energy by a microphone transducer. Its nature may change; its wave-like characteristics remain unchanged during its storage, transformation, duplication, amplification. Analogue audio has been susceptible to significant information loss, as noise and distortions tend to creep in at each stage.

\textsuperscript{96} en.allexperts.com/e/d/di/digital\_audio.htm
The digital audio chain begins when sound is converted into electrical signals — ‘on/off’ pulses — rather than electro-mechanical signals. The advantage is the ability to be copied or transmitted more conveniently, and with lower loss. In a digital recording system, sound is stored and manipulated as a stream of discrete numbers, each number representing the air pressure at a particular time. The numbers are generated by a microphone connected to a circuit called an Analog To Digital Converter, or ADC. Each number is called a SAMPLE, and the number of samples taken per second is the Sample Rate. Ultimately, the numbers will be converted back into sound by a Digital To Analog Converter or DAC, connected to a loudspeaker. The numbers are in the binary number system in which only two characters are used, 1 and 0.

Digital audio, simply put, is audio in digital form. Specifically, digital audio is a digital signal encoded as bits of information. An analog signal is converted to a digital signal at a given sampling rate and bit resolution; it very likely will also contain multiple channels (2 channels for stereo or more for surround sound). The higher the sampling rate and bit resolution the more fidelity. Digital systems' sampling rate limits the bandwidth and bit resolution limits the dynamic range.

A digital audio signal starts with an analog-to-digital converter (ADC) that converts, as the name implies, an analog signal to a digital signal. The ADC runs at a sampling rate and converts at a known bit resolution. For example, CD audio has a sampling rate of 44.1 kHz (44,100 Hz) and 16-bit resolution for both channels (stereo). One advantage to this is that audio can originate in the digital world such as with software synthesizers or digitally created sheet music. Creation in this manner does not rely upon a predetermined sampling rate or bit resolution. After being sampled with the ADC, the digital signal may then be

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97 Principles of Digital Audio - by Ken C. Pohlmann
98 www.statemaster.com/encyclopedia/digital-signal-processing
altered in a process which is called digital signal processing where it may be filtered or have effects applied. The digital audio signal may then be stored or transmitted. Digital audio storage can be on a CD, an iPod, a hard drive, USB flash drive or any other digital data storage device. Audio data compression techniques such as MP3 are commonly employed to reduce the size. Digital transmission can be streamed to other devices.

The last step for digital audio is to be converted back to an analog signal with a digital-to-analog converter (DAC). Like ADCs, DACs run at a specific sampling rate and bit resolution but through the processes of oversampling, upsampling, and downsampling, this sampling rate may not be the same as the initial sampling rate.

3.20 **SUBJECTIVE EVALUATION**

Audio can be measured and analyzed to more exacting measures than can be done by ear, but what this technical measurement and analysis lacks is the ability to determine if it sounds "good" or "bad" to any given listener. Like any other human opinion, there are numerous parameters that widely vary between people that affect their subjective evaluation of what is good or bad. Such things that pertain to audio include hearing capabilities, personal preferences, location with respect to the speakers, and the room's physical properties.

On a Compact Disc, the bits are microscopic pits burned into the plastic by a laser. The stream of pits spirals just like the groove on a record, but is played from the inside out. To read the data, light from a gentler laser is reflected off the surface of the plastic (from the back: the plastic is clear.) into a light detector. The pits disrupt this reflection and yield up the data. It is very important to safeguard the top portion of a CD, where the information is stored and a label is stuck.
3.21 **The Benefits of Being Digital**

Digital circuits are complex, but the components must be precise; most of the circuitry merely responds to the presence or absence of current. Improving performance is usually only a matter of increasing the word size or the sample rate, which is achieved by duplicating elements of the circuit. Hence good digital systems are cheaper than good analog systems.

Digital devices usually require less maintenance. Digital components either work or don't, and it is much easier to find a chip that has failed entirely. Digital systems have few moving parts, and for such parts, a little vibration or speed variation is not important. In addition, digitally encoded information is more durable than analog information, again because circuits are responding only to the presence or absence of something rather than to the precise characteristics of anything. It is possible to design digital systems so that they can actually reconstruct missing or incorrect data. The aspect of digital sound that is most exciting to the electronic musician is that any numbers can be converted into sound, whether they originated at a microphone or not. This opens up the possibility of creating sounds that have never existed before, and of controlling those sounds with a precision that is simply not possible with any other technique.

3.22 **Compact Disc**

A Compact Disc or CD is an optical disc used to store digital data, originally developed for storing digital audio. The CD, available on the market since late 1982, remains the standard playback medium for commercial audio recordings to the present day, though it has lost ground in recent years to MP3 players.

An audio CD consists of one or more stereo tracks stored using 16-bit PCM coding at a sampling rate of 44.1 kHz. Standard CDs have a diameter of 120 mm and can hold approximately 80 minutes of audio. There are also 80 mm
discs, sometimes used for CD singles, which hold approximately 20 minutes of audio. The technology was later adapted for use as a data storage device, known as a CD-ROM, and to include record-once and re-writable media (CD-R and CD-RW respectively). CD-ROMs and CD-Rs remain widely used technologies in the computer industry as of 2007. The CD and its extensions have been extremely successful: in 2004, the worldwide sales of CD audio, CD-ROM, and CD-R reached about 30 billion discs. By 2007, 200 billion CDs had been sold worldwide.

A Compact Disc is made from a 1.2 mm thick disc of almost pure polycarbonate plastic and weighs approximately 16 grams. A thin layer of aluminium or, more rarely, gold is applied to the surface to make it reflective, and is protected by a film of lacquer. The lacquer is normally spin coated directly on top of the reflective layer. On top of that surface, the label print is applied. Common printing methods for CDs are screen-printing and offset printing. CD data is stored as a series of tiny indentations (pits), encoded in a tightly packed spiral track molded into the top of the polycarbonate layer. The areas between pits are known as "lands". Each pit is approximately 100 nm deep by 500 nm wide, and varies from 850 nm to 3.5 μm in length.

While CDs are significantly more durable than earlier audio formats, they are susceptible to damage from daily usage and environmental factors. Pits are much closer to the label side of a disc, so that defects and dirt on the clear side can be out of focus during playback. Discs consequently suffer more damage because of defects such as scratches on the label side, whereas clear-side scratches can be repaired by refilling them with plastic of similar index of refraction, or by careful polishing. The original target storage capacity for a CD was an hour of audio content, and a disc diameter of 115 mm was sufficient for this. The 74-minute playing time of a CD, being much longer than the 15 to 20
minutes per side possible with long-playing vinyl albums, was often used to the CD’s advantage during the early years when CDs and LPs vied for commercial sales. CDs would often be released with one or more bonus tracks, enticing consumers to buy the CD for the extra material.

### 3.23 Video Compact Disc

VCD stands for 'Video Compact Disc' and basically it is a CD that contains moving pictures and sound. If you're familiar with regular audio/music CDs, then you will know what a VCD looks like. A VCD has the capacity to hold up to 74/80 minutes on 650MB/700MB CDs respectively of full-motion video along with quality stereo sound. VCDs use a compression standard called MPEG to store the video and audio. A VCD can be played on almost all standalone DVD Players and of course on all computers with a DVD-ROM or CD-ROM drive with the help of software based decoder / player. It is also possible to use menus and chapters, similar to DVDs, on a VCD and also simple photo album/slide shows with background audio. The quality of a very good VCD is about the same as a VHS tape based movie but VCD is usually a bit more blurry. If you want better quality checkout SVCD,CVD or DVD.

### 3.24 DVD-Audio

DVD-Audio is a format for delivering high-fidelity audio content on a DVD. It offers many channel configuration options (from mono to 7.1 surround sound) at various sampling frequencies (up to 24-bits/192kHz versus CDDA’s 16-bits/44.1kHz). Compared with the CD format, the much higher capacity DVD format enables the inclusion of considerably more music (with respect to total running time and quantity of songs) and/or far higher audio quality (reflected by higher linear sampling rates and higher vertical bit-rates, and/or additional channels for spatial sound reproduction).

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Despite DVD-Audio's superior technical specifications, there is debate as to whether the resulting audio enhancements are distinguishable in typical listening environments. DVD-Audio currently forms a niche market, probably due to the very sort of format war with rival standard SACD that DVD-Video avoided. DVD (also known as "Digital Versatile Disc" or "Digital Video Disc") is a popular optical disc storage media format\textsuperscript{101}. Its main uses are video and data storage. Most DVDs are of the same dimensions as compact discs (CDs) but store more than 6 times the data. Variations of the term DVD often describe the way data is stored on the discs: DVD-ROM has data which can only be read and not written, DVD-R can be written once and then functions as a DVD-ROM, and DVD-RAM or DVD-RW holds data that can be re-written multiple times.

DVD-Video and DVD-Audio discs respectively refer to properly formatted and structured video and audio content. Other types of DVD discs, including those with video content, may be referred to as DVD-Data discs. The term "DVD" is commonly misused to refer to high density optical disc formats in general, such as Blu-ray and HD DVD.

3.25 MP3

The name of the file extension and also the name of the type of file for MPEG, audio layer 3. Layer 3 is one of three coding schemes (layer 1, layer 2 and layer 3) for the compression of audio signals\textsuperscript{102}. Layer 3 uses perceptual audio coding and psychoacoustic compression to remove all superfluous information (more specifically, the redundant and irrelevant parts of a sound signal. The stuff the human ear doesn't hear anyway). It also adds a MDCT (Modified Discrete Cosine Transform) that implements a filter bank, increasing the frequency resolution 18 times higher than that of layer 2. The result in real terms is layer 3
shrinks the original sound data from a CD (with a bit rate of 1411.2 kilobits per one second of stereo music) by a factor of 12 (down to 112-128kbps) without sacrificing sound quality. Because MP3 files are small, they can easily be transferred across the Internet. MP3 stands for MPEG-1 Audio Layer III. It is not a separate format, but a part of MPEG-1 video encoding format, developed by MPEG group in early 1990's. Too often people refer MP3 as MPEG-3, which is incorrect, because such format doesn't even exist. MPEG-1 Audio Layer III (MP3) is a method to store good quality audio into small files by using psychoacoustics in order to get rid of the data from the audio that most of the humans cannot hear.

MP3's bitrates vary from 8kbps (that is 8 kilobits per second, not kilobytes) to 320kbps. When MP3 phenomenon began in 1996, most of the audio files were encoded using 128kbps bit rate, which is still the most popular bit rate in the world -- although most of the people agree that by using slightly higher bitrates, like 192kbps or 256kbps, the audio quality can be compared with the CD quality.

### 3.26 Multitrack Recording

Multitrack recording ('multitracking' or just 'tracking' for short) is a method of sound recording that allows for the separate recording of multiple sound sources to create a cohesive whole. This is the most common method of recording popular music. Multitracking can be achieved with analogue, tape based, equipment (from simple cassette based four or eight trackers to 2" reel-to-reel 24 track machines), digital equipment that relies on tape storage of recorded digital data (such as ADAT eight track machines) and hard disk based systems, often employing a computer and multitrack audio recording software. Multitrack recording devices vary in their specifications, such as the number of simultaneous tracks available for recording at any one time; in the case of tape
based systems this is limited by, among other factors, the physical size of the tape employed.

Some of the biggest professional analog recording studios used a computer to synchronize multiple 24-track machines, effectively multiplying the number of available tracks into the hundreds\textsuperscript{103}. For computer-based systems the trend is towards unlimited numbers of record/playback tracks, although issues such as memory and CPU available will in fact limit this from machine to machine. When recording, audio engineers can select which track (or tracks) on the device will be used for each instrument, voice, or other input.

At any given point on the tape, any of the tracks on the recording device can be recording or playing back, so that an artist is able to record, for instance, onto track 2 and, simultaneously, listen to track 1, allowing him to sing or to play an accompaniment to the performance already recorded on track 1. He might then record on track 3 while listening to track 2. All three performances can then be played back in perfect synchrony, as if they had originally been played and recorded together. This can be repeated until all of the available tracks have been used, or in some cases fact, reused.

At any given point in the recording process, any number of existing tracks can be "sub-mixed" into one or two tracks and the original tracks erased, making more room for more tracks to be reused for fresh recording. Multitrack recording also allows any recording artist to record multiple "takes" of any given section of their performance, allowing them to refine their performance to virtual perfection. A recording engineer can record only the section being worked on, without erasing any other section of that track. This process of turning the recording mechanism on and off is called "punching in" and "punching out".

\textsuperscript{103} How to Set Up a Recording Studio by David Mellnor
When recording is completed, the many tracks are "mixed down" through a mixing console to a two-track stereo recorder in a format which can then be duplicated and distributed. Most of the records, CDs and cassettes commercially available in a music store are recordings that were originally recorded on multiple tracks, and then mixed down to stereo. In some rare cases, as when an older song is technically "updated", these stereo (or mono) mixes can in turn be recorded (as if it were a "submix") onto two (or one) tracks of a multitrack recorder, allowing additional sound (tracks) to be layered on the remaining tracks.

Multi tracking, actually a byproduct of film recording brought many new aspects to carnatic music recording. First, each artist’s output was fed into separate tracks. So if just one artist made a mistake, repeated takes for the whole group was not necessary. Keeping all other tracks, it was possible to re-record just the one track. So only the required portions could be edited. Carnatic music recordings started using playback singing techniques. The artist can first record the percussions and strings without his / her presence and then dub the voice.

Background music for carnatic music records also came into effect. A new genre of music directors for carnatic albums emerged. People started enjoying listening to music with background scoring.

3.27 **Flexibility**

During multitracking, multiple musical instruments and vocals can be recorded, either one at a time or simultaneously, onto individual tracks, so that the sounds thus recorded can be accessed, processed and manipulated individually to produce the desired results. For example, after recording some parts of a song, an artist might listen to only the violin, by 'muting' all the tracks except the one on which the violin was recorded. If he then wanted to listen to the vocals in isolation, he would do so by muting all the tracks apart from the vocals track.
he wanted to listen to the entire song, he could do so by un-muting all the tracks. If he found a mistake in violin part, and wanted to replace it, he could do so by re-recording only the violin part (i.e., re-recording only the track on which the violin was recorded), rather than re-recording the entire song. This kind of editing freedom is one of the biggest benefits of multitracking.

If all the voices and instruments in a recording are individually recorded on distinct tracks, then the artist is able to retain complete control over the final sculpting of the song, during the mix-down (re-recording to two stereo tracks for mass consumption) phase.

For example, if an artist wanted to apply one effect to a synthesizer part, a different effect to a guitar part, a 'chorused reverb' effect to the lead vocals, and different effects to all the drums and percussion instruments, he could not do so if they had all been originally recorded together onto the same track. However, if they had been recorded onto separate tracks, then the artist could blend and alter all of the instrument's sounds with complete freedom.

Multitrack recording allows a single musician to record multiple parts, allowing duos and trios to produce a larger sound, larger groups to double parts or add different instruments, and also a solo performer to create an ensemble sound, playing different parts.

### 3.28 Using a Personal Computer as a Multitrack Recording Device

Today, a sufficiently dedicated and talented artist can literally produce an album in his/her own bedroom, using only his/her personal computer as a professional tracking machine. In order to use a personal computer as a multitracking device, a minimum of three items is required:

1. A personal computer which has a sound card
2. Multitrack recording software installed and running on the computer. Suitable software is available at low prices or even free, in the case of Free and Open Source Software.

3. At least one or more recording sources such as a musical instrument, a good microphone to record the vocals of a singer and/or any other sources of sound to be recorded. This is all that is needed to set up a multitracking studio at home capable of producing high quality recordings. The standard sound card in a personal computer can be used to capture sounds. This is done simply by attaching either a microphone to the microphone input jack if a vocal track is to be recorded, or by attaching a stereo cable from the electronic device (such as a synthesizer or a guitar amplifier) to the line input of the sound card. Computers with appropriate software and hardware can record multiple audio tracks at once. This audio interface hardware sends audio signals to the computer and may interface with the computer via a PCI card, USB or firewire connections.

The instruments and singers' voices are recorded onto individual files on the computer's hard drive, which function as tracks as per traditional multitracking. Effects such as reverb, chorus & delays can be applied by the computer software. When the musicians are happy with the sound, the multiple tracks are mixed down onto two clean tracks, again within the multitracking software. Finally, the final stereo recording can be burned to a CD, which can then be copied and distributed.

Musicians now have the ability to record their music on their own computer. Limitations come from the amount of RAM and hard drive space available mainly. What you'll need to record is a computer with a sound card and software to do the multi tracking for you. With this you will be able to record several tracks of guitar, drums, vocals, etc. and mix into one song. You can even

104 en.allexperts.com/e/m/multitrack_recording.htm
put these on the web so that anyone can hear them. You'll need to understand real audio to do that and get a web site.

The musician can put his/her songs on the Internet with a Real audio file, or an MP3 file. First, you need to have an audio file to work with. This is made from a recording he has done and made a wave file from. Most people use recording software to make that. An audio file in a wave format is generally too large to post to the internet and would take too much time to download. That is why people compress these files to MP3 or real audio type formats. Once you have the audio file you can convert it to an MP3 file and post to the internet.

Real audio is another method of saving an audio file to the internet. The musician can first record the song, and then use the encoder to encode the file to Real Audio. It would be good to experiment with live encoding vs. encoding from a .wav file.

3.29 **COMPUTERS AND MUSIC EDUCATION**

Musicians and Music Educators have been involved with computers since the first computers were developed. In the early days, computers required a great deal of space and musicians and educators needed strong skills in computers and computer programming. Consequently, applications were limited to large computer systems at universities and corporations. The development of the Personal Computer and the extension of its power, speed, and memory have made it possible for musicians and educators to use the computer to assist them in their tasks with a minimal amount of experience and computer knowledge.

There is a number of courseware or computer-assisted instruction ranging from helping with music history, music theory, and performance to music appreciation and tracking student progress. In addition to this assistance existing

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in disk form and CD-ROM formats, the computer has now become a
communication tool offering a number of additional alternatives to using the
computer as an adjunct to music learning. There is a wealth of information of
the World Wide Web and e-mail provides a means for teachers to be in touch
with students and parents, and vice versa.

With the emergence of the computer as a multi-media environment (text, images, videos, and sound), music educators have benefited tremendously from
the new technologies. We have barely scratched the surface of the possibilities.

There is an ad on television which shows a young boy having difficulty batting
with his baseball team. He always strikes out\textsuperscript{106}. The coach goes home, picks
out material from the internet on developing the correct swing and angle on the
ball. He organizes and writes it to a CD-ROM. He gives it to the boy, and the
next we see is the boy connecting with the baseball. His teammates are
impressed. One of his teammates asks to borrow the CD-ROM. The results
produced ultimately is one and all of them improve their techniques. The
learning metaphor could apply to anything: a student in chorus who is having
trouble learning a choral part...... a personalized CD gives the student a model to
practice with. You can imagine a number of possibilities of individualizing and
personalizing music learning.

Of course, we are in a time when not everyone has access to computers and the
internet. Things are changing rapidly. Several years ago, we were not aware of
the World Wide Web. The information explosion in the past three years is
unparalleled in the history of our planet. The power of new technologies has
been the ability to make the costs affordable to the lowest strata of culture to the
point that what was once a luxury now becomes a necessity. This reality
challenges us as music educators. The role of the music educator is changing

\textsuperscript{106} nyu.edu/classes/gilbert/cai
from the dispenser of knowledge to the facilitator of learning, creating, and making music. Of course, this has always been true of the best music educators, and now we have additional resources to support this process.

### 3.30 Audio Editing

Audio editing is a process that requires a lot of patience, music knowledge, skill and instinct. Tape editing is performed simply by cutting the tape at the required point, and rejoining it to another section of tape using adhesive tape, or sometimes glue. This is called a splice. The splicing tape has to be very thin to avoid impeding the tape's motion, and the adhesive is carefully formulated to avoid leaving a sticky residue on the tape or deck. Usually, the cut is made at an angle across the tape so that any "click" or other noise introduced by the cut is spread across a few milliseconds of the recording. The use of reels to supply and collect the tape also made it very easy for editors to manually move the tape back and forth across the heads to find the exact point they wished to edit.

Introduction of tape editing helped carnatic musicians in a big way. Till then, a recording that had to be done for 22 minutes to fit a side of an LP or a recording that was done for any fixed timing had to undergo many 'takes' till the correct timing was achieved. And during the recording, if there was a small error on the part of the artist, the recording had to be repeated and sometimes, during the repetition, errors used to occur in a different place. This made the whole process tedious. Also, if the recording involved more than one musician, the problem became manifold.

But audio editing solved all these problems. An expert with music knowledge could easily edit down a 30 minute recording to a 22 minute one without the listener even realizing that an editing was done. Also the mistakes could be rectified by replacing only the portion with the error by making the artist perform only that particular portion, record it, cut it and splicing it along with
the original to make a continuous correct recording. When many artists are involved, track recording helped a lot. Each artist’s music could be recorded in a separate track and only the artist who committed the error needed to repeat the performance. But though all these made the life much easier for the performers, a new set of audio specialists called sound / music editors came into the picture.

3.31 AUDIENCE:

With the introduction of audio, the carnatic music concert shifted place from the darbars of kings, residences of Zamindars & the elite to temples, sabhas or auditoriums specially meant for such programs. The public address system helped to increase the number of listeners who could comfortably hear the music. The soft nuances of music also could be clearly heard. But along with this, the tiny imperfections also could be heard. This meant that while the audience appreciated the artists’ expertise, they were equally demanding and the artists had to work hard to deliver good music. The imperfections that were hidden in the absence of a microphone were too obvious.

The type of audience also changed. The new breed did not have the luxury of kings & zamindars to listen for hours together. They were working class and had lesser time for entertainment. The duration of the concerts became shorter. And the duration of individual pieces also was shortened. There was a time when a single raga alapana took more than 3-4 hours. Now the new audience did not have time for such luxury. Also they wanted more lively music than elaborate classical music. After a long day’s work, they wanted something lively. This was the time lighter raga came to be introduced to carnatic music. And Tamil music started getting its due importance. The common man enjoyed it more if he could understand the sahithyam. Since most of the audience consisted of tamilians, kruthis in Tamil were appreciated. In Karnataka, Andhra & Kerala, compositions in the local language gained popularity.
There was another type of audience to carnatic music other than visitors to these sabhas. The introduction of recorders and records meant that these concerts can be recorded live in a cassette recorder and heard by the whole family in their home. The introduction of cassettes and LPs meant that the artist entered the homes of music lovers. The popularity of carnatic music and musicians increased. The total number of listeners increased exponentially, but the number of listeners who attended a live concert decreased. The luxury of listening at home made many stay at home to listen to good music. This brought about an argument that carnatic music’s popularity was declining – the consideration only being the low turnout at live concerts. This was not true. The audience was definitely there, in larger numbers actually, but the type of audience changed.

### 3.32 Propagation

Microphone & PA systems definitely revolutionalised the propagation of music. The major problem in ‘sevi vazhi kalvi’ was done away with this introduction of media. There was no dilution in quality due to a poor student or too much distortion. The music of maestros could be heard by everyone in their generation and also in future generations to come. One could learn from masters who are not living anymore by listening to their recordings. Teachers could record their music for their students, which could be used for reference.

Streaming audio in the net changed the way we look at recorded music. With just a microphone and computer, anyone could record music and upload on to the youtube for the whole world to hear. Many sites that let one download carnatic music for free like Ragaa.com etc helped even the youngsters who are web savvy to download and listen to good music.