AN HISTORICAL SURVEY
OF TECHNOLOGY
USED IN THE PRODUCTION
& PRESENTATION
OF MUSIC
IN THE 20TH CENTURY

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An overwhelming majority of the material contained in this thesis (words and illustrations) is original and based on my years in the music industry, and from considerable research in the field. Where certain referential material, or specific supporting quotes are included they have been appropriately noted, and referenced to their source. None of this work has been used for any other submission for a higher degree at any other institution.

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Tom Lubin
March 13, 1997
THESIS ABSTRACT

This paper explores the historical progression of the technological development of records and radio and its impact on popular music. It also includes the production technologies that create recorded music, the development of records, cassettes and CDs, and areas of reproduction that have an association with popular music including the sound technologies of radio, film, television, background music, and the jukebox. This paper is not a cultural or social study, but is primarily an historical account of media technology in music production and delivery. Certain social and cultural consequences and issues are included as background and sidebars to the primary topic. The technology of live performance has been omitted because it alone represents a body of material large enough for an entire paper.

Technology has provided a means for the sound and production of popular music to move from what had previously been primarily an oral tradition to a documented, fixed, and easily duplicated commodity for distribution and sales. Technology of the 20th century has turned music, and in particular popular music into a product.

Before recording, music notation was the only means of preserving a composition other than memorising it. While notation can define notes, tempo, and rhythm, it is open to interpretation, and cannot exactly define sound, nor document performance. Starting sometime in the 17th century, mechanical reproducers, music boxes, and on a larger scale, musical clocks provided various means of mechanical reproduction of melodies. However, these devices were neither affordable, nor mass produced, and almost exclusively purchased or commissioned by the elite. It was the invention of sound recording in the late 19th century that provided a means for a musical performance to become an affordable consumer product available for not only public but also private consumption. Corporate giants in music production and media delivery built their businesses on this technology as did the consumer electronic industry, which was established to exploit and manufacture the products that grew from these new inventions. Today, not only are these corporations the marketers of new media technology but they are the principal inventors of it. These corporations are also the owners of programs featured on the various media.

The pop song, popular music in general, and the democratisation of music for the masses, has been influenced by the technology of the 20th century. From the beginning of record production and radio, throughout the first half of this century, the technical parameters of the various production tools and delivery mediums played a significant part in what types of music would be produced and the recording techniques that would be employed. As the technology improved, so did the quality of production, reproduction and transmission, with the result that the range of musical material that was technically suitable became broader. Starting with its introduction in the late 19th century, the progress of sound invention was constant but gradual until the late 1920s when the amplifier tube affected every aspect of 20th century life, and specific to this topic, changed music production techniques and the types of artists who would be popular. The next leap came in the late 1940s, when an avalanche of electronic innovation allowed new musical styles to emerge, caused production techniques to change, and brought new delivery systems to the public which also forced existing delivery systems to reinvent themselves. These post W.W.II events spawned the very creation and delivery of modern popular music and rock and roll. Market forces have stimulated the production and marketing of every type of popular music.

Western society now travels through a sea of music emanating from countless hidden sources. Such music delivery systems provide a continuous musical score for most people's personal histories. Sound, fragments of sound, and the very processes by which sound is created and manipulated have become products and commodities. The technology has allowed anyone to participate in the creation and hearing of music. This paper traces the history of the various technologies that, in so many respects, have provided a catalyst for that which is created, and the means by which music is listened to in the 20th century. With rare exception, each new invention, delivery system, or process has had both supporters as well as detractors. Throughout this paper, both the positive as well as the negative effects of these developments will be explored.
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March 9, 1997
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This paper is an historical review starting in the late 19th century, of the technology that has affected the creation and delivery of recorded sound, in particular commercial popular music. It describes the incremental changes that have occurred in the production and presentation of popular music directly related to the progressive development of these many technologies. Some of these developments modified the creative direction of recorded music, others changed industrial, social and cultural aspects of recorded music. These emerging technologies affected both the creator and the consumer. The application of the inventions outlined over the following pages made the record industry itself. The record froze a performance in time, and with increasingly sophisticated technology the sound became more important than the lyric and melody. Above all else, the record and its commercialisation turned music into a commodity (referred to as "product" by the music industry). While all music has been affected by the developments outlined in these chapters, the popular song and its production has been most affected by these inventions and their application. For the purposes of this work, a "pop" song is one which is widely popular and commercially successful, at least for a time. Integral to pop is its "sound" which is directly attributed to the technology available at the time of its production. This "sound" is as important to the success of a pop production as the melody or rhythm.

The invention of records turned a musical performance into a commodity that allowed individuals to listen to their choice of music by themselves and when they wanted. Once a recording was created, the choice to hear the music was solely that of the listener. Most people own their own playback system and a selection of their favourite music, but for those who don't, music is freely available on radio or for a few coins from a jukebox. Listeners play a recording because they want to "actively" hear the music. Or, they might play music as a background at a party or some other social occasion. Technology in music delivery has altered the spaces that people work, shop, and play in. Background music is everywhere.

Many popular and academic books and articles have been written on the social and cultural consequences from the development of music production and delivery technology. This paper is not a cultural or social study but is primarily an historical account of the technology used in the recording and presentation of music. Where it seems relevant, the author has included certain social and cultural issues as background and sidebars to the primary topic. A topic such as this often raises many questions which deserve further exploration. In the conclusion, there are some observations that have arisen through the course of this work's creation and which could form topics of future research.

As in recorded music production, the technology of live performance has rapidly expanded since the mid sixties. To cover this subject would require inclusion of such things as sound reinforcement, communication systems, staging, rigging, pyrotechnics, large screen TV, cranes, set design, transport methods, all forms of computer controlled lighting, and disco. There is no question that live performance is an important form of entertainment. It predates records, plays an important part in the commercialisation and promotion of popular artists and in the case of disco has led musical trends. However the technology of live performance is beyond the scope of this paper.

Over the past several years, material for this paper has been collected through significant literature searches and through interviews with prominent people in the industry. Many of the observations that are expressed in this work reflect the author's years of experience as a professional music recording engineer and producer, a product manager involved in marketing and developing new technology, a teacher and a writer chronicling those technological developments that have affected the production and delivery of recorded music. This paper provided the author with an opportunity to construct a narrative that included both reference material as well as many examples from his personal experience. It is a history of sound technology, and the impact such technology has had on
the creation and delivery of recorded music (and pop music in particular). It includes many first hand accounts by those who use such technology (the author and others). For those who do not have prior knowledge of the technical aspects, the inventions or the process described, Appendix 1 is a glossary of terms and explains more technical aspects of the technology.

**Historical Background**

The paper contains an historical background section which briefly outlines many of the relevant technological developments that predated the phonograph, speakers and microphones. It provides some background to those events leading up to where this paper begins.

**Where does the path begin?**

The origins of music production and delivery technology came primarily from England, America, Germany, France, and Japan. The cylinder based phonograph was invented in 1877 (Giscard, 1993, pp.137-138), and ten years later the record based gramophone was invented. During the first decade after the invention of the record, one out of every three phonographs manufactured were coin operated in penny arcades. Those who could not afford the initial investment in a phonograph had access to recorded music via these pre-jukebox record players. However, by the 1920s, the cost of records was low enough for low income people to acquire their favourite music. The gramophone and the invention of a mouldable coal-based shellac allowed the creation of the record industry. During the first few decades of the record industry, tens of thousands of titles were released. The majority of the music could be broadly categorised as "popular" and included bagpipes, whistling, novelty songs, every type of solo instrument and vocals.

Recorded music dissolved many social and economic boundaries associated with musical performances and taste. Those who seldom, if ever, attended live musical performances, began to have an appetite for records. In America by the 1930s, if there was even a limited market for a certain type of music, someone was producing those records, in particular for poor blacks, Latins, country folk, and other ethnic minorities. As a result, music that had never been widely heard, or which was considered socially unacceptable, was available on record (though up until the 50s this would require going to a "bad" part of town to find them).

The record industry has become not only the provider of music in this century, but, through the themes and images of its artists, the purveyors of style and cultural change particularly for the young. Recording artists have also chronicled, and on numerous occasions, driven political and social change. In one of numerous examples, David Pichaske (1989) describes the role played by pop music in the 60s:

> It offers the most accurate record of persons and places and spirits. More important, it provides a common history. We may not have been in Montgomery, Alabama, but we have all sung or heard sung "We Shall Overcome", "We Shall Overcome" created a sense of unity among diverse peoples and purposes, a community of pacifists and hippies, and whites and blacks, a bridge between 1962 and 1969. The songs of the 60s gave support to 60s history and sociology. (p. xix-xx)

At the time of the gramophone's invention, views were considerably varied about the impact records would have on the music industry of the time. In 1903 a questionnaire was circulated by the Parisian music industry to local performers, teachers, promoters, etc. Results indicated that most performers embraced the concept of recorded music since it provided a means for their ephemeral interpretations to be documented. More than one promoter saw it as a way of keeping people in the wings quiet since no one wanted to mess up a recording. They also felt it would provide negotiating leverage since a record could provide musical playback during musician strikes. Most thought records had an educational role since they made musical performances readily available to students. "But later on, when people began to understand the uprooting it would cause, the conservatives were fraught with worry. The phonograph was then seen as something dangerous" (Attali,1977, p. 94).

There was concern that it would cheapen the public's perception of music, that it would alter the status quo, and of course eliminate jobs. Throughout this century these three concerns have accompanied each new emerging technology. One way or another, those opposed to the changes brought on by the technology are either pacified, eventually embrace it, or are left behind. The specifics of these three issues are outlined in each chapter.

**The chronology of events**

This paper is divided into sections with several chapters in each section. With a recognition that music production and media technology did not evolve in a linear fashion, there are places where the time lines are blurred and inevitable digressions occur. There are some overlaps and references to events described in other chapters and these have been noted.
Big pictures: Section I

Section I explores ideas that could be described as “big picture” concepts. In the first chapter, three broad themes are explored that have emerged from the introduction of records, recording and broadcasting. The first is the “sound” of pop, a direct result of the technology. The second is technology’s ability to alter previous understandings of time, place, and space. And the third is the ability of technology to capture some sort of quality in the recording artist’s performance that at some later time makes a listener emotionally respond to a playback of that performance.

Chapter Two begins a journey of technological development with some theories of invention, and why the speed of development seems to have accelerated with each advancing year of this century. It then goes on to outline the development of what could be considered the 20th century’s most important electrical/electronic invention, the electron amplifier tube. The chapter traces its subsequent development, its eventual demise due to the invention of the transistor, and its re-emergence in the 1990s as an important part of musical sound.

A place for listening: Section II

Along with amplification, the other common consolidating factor in music production and delivery is the listening space which includes not only the speaker but the cabinet and room in which they are placed. Chapter Three outlines the personal listening experience, the difference between what the creators and the consumers hear, the listening environment, the development and impact of car stereo, home stereo, and such things as the Walkman.

Modern inventions have made it possible for the listener to enjoy music in complete isolation, unaffected by the response of others, perhaps temporarily unaware of their surroundings, concentrating only on the music they have selected. (Storr, 1992, p. 109)

The tools of production: Section III

Section III contains chapters that identify the technologies of production. Chapter Four explores the technological evolution of recording equipment and the impact it has had on the production content, styles and techniques employed by the record and broadcast industries. One of the few books that deals with the effect of music technology on music production is Rock Formation by Steve Jones. Jones (1992) concludes that critics and musicologists:

Rarely mention the sonic and composition limitations of the equipment used for recording. The effect those limitations have on the composition and realisation (fixing of sound in a specific medium for later consumption and/or manipulation) of music plays a critical role in the production of popular music. Therefore it is at the level of composition and realisation that one should begin to analyse the relationship of technology and popular music, for it is at that level that popular music is formed. (p7)

The rapid spread of music production technology erupted from the early 50s allowing pop music to become bigger than life. It is no coincidence that it was at this time that the magnetic recorder became widely available, allowing the recording process to become more than the documentation of a performance. From then to the present, the production studio has undergone constant and rapid change. For many, the “pop sound” began sometime in the mid fifties with the emergence of rock and roll which rose to awareness as a mainstream phenomenon with the popularity of the movie "Blackboard Jungle", and its title song, Bill Haley’s “Rock Around The Clock”. This technology had its beginnings about 70 years before in the late 1870s. Chapter Four covers the development of the phonograph, the gramophone, and magnetic recording.

Chapter Five starts with a history of the computer and its application in audio processing and storage. It then continues with the development of digital audio technology through the 80s into the 90s with the replacement of analogue technology with digital systems. With the development of the digital recorder has come the sampler. The sampler has become “the ideal tool for pop to take itself apart, thus arriving at [what some observe as] modernism and post-modernism simultaneously” (Beadle, 1993, p6-7). Today’s generation of music creators have fully embraced this form of sound reconstruction. If anything, samplers have provided greater access to the creation and popularisation of such music. It has created “a new kind of performer, a virtuoso of the short phrase capable of infinitely redoing takes that are perfectible with sound effects [devices]” (Attali, 1977, p. 106).
Closest to musicians are their musical instruments, and at the heart of rock and roll is the electric guitar, and guitar amplifier. While most of pop music has held the electronic keyboard in a more passive role to the guitar, its prominence has been ever increasing since the introduction of digital keyboards and a common control language (MIDI) that facilitates communication between all electronic devices. Chapter Six explores electronic musical instruments and the events that stimulated their creation and development.

Microphones, audio mixers and all manner of audio signal processors that comprise a broad category of production tools are the subjects of Chapter Seven. More than anything else, the technological developments in this area have contributed to the sound of pop music. Chapter Seven describes these production devices. In Appendix 1, there is considerable detail of the technical characteristics, with many examples and illustrations of these devices, their application, and the effects they have contributed to the sound.

The delivery mediums: Section IV

For some centuries, sheet music had existed and had already objectified the written score. In the 20th century, records objectified the performance of music. With the invention of the phonograph record music became a commodity or as the record industry refers to it, "a product". Further, the product - the record, could be obtained by anyone who had the money to buy it. The record listener did not need musical skills. The acquisition of a certain record was the determining factor as to what music could be played. No one needed to gather together a number of musicians to play a score. The record allowed the listener to have "a solitary relationship with a material object" (Attall, 1977, p. 32).

Chapter Eight traces the development of the medium of distribution starting first with the Edison cylinder followed by the gramophone disk developed by Émile Berliner, and moves through the evolution in delivery mediums (shellac and vinyl disk, tape, 8-track cartridge, cassette, CD, 45, LP, stereo, etc.) to the present day. Each delivery medium is referenced to its impact on record companies, the production process, and the creative artist. The chapter also describes several manufacturing changes that have affected the music production process, the sound of the release, and the presentation of the final product. Since the success of these delivery mediums is reflected in sales, a short history of the growth of the record industry through this century has been included in the second half of the chapter, noting items of special interest such as the ascendance in the 50s of the independent labels that were so important in the emergence into the main stream of rhythm and blues (R&B), country, and rock and roll. Because the introduction of the stereo record had such an impact on the industry there is also a short description of stereo recording.

The delivery systems: Section V

The chapters in section V cover the various delivery systems that have been used to present popular music starting with radio in Chapter Nine. While records started the process, the growth of radio in the 1920s opened the spigot on a musical ether that would eventually fill nearly every space society occupies. Beginning in the 20s highbrows could hear music hall songs without having to be there, and the lower classes could hear classical music and operas from places they could never attend.

"It was an age in which music was heard, rather than listened to, on the radio, on gramophones, in restaurants and in the street." In America "Tin Pan Alley and the law of supply and demand triumphed...", but in the U.K. at the BBC "Sir John Reith and his associates were determined to provide what they thought the public ought to have, not what it wanted." "Laziness and lethargy (of the British musical hall composers) in Britain had enabled the Americans to push ahead with the gramophone, the disenchantment of the young Edwardians with the complacency of their elders had led to the rapturous reception of ragtime, and the dozy [e.g., sleepy] traditionalism of the British popular song composer led to stagnation (Pearsall, 1976, p9-19).

Radio created one other uniquely new condition of social significance. Each listener of a station shared a common experience with everyone else that might be listening. During the "Golden Age" of radio, listeners could imagine that they were participating in a performance that was going out to millions of people through the wonders of modern technology. Radio quickly became a powerful force in shaping and focusing social thought and providing the signs of the times.

As television developed in the late 1940s it too became an important outlet for popular music. Eventually a new genre of music production and delivery emerged, the music video. While the development of the video clip seemed to arrive with MTV, in fact it had its roots in the beginning of film at the turn of the century. Less obvious, but in some respect more concentrated and international in its impact compared to radio, records, and TV, is the feature film. Popular films are seen by
more people (different ages, social groups, cultures), in more places of the world than any other media. The technological developments of film sound and records were nearly one and the same for about 20 years after the turn of the century. Chapter Ten on Sound and Image includes film and television, and their various means of delivery.

Chapter Eleven looks at the background music industry which is a major employer of music producers, and has contributed to the general economy of the music production industry. The largest of the companies in this industry, Muzak, has invested heavily in research and development to improve the manufacturing of the phonograph disk and tape-based delivery mediums. The music service these companies provide has become a background score to most people's lives in this century. This wash has contextualized the recollections of our personal histories. This background technology has provided an alternative to broadcast, and in many respects has had a wider influence on all of society than the more overt radio or TV.

During much of this century for those who were too young or poor to go to dance halls and clubs for entertainment, the uptown nickelodeon or downtown jukebox provided the music for an evening out. For nearly four decades the jukebox was an important source for the latest in music. For a good many of those who patronised the jukebox, it provided a place of collective consumption of records before the early 50s when players in homes became common. Jukeboxes were crucial in the growth of the record industry in the 30s, and in particular the production of regional, ethnic, and black music. Jukeboxes were stocked by local operators who responded to the requests of local customers. To supply this need for regional and ethnic music independent record companies (followed by majors) began to record artists they would not have previously considered.

Conclusions: Section V

Chapter Thirteen reviews the significant issues that have been raised in the paper and brings them together to form many broader conclusions. This chapter also includes some issues that emerged as worthy of further investigation at some future time.

It is the author’s hope that this work will not only represent a suitably academic effort but be a genuinely good read.
HISTORICAL BACKGROUND

The Ancients

At the beginning of civilisation, people in Asia Minor digging in the earth sometimes came up with a yellowish, glass-like stone, amber, a fossilized form of resin that oozed from certain types of prehistoric trees. When they rubbed it with cloth, it mysteriously acquired the power to attract small pieces of straw, leaves, feathers and such. Today we describe this as an electrostatic phenomenon. The ancients believed by holding and possessing this powerful “magic”, their “spirit power” was enhanced. They believed that materials with these properties had “souls” which accounted for their unique behaviour.

As early as 600 B.C., a Greek philosopher, Thales of Miletus, wrote about experiments he conducted with amber, which the Greeks called “elektron”. It is from this word that we get the modern words, “electricity”, “electron”, and “electronics”.

Magnetism

An even more wonderful “magic” was occasionally dug out of the ground. A certain type of heavy black stone would attract pieces of iron. These stones were called Magnets, probably because they were particularly plentiful in a region of Asia Minor that was called at the time, Magnesia. The Greeks thought that magnetic rocks were possessed, had mysterious properties, and all sorts of legends were spawned by these qualities. They also felt the stones had medicinal benefits and were a popular healing amulet (as they are today). It was believed that if they were rubbed with garlic their power of attraction would be lost, but if goat’s blood was smeared on them the strength would be intensified.

The Chinese may have been the first, sometime around 1000 A.D., to discover that when the magnetic stone was hung from a string, it would always align in a north-south direction. They shaped the rock into a pointer and attached it to a pivot to make a compass. The rock was called Lodestone (or leadstone), probably because of its ability to point the way during journeys. It was most likely introduced into Europe by the Arabs, but the first mention of it in western literature was in a letter written by an English monk who saw it in Paris about the year 1180.

In later times (1590s) William Gilbert, President of the Royal College of Physicians, ground the material into tiny spheres and experimented with them in all types of situations. He concluded that the earth was a giant magnet and that the entire atmosphere was held in place by magnetic fields. This was a revolutionary concept. He presented the idea that all the spheres in space were magnetic in nature, and everything inside their atmospheres was pulled to their centres by gravity. He concluded that there was a vacuum between the planets. Gilbert was the first to present this theory, which challenged Aristotle’s notion that nature hated vacuums and that all of space was homogeneous. Gilbert’s book, De Magnete (On Magnets), started a whole round of experiments with magnets.

A stargazer

Around 1644, a student of Galileo, a northern Italian named Evangelista Torricelli, began experiments on the effect of altitude on a column of mercury. One of his assistants, Vincenzo Viviani, filled a six foot tube with mercury and then upended it in a dish also filled with mercury. The mercury flowed down into the dish, but it stopped, with a 30 inch column remaining in the tube. Torricelli figured that the air pressure on the mercury in the dish had to equal the weight of the mercury remaining in the tube and that a vacuum remained at the top of the column. Thus, air pressure was defined, and the possibility of a vacuum was suggested. He wrote a letter to a friend, Michelangelo Ricci, stating that “We live submerged at the bottom of an ocean of air”. Ricci knew that the Catholic church would not look kindly on this concept since it was contrary to church beliefs. The letter eventually made its way to a Minorite friar who lived in Paris. Instead of suppressing the information Father Marin Mersenne widely distributed the letter.
One of the people to see it was Blaise Pascal, who lived in Rouen at the time. He agreed with the premise that air pressure changed with altitude, but he had no way of checking it (no mountains near Rouen). So he got in touch with his brother-in-law, Francois Perier, who lived near Clermont Ferrand, where there are mountains. Perier left one column of mercury in a dish at the bottom of the Puy de Dome and climbed to the top of the mountain with a similar set up. At the 4000 foot summit, the other tube of mercury was upset and observed. Under every possible condition, with wind blowing or not blowing, with or without rain etc., the column of mercury at the summit was lower than the one at the base of the mountain (of coincident note, the top of the dome was also the site of an ancient Roman temple to the god Mercury). The air pressure at the top of the mountain was less, so less mercury was supported.

By 1675, barometers were a frequent part of what an astronomer would take to a mountain top while observing the stars. A French astronomer named M. Jean Picard was walking home after a night of star gazing twirling his barometer at the end of a string. He noticed that the barometer was glowing. The faster he spun it the brighter it got. He wrote about the phenomenon and labelled it the “glow of Life”. For years afterwards, he pursued the effect.

The first generation of electricity
As is typical of modern civilization, the exploration of high energy concepts was pursued by engineers in the military. One of these engineers was a German named Otto von Guericke. In his later years he became the mayor of Magdeburg and spent much of his time as a scientific hobbyist amusing his friends and travelling with his experiments. He picked up on Gilbert’s work (of the 1590s) and sometime before 1663 came to the conclusion that certain materials would act attractively when rubbed. He discovered that very pure sulphur was particularly attractive. He made a sphere of sulphur, stuck a rod through it, and mounted it horizontally. It had a crank and a gear train so that it could be spun at quite high speed. While spinning it, he would rub the sphere, and sure enough, it would become quite attractive to lighter materials such as paper, feathers, and even water. He concluded that it was the same force which kept everything earth bound and prevented anything thrown into the air from floating straight off into space. One night he discovered that it glowed, and that the light would reach out to his hand if he held it a few inches from the sphere. He also observed that a crackle was made. He concluded that this was another aspect of magnetism, and, in 1672, he published a book about his many experiments, Experimenta Nova Magdeburgica (The New Magdeburg Experiments). He gave only one paragraph to his sulphur bulb, but it captured the imagination of a great many experimenters who would come along in the following century. Guericke had discovered electricity.

Weather watchers picked up on the similarity between Guericke’s sparking and crackling and lightning and thunder. The biblical scholar Bede, in Saxon England, speculated that lightning was the rubbing together of the clouds, and that thunder happened when they ran into one another. Then there was the problem of the mortality rate of bell ringers who were in a high risk group due to electrocution. During the middle ages it was the custom to ring the church bells to disperse thunder, but the only thing that got dispursed were the bell ringers. As late as 1786 the Parliament of Paris had a law forbidding this practice. During the preceding 35 years there had been 386 recorded lightning strikes with no fewer than 103 bell ringers electrocuted at the ends of wet bell cords (At the time, in fact, the mortality rate for bell ringers rivalled that of royalty).

One of Sir Isaac Newton’s students, Francis Hauksbee, was the first to create at will the effect of Picard’s “Glow of Life”. He placed mercury in tubes which were fitted with valves and then spun. He observed that when the tube was half filled with air and in a partial vacuum the glow was greatest. In 1705, he told the Royal Society that the glow was the result of friction between the glass and mercury and that similar glowing would occur when materials such as wool and amber were rubbed together. A year later he built his “Influence Machine” - a glass globe holding some mercury, which could be spun with a spinning wheel type mechanism. The sphere could have all the air evacuated from it, and then slowly fed back into it. Hauksbee found that rubbing a hand on the spinning globe made the light brighter. It also caused a sound which was compared to the crackle of lightning and small metal particles were attracted to its surface.

Around 1707, also in England, a Dr. Wall wrote that in some way, lightning and thunder seemed to represent electricity. In 1729, Stephen Gray, another “Age of Reason” experimenter, took a glass tube with a cord at one end and vigorously rubbed the tube. He discovered that a thread attached to the cord could carry an attractive influence and feathers would attach to the string. By having wires rubbing against Hauksbee’s spinning ball, electric current would flow when the circuit was completed by touching the ground. By 1735, Gray had reached the same conclusion as Wall. In fact, Gray was eventually able to get the attractive influence to extend down an 800 foot long string.
The first use of electricity

The phenomenon of electrostatics became a medicine show. Travelling experimenters would (for a few pence) put on a show of electromagic from the tailgate of their equipment loaded wagons. Crowds would gather to be astonished by the glowing, spinning balls, the mysteries of electromagnetic attraction, and the muscle twitching effect of electricity. Falling under the category of "too weird for words, but still might be fun," was "The Temple of Health" in London. Established by James Graham, the facility featured as its main attraction "The Great Celestial or Magneto-Electro Bed". Childless couples would engage in reproductive activity while being attached to "therapeutic" electric fields generated by Hauksbee's machine. Another experimenter, in Holland, caused great excitement by strapping small boys into wood frames, running electricity through them, and seeing if they would attract any materials. The only things they attracted were titillating observers and anger from the local populace.

About 1745, at the Dutch University of Leydon, a glass jar full of water and two immersed metal plates were "filled" with the electricity generated by Hauksbee's machine. When the two terminals were touched, it did in fact hold quite a jolt. The jar became known as the "Leydon" jar. A member of the church took the next bizarre turn. In 1746, a French monk named Jean-Antoine Nollet got a number of his fellow monks to hold hands, and then the two end monks touched the terminals of a leydon jar. Nollet observed how everybody jumped at the same time as the current flowed through one monk to the next. In a peculiarly French fashion Nollet had no shortage of people with which to experiment. A wealthy lady admirer of Nollet later wrote that, through his door came a constant flow of duchesses, peers, and beautiful women.

Enter Ben Franklin

The British Royal Society in 1750 received a letter from Ben Franklin explaining his observations and electrical theories. He felt there were two types of electricity, positive and negative. The reason that electricity travelled from one place to another was a desire for the positive influence to move towards the negative influence in order to arrive at a natural equilibrium. He was the first to conclude that lightning would be attracted to a positive iron rod firmly planted in the ground. He wanted to use a church steeple to demonstrate his theory, but the Royal Society was not interested. He attempted to get one installed on top of a Philadelphia church, but they moved too slow for him. The next time there was lightning and thunder he went out with a kite, a key, and some wire, and soon was thrown to the ground. Lucky to be alive, he published his finding in his own Poor Richard's Almanac, the 1753 edition. By 1760, grounded lightning rods were being installed in England to minimise lightning strikes to steeplees and other high buildings.

In the mid 1700s Luigi Galvani had observed that when he took two dissimilar metal rods and touched the leg muscles of a dead frog, the muscle would contract. Alessandro Volta had studied Galvani's work and in the late 1700s he welded several sets of copper and zinc rings together, stacked them up with a felt separator between each set of rings, put them in a jar and immersed them in acid water. He had discovered that a chemical reaction occurred that spontaneously generated a continuous flow of electricity. The battery was born (not unlike the ones we have today). By wiring the plates in either series or parallel, he was able to change the amount of potential power (voltage) or the amount of electron flow (current). In 1800, he published his work and started selling the first commercial batteries.

Consolidating the knowledge

The connection between electricity and the magnetic attraction of lodestones was re-examined. Volta's plates were free floated in a leydon jar to see if they aligned north and south, which they did not. The experimenter did mention that a nearby steel bar was influenced by the placement of the batteries but this seemed to have no special significance to them.

A Danish physicist, H.C. Oersted, was concluding a lecture on electricity and magnetism. In the lecture he had stated that there was no magnetic effect when electricity was passed through a wire. At the end of his lecture he demonstrated this, except that when he connected up the wire, the nearby compass pointer swung toward it. Oersted was surprised by this unanticipated occurrence, and published his observation. A year later, a Frenchman, Andre Ampere, based on Oersted's discovery, concluded that electricity flowing through a wire produces a magnetic aura or field outside the wire. This was a significant breakthrough in the course of history. Around 1825 an Englishman named William Sturgeon wound a wire around a piece of soft steel, hooked it up to a battery and made an electromagnet. Michael Faraday took the opposite approach and twirled a magnet in the middle of a horseshoe shaped winding and generated an electrical current in the winding.
In 1857 Hermann Helmholtz, a German scientist and a musician, discovered that the strings of his piano vibrated when he yelled into it. He also knew something about magnetism and the effect of an electromagnet. He took a tuning fork and mounted it near a winding and then switched a voltage on and off through the wire. The fork vibrated. The concept of a speaker was born (Helmholtz identified many other acoustic principles).

In 1871, Zenobe Gramme, a Belgian, demonstrated to the French Academy of Science, a dynamo which was a generator of continuous and reversible electric current. For some years earlier, other scientists had been building experimental versions of electric generators, but in 1873 this was the first to be fully developed. Ten years later, Marcel Depez transmitted an electric current through long distance transmission lines (from Lebourget to Paris).

The birth of broadcast

Toward the end of the 19th century, electromagnetism had become a popular science. Sturgeon and Faraday have extensively described their experiments. In 1864, James Maxwell had postulated that light was a series of electromagnetic radiations. By 1888, Heinrich Hertz had created a device that would generate low frequency electromagnetic waves. In 1893 a Russian, Nikola Tesla, the inventor of the modern electric motor and a wide range of other devices, presented a lecture describing a method for radio transmission. His paper was translated into several languages and widely distributed. In 1895, Aleksandro Popov built a receiver that would pick up such radio waves. He proved that a receiver could pickup signals that were generated specifically for reception by the receiver. But it was Marconi, in that same year, who was able to take broadcast out of the lab and into the kitchen. He built a transmitter that sent a signal to a receiver from one side of his mother's kitchen to the other, where it rang a bell. He attempted, with little success, to get the Italian government interested in the invention. Eventually he travelled to England.

Marconi demonstrated it to the British Post Office. They encouraged him, and in 1897 he sent a signal across the Bristol Channel, a distance of nine miles. The following year, he transmitted across the English Channel, a distance of 31 miles. It was also successful and before long the Marconi Wireless Company had many such transmitter/receiving stations. Marconi probably had access to Tesla's paper, but was still able to gain a patent on the method of radio broadcast. Years later the U.S. supreme court ruled that Tesla had in fact invented radio, nonetheless Marconi was the person who commercialised it.

It was originally felt that the curvature of the earth would limit the transmission range of radio, but by 1901, transmission from Cornwall to St John's Newfoundland was successful (a distance of 2000 miles). The broadcast medium continued to use Morse Code.

The need to tune the transmitter and receiver to a specific broadcast frequency was obvious as soon as there was more than one transmitter. In the beginning, the receivers had arrays of buttons that selected preset frequencies. Adjusting the tuning was nearly impossible. The first dial and easily tunable radio receiver was invented in 1917 by an American, Edward Armstrong. His design approach continues to be used in nearly all radio receiving equipment. By 1927, tuned transmission and receiving systems were wide spread.

Starting at the end of the 19th century and throughout the 20th century, there has been a continuous flow of new inventions and refinements in the technology of all forms of electronic media. The material which follows is about the development of these inventions and their influence on the creators and the users of the technology.

(Much of the information in this chapter is from the James Burke book Connections.)
SECTION I
THE BIG PICTURE:
20TH CENTURY TECHNOLOGY
TIME & INVENTION
There are three major integrating themes that tie together the implementation of records, recording, and broadcasting technologies.

- The “sound” of pop which has been created as a direct result of the technology.
- The ability of the technology to alter previous models of time, place, and space.
- The ability of the technology to capture some illusive quality that causes listeners to be emotionally moved by the recording— in some cases no matter how many times they hear it.

These motifs provide common thread throughout the music production and reproduction and begin this work because they are not specific to a certain type of music, technology, or industry. They are broad themes held in wide panoramas and provide an overview of the effect of technology on music recording and delivery in the 20th century.

1. The “sound” of technology

Before records and technology’s impact on music production, musical passages and phrases, a good story and a memorable chorus were the primary identifiers of a pop song. They are still important, but these “hooks” (an instantly memorable musical attribute) now include “the sound.” Those in music production often refer to the sound of a recording separate from the song. A recording can have a good or unique sound and at the same time the song transported by the sound can be terrible, and vice versa. The public is equally interested in “the sound,” and its desire to hear every bit of it is reflected by its willingness to buy expensive home and car stereos and the proliferation of the Walk/DiscMan.

From the very beginning of recording sound, the technology of the day has had a primary impact on the quality of the sound, both creatively and technically. As pop music evolved from the product of Tin Pan Alley to the music of today, the “sound” became the most distinctive quality of a pop record. As Dick Clark once commented “[the sound is] what the kids listen for... the more different, the more original, the more unique the sound is, the more chance a record has of becoming a hit” (Aronowitz, 1963, p. 91). The Rolling Stone Illustrated History of Rock and Roll contains chapters on the sound of New Orleans, Chicago, Motown, and San Francisco. A few examples of regional sounds associated with specific acts include Memphis (Elvis, Jerry Lee Lewis, Carl Perkins, Wilson Picket), Nashville (for decades the sound of country music), San Francisco (late 60s, psychedelic, Joplin, Jefferson Airplane, Santana, The Grateful Dead, and flower power), Merseyside (Gerry and the Pacemakers, Dave Clark 5, Merseybeats), Sugar Hill (in Harlem with street rap and hip hop of the late 80s), Jamaican (Peter Tosh, Bob Marley, Jimmy Cliff, reggae in the early 70s), Motown (the 60s Detroit, Temptations, Jacksons, Supremes, and others that make up an almost endless roster), Philadelphia (the late 50s early 60s with The 4 Seasons, Dion and the Belmonts, The Chordettes, then again in the mid 70s with The Three Degrees, The O’Jays, Harold Melvin and The Blue Notes, The Commodores), The Miami Sound (late 70s, The Bee Gees and others of the disco period, late 1980s with Gloria Estefan and others).

Listed above are but a small number of the places that have originated identifiable sounds during a certain period. Hardly a year goes by without a few regional sounds and a cluster of acts associated with those sounds. The unique sound can be the product of any number of permutations. Often it is some new form of electronically generated sound or its application—a unique adaptation of a rhythm or musical structure or centered by the inclusion of ethnic instruments and musical form from local culture. Generally one or two acts associated with a regional sound emerge as headliners. Often their success becomes the catalyst for many other acts from
that region to be signed by labels attempting to cash in on that area's immediate popularity. While these areas were making music before the spotlight fell on them and continue to do so after the attention moves somewhere else, for that certain time, those regional sounds and the musicians who are a part of it have world wide recognition and popularity. Their recordings will have an influence on the direction of production all over the world, not just for that time but in some cases for generations to come.

Nearly all pop music is instantly recognised by its creator's sound. A significant reason why artists are successful recording acts is due to their ability to produce a unique sound the public prefers and identifies. The identifier is most often the quality of an artist's voice, but equally identifiable may be a certain style associated with the artist: Glen Miller's horn section, the Mills Brothers' vocal rhythms, Phil Collins' drum sound, Van Halen's guitar technique, Queen's harmonies, Billy Joel's piano style.

A most significant sound was that created by guitar legend Les Paul. The first practical application of "overdubbing" in music production has been attributed to him. This technique is a cornerstone of multi-track production and the pop music sound. Essentially, artists record a vocal (or other instrument), and then, while listening to what they have already recorded, they record another track. In the case of vocals, this gives the effect of someone singing with themselves. In some cases a vocalist might create a harmony part, in other cases the effect will simply thicken the vocal sound. Many weak pop singers from Gary Lewis and Nancy Sinatra to Kylie Minogue have used this technique to strengthen their vocal sound. Using this technique, Les Paul had several hit instrumental records, including a 1948 recording that had multiple guitar parts all of which he played. In 1949 he married a singer named Mary Ford and they began a recording career together. They changed the way pop music sounded with their 1951 hits "Mockin' Bird Hill" and "How High The Moon". Les Paul was years ahead of what was common practice in music production at the time. He established a production style and developed many of the techniques that are used today, but in the beginning, this sound was considered by most in the music industry as exclusively the "Les Paul Sound". Paul was also influential in the development of many pivotal inventions including the electric guitar and the multi-track recorder.

Another landmark pop sound was created by Phil Spector. He may be considered the first record producer to have attained "star" status for the sound he achieved. In the early to mid-60s his L.A. based sound was distinct and identifiable. As has been the case with a few "sounds", it was geographically limited to a specific studio which had the qualities to create that sound (Gold Star Studios in Hollywood). As time would prove, his production style was locked in a narrow band of time, yet these records remain some of the most identifiable and popular in rock and roll history. His productions were the first records of the second wave that followed the first wave of rock and roll, and were produced with all the technology available. At the same time they retained the naivete of the fifties and early 60s. The world outside the studio would put a chill on such innocence which was disappearing by the time he produced Tina Turner's 1966 classic "River Deep-Mountain High". By the late 60s, Spector's innocence seemed out of place as pop music found its voice of awareness, concern and outrage. Spector's heyday was just before the proliferation of large multi-track recorders (greater than 4-track). His sound was achieved with full orchestras playing with a rock rhythm section. 8 and 16 track recorders would change this production approach. Multi-track recorders meant a few musicians could produce a large sound through the overlaying of multiple performances as Les Paul had done. Once the small group had completed most of the recording, "sweetening" might be added to the basic tracks by bringing in session musicians who would play strings (violins, viola, cello, harps etc.) and horns (trumpets, trombones, saxes, etc.).

The Beatles, under the tutelage of producer George Martin, evolved their sound continuously throughout the group's recording career. They started with Spector's simplicity, but moved with the mood of the time embracing the available technology. They were a rarity in that with each new album they were able to push the boundaries of commercial pop music farther and farther into artistic and experimental realms of the avant-garde. Near the end of the group's career, when "Come Together" was released, those who heard it for the first time decided it had to be the Beatles because it was so different from anything else they had heard. They were able to produce different and increasing experimental records while maintaining continuity and wide popularity. By the mid 60s they had established such a tremendous base of fans that they became the authoritative definers of pop music trends and styles. They did not need to follow fashion, they were fashion.

The Beatles set the standards that have been followed to this day. Occasionally the Beatles would have a weak cut or be a bit self-indulgent, but they'd always find their way back to the legacy of that long and winding road. Their sound, as orchestrated by their producer, became
the benchmark for nearly all other acts of the period. Each Beatles' album brought with it innovation and new sounds that other producers would build from. Even after the Beatles broke up, for some years afterward, McCartney and Lennon independently had albums that the rest of the industry modeled. The sounds they created reflected the technology of the time and set the stage for the next generation of music production.

The Beatles were also the first pop act to release concept albums starting with Sgt. Pepper's Lonely Hearts Club Band. Triggered by the success of this landmark release in the late 60s, henceforth pop albums were not merely collections of singles. An increasing number of acts constructed thematic albums which cohesively connected the songs. While singles from many of these albums were AM hits, the concept album was designed to take advantage of the high-quality transmission of FM stereo which, by the mid 60s, had become an important part of the counter culture, and record promotion and marketing. The wide proliferation of compact stereo record players in the hands of college age adults also encouraged large portions of them to gather with friends around their playback system, for an evening of wine, weed and reflection as they listened closely to the content and sounds of dozens of popular concept, sound oriented albums that became the progressive rock era of the 70s.

"The sound" is a formula

"The sound", in many cases, could be described as a formula and naturally enough each subsequent wave of music producer builds on and modifies earlier formulae. The ingredients which make up these formulae come together as new devices become available. Some formulae come and go without major influence on the public while still exerting influences on later generations of music producers who may take these earlier sounds and create new ones that then have significant impact on the public. Formulae are often so identifiable with the state of the technology that in some many cases it becomes easier to place the period of production than the actual artist. As earlier mentioned, the emergence of many artists into the public consciousness is often directly associated with some new sound or trend. In later years artists may develop distinct qualities that separate them from their peers, but their initial release may be indistinguishable from a prevailing popular sound or in some cases a formula of the past. In many cases, artists will attempt to copy a successful formula in order to achieve a common extension with an already popular and clearly identifiable quality, or they may simply be so influenced by an earlier artist that their early style replicates that of their influence. A case in point is the first record to have wide success from Dire Straits. The 1979 song “Sultans of Swing”, sounded very much like something Bob Dylan would have created during his first electric period. The Dylan influence would have been almost unavoidable since Dire Straits' Mark Knopfler played guitar on Dylan's 1979 album “Slow Train Coming”.

In the 70s large scale multi-track and the introduction of digital processors created a new generation of record producers with an increasing awareness of studio techniques and what the immediate technology could provide. A key factor to a successful producer's career became his/her ability to create a sound that was unique while still maintaining a link to recent past sounds. When the public buys an act with a unique sound, the producer(s) that creates it often can produce other acts using the same sonic style and taste. Their swarm of records (meaning a group of productions with different artists, produced by the same people, sounding similar) will have popularity during a certain season lasting from as short a time as a few months, to a few years. During that season these producers will find open doors and available budget from labels for whatever they want to produce. They may be so successful that a label will sign an act on their word alone. Labels will also bring them acts that are already signed and pay them handsomely if they will just take on that act, even though in many cases that act doesn't fit the producer's mould. There are many good producers who are able to evolve with the trends and change depending on the artist, but many successful producers are locked into their formula. At some point the public will most likely become saturated with that sound and move on to another.

In the 1960s, the Motown sound was created in Hitsville USA, a studio cobbled together in a house in Detroit. Motown's founder, Berry Gordy, could only afford used equipment and the bare essentials which gave recordings made there a very distinct sound. The sound was also the result of the songs and production formula of the founding Motown producers Smokey Robinson, Eddie Holland, Lamont Dozier, and Brian Holland. Their early success with this sound made it possible for them to produce dozens of acts with a similar sound, many of which had more or less success. Some of those artists were enormously popular and represented the Motown sound. The Supremes, Diana Ross, The Jacksons, Smokey Robinson, The Temptations, Stevie Wonder, and more. When Barry Gordy moved the company to California the old house became a museum, and new facilities including state of the art studios were built in Hollywood. Ironically, the Motown sound then seemed to loose its distinction. The records were recorded in one of the nation's best studios and sounded like everybody else's recordings. The place and the equipment at hand had been an important part of that original Motown sound.
Moving to more recent times the production team of Stock, Altenk, and Waterman provide another good example of an identifiable style developed by a production team. This trio in the late 80s to early 90s were able to take a successful formula and use it with a variety of artists (Banarama, Kylie Minogue, Rick Astley, Jason Donovan). Like the Motown production team they used the technology available at the time to create a unique and successful sound by exercising nearly total control over their productions. Other producers who have found a sound and then parlayed a number of artists include Georgio Moroder (Donna Summers, Midnight Express, early 70s), Karl Richardson and Alby Galuten (BeeGees, Saturday Night Fever, late 70s).

In several cases, a group of session players have created a formula. A prime example was the L.A. “Wrecking Crew”, featuring the rhythm section of drummer Hal Blaine, and bassist Joe Osborne, who made countless slick sounding “Hollywood” hits with the Righteous Brothers, Ronettes, Beach Boys, Mamas and Papas, Jan & Dean, The Monkees, Simon and Garfunkel to name a few.

A second example is the Stax’s rhythm section of the 60s. Stax was a small label based in Memphis with a studio located in a rebuilt movie theatre. Its greatest success was in conjunction with acts on the Atlantic label. The house band was successful in its own right as Booker T and the MGs. The band was originally called the Mar-Keys. The guitarist was the legendary Steve Cropper. Most of the hits of Carla Thomas, Sam & Dave, Otis Redding, and Wilson Pickett (to name a few) were backed up by this band. It was the Stax sound that was central to the film “The Blues Brothers” in which Cropper and Donald “Duck” Dunn on bass also performed.

Another was the Mussel Shoals Rhythm section who lived in a small town in Alabama. Cher, The Stones, Aretha Franklin, and Etta James, were but a few of the artists who made the journey to this small town in Alabama. Like Hitsville, Muscle Shoals Studio is another example of something changing when improvements are made. The original studio was a converted concrete block and feed store that had been equipped with a bare minimum of equipment. Artists came from all over the world to work in that funky studio outside that tiny town, with those musicians. Most of those who came through signed their names on the bathroom wall that doubled as a vocal booth. Then, after all that success, the Muscle Shoals band decided to build a “real” studio down by the river with better equipment and a professionally designed room. But the magic was no longer permanently in residence. The Muscle Shoals Rhythm section remains active and great record are still produced there, however, the magic comes and goes like it does everywhere else. There was just something about that funky old block building on a dusty road outside of a little town in Alabama.

The Sound Of Nostalgia

In the 90s, a substantial percentage of current releases have some production aspect or sound taken from the past. The song is new (sometimes), but the sound(s), style and/or formula come from an earlier time in pop music. The do-wop sound of the 50s is commonly heard and has been used by Billy Joel (River of Dreams) and Colour Me Badd to name a few. The Boyz II Men “End Of The Road” single has a feel and formula more in keeping with sounds of the Mills Brothers or Ink Spots of the late 40s and early 50s. Another is the Charles and Eddie single “Would I Lie To You Baby” that has a sound and style reminiscent of early Motown or a ballad from Stax act Sam and Dave (of that same period). It would seem pop music has reached a point where nothing is completely new, and that which is old is new again. As Beadle (1993) observes, “while other art forms usually take centuries to go through the same cycle, popular music will always find some way forward, and has always tended in moments of weakness to feed off itself” (p. 9). But as Peter Travis a night club DJ points out, there are 50 years of people who have grown up on rock and roll. When rock first started there wasn’t a storehouse of oldies, it was all new. Now there is a history as Messer (1994) observes:

Rock and roll started in the 50s, so you’ve got a whole generation of people who have grown up with it, who were 19 then, and are now elderly people; and there are middle aged people who have grown up through the 60s and 70s. (p.88)

The 1990s have been the decade of reissue, review, reflection, reuse, and reprocess. According to Shales (1986) Today’s record producers have:

..the texture, style and tone of all the other decades. At least those who have been recorded on tape and film. The redecade is everything that preceded it thrown into one big electronic revue. The redecade is the decade of replay, recycle, recall, retrieve, reprocess, and rerun. When everyone is having deja vu, nobody is having deja vu. Deja vu is the prevailing vu.(p. 67)
2.

Music composition and changing concepts of time

A significant number of young people of the 90s are as interested in the music of Orbison, Hendrix, Zeppelin, Morrison, the Beatles and any number of acts of the past as they are in the music being created today. While prevailing styles may define a generation gap, rock and roll per se does not. It is not only those approaching middle age who attend McCartney, KISS, and Stones tours. A large percentage of those attending are the children and grand children of those who were first influenced by their music. This interest in rock's roots has been significantly affected by the introduction of the CD. This new medium has been the catalyst for the reissuing of nearly every recording of any significance that has ever been made and in particular the past 50 years of rock and roll. And of course with this reissuing comes not only rekindled interest by those who have long since lost their original vinyls of this material, but first time interest by those who were too young (or not around) to have experienced this music first time around. As did the first generation of recordings provide the means for Robert Johnson and Elmore James to be heard by every blues guitarist who followed, the CD has allowed today's computer based musicians to access the sounds on every recording that's been a part of rock and roll.

Recording and reproduction technologies have altered the relationship between the reproduction or playing back of a performance and when the event occurred. A number of time shifts have come into existence due to the facilities which technology has provided. Prior to the introduction of recording, listening to a performance required musicians to play their parts and the audience to be present as the program unfolded. For all participants it was a real time experience. Songs in a concert can evoke reaction in an audience, but the audience has no control as to which song the artist will play or when the artist will finish. And seldom are numbers of the audience able to ask for their favourite song to be played "one more time". For the artists' part, when they perform a concert, it exists only for the moment, and after it is done it is but a memory. They can not change that performance, review it, scrutinize it, rewrite it, or re-perform it. The changes in time and performance relationships have been incremental starting with the first recordings in the 1890s.

The first example of time shifting came with the record which eliminated the need for the musician to play the song every time the listener wanted to hear it. Before recording, the only time that existed was real. A musical performance took a certain amount of time to be played and listened to. The musician(s) and the listener(s) occupied the same space in time, and both of them had to be there for the music to be heard. The invention of recording changed the listener/performer relationship but did not change the relationship between the length of the recording and time required for the music to be recorded. Several takes may have been recorded but once one was chosen, the amount of time it took to play the song equaled the length of the performance. The number of parts in the arrangement also remained directly related to the number of musicians available to perform the arrangement.

With the emergence of tape recorders in the 1950s, a second time shift in the performance came into effect. The time it took to play the song continued to equal the time it took to perform the recording, but multiple "takes" could be edited together and tape allowed time to be cut, edited, and rearranged. The total time of the completed recording no longer represented the time it took to complete all the takes from which the master was assembled or even to play a single take that was later edited for release. The recording was now a transparently connected assemblage.

A third shift emerged with the technique of "sound on sound" recording which allowed both editing and composting. The technique of playing along with a previously recorded performance while recording on to another recorder was developed by Les Paul using disk recorders, but was not practical or commercially used until the introduction of tape recording. Once the tape recorder became available, this technique became viable in music production. With sound on sound there was still no way to make changes to earlier layers of the composite. It did, however, provide a means for the musician to add parts to a recording, hence a fourth time performance variance was reached with the number of musicians involved in the recording no longer directly related to the number of parts in the final product.

Multi-track provided a fifth time performance shift in contiguity. With the technique of recording parts on separate tracks, it became possible to return at any time in the production process and re-record them. In order to make these changes the performer(s) were required to replay the parts. This technique was also popularised in music production and magnetic recording by Les Paul, however, in film sound it had been used from almost the beginning of optical sound recording in the late 1920s. In music production a combination of multi-track and sound on sound techniques were common practice until large scale multi-tracks and synchronisers were developed that provided almost an unlimited number of tracks. The Beatles recorded almost all
of their recordings on two 4-track recorders. When one was full, it would be mixed with new parts onto another 4-track recorder.

The sixth shift was of the sound itself. With the invention of the sequencer and the MIDI-controlled sound module, it became possible to change the sound of a part without replaying that part. Something that had been first conceived as a horn part could in a moment be changed to a string part. The seventh shift is also associated with computer-controlled MIDI systems and is the method of playing the parts. MIDI has allowed composers without performance skills to use the computer and various devices to generate the notes and to use word processing type features to cut, copy, edit and paste loops and small phrases of notes into complete composition and move notes with simple “point and click” mouse control. The eighth shift has been coming for some time with the introduction of random access digital recording and samplers in the late 1970s. The sampler has allowed the deconstruction of previously released or recorded material, and its reconstruction into a new form of music. In the 1990s virtually all time base and performance restraints have been eliminated. The notion of original artist’s rights has been thrown into question, and ownership of every aspect of a previously recorded production has been thrown into litigation. The effect of samplers on music production is almost a sub-theme throughout this paper since it goes hand in hand with the creation of the CD which has provided the samplerist with sounds from every period of recorded history. The sampler has objectified the fabric of a musical performance, the very “sound” itself.

The eighth shift has come with the latest delivery technology which gives listeners the power to change the sequence of performance and, given the tools and talent, alter the sounds of the performance and add sounds of their own. In the 90s even the listener has been given the power to alter the performance.

Ephemeral time

Sound emanates and occupies space and can only exist as a continuous event across time. Like time, any given point in space can only be described in relation to what has passed and what will occur and can only be observed as a thing of change. Sound is always in motion until it ceases or dissipates. Sound is never stationary. It is a continuous stream of moments of audible vibrations across endless time. To stop sound is to create silence. As Walter Ong (1982) puts it “Sound exists only when it is going out of existence.”(p.71) On record, each of these continuous moments are exactly placed in the relative time of the recording. Recorded music is conveyed electronically by means of a captured performance, be it live or through overdubbing. When performers play songs the length of their performance will probably vary, but once on record, the length will not change. These “fixed moments on... have become... the principle object of fascination. Recorded music has harnessed time and space, transforming a given performance into an article valuable unto itself” (White, 1994, p. 56-60). It is a parcel of time. Before the introduction of records someone may have had the opportunity to hear a song once in a lifetime, today people can hear it whenever they want, as often as they want. These parcels can be repeated at will and reorganised any way the owner may choose. The music listener also has the opportunity to have multiple versions of the same song. The rarest and most spectacular of programmes are now “accessible to a multitude of people, and become repeatable outside of the spectacle of performance” (Attiell, 1977, p. 100).

In the age of multi-track, recordings of live performances are seldom immune to reconstruction and repair. Nearly all live recordings are remixed from a multi-track recording of the performance, and the recording of multiple sets, and in many cases an entire tour, allow the producers to assemble the best selections. It is also common practice that some of the individual tracks might be re-recorded to improve a shaky live performance. New parts may also be added as well as enhanced audience reactions. A “live” album seldom is.

In the early 70s Carlos Santana made a number of albums with different people. One of the projects was with drummer Buddy Miles, the leader of the band “Electric Flag”. Santana had played with Buddy in New York and the two of them made arrangements to team up for some recording and a few concerts. One of these concerts was a large festival in Hawaii. CBS contracted a mobile recording company based in Hawaii to provide the truck and all the recording equipment. Since Hawaii is out of the mainstream of recording, no one making the arrangements from California had any real idea what the equipment would be like. When the engineer and producer got to the concert, they were shocked by what they found. None of the equipment was up to what was required and the recording equipment was interacting with the PA with the consequence that the recording microphones had a significant amount of hum.

Nor did the lead up to the concert go well, with the relationship between Buddy and Santana becoming increasingly frayed. When the two of them had met in New York a few years before, Santana was still into the rock and roll life style and at the time he had more in common with
Buddy. When Santana went back to his roots in the mission district of San Francisco, he had also found religion through guru Sri Chinmoy. While working with Buddy seemed like a good idea at the time, the reality left something to be desired. Buddy's hedonistic ways and his bawdy gratifying personality ran counter to Santana's newly awakened spiritual view of the world. Buddy wasn't all that pleased with Santana either believing he was puffed up with his own cosmic importance. By the end of the concert Santana and Buddy were ready to kill one another. The concert was acceptable but the recording was dismal. Back in San Francisco, the recordings were considered almost unsalvageable. On top of that Santana wanted nothing more to do with Buddy.

The label had spent a lot of money and insisted that something come out of the remote, so a process of making a manufactured "live recording" was begun. Everything except Buddy's drums were re-recorded. Even the audience reaction from the Hawaii concert was flawed so audience reaction was found in the recordings that Santana had made the previous year at the Monterey pop festival. In order for the audience reaction from Monterey to not sound phony several days were spent creating a reaction tape with applause segments, oohs and ahs, and in-sync chanting. Also created in the studio was a sense of ambience similar to that which is heard through a large PA playing to tens of thousands of people. In the end the final record sounded like a live album. It was never considered one of Santana's best efforts but the public bought Carlos Santana & Buddy Miles! Live! and believed that what it was buying was something that had actually happened in Hawaii. Everyone received royalties including Buddy, and the record was a profitable venture. The album was an amazing trick of time.

From the outside looking in, from the inside looking out

Modern recording technology has created a new relationship between the listener and the artist. When listeners hear a song, they know how long it is, and where they are hearing it, but they have no idea how long it took the creators to make that recording or what equipment was used, and only by further investigation of the liner notes or other sources would they have any idea where it was recorded or specifically by whom. At the other end of the process, creators have no idea how many people will hear their effort, or how many times over and over they may listen to the recording. In many cases the artist's feedback is in the form of record sales and a range of other indicators associated with the marketing of the records (air-play charts, record store promotions, fan letters, T-shirt sales, reviews, etc.) Even live concerts are directly influenced by record sales in the form of tour support provided by the label.

Pop artists' success is most often judged by their record careers. Even if their recordings are widely popular for only a short time they will be expected to perform those songs no matter how many years may pass. A significant number of those who attend their concerts will be familiar with those records, and will expect artists to faithfully reproduce them in concert. Attali (1985) notes the irony in this when he says "people originally intended to use the record to preserve the performance, and today the performance is only successful as a simulacrum of the record" (p. 85).

A substantial amount of popular recording no longer involves any acoustic performance as the sounds are created by computer stored or controlled sound sources. The sound is not created in space, it is only heard in space. Still, we have a desire to hear the spatial experience of ambience and the impression of an environment in which even these sounds seem to be "performing". Modern contemporary music production seldom attempts to build a realistic acoustic environment to represent the natural acoustics of a venue. The environment in which the pop music production is wrapped characteristically involves multiple overlapping environments that are unreal but which the listener accepts, and, in fact, desires as part of the sound. The sounds are larger than life. The proliferation of surround sound encoded recordings and the increasing sale of surround sound home systems is one more example of a sound experience being created and delivered that is beyond the documentation of a live performance.

The significance of the separation of artist's live performance from their recording persona is multi-faceted. It has changed what musical artists are, the skills they require, where they make most of their income, the thoughts and themes they portray in their music, and how they approach and implement the creative process. It has also changed what the public expects they should be as it is most often based in the first instance on a video clip and a recording, and possibly only later on a stage performance. As a percentage, only a small number of record buyers will ever see a concert of the act whose records they have. The artist today creates a production in the studio and usually delivers a live performance that mimics that creation. This is what the public expects to see and hear. In the 90s, such record quality live production has become common. In 1966 such was not the case. In the 60s technology of the studio far surpassed what could be presented in a live performance. In an interview a few days before the Beatles last live concert, drummer Ringo Starr commented that the sounds on "Revolver" made performing live nearly impossible.

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We can't do a tour like before because it would be soft of us to go on stage, the four of us, and try to do records we've made with orchestras and bands. We'd have to have a whole line of men behind us if we were to perform. (Kleinfelder, 1993, p. 430)

There was a time not that long ago when those coming to a live performance did not come with a concrete vision of what they were going to hear. In the 90s, artists will use all of the devices of the studio during their live performance to create a nearly perfect match between their live sound and the sound of their recordings. The majority of the public expect nothing less. Recorded music once represented a musician's best live performance, now the best live performance must closely emulate the recorded art. The live performance in effect imitates the recorded art. With today's technology almost anything can be duplicated with very few gaps between the "on stage" performance and the recorded one. What's missing is so small that when the act is seen and heard in concert, an audience familiar with the material, tends to fill in those gaps. The mind's ear constructs all the "missing" parts as though they were also there.

The performance expands on the music in the spectacle of the event, the lights, staging, big screen TV, inflatables, gantries, fireworks, and sheer loudness of the sound. It is common practice for those performing to be listening on hidden wireless earphones to playbacks of a recording specially prepared for the live performance in order to maintain precise timing with the lights, fireworks, and other effects. While the live performance of acts may be controlled or at least affected by their recordings, in the studio, acts have the opportunity to re-invent themselves. During this time they have the opportunity to exert total control, often marking the beginning of a new phase for their career. With the album, the subsequent tour will most likely bear the same name and feature most of the album's material.

The fan's desire to be a fly on the wall

In the studio artists can create every bit of music that is heard. They can create a space that is filled with only their input and choosing. Though their music may reflect all of society's influences, they have the opportunity to filter it in any way they choose, void of any synergistic influence from other musicians (if they so choose). The space they create is singularly theirs. They can take almost an unlimited (budget permitting) amount of time to complete a production. They can restrict access to such a degree that the only person who will eventually enter this manufactured space will be the listener, who, by playing an artist's completed effort, will occupy the same space created by the final mix. The boundaries become finalised with the issuing of the product. Many music fans are fascinated by the recording studio and the process of production. When fans buy the record it is as though they have earned the right to sneak into the control room, put on the recording and push the play button, so they might share the space created by their selected artist. Many would like to be a fly on the wall while the music of their favourite artist is being constructed, shaped and evolved. The music conjures up in their mind the spirit of the performer they're listening to, but these aberrations never materialise. The listener and the spirit they unleash when a recording is played, exist in different places. As Eisenberg (1987) observes,

The record listener and the musician - like the stargazer and the star, like the man and his familiar ghost - do not inhabit the same world. This is the premise of their intimacy. And their intimacy is even closer when the ghost is not seen, since it then seems that the two worlds are not tangential, but coextensive. (p. 57)

There was a time when to listen to a record would evoke a memory of musicians playing the instruments that were heard. Average listeners had some idea of how a guitar, piano, drums, and bass might look and sound. They could play "air guitar" along with Pete Townsend or Jimmy Page because they could imagine fingers moving up and down the frets as the guitar pick moves its way through melodies. Today more often than not, the sounds don't instantly evoke the instrument that creates them. It is less clear as to what is making the sounds and how they were "performed" due to modern technology. Listeners may know someone who has a keyboard that makes all sorts of sound, but exactly how it happens is far beyond them. For listeners, the technology has provided greater access for them to participate in exerting some control over what they hear. However, its complexity has clouded any association between performer and performance. Records and the technology of the record production process has allowed the typical (non musician) listener to experience music outside of a framework of musical performance or musical instrument playing. The public will even buy different versions of the same recordings which seem to satisfy its desire to have some part in the decisions of productions in certain recording. The "dub" version of recordings, made famous during the heyday of Reggae, were particularly interesting since an entire album would be made of different versions of multi-track mixes of the same basic song. Today, many dance records have the same song remixed several different ways.
while Rap, Hip Hop, DJ scratch, and much of techno have no association with an instrumental performance but are attached to a presentational performance more comparable to poetry reading or an avant-garde art piece than a musical performance.

**Authenticity and the cringe/whinge against the technology**

As was mentioned in the introduction of this paper, there were those who despised about the effect of records on music as it had been previously known. Later, there was despair about the effect of radio, then despair about the jukebox and background music. When multi-track recording became a reality, despair was widespread and continues today focused at MIDI control, computers and samplers. There is little chance that despair by some will subside since there will always be those who view the present and future as less than the past, less "genuine", less "authentic", less "original", requiring less "musical skills" and so on. Technology in the 20th century has accelerated the changes that have occurred in music production, but such change has existed from the beginning of civilisation. Only in the past, it was simply much slower and gradual. Resistance to such change has many reasons. The most common are encapsulated in the phrases, "the old ways are best", "there is a tradition", "that wasn't how I learned it", "it will affect my job", "I don't understand it", "it's not like what I know", but the most likely, though seldom admitted is "I'm threatened by such change" and "it's something I can't control".

New technology provides new opportunity and its introduction by inventive, experimental, and creative popular artists has always meant that certain other musical factions have resisted or at least disliked it. As far back as 460BC, Terpander, a Greek musician of great note and eminence for his incomparable mastery of the harp, added another string to his instrument for the sake of variety. Though he was held in high esteem for his virtuous and heroic deeds, his deviation from the norm created such an uproar that the ruling council took his harp away from him, cut the string, and then spiked the offending instrument to a post for all to ridicule. (Portnoy, 1954, p. 20) The belief was that such change was influenced by evil spirits. In the 20th century a goodly number of popular music critics would seem to share the view of the Athenian ruling council.

Other critics focus more on the issue of "authenticity." The authenticity of recorded music has been questioned from the beginning of its technological evolution through to the present. In the beginning of record production, recording was primarily a process of getting a good performance and documenting it. The recording was a reproduction of the time and place of the session. But these first records were seldom representations of a live performance since the medium dictated the choice and style of production. The choice of music for the first records was that of marching bands. In those early days it was the only music loud enough to push the embossing stylus into the tin foil cylinder. Not only was the selection and placement of instruments and hence material, dictated by the technology, almost immediately new instruments such as the Stroh violin, viola, cello, mandolin and guitar were invented specifically for recording. They were invented by Charles Stroh and were considerably louder due to the addition of an amplifying horn that was attached to the wooden body. They were often intermixed in a recording session with their conventional cousins.7

What is more at the heart of the matter is to question the standard of comparison by which something is judged authentic. If the reference is a live performance, there is some difficulty if, as is the case with many acts, the live performance only comes after a successful record. Then, the record may be considered more authentic than the live performance. Possibly what is needed is to change the viewpoint of the musical performance when we consider the authenticity of a contemporary record as compared to a live performance. When we go to concerts we see performers from the perspective of a member of the audience - they are at a distance and loudly amplified. When we hear them on a record, we are standing next to them, or possibly sharing their inner thoughts. If there is any hint of an audience we see them through the eyes and ears of the performer. The record/CD buyer is well aware that the record/CD is not a live performance but is something produced (and reproduced) by the turn of a volume control. "There is no real element of substitution, since the sounds are created in exactly the same way for the audience as they were for the performer; through the activation of a loudspeaker by electrical impulses" (Mackay, 1981, p. 93).

As Frith (1992) observes:

...music machines have not, in short, been as dehumanising as mass media critics from both the left and right perspective have suggested. For a start it was technological development that made our present understanding of musical "authenticity" possible. Recording devices enabled previously un reproduceable aspects of performance — improvisation, spontaneity — to be reproduced exactly... This affected not
only what sort of music people listened to, but also how they listened to it, how they registered the emotional meanings of sounds, and the musical shape of their own emotions. Recording... has extended the possibilities of expression in all pop genre. (p. 69)

The acceptance of a new viewpoint does not mean this new position can be entrenched. The changing environment of recorded music and its production must be constantly reviewed in light of the technologies of the moment. As Goodwin (1992) puts it, "In undertaking that task, we have to recognise that definitions of music and musicians have changed. The new technologies of pop music have not created new music. But they have facilitated new possibilities..." (p. 97). A record/CD is not necessarily a representation of a performance, but it is always a means of expression. Records are authentic reflections of a musical artist’s feelings, beliefs, and creativity.

3.
“I know it when I hear it”

A popular record appeals to a large cross section of the public. So many different types of records have been hits that it is impossible to identify a unifying tangible characteristic that exists in all, or at least most hits. The record industry has tried to quantify it, but in the end only intangibles provide a common thread. A popular recording holds a certain elusive essence some call soul, others call magic. And while they may not know exactly what it is, or how to get it, successful people in the music business have a certain gift at knowing it when they hear it. Intuitively the public also knows it and will crave to hear such recordings over and over again, and if people are sufficiently moved they will purchase the record. Eventually their desire to hear it over and over again will dissipate, but it is likely that at some future playing they will again be moved.

Some artists are much better live and their recordings never seem to capture the intensity that they can so easily generate when performing. Others are much better suited to the art and craft of recording. The Checkmates, a highly regarded soul band, and The Tubbys, a very visually oriented band are two such examples of acts that were never able to produce records that had the intensity of their live performances. On the other hand, Steely Dan made recordings that held an intensity that never appeared in any of their rare live performances. Donald Fagen and Walter Becker once said that what they really enjoyed was writing songs and then recording them. They had little interest in performing live. They would have had just as much fun doing it on a four track in their basement as they did working in isolation for a year in a state-of-the-art studio. It was the process they loved. It didn’t bother them to hire somebody like guitarist great Lee Ritenour to come in and play fifty takes of the same solo.

Technology and contemporary production techniques capture what are often referred to as magic moments. Sometimes these moments are continuous in that three or four people play together at the same time to create them. Often the magic is scattered throughout special moments in a single recording session, but more likely those moments will be separated in real time and space by weeks or months and thousands of miles. The multi-track process becomes the bridge between these moments. (The development of multi-track recording, associated professional and industrial practices, and their impact on the creative process are the subject of the second half of chapter 3). Multi-track developed a whole new recording art form that is constructed from isolated segments, often one musician at a time. If everything is working, the process can seamlessly bridge the gaps in time between a great rhythm section track that was recorded in New York City in September and a phenomenal vocal dubbed on the track in Los Angeles the following June. When all those moments are put together, an aura of the whole will emerge that is greater than the sum of all the parts. Hopefully, what emerges will be a focused vision as the fragments are added and the project moves to some completion. The combination of the various egos or alter egos as captured on each track will sum to contain that identifiable essence of a hit recording. Needless to say, achieving this quality is exceedingly difficult. Sometimes, these overlapping moments of time and space are magical and when they combine they coincide. Sometimes the best fragments work against each other to form a dissonance between and within the energies. Magic can be so unstable, so explosive, constructive or destructive, depending upon how the energies are combined. Modern production techniques allow constant review and redo but sometimes the striving for perfection in performance results in a moving rendition being altered in attempts to “improve”. The Navajo Indians believe that in perfection there is no soul. When they make a blanket there is always a slight, intentional flaw somewhere in the pattern. In the process of making records, it often happens that the “demo” of a song has a better feel than the “master” does. When a song is first recorded the sound will often possess something, a hidden spirit, that is lost during the process of polishing and perfecting. Everything done throughout the process can re-enforce the magic or disappointingly neutralize it. Certain blends and balances capture the essence while others do not.
The technology allows the creation of product which might have artists' input but not their participation. A great many musicians in successful acts are so busy that they can’t afford the time to be in the studio through the whole creative process. In a good many cases, if the production is being supervised by a producer, the band, or at least the less involved members, may simply become bored and would rather use their time doing something else. The only time they may show up in the studio is to add parts and to review the final mix. Nor is it unusual for the act to be on the road when the final mixes are completed and for them to give their final approvals based on what they hear on a DAT playback through headphones, a car stereo or portable playback system in a hotel room. The technology however, does allow the producer to make significant changes without the act’s participation and the act may simply have to wear it since the label may decide to agree with the producer’s approach.

Sometimes releases in different countries are not in keeping with the wishes of the act or producer. Such was the case when Capitol Records released in the U.S. poor sounding stereo records (drums right, bass left, etc) of the Beatles singles which were intended for release in mono. Occasionally artists are able to stop such meddling, providing they have the stature to prevail with the powers that be. In the mid 70s, at a time when his last several albums had all been huge sellers, Carlos Santana was phoned at home one day and told by an engineer friend at the studio that the local artist and repertoire (A&R) manager for the label was in the studio editing a new version of an upcoming Santana single. Santana knew nothing about it and decided to drop by the studio to hear what was going on. When he got there the A&R manager was a bit flustered that Santana had shown up unannounced, but his ego was large enough that he quickly recovered and offered to play Santana what he described as the next single. Santana hated it. An argument broke out. The A&R manager informed Santana that he had gone to school to learn how to do this. It should be pointed out that the A&R manager had never produced a hit and had the job because of a close personal association with the head of the label. Santana told him that they had obviously attended different schools and left the control room telling him that there was no way his version would ever see the light of day. The A&R manager maintained that he had the confidence of the head of the label. Maybe, but so goes the story, Santana talked to the head of the label, and the A&R manager’s version was never heard of again (except possibly on his car stereo).

Posthumous performance

Modern technology has also created new works from artists who have passed on. There have been many cases where recordings have been started by an artist, but an untimely death disrupted the completion of the production. These “in progress” recordings of sonic images begun in a certain time and space are often completed in time and environments totally different to those originally present. Nonetheless, there is little question that the spirit held in the original recordings has a significant influence on those who complete the project. A few productions provide for interesting examples.

The Doors usually wrote and recorded their songs by first listening to Jim Morrison recite his lyrics. Sometimes he would have an idea for a melody and sometimes the band would just try to establish a musical feel that fitted Morrison’s poem and build the melody from that. When Jim died, The Doors recorded two other albums, but without Morrison the heart and soul of the band was gone and the albums were not successful. They eventually stopped playing together and went their individual ways. Several years after Jim’s death, Robby Krieger, John Densmore and Ray Manzarek got back together to compose the music behind Jim’s poetry readings for “An American Prayer”. All of the Door’s albums prior to Jim’s death were engineered by Bruce Botnick and with a couple of exceptions produced by Paul Rothchild. The Doors did most of their song writing in the studio. Jim would bring in a poem and the band would begin to craft the words into a song. Many times Morrison would not write the words down but recite them from memory into a tape recorder. For many of these poetry readings, Jim would work with another engineer, John Haeny, without the rest of the band or the producer around. For this reason Haeny had a closer awareness of the poetic material that was never used than the rest of the band or Rothchild. John’s memories of those poetry readings stayed with him for years.

Jim and John had discussed the idea of releasing an album that was more poetic than musical. The album would have a theme reflective of Jim’s belief that when he was young he had been possessed by the spirit of an American Indian Shaman who he had seen die. His family had been
on a desert road and passed by a car accident that had been fatal for the Indian. Jim and John spoke often of this incident when they were working on the poems. John's commitment to the project grew as he continued to reflect on what Jim had said. The unfinished recordings of poems became an unresolved obsession. By the mid 70s John had come to the conclusion that the poems could and should be released, and felt that they would be best presented with music from the original members. He negotiated with the Doors label, Elektra, and with the copyright holders of the Morrison estate. He also got agreement that the original members of the band would participate in creating the music.

The first step for John was to collect all of the poems, not just the ones of which he was aware. Some of the recordings he found and wanted to use had been recorded by Jim on a domestic recorder in his hotel room in Paris. The quality of these recordings was not particularly good. John took these low quality tapes to the only company at the time offering digital processing, Soundstream, based in Salt Lake City, Utah (recall that this was the mid 70s and digital processing and recording were in their infancy in commercial recording). After he had cleaned up the tapes the production process began. The poems were introduced to the members of the band and the score to fit the poems was composed. Of course, this time they couldn't ask Jim to speed up, slow down, or wait a few bars, but they did what they could electronically by editing different bits of Jim's voice in and out while still trying to keep a consistent flow to the readings and their message. Through the recorder's ability to transcend time, they worked as they always had, except Jim's physical presence was replaced by a spiritual one. In the time since Jim had died the technology had also advanced so there were differences in production techniques. For instance, the number of tracks available had multiplied by a factor of three (from 8 to 24 track).

The creation of "American Prayer" had been a project driven by the interest of John Haeny, but once the other members of the band got involved they too became mesmerised by Jim's spirit held captive in old recordings and now resurrected. It brought the band and Haeny back to a point in their lives some many years before. When the album was released in 1978 it was acknowledged as a fitting final album for the Doors and Morrison. Hearing the album, the listener could imagine that Morrison and the band were again sharing the same physical as well as emotional space within the illusion of playing and singing on the same recording. The reality was an amalgam of time, an overlapping collage of events that through the process of recording had been combined as a single event that could be re-experienced every time someone played the record.

Another interesting example of posthumous recording is of Jimi Hendrix whose popularity seems to have been rekindled in recent years, attracting a wider market than he achieved during his life. After Jimi's death there were many records released as either being by him or his band The Experience. Jimi's early recordings were well managed and produced by Chas Chandler, and later by Eddie Kramer, but much of his later studio work was primarily self produced and poorly organised. Most of these recordings were musical wanderings, fragments and riffs of little direction and redos of previously recorded material. At the time Jimi was attempting to produce himself with no success and Kramer was busy supervising the construction of Electric Lady Studios. Once Electric Lady was completed, Kramer was brought back into the picture in an attempt to put some discipline in Hendrix's sessions. In the late 60s the scene in the village where the studio was located was rich with live gigs so Jimi would often jam with players he would meet in the clubs. They would come back to the studio after the clubs had closed and after the previously booked sessions had concluded, and would record until dawn. If inspiration hit, great, but most sessions were so filled with various libations and groupies that little was accomplished. It all sounded great at the time, but in the morning would seldom warrant a relisten. The label kept paying its portion of the bills figuring that anything Jimi did was bankable. It was a time when the record business was so profitable that labels didn't pay much attention to production budgets. It was a time of technological indulgence and creative excesses that would last into the mid 70s.

Jimi was committed to the idea that at any given moment something great would happen so the multi-track was left recording at all times. None of it was ever recorded over since Jimi believed that anything might be returned to for reference or further production, but of course it seldom was. The number of tapes that were stored in Electric Lady's vaults grew and grew as the sessions went on, and later they were added to by the consolidation of tapes that had been recorded at other studios before Electric Lady's opening.

After Jimi died, the production company attempted to mine enough songs from the tapes to satisfy contract requirements to Jimi's label for more Hendrix albums. Rough mixes were made of all of the tapes. It took months of early morning sessions. Unlike the original sessions, none were dropped by for these sessions. When each tape was put up, it would be played through and the musical sections copied to a tape that could go to Eddie Kramer and the production company.
(When Chandler withdrew from a production role due to differences with Jimi, Kramer took on the unofficial role of co-producer, though in Jimi's lifetime, Kramer was not officially acknowledged in this capacity. Kramer did three of Hendrix's albums before Jimi's death and four posthumous albums.)

When the rough mixes were made, the studio lights were dimmed. With the multicoloured ceiling lighting at half glow, the studio looked much as it had been when Jimi was working. In between the music recordings was also recorded all the discussions between the people who Jimi had invited into the studio. While remixing those sessions, the engineers would occasionally find themselves drifting off to those sessions when Jimi was still on the other side of the control room glass. His presence was surely felt. When the mixes were completed and reviewed, to everyone's dismay very little of the recordings were complete enough to release. There were only a handful of "songs" that were fully produced with quality performances.

Kramer, took on the job of doing what was necessary to finish the recordings. Noel Redding and Mitch Mitchell were brought back into the studio to work on the tracks. Jimi's late night sessions were methodically added to in order to create enough music to make three more albums. There were those close to Jimi who disagreed about the manufacturing that was going on, but Kramer felt that as long as the additions were faithful to Jimi, then the authenticity would be maintained. Some of that work came frighteningly close to materialising Jimi. When Kramer was working on "Drifting" he discovered that all he had was a "direct" guitar part from Jimi. It had been intended as a guide track, and would have been replaced later, but later had never come. Kramer took the direct sound of the guitar and ran it back through one of Jimi's Marshall amplifiers that was in the studio. He adjusted it for the right amount of distortion, miked it, and re-recorded it for use in the final mix. All the lights in the studio were off and the only thing that could be seen was the green glow of the pilot lights on the front of the Marshall's electronics. It sounded as though Jimi was standing in the studio playing through the amp. Kramer (1992) recalls the incident.

The back door of the studio had been open and in the midst of transforming the sound to tape, an assistant engineer was started to hear Jimi's screaming guitar in Studio A. He came running into the control room flustered, his face white as a sheet, sure that he had heard Jimi playing again, before he had realised what I had been doing. (McDermott/ Kramer, p.378)

Kramer would probably agree that while Jimi's physical presence was no longer there, his spirit was surely with them. The final recordings seemed to hold the same time base continuum, but the construction was anything but. Over the following decade many records were manufactured from the fragments of other Hendrix sessions recorded in many other places. Many of these records would involve players even further removed in time and place from the original tracks and Jimi's original intent. In some cases Jimi's guitar parts were added to or rerecorded by other guitarists. These were the albums produced by Alan Douglas. These albums had no indication that others besides Jimi were playing the guitar. Also, cuts were tantamount to being The Experience even though they were not played by Mitchell or Redding. Yet all of them would sound like they were performed in the same time, in the same space. Not surprisingly most of these recordings underwent such change and were manufactured from sessions so inferior that they failed as representations of Hendrix's genius.

To conclude this chapter on technology's ability to alter time and store magic, a final story with a happier beginning and a critically acclaimed outcome. Natalie Cole grew up in the music business. Her father, the legendary Nat King Cole, had made countless classic recordings before multi-track became a reality (he died in 1965). A few of his hits were in fact made before the introduction of tape and most were released before the wide acceptance of stereo. Natalie sang for her father on several occasions, but only a few times did she actually sing with him. Nat died before Natalie began her successful career. Needless to say there was always a feeling in Natalie of incompleteness that she had never been able to share her success with her dad. Some years ago she discussed with Dan Cleary, her manager, how great it would be to make an album of songs made famous by her dad. In 1991 Natalie teamed up with executive producer Tommy LiPuma. The same arrangements were recreated, and in many cases the studio that Nat had used at Capitol Records in Hollywood was used. Many of the original musicians were asked to play on Natalie's remake of her father's song book. For some years in her live show Natalie had sung with her dad's recording of "Unforgettable". For the album, Nat's original vocals were seamlessly transferred to Natalie's master. "The result was pure magic. The album was enormously successful. The first single from the album "Unforgettable" was a top ten hit. The video was an extra bonus for Natalie because more magic was used to bring her and Nat together in images as well as sound. Contemporary technology had effectively manipulated time and place. Forty years separated the recording and pictures of father and daughter. In this case there was nothing
deceptive in what had happened in the studio. The public knew the times of the two creations were far apart but the magic was accepted. The public embraced the joy Natalie had in singing with her dad. Tommy LaFauna (1991), recalled how this production had affected him. “Being a part of recording these songs, reborn through Natalie, was an exceptional experience. It made me realise what a great legacy has been handed on” (Album notes).

Finally, it is also the time machine nature of modern technology that allows people to re-evaluate groups like The Monkees, whose records became cult classics long after they were disbanded. Often when artists who have been around a long time score with a hit, a new and instant respect for them seems to come with it which is accompanied by a new interest in their past recordings, many times by people who were not there the first time around. Such was the case for Tina Turner, who, with a hit album Private Dancer (1984) went from being almost forgotten to a Grammy Award winner. The industry, so quick to label someone a has-been, universally respects a survivor who can reclaim hit status. Another example of this was John Farnham’s 1988 “Whispering Jack” album which returned him to major star status after years without a hit record. He had been unable to get a major label contract and as a result the album was produced independently. It sold nearly a million copies in Australia, and millions more overseas. His success continues with many hits records since 1988. When a new hit record from an artist who has been off the charts provides such a possibility, people respond with a desire to see an artist of their past lead them into the future. It’s as if they were never down. Past resurrections of groups like Chicago, The Eagles, The Beach Boys, KISS, and the Moody Blues as well as solo artists like James Brown, John Fogerty, Tom Jones, and David Bowie are just a few that substantiate this phenomenon. Who from the past will be huge again tomorrow? Would anyone have expected a “new” Beatles record in 1996 with John Lennon singing vocals. The fab four are once again releasing product and receiving acclaim with several Grammy nominations. Who will again be the fairest of them all, if only for a season?

Conclusion to concepts of time in music production

Walter Benjamin, though writing about film, made some interesting observations that are valid, about multi-track music production. Benjamin (1969) wrote,

The artistic performance of a stage actor is definitely presented to the public by the actor in person; that of a screen actor, however, is presented by a camera, with a twofold consequence. The camera... need not respect the performance as a whole,... also the film actor lacks the opportunity to adjust to the audience. (p. 230-231)

Similarly, recorded music no longer shares the concepts of time and space associated with a live performance and as such the artist can construct, deconstruct, and then reconstruct the same musical moments forever. When we listen to records we are overhearing a time in artists’ lives and sensing the space they occupied at the time. But three minutes of music could be years in the making and involve musicians who never met when they played their particular part of the recording. Or like the Doors or Beatles, the lives of most of the members has moved along life’s highway while one of the members is only there in memory. Most record buyers understand this and accept “that recorded music is itself a kind of Illusion, sounding spontaneous but having been willingly - if not meticulously - submitted to limited conditions in order to be effectively re-experienced by the buyer”(White, 1994, p. 60). Karl Stockhausen said that when you listen to music at home and you close your eyes, “the inner eye opens to visions of time and space which overstep what the laws of the physical world around us permit; spatial perspective and the logic of cause and effect in temporal events are both suspended” (Eisenberg, 1987, p. 248).

Before we begin to explore the invention, development, and evolution of the various technologies that have affected recorded music in the 20th century, the stage will be set in the next chapter by presenting some theories about the process of invention as they developed during the late 19th and early 20th century. The chapter will then describe the development of what is considered by many to be the most important electronic invention in the 20th century- the electron amplifier.
Notes: Chapter one

1 The mid to late 60s would see John Kennedy, Bobby Kennedy, and Martin Luther King murdered. There was the bombing of the Ho-Chi-Minh trail preluding the expansion of the war in Vietnam, an acceleration of the Vietnam draft and the ensuing protest against it. Civil rights movements and violence against them, the emergence of the love generation and the drug culture. The innocence of the 50s and early 60s was tarnished by all these things and just around the corner would be the killings at Kent State where the Ohio National Guard turned their guns on a hillside of college students protesting against the war. Innocence in music was shouted out of existence by the songs of conscience that were written and sung.

2 Just follow along in your mind these song titles, paying particular attention to the changes they contributed in musical direction, innovation and of course sound: "She Loves You" - "If I Feel Fine" - "Norwegian Wood" - "Eleanor Rigby" - "Helter Skelter" - "A Day In The Life" - "Hey Jude" - "Revolution" - "Come Together" - "Let It Be".

3 To cover its investment the label's "Committee" will attempt to influence (hopefully positively) the artist and the production by insisting that others get involved who have successful track records. Unfortunately the result may be that whatever was unique about the act is jeopardised when the "Committee" insists on bringing in a "Big Name" producer who may know nothing about what is right for this particular act or producing their particular style of sound. Consequently, "Big Name" takes the band in the direction with which they have had the most past success. And so a few arrangements, a few songs and even a few key people may be changed. "Big Name" might bring in "Heavy" players to sweeten the sessions. "Committee" and "Big Name" figure this will improve the "product" because everybody is just so important (they have lunch a lot, drop names, exchange numbers, or favourite foreign car mechanics, etc.). The act may try and fit in with the "just too hip" crowd, because they think that's where they have to be. The budget goes right over the top, the "Committee" pays it because "Big Name" is insisting the production costs are justified ("The act is just so difficult"). However, most of the production money goes for "Big Name's" advance, his cronies "Heavy" player's session fees, and the Jacuzzi equipped studio in which "Big Name" is a partner. "Big Name" also takes the view that going over budget has the effect of committing the label to recouping its investment by putting a strong push on the release.

It is not uncommon for the first major label record that an act produces to include part of this scenario, and when the record is done the act feels raped and disillusioned. The producer claims they were uncooperative, and the label can't understand why it signed the act in the first place. Of course, since "Big Name" is a big name, it can't be his fault (after all the "Committee" hired him) so his career goes on in that "so cool no one ever takes their shades off in the studio", way as if nothing happened. As long as he continues to produce an occasional hit he can remain in the "Big Name" club, since he is remembered for his successes not his failures. The record and the band gets shuffled around since nobody on the "Committee" wants to take responsibility for them, and eventually they are dropped from the label. The possibility of this happening is even more likely if members of the signing "Committee" are no longer with the label and have fallen from grace. The band arrived at the front door of the label in a rented limo, but now their unsold records are sitting out back near the dustbin which happens to be overflowing with press clipping showing the band's smiling faces at the contract signing just a few months before. Cynical, yes! Truthful, also yes.

4 MIDI stands for Musical Instrument Digital Interface. It is a widely used industry standard that allows the interconnecting and control of digital sound generators and processors. The development and application of MIDI is fully covered in chapter 6.

5 The CD-M finally places in the hands of the consumers the ability to participate, in a sense as though co-producers, with their favourite act in the creation of the music they hear. The CD-M format is described in chapter 8.

7 In 1969 Jimi and his production company built Electric Lady Studios. He spent much of the last few months of his life working there. Prior to its completion he was a constant client of the Record Plant (N.Y.) and Olympic (London) as well as several other smaller studios. Jimi loved to record.

8 See Appendix 1.

9 Record Of The Year, Female Pop Performance, Female Rock Vocal Of The Year, Song Of The Year for "What's Love Got To Do With It?".
THE PATH OF INNOVATION
AND INVENTION

The path of invention

The process of invention and change has often been viewed simplistically as something which is generated by the genius of individuals, conveniently labelled as 'inventors'. This myth of the single inventor was well fostered by Edison who found financial advantage in promoting himself as someone driven to exhaustion by his visions. But as technological historian James Burke (1978) notes in his book "Connection",

No individual is responsible for producing an invention ex nihilo. The elevation of the single inventor to the position of sole creator at best exaggerates his influence over events, and at worst denies the involvement of those humbler members of society without whose work his task might not have been possible. (p.288)

History of invention is not a straight line. It is a crisscrossing of ideas, people and needs that at points in time serendipitously converge to provide the ingredients of invention. "At some point every member of society is involved in the process by which innovation and change come about" (Burke, 1978, p. 13). In fact, Edison was probably the first to collect around him a commercial think tank filled with inventive specialists in all the emerging fields of the early 20th century. A significant contributing factor to the rate at which change occurs is the speed at which information about one discovery reaches those who might use that information to make new discoveries.

The explosion in communication technology in the 20th century has rapidly accelerated the speed with which information can move from point to point. The availability of information has been a contributing factor in the ever increasing trend toward scientific specialisation. Scientists once needed to know a certain amount about everything that might affect their work. Now, specialists with a narrow focus can easily access a wealth of information outside their expertise. This has changed the practice of invention by a lone or small group of generalists to the now common practice of teams of specialists working on different aspects of the same problem. The degree of risk and complexity of high tech products and the need for substantial resources to implement commercial exploitation has meant that invention is increasingly done by teams working in labs operated by major multinational corporations such as Bell, Westinghouse, RCA, Sony, G.E., Western Electric, IBM, Motorola, Yamaha, etc. Universities and private development labs have also become principal providers of commercial innovation. Of prime importance is the understanding that invention in this century is a high stakes endeavour primarily driven by those who believe such invention satisfies some social or cultural need and always represents an economic opportunity.

Times and places

The chronology of invention is often given specific dates and spans of time are conveniently labelled. While this does provide points of reference, it is also an oversimplified view of history, "for to give any period a specific label is to ignore the overlapping nature of the passage of events"(Burke, 1978, p. 288). Throughout this paper, the year of an occurrence has been included to provide a chronological perspective, but these dates are based on the available literature, which in some cases have conflicting dates for the same events. However, inventions of the 20th century are somewhat easier to identify in terms of their commercialisation which becomes more a matter of public record. The "moment" for such invention is sometimes so ripe inventors can file for an identical patent within hours of one another. "The idea [is], so to speak, in the air ready to be seized"(Williams, 1987, p.7).
One famous example occurred on January 14, 1876, when Alexander Graham Bell filed his patent for the telephone at noon. Two hours later Eliza Gray filed his patent for essentially the same invention which he had independently developed. It would take 10 years before Bell was awarded free title to the telephone patent. Another was the patent for the vacuum tube. DeForest patented his triode tube in 1906 and called it an Audion. In the U.K., John Ambrose Fleming, the inventor of the diode tube, successfully challenged DeForest's patent. It was 40 years before the English ruling was reversed.

Common conditions of invention

While innovation and invention seems to appear from a collection of haphazard events it emerges that certain recurring conditions are present:

1) The first is that “innovation occurs as the result of deliberate attempts to develop it” (Burke, 1978, p. 289). For instance, most of Edison's inventions were created due to his seeing a need and commercial application for that new invention.

2) Secondly, it is common for “the attempt to find one thing leads to the discovery of another” (Burke, 1978, p. 289). For instance, Oersted attempted to use a compass needle to prove that the flow of electricity did not create an electromagnetic field. When the magnetically responsive needle rotated into an alignment with the wire and away from magnetic north, it became obvious to him that there was a magnetic field radiating around the wire when electric current was passing through it.

3) Another common factor that influences discovery occurs when an unrelated development has a strategic consequence on the development of the primary product. Such a convergence occurred when I.G. Farben, a large chemical company in Germany, found out that Fritz Pfluemer, an inventor working in the area of magnetic recording, had discovered a way to apply magnetic particles to paper tape. Farben had just invented a way to make superfine magnetic particles and was looking for something to do with it.

4) War is also a prime stimulant for discovery, at least for a certain type of invention. Military necessity was a significant factor in the development of radio during W.W.1 and the need for tools of propaganda in Germany during W.W. II had a great deal to do with the perfecting of the magnetic recorder.

5) Many discoveries also appear through accident and unforeseen circumstances. An interesting example happened in 1875, when Alexander Graham Bell was attempting to perfect the telephone and his assistant Watson clamped a connecting wire too tightly. The wire was supposed to provide an intermittent contact instead it became continuous. The transmission between the two experimental stations became dramatically clear allowing Watson to hear Bell request his presence in the other room.

Innovation and invention in the age of technology

Everett Rogers has spent much of his life researching, analysing, and writing about the methods by which ideas in the 20th century are disseminated, and how they are acted on to create innovation and new inventions, which in this case means ideas, practices, policies, and of course new devices. His work extends to how those inventions are assimilated and the consequence of their introduction, adoption or possible rejection. He has authored or co-authored a number of books on communication networks and theories on the diffusion of invention. From his work some conclusions can be drawn regarding the growth of the electronic technology and in particular those developments that have affected the creation and delivery of music in the 20th century.

Rogers observes that the most important requirement for innovation is a means of getting ideas from one person to another. These channels of communication are essential for the growth of ideas to expand and integrate into complete inventions. Communication is also required for new inventions to be disseminated, and adopted (or rejected) by the public at large. Without communication, the innovation may simply never make it into the mind(s) of those who could see a new application for it. In some cases advanced ideas have died with a civilisation and centuries later been rediscovered. The development of writing and more importantly, transportable writing materials, and the opening of trade routes between ancient civilisations stimulated the flow of knowledge across far-flung trade regions. Traders were not only the bearers of goods but were the conduits for news and ideas, the transporters of invention. For centuries caravans and trading ships were the main means of information flow. But until modern times, it was a slow process for knowledge to get from one place to the other, the further back in antiquity, the longer it took. At the dawn of civilisation, centuries were required before important ideas found their way into other cultures where they would be built on. Often the idea would arrive as a fragment, or as an anecdotal story from goods traders. They would seldom know the source of the information, how long it had been in existence, if others were advancing the idea,
exactly how it worked, and so on. Those who were innovators seldom had contact with many other innovators since their personal network seldom extended beyond their immediate areas and often centred around an educational community. If new ideas came from outside of the area, they would rarely have the opportunity to meet with the source of that information to discuss the development and when an idea was furthered, the advancement seldom made it back to the source of the earlier innovation. With the telegraph and then the telephone, communication between those who were working with new ideas became more immediate, though, for several decades, not particularly convenient.

In the 20th century, particularly with the introduction of radio after W.W.I, advancements in electronic communication have generated an accelerating round robin of invention. While mass media has been key to the desire for and spread of consumer technology and a general public awareness of megatrends, high speed access between individual or groups of innovators has been the most consequential for the development of innovation and the creation of inventions. Since the 70s the speed at which information can be transmitted, diffused, reviewed, assimilated, and acted on has rapidly accelerated to where there are nearly no boundaries or restriction between those interested in the latest information or innovation.

In the early 1970s the Internet was invented when various scientific and education communities recognised the advantage of having direct information connections with each other and it was technically possible. The origin of the system goes back to a network established by the U.S. Department of Defence to improve the survivability of their computer system against any of their computers taking a direct bomb attack. The idea was that if any of the computers was destroyed others would be able to operate and control those functions controlled by the destroyed computer. Over time, all military establishments became part of this network. Because of the close ties between the military and research facilities, the latter were eventually included in the scheme. Soon the system was being used for data transmission far outside of its original intent. Using the network required relatively advanced computer skills and was not suited for general access, but in 1989 Tim Berners-Lee of CERN (the European research laboratory for particle physics in Switzerland) described a wide area hypermedia information retrieval approach which would give wide access to information through the already established Internet system. This was referred to as the World Wide Web, or Web for short. Since that time the development of the Web has been extraordinarily fast due to a number of factors, but two primary driving forces have been the number of governments, in particular the U.S., that have mass marketed the concept of the Information Super Highway and the development of all forms of Interactive media (Kent, 1994). The use of telephone lines and the Internet has become an important factor in the distribution of information and communication between widely separated groups. The wide use of a fibre optic telephone system will further expand this information to real time interactive video and sound and the wide use of high quality teleconferencing.

The convergence of communication

Before this information age, communication about invention was primarily linear and seldom bidirectional. It is now convergent and networking loops are common among innovators. Ideas come to people from everywhere and they are able to directly communicate with those sources. Ideas can be developed by repeated feedback between various parties involved in the development. It does not require that a source send to a specific receiver. Once the information is “published”, it can generally be received by anyone, not just those the sender may have thought would be interested. As Rogers and Kincaid (1981) summarise:

The convergence model of communication,... is essentially “sourceless” and “receiverless... and a holistic process. It almost always involves many other individuals than just a “source” and a “receiver”, even at its most elemental level of communication events. (pp. 71-73)

With the first appearance of universities, knowledge became centralised. For centuries, members of universities and the church advanced the body of theoretical knowledge, with applied innovation coming from entrepreneurial trade people (Gutenberg and movable type, etc). The Renaissance saw the emergence of gentlemen scientists, who were wealthy aristocrats who could afford to pursue their scientific interests. Some of them were particularly gifted at putting together several theoretical ideas previously understood into something that had a practical application, or connecting together several bits of information that might solve some other unsolved mystery or problem (Watt, Volta, etc). Practical devices set the stage for the industrial age. With the industrial age, development became more focused on commercial outcomes and products, with commercial labs being set up to identify needs and then invent commercially viable products that would satisfy those needs. In electronic media the three labs of major importance were those of Edison, Bell, and Westinghouse. Later many other manufacturers would have labs, RCA, Western Electric, and Westrex to name a few. Starting early in this century, it became
relatively common for researchers in one lab to move to another lab and bring their knowledge with them. The centralisation of research and knowledge coincided with the development of these labs. Information flowed more easily between groups, barring commercial and patent considerations. Today such labs are an essential part of any high tech company.

In some countries, government-controlled national broadcasters established labs to develop the equipment and expertise which they needed to expand and improve their networks. Such was the case in Canada, the U.K., Germany, Switzerland, Australia, and many other countries. The militaries of the world became prime contractors in research and depositories of information. Commercial spin-offs from military requirements have been the driving force behind countless innovations including the development of FM radio (see chapter nine), the computer (see chapter five), and the transistor and integrated circuits (discussed later in this chapter).

One of the most important centralised sources of information was set up during and after W.W. II by the Allied forces to collect and report on any new discoveries it came upon as the army moved across Europe and Japan. It was through this information clearing house that improvements in magnetic recording discovered during the war by the Germans would immigrate to America, where it would be commercialised by Ampex (see chapter four).

During the last 25 years, the number of sources and receivers of innovation have grown dramatically due to the diversification of high tech development and manufacturing, the proliferation of computers and those who can operate them, and the establishment of global data networks such as the internet. The number of information pools are equally vast, ranging from large general and scientific libraries to extremely small specialised information services, any one of which could hold strategic information for invention and innovation. These computerised networks are well connected and organised, but such diversity has meant a regression to decentralised information pools.

While access to the information is not difficult, the problem for a researcher is knowing where to look. In the late 20th century there is so much information that an overwhelming majority of it is simply overlooked. One of the biggest tasks faced by researchers is choosing which information is useful to them and what they will not bother to even look at due to lack of time. The sophistication of internet search engines has become a key tool the researchers in their quest to evaluate, screen, and retrieve information which they will find useful.

The determination to read a certain article depends on its relevance to immediate requirements and whether the researcher knows the author(s). As Rogers comments, “The diffusion of invention, thus, is essentially a social process in which subjectively perceived information about a new idea is communicated” (Rogers, 1983, p. xix). This approach is reasonable for someone who is experiencing information overload, but it tends to limit the sources of new ideas and prevents applicable transferable ideas in other unrelated networks from entering into the thinking process. Such was the case in the implementation of AC bias, a design concept that was used in radio broadcasting decades before its implementation in magnetic recorders (see chapters four and chapter eight). In extreme cases this can even happen in large corporations that have several research cells. For instance, at Sony, the designer team developing a small cassette recorder/player was unaware of another team that was perfecting light weight stereo headphones. A visiting executive touring the building brought the one group to the attention of the other (see chapter three).

20th century innovation
Rogers defines invention as “the process by which a new idea is discovered or created. In contrast, innovation occurs when a new idea is adapted or used” (Rogers, 1983, p. 138). He proposed the method by which invention and innovation occurs. From his work the following has been paraphrased with the addition of relevant examples.

problems (basic & applied)

Rogers, 1983, p.136

• Most research is driven by some need or problem.

• Once the basic knowledge is acquired or developed it is then used as the building blocks for undertaking applied research. In some cases the researcher(s) unexpectedly discovers that the development solves a known problem that was not the original purpose of the research.

• Development of the idea moves toward a point where the invention or innovation can be commercialised to solve the problem. In the case of electronic media technology this most often involves the manufacture of a device which is marketed to the relevant industry or the consumer.
• The next step is the diffusion and adoption of the device or process. During this period a wide range of factors will contribute to the success or failure of the invention (see chapter two).

• Finally there are the consequences of the introduction and implementation of the technology. This is a broad generalisation and Rogers (1983) points out that “these six phases are somewhat arbitrary in that they do not always occur in exactly the order shown here, and certain of the phases may be skipped for certain innovations” (p.136).

In professional media technology there is an inevitable loop in the development cycle from the advanced professional user back to the manufacturer’s research group as the users modify and adapt the product. In many cases their desire to create unique features is driven by a feeling that they know better than the manufacturer how such products should work. Often it is a desire to have something which only they can offer their clients, or which is needed to satisfy a creative conception which they are involved with. Often, the manufacturer will incorporate these features in later releases of the product.

Professional electronic media production people are notorious for reengineering and reinventing products. In some cases the new innovation is so radical that the device becomes a new invention with an application far removed from its designer’s original intentions. Some manufacturers attempt to stop such user modification and reinvention by encrypting software, encapsulating components, removing component numbers and so on. Other manufacturers encourage and embrace the process as a natural part of their developmental feedback loop and a natural part of their design process. Many manufacturers now make available digital access ports and publish the digital coding structure of devices so that new applications can be written by users. This is particularly the case in devices that use some form of open architecture software such as those provided in MIDI, AES digital, OMF multimedia or other industry-accepted published standard or DOS or MAC based computer operating systems. In many cases such software accessories expand the applications the device can be used for and increase compatibility with other devices. These manufacturers see such “backyard” invention as an important part of their efforts to promote to an industry in which the device has wide acceptance and they will actively help those who develop such software with both technical support as well as marketing the accessory software. The ideas are embraced as free research, and in some cases the practitioners/inventors may come up with something so revolutionary that they will be compensated. “The user might even build a prototype model of the new product, and then turn it over to the manufacturer. So the ‘adopters’ play a very important role in designing and redesigning these industrial innovations” (Rogers, 1983, p.177).

The process of development

The development of a high technology product usually passes through four phases. These phases are accompanied by uncertainty which diminishes as the innovation moves through the four phases.

• The first is a period of innovation when the idea is developed and manufacture grows from prototype to initial introduction of the product into the market.

• The second is imitation when a second generation of companies enter the market with competing products.

• The third is a period of technological competition when the market sees improvements on the innovation and a rationalisation of manufacturers.

• The fourth is a period of standardisation when activities are concentrated on improving the cost of production and prolonging the product’s life.

Rogers (1983) explains:

As an industry moves through the first phase of innovation, to imitation, to technological competition, and finally to standardisation, we expect:

• Uncertainty about the innovation to decrease.

• Average firm size to increase

• The R&D function to become more formalised

• The influence of marketing on R&D to increase

• The innovation to become more standardised in the industry.” (pp.142-143)
The innovation phase

During this period there is a great deal of trial and error problem solving, with production limited to hand built devices and software that is usually prone to be unreliable, partly because it is under developed and secondly because it is operating on evolving hardware.

It is also during this period that the manufacturer will decide if and when to commercialise the innovation. While an innovative idea might hold much potential, it may not be possible to cost effectively implement it. It may be something that requires innovations outside of the manufacturers control, for instance cost effective high quality digital recording had to wait until the inexpensive analog to digital and digital to analog converters and high speed high capacity storage systems were available. In some cases the innovation is kept secret because its development might cause its developer commercial hardships. Such was the case when Columbia, Victor and Westrex kept secret the development of electric disk recording until they had time to commercially prepare themselves for the transition (see this chapter, page #37). In recent years some companies have held back gradual innovation until they are able to fully develop a product that will hopefully dominate the industry when the product is introduced. They fear that with partial introduction, competitors will reverse engineer the product, steal the key idea, and enter the market with a competing product. Even back as far as the early stages of the magnetic recorder, Poulson held back manufacturing a device, preferring to raise speculative money that was used for further development. He feared that once the product was on the market it may not meet expectations. He also wanted to ensure the longest possible time for sole exploitation and once manufactured, the clock on his exclusive rights to the patent would be counting down.

The risks of development

The transition from the marketing objective, through prototype, to product has a high degree of uncertainty or risk because most new devices or processes incorporate several innovations that have a “functional interrelatedness”. It is further exacerbated by the fact that the software (digital programming) is generally written as the hardware (the component design) is being developed. Because the designers of hardware and software require quite different educational backgrounds and design strengths, it is only in rare cases, or in very small companies, that the same developers will do both.¹

The marketing department of a commercial manufacturer is often the starting point for the development of a new product since it generally has the closest contact with the potential customer and the best idea of what is needed. Within marketing, a product profile will be developed that outlines the purpose of the product, its application, function, features, and a target price. The hardware and software designers working with the product manager (usually from the marketing team) and the project manager (the coordinator of the research group) create a high level design that identifies the device’s function and purpose taking into account such things as estimated time and cost of development, what hardware will be necessary, current hardware limitations, cost of such components, alternate approaches, etc. The hardware and software designers working with the project manager will then create a detailed time line for development. The entire project will be divided up into work modules that coordinate with each other in a logical order. The project manager will keep track of the progress to make sure that critical developments happen in the right sequence and time frames. For instance, the hardware designers will need a certain bit of software at a certain time in order to test the operation of their progress before they can continue. Conversely, the software developers need certain hardware components to be completed so they can test a software module before they proceed. Such project management is critical for the smooth and timely development of complex high tech products. Inaccurate time of development estimates, or any other unforeseen design problems can cause disastrous development time blowouts and huge financial cost overruns. Design problems may occur when a design team discovers that the published specifications of a critical component is in error. If no substitute is immediately available they may have no choice but to proceed in anticipation that the component manufacturer will solve the problem to meet the specification. For example, the published versus the actual speed of data transfer from harddrives is a major problem for high end developers of digital audio/video products.

Both groups are developing their hardware or software based on what they anticipate the hardware or software will do. In well managed projects, chief designers within the project group are constantly meeting to clarify issues as they arise. At the prototype stage of the hardware, the software is also at a beta stage and both of the elements are a far cry from their eventual construction and design. From this point it is a constant fine tuning of all the elements as their functionality is expanded to meet the design objective. Once the prototype hardware is complete, the hardware design team puts together a manufacturing kit that contains a component list, drawings for the circuit boards, mechanical layouts, and the enclosure and/or control surface design. All of this information is given to a manufacturing engineer representing the fabricator.
In many cases the manufacturing engineer will come back to the hardware design team with suggestions so that the device can be more cost effectively manufactured. There may even be something in the design that prevents the use of some manufacturing process in which case decisions have to be made. The manufacturing engineer will also provide lead times for component delivery and a time line of manufacture. It is not uncommon for the lead time of some high demand components, such as certain types of microprocessors to be as long as nine to twelve months. Most manufacturers of media production equipment are doing well to get something manufactured within six months after the manufacturing kit has been submitted to the fabricators.

During the transition from prototype to production release there is a great deal of uncertainty and potential risk as the hand built, fine tuned test model is converted to something that can be produced by an assembly line and automated machines. It is only when a production prototype has been manufactured, that all the components of the software and the hardware can be integrated and final software debugging can begin. The more complex a system, the more innovative, the more new ideas and untried components or subassemblies, the more likely that the time estimated for integration will be unexpectedly extended, and the greater possibility that both hardware and software will need some modification (referred to as revisions).

Most manufacturers hope that integration revisions can be handled in software redesign or simple wiring modification that can be added to the first production run and included in later production runs since the cost and lead time of hardware revisions is considerably greater, particularly if it means a change in some hard to access critical component, new printed circuit boards, integrated circuit design, or some modification to the physical housing of the device. One small mistake in a printed circuit board layout or an unforeseen change in components can extend the production schedule by months. Not only does this cause production cost overruns, but often adversely affects sales due to an inability to satisfy delivery dates on pre-release orders. In most cases there is also marketing and advertising which is timed in anticipation of release dates. In electronic media products timing of release dates are nearly always focused at major international trade shows. These conventions are sponsored by such organisations as the NAB (National Association of Broadcasters, U.S.), NAMM (National Association of Music Merchants, U.S.), AES (Audio Engineering Society in U.S. and Europe), IBC (International Broadcasting Convention, Europe), Broadcast Asia (Singapore), and INTERBEI (Japan). A failure to release a product on time is generally seen by production people and dealers as a sign that the product may be destined for problems and they begin the look to other vendors for their needs.

With a delay in a product release, the immediacy of the market place can provide an opportunity for a competitor to introduce a similar product and capture the market. If the release drags on, its functionality may be surpassed by products that have come out in the meantime. Such has often been the case with music and video production products. A particularly good example of this was the Fairlight video processor which took so long to develop that by the time it was released, many other lower priced products with more powerful features were available. The failure of the Fairlight video products contributed to the company’s eventual bankruptcy in the late 80s.

The initial release

The more complex a device is, or if it incorporates the latest technology pushed to its capability, the more likely that initial releases will have some problems. No matter how much beta testing is done by the manufacturer, the user will always find some combination of function that will cause the system to have some problem. In the highest performance equipment, product testing may not show up a weakness which is only found when a customer operates it under high stress and to its anticipated limits. Also component failure most commonly appears in first production runs. In some cases service bulletins will be sent out to fix the problem or new software will be distributed. In rare cases a complete recall will be required, and if the problem drags on, customers may lose faith in the product, reject it, and insist on getting their money back. Needless to say, the product will be doomed.

Two examples come from the music production industry. When Ampex introduced its first specially built 24 track audio tape recorder, customers found that after several months of operation, individual tracks that were in the “safe” position would slowly activate the erase electronics. It seemed that a transistor switch that had replaced a relay in the earlier design had been slightly underrated in the design. The transistor was inadequately rated for continuous operation, but the designers had not allowed for the surge which occurs at the initial turn on of the circuit. After several months the transistor began to weaken and eventually would slowly turn on the erase circuit as the tape travelled past the heads. All of the machines in the field required upgrading. Ampex also had to reimburse a few studios for recordings that had been destroyed. Luckily Ampex was large enough to weather the problem.
Such was not the case with Linn. In the early 80s Roger Linn's company was a leader in the fledgling field of digital sample players and dominated the professional market for drum machines even though it was a small company compared to multinationals such as Roland and Yamaha. There was considerable anticipation of the Linn 1000, and the company had presold a substantial number of models in order to generate cash flow. Both software and hardware problems caused the release to constantly slip and customers to become increasingly hostile. Finally it was shipped, but by and large the unit was unreliable. After several months of nearly continuous upgrades in the form of new IC chips, the problem was identified as hardware related and a complete recall was made. Most of the customers chose to abandon the company and buy a competing product that had come out in the meantime and was reliable. Linn never recovered and went into receivership.

The proliferation and consolidation of imitators

As the product becomes more stable and is accepted by the consumer or industry, uncertainty about it goes down, and a new phase begins as imitators of the product enter the market. These companies build devices that use the existing technology to fit into a certain specific niche. "The new firms are often spin-offs from existing companies in the industry, in which an entrepreneur with a 'hot idea' for a new product launches a firm to produce it" (Rogers, 1993, p. 141). The adoption of the 8-track cartridge for application in radio broadcast is a particularly good example. In the early 60s the cartridge was developed for portable music playback systems, in particular in cars. When a few small companies took the format and adapted it into an instant start, into recuing, continuous loop, audio delivery system, it went on to become a mainstay of radio. Its use in this application lived long past its original intent since the 8-track for music delivery was soon superseded by the Philips cassette. Only in the last few years has radio begun to move from 8-track tape cartridges to digital delivery of commercials, public service announcements, romos, etc.

During this period of imitation, the R&D department (Research and Development) is increasingly involved in improving the product and such development becomes increasingly driven by the marketing department.

Standardisation

As the product/process becomes more established, and the companies involved grow, the larger companies are often able to continue to evolve their products and fall away or be eliminated by those companies that have achieved market dominance. The maturation of the product or innovation also reduces the possibility that smaller companies will enter the market even though the uncertainty of acceptance of the invention is low and the fundamental underpinnings of the design are well established. R&D is now concentrated on improving the product, extending the product's life, modifying its application to suit other markets and reducing its cost; price competition becomes an issue.

Through this final phase there are no major innovation in new models, however there is generally some form of standardisation where the major manufacturers agree on methods of compatibility. In some cases a standard format occurs in an ad hoc fashion as all competitors adopt the standard of the original product. Such was the case with tape recording where many specifications for magnetic recorders were defined by Ampex, or the leader is so dominant that customers require all others to use that standard to achieve compatibility, such as the AVID MF (Open Media File) data transfer format (AVID is dominant in computer based, non linear video editing systems). In some cases a major manufacturer develops a format and then gives the rights freely to anyone, providing the standard is adhered to. A particularly successful implementation of this approach was the introduction and acceptance of the Philips audio cassette. In product groups that have been on the market for some time and have themselves evolved through a range of technological development, individual groups of manufacturers agree to establish a standard. The establishment of the MIDI specification was the result of such a gathering. The development of MIDI was only possible after the integration of low cost microprocessors in digitally controlled keyboards and sound processors and would have been impossible in the early days of analog and digital devices (see chapter six).

Sometimes an industry consensus occurs after years of debate over which system or approach best, as was the case with the DASH digital tape standard. In some cases, by the time the standard is reached, the technology has moved past that particular product, and even though there is now a standard, no one really cares but the few manufacturers who were heavily into that technology. Certain types of computer storage media have experienced this as have the formats for digital cameras that are sold at the consumer level by Kodak, Canon, and others. When industry giants have such a vested interest that they refuse to consolidate their specifications, the product is often destined for failure. Such was the case in the late 70s when RCA and Columbia both had competing quadraphonic playback systems, and neither was willing to budge.
The consumer refused to buy anything until a single decoder system could be agreed on, the home stereo manufacturers refused to tool up for mass marketing of a quad product until RCA and Columbia worked it out, and none of the record stores were willing to stock stereo version of a record as well as the two versions of quad disk (see chapter eight).

The adoption process

The adoption of a new invention or innovation involves several phases with a precursive set of conditions that includes the following considerations:

- How compatible are they with previous practices?
- Is there a recognised need for the innovation or a recognised problem which it solves?
- Is there an existing interest in the innovation?
- Is such innovation common within the social system of that specific network?

In industries where these conditions are not already in place, the vanguard of change will only come from a small percentage of those involved, and they will be considered radicals by the overwhelming majority. However, in industries involved with media technology, these conditions are almost always present. While some corners of high tech oriented organisations are more enthusiastic than others, such organisations seldom intentionally hire luddites. Of all the conditions, probably the most important is a need or problem that exists prior to the appearance of the solution. As Rogers (1983) puts it, there is already “a state of dissatisfaction or frustration that occurs when one’s desires outweighs one’s actualities, when ‘wants’ outrun ‘gets’”(p.166). In other cases a need may be created when someone learns of the innovation thus “innovation can lead to needs as well as vice versa”(Rogers, 1983, p.166). In media technology, sales people play a key role in this process by creating needs among their customers by pointing out the advantages of these new products. Knowledge, and in particular favourable rumours about its practical use, motivates adoption of innovation.

Prior conditions:
1. previous practice
2. felt needs/problems
3. innovativeness
4. norm of the social system

communication channels

knowledge → persuasion → decision → implementation → confirmation

Characteristic of the decision making unit:
1. socio-economic characteristics
2. personality variables
3. communication behaviour

Perceived characteristics of the innovation:
1. relative advantage
2. complexity
3. compatibility
4. trialability
5. observability
6. cost/benefit
7. peer/customer/creative pressure

Knowledge

The adoption process begins with an awareness of the innovation and what it can do. Rogers labels this the knowledge phase. Research has indicated that "knowledge is most likely to be acquired by those who have higher educations, are in strategic positions within an organisation, in higher socioeconomic groups, have more contacts within an industry, read more, have higher computer and communications skills, etc. compared to those who have lower skills in the same areas(Rogers, 1983, p. 238). The knowledge that is required also varies with the position held by the receiver and knowledge brought to the inquiry. Those in management are most interested in principle knowledge of a "big picture" nature such as the cost/benefit, overall function, advantages, and so on." Engineers want more information about how it works, the computer system...
employed, the quality of service manuals, availability of spare parts, back up and support, etc. The practitioners want to know what it can do, how to use it, who else is using it, what productions have used it, and where they can see it in operation.

The information is disseminated in a number of ways with mass media channels more effective "in creating knowledge of innovation, ... and interpersonal channels more effective in forming and changing attitudes toward the new idea, and thus in influencing the decision to adopt or reject a new idea" (Rogers, 1983, p. 35-36). Uncertainty about such adoption is reduced as more knowledge is acquired and the process moves into the second phase- the persuasion stage.

Persuasion

During the persuasion stage individuals often mentally trial the innovation as it applies to their needs. They project into the future the benefits and consequences of adopting the new invention or innovation. It is during this phase when views about the innovation are established. Put simply, the outcome of this phase is a favourable or unfavourable mindset toward the innovation. As Rogers (1983) explains;

At the persuasion stage the individual becomes more psychologically involved with the innovation; he or she actively seeks information about the new idea. Here the important behaviours are where he or she seeks information, what message he or she receives, and how he or she interprets the information that is received. (p.170)

The characteristics of the innovation also play an important role in this process. There are seven broad attributes of innovation five of which are suggested by Rogers (1983): "(1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, and (5) observability" (p.35) The last two are more specific to the electronic media industry and particularly influential in the production industry: (6) the cost/benefit of implementation or acquisition, and (7) peer group pressure brought upon by success with the product, generally as heard on a hit recording or seen in a video or film.

Decision and implementation

The persuasion phase builds understanding and diminishes uncertainty about the innovation. At some point that is unidentifiable, pros and cons are weighed up, a balance is found, and a decision is made at least for the time. This is the third phase of the process, and leads to the implementation phase.

During the implementation stage the user begins to adapt and reinvent the innovation. This tradition has become established that all manufacturers not only have their new devices tested and evaluated by those they consider to be industry leaders, but they will usually audit the industry for the functional requirements a new device should have before it is fully developed so that those features that were not anticipated in the original design, but are now seen as commercially desirable can be incorporated. For this purpose most manufacturers retain industry leaders as consultants and hire them as clinicians, and product specialists. These people are often relied on to act as spokespeople for new products and processes.

The product may change direction due to a number of factors such as market conditions, consumer reaction, legal issues, timeliness, cost, etc. Such was the case with the Beta video format and the DAT (see chapter eight) formats which were both intended as consumer products. Both failed in this market but became important formats in professional production.

If implementation goes smoothly the innovation experiences continued adoption. The time required for an industry to embrace an innovation is an "S" curve with adoption usually slow in the early days, but with success transition to the innovation accelerates. If the first to positively adopt the innovation have favourable results, others who are undecided in the process will be influenced to also implement the innovation. Rogers (1983) indicates that once a threshold of 10 to 30 percent is reached, the adoption accelerates exponentially (p.240).

As successful implementation expands, those who had earlier rejected it will be influenced to reevaluate and quite possibly reverse their decisions. If an innovation is so overwhelmingly supported, it will become an industry standard and the technology it replaced will simply become anachronism. If on the other hand, even if the innovation is in theory a good one and works during the prototype stage, if the implementation becomes a disaster, it is likely that the innovation will splutter. It may then only be adopted by a few who are willing to accept the shortcomings in order to gain the market advantage of being seen as a technological leader. The rest of the industry may simply wait until further development occurs or some new format appears.

Such was the case with digital multi-track sound recording which was first introduced in the late
70s. It took some twenty years for digital multi-track to become relatively common place, and technology moved from large reel to reel formats through a couple of generations of cassette tape and hard disk storage formats. If the introduction of the innovation is a dismal failure it may simply be discontinued.

Confirmation and consequences

The confirmation phase completes the process. During this period market forces and peer group influence play an important role in the continued adoption or rejection of an innovation. If success or support has not come along with the innovation, even those who lead the way in the adoption will eventually abandon it. Generally, those who are the first to adopt an innovation are usually the last to abandon their decision and conversely, late adopters are the first to change their minds, although if rejection is a prevailing trend late adopters would simply never adopt. If an idea is successful, then those conditions earlier identified in the commercial development of a product would apply.

The social consequences of adoption

During the period of adoption it is inevitable that there will be some consequences. Nearly all innovation affects someone, some industry, some company. Consequences embrace a wide range of possibilities that include issues that are technological, legal, economic, social, cultural, work practice related, industries being superseded, disenfranchised, relocation of centres of activity and so on. Fear and anxiety by those who believe an innovation will adversely affect them is also an important factor. Consequences of any given innovation can be positive for some and negative for others. While the former may represent an overwhelming majority, the latter may be devastated. How severe, rapid and far reaching these consequences will be varies with each new innovation and the rate at which the innovation is perfected and adopted. While innovators may have an idea of the anticipated consequences of their innovation, the conditions of change always bring unanticipated outcomes. But as Rogers (1983) concludes, "It is usually difficult or impossible to manage the effects of innovation so as to separate the desirable from the undesirable consequences" (p.411).

Rather than citing several examples here, throughout this paper are accounts of the effect of advancing technology. Two examples of consequences were so global that they provide food for thought for the rest of this paper.

Through the first half of this century there were significant forces in the American Musicians Union who felt that radio, and to a lesser degree records, were reducing the number of live performance jobs. This threat eventually became intolerable for the hard core faction controlling the union. The hostility was further fuelled by the growing presence in the mid 30s of jukeboxes in bars and diners and the emergence of Muzak as a provider of background music for restaurants and hotels. As far as the American Federation of Musicians was concerned, recorded music delivery systems that were going into such establishments were replacing live musicians. James Petrillo, president of the AFM, filed legal action against RCA citing that playing a record over the radio was a violation of copyright. He was determined to prevent record companies from providing music to the background music industry, jukeboxes, or for that matter broadcasters. In 1940, the federal court ruled against the union. Petrillo disagreed with the decision and commissioned Ben Selvin (a former band leader from the 20s, an expert in broadcast, and a successful recording artist) to write a report that Petrillo hoped would substantiate the claim that recordings and broadcast were putting musicians out of work. The Selvin Report came out in 1941 and dismissed the political manoeuvring that had been going on. It stated that union action was not called for since record companies were in fact paying millions of dollars to session musicians. The report was supported by the AFM rank and file and band leaders but not Petrillo. On 1 August, 1942, he was able to engineer a sanction for a strike to bar all union musicians from working in recording studios. It lasted for four years when the record labels finally agreed to the concept of mechanical royalties for principal recording musicians as compensation for the possible loss of live performance income. This was a significant milestone since it meant that non-composing musicians could receive ongoing royalties for record sales.

But the strike had an unexpected impact of a different kind. Popular music had been developing along a certain course - in 1942 the big band era was in full swing. While other recordings were being made, the big band was the heart and soul of the mainstream record industry. The AFM strike forced the record labels to become more resourceful in their pursuit of selling product by recording other forms of commercial music that was not unionised. Hillbilly music, now called country and western, blues and other styles of music performed by self contained bands, were given an opportunity that might not have occurred if the AFM had not called a strike. This move to self contained bands also set the stage for the merging of blues, country and folk into a musical form that by the end of the decade would be the precursor of rock and roll. At the same
time, the strike disrupted the music of the big bands and probably killed the careers of a generation of up and coming big band musicians who were pursuing that style of music.

A second example involves issues of copyright. Starting in the early 20s, music publishers had experienced a sharp decline in the sale of sheet music of popular songs. It was commonly believed that the gramophone and to a lesser degree the player piano was responsible. Player pianos were extremely popular at the time and the availability of piano rolls with the latest songs were wide spread. Not only would the roll play the piano, but the words were printed on the roll and could be read as the music played. If musicians wanted to learn songs, they no longer had to buy the sheet music. The recording or a performance of a piano roll would do. There also had been a dramatic decline in the pre-gramophone practice of musical evenings where everyone got together and sang or played their favorite songs. It was simply easier to give the gramophone a crank. Also, records had raised expectations of what a song should sound like, so fewer and fewer people were willing to attempt their amateur rendition. The drop in sheet-music sales also reflected the decline in the popularity of music halls and vaudeville and the increasing popularity of radio.

Before radio and records, a singer would be able to identify themselves with a song and sing it for months (possibly years). Every time they sang, a few sheets of music would invariably be sold. Radio changed that. When a song was sung on the radio it was heard by tens of thousands of people, not hundreds, but they didn’t buy the sheet music. “Why should they? If they liked the song they would go out and buy the record” (Pearsall, 1976, p. 84). In 1924, William Boosey, of Chappell publishing, predicted that the performing rights fees would become the composers’ chief source of income. He was right.

With the exception of France, popular music was not well protected under the copyright laws of the 19th century. In France however, copyright protection of opera and symphonic music publishing and performance had been in place dating back to the 1790s. In the late 1840s, three prominent popular composers attended a cabaret where their songs were being performed. After the performance, they refused to pay for the check, claiming that the law of 1791 applied to these “works”; ‘You use our labour without paying for it, so there’s no reason why we should pay for your services.’ The magistrate agreed, in a decision of August 3, 1848; that decision was upheld by the court of appeals on March 26, 1849; and the law of 1791 was applied to all music works.” (Attaill,1977, p. 77).

In 1850, the same three composers founded, in 1850, the first composers/publishers association, SACEM (Syndicat des Auteurs, Compositeurs, et Editeurs de Musique) dedicated to obtaining royalties for popular music publishers and composers. The French laws and the various legal precedents established that if anyone profited from a musical composition, the author and the publisher were entitled to royalties. This allowed for a smooth implementation of mechanical and performance royalty payments when records and broadcast came along. Outside of France, such protection was hard fought. While sheet music did have copyright protection under the laws of the U.S. and U.K. (and other similar legal systems) for the publishers, there was no protection for performance of mechanical reproduction. Nor did the composers have any rights except those through the terms of their publishing contract which in most cases did not provide royalties. The composer was simply paid a flat fee on signing. No matter how successful a song or composer would be, royalties were seldom part of the deal. Well known composers were able to slowly change this practice. However, when the publishers were faced with the loss of their traditional income brought on by the decline of sheet music and the growth of records, they decided that a closer association with the authors was their only hope. Besides pursuing the introduction of laws that would cover new mediums of delivery, they formed associations similar to SACEM. In the U.K., in 1914 the publishers and composers formed the Performing Rights Society. In the same year the American Society of Composers, Authors and Publishers was established in the U.S.

With the development of broadcast, jukeboxes, and background music, ASCAP contended that royalties should be paid when a record was used for any of these commercial purposes. In the late 20s, Boosey, who was then the president of the PRS, was able to negotiate with the BBC on behalf of its composers and publishers, a copyright fee for each composition played. In 1932, ASCAP was able to make a similar deal with the NAB (National Association of Broadcasters). At the time, ASCAP was considered in a stronger position when matched up against the fledgling broadcast industry, so it was able to get a substantial percentage (5% of a station’s income). This deal was considerably better than the 2 1/2% the PRS received from the BBC. In general, composers and publishers were finding that their source of income was increasing from the sale of records and declining from publishing.
As the end of the decade approached, ASCAP was making noises that it believed its percentage should be greater. ASCAP badly misjudged its strength and the resourcefulness of the broadcast industry. Radio was more confident and had developed a strategy to break ASCAP's stranglehold on copyright administration. In 1939, 256 broadcasters formed BMI (Broadcast Music Incorporated) which then went about obtaining legal coverage for songs not already under the control of ASCAP. In 1940 ASCAP struck the broadcast industry. ASCAP insisted that the royalty should be raised to 15%. The radio stations simply stopped playing ASCAP material and switched entirely to BMI administered material. During the strike, not one ASCAP song made the top 20. The strike lasted for a year and in that time several prominent ASCAP publishers changed affiliation (notably country and western giants Acuff-Rose and Ralph Peer) to BMI. When the strike ended, ASCAP was worse off than before and had to settle for 2.8%, and by then BMI was well established and formidable competition to ASCAP's dominance.

BMI, due to the nature of its very creation, had a much closer association with broadcasters and was active in encouraging minority audiences. Secondly, since BMI had to create an entirely new catalogue of previously unaffiliated writers and publishers, it was quick to turn to country, blues and folk writers and publishers who had been shunned by ASCAP and to assist the development of many independent labels to market this music. This would make BMI the powerhouse driving rock and roll writing in the 50s. It began sponsoring all sorts of workshops, clinics, and scholarship programs and offering signing fees to develop new writers. It subsidised such groups as the L.A. Songwriter Showcase. With BMI leading the way, ASCAP also became less conservative, more aggressive and involved in programs encouraging new popular artists and independent labels.

The ASCAP strike of 1940 and the AFM strike of 1942 were the direct result of technology's impact on the old school publisher/writer in the first case, and the performing musician in the second. The strikes dramatically affected the status quo. The ASCAP strike won nothing for ASCAP but its impact on the music industry of 1940 was extraordinarily positive. This strike moved songwriting out of the era of tin pan alley and a certain hack style of homogenised song. It opened a window of opportunity for a whole new breed of popular songwriters who were not locked into a formalised structure. These writers were able to get their music heard, performed and recorded because the old guard was on strike. It allowed blues, folk, and country, all previously treated with indifference by the ASCAP establishment, to surface into the view of the wider population. This music was the roots of the musical forms that would become rock at the beginning of the next decade.

In the case of the AFM strike, the issue of royalties for performance was hard won by the union, but it is unlikely that anyone would have anticipated how this strike would change the development of pop music. In that time music moved from the big band era to self-contained bands. It also provided a vacuum that was quickly filled with so many other types of previously unheard popular music.

The development of the most important invention

The invention and pioneering applications of the vacuum tube must be considered one of the most important of the 20th century. In respect to pop music, it may be the single most important invention. Without amplification there is no radio, records, distortion, or rock and roll.

The development of the vacuum tube also had its beginning at the Edison Labs. While perfecting the electric light, Edison discovered a phenomenon that pointed the way toward the amplifier tube. In 1883, four years after he had created the light, he was disturbed by how the glass housing became clouded as particles of the copper filament seemed to boil off and attach to the inside surface of the bulb. He decided to put an additional metal plate into the lamp, hoping that the particles would be attracted to the metal instead of the glass surface. In the course of his experiments, he discovered that when the bulb was on, electric current would flow between the positive side of the filament and the collecting plate. He didn't know why this was happening, but noted it in his work book as the "Edison effect".

In 1904, seven years after J. J. Thompson had discovered the existence of the electron, another English scientist, J. Ambrose Fleming came up with the correct explanation of the "Edison effect". In the vacuum of the glass casing the heated filament does not burn up (because of a lack of combustible oxygen) but electrons leap from the heated wire and are then attracted to the plate. The electrically heated filament was named the emitter (of the electrons) and the positively charged plate, the collector. Fleming called this a diode and patented it in 1904. This discovery had little impact until, in 1906, an American scientist, Lee De Forrest, designed a method to control the electron flow between the two electrodes. He placed a fine metal screen in the electron path and connected it to a weak positive voltage. This caused the electron beam to accelerate sympathetically with voltage changes applied to the screen. The screen itself was so
physically light that very few of the electrons were actually attracted to it. Nearly all of the
electrons flowed through to the collector. Of most importance was the fact that the beam could
be modulated by slightly varying the “positiveness” of the screen. As the screen voltage became
more or less positive, a greater or lesser amount of electrons would travel to the collector until
saturation was reached (the maximum amount of current the system was capable of passing).
The electron amplifier tube was a reality. DeForest patented his triode tube in 1906 and called it
an Audion. In much of the world this device was called an electron valve. In the U.K., Fleming
successfully challenged DeForest’s patent but it was reversed 40 years later. In the U.S. there was
no such challenge. DeForest applied his amplifier to various purposes including a radio transmit-
ter and receiver. The transmission of radio waves through some sort of atmospheric medium
termed the ether caused DeForest to describe it as “those silent etheric voices, which seem often
less of nature than of the spirit realm” (Lewis, 1991, p. 79)

Electric disk recording had been designed and patented as early as 1903 but in order for the
patent to have a practical application an amplifier first had to be invented. With the invention of
the vacuum tube two British engineers picked up the problem in 1919. In 1920 they recorded
the Armistice Day service in Westminster Abbey using an electrical system. This is also believed
to be the first recording to use a remote microphone transmitted over telephone lines to a cut-
ting system some way away. Both Columbia and Victor were impressed with the results and
independently began research into the new system.

Since its creation by Alexander Graham Bell, Western Electric had continued his work in the
field of audio transmission and storage. In 1913 it obtained exclusive rights to DeForest’s Audion
tube design. Over the next several years it made many improvements to the amplifier. By the
eyear 20s Western Electric’s design teams had connected the microphone to a DeForest amplifier
and used the output to drive an electric record cutting system. During the same period the
quality of the wax medium that was used for record masters had also improved.

The impact of amplification on the recording process

In 1923 Columbia (America), and Victor (U.K.) invested in the electric record cutting system
developed by Western Electric and the three kept it a secret for over a year after the two record
companies began to use it to re-record their most popular titles. They also made sure they sold
all of their pre-electric stock. Victor and Columbia justifiably feared that their existing acousti-
cally recorded catalogue would become obsolete overnight. The secret was well kept, and when
the two companies announced the new process in late 1925 the rest of the record industry was
outraged. Nonetheless, when the new technology was introduced it was obvious to all that the
new process was essential if any record company was to compete with the new product. All the
other labels had no option but to use the new process which of course included a fee to the
developers, Western Electric, Victor, and Columbia. The new records had previously unheard
clarity and dynamics, but the consumer was faced with the need for an improved player to hear
the benefit. The first of these reproducers was a mechanical unit also designed by Western
Electric and licensed to Columbia - Victor, called the Orthophonic. Most consumers bypassed this
machine and eventually purchased an electrically amplified record player which appeared on the
market in the late 20s.

The invention of the vacuum tube and its application in record cutting, sound reproduction,
and radio, made the 30s a pivotal period for the record industry. The need to project as though
a live performance was essential in the making of mechanically recorded sound but amplified
recording changed that. Amplification and electrically recorded sound provided the means for
records to become more intimate and at the same time bigger than life. Microphones could be
placed in front of different instruments, the musicians could be positioned for comfort and
acoustic isolation and the different sounds could be blended using electric mixing equipment
(called “desks” in the U.K. and “consoles” in the U.S.). The change in the type of artists that
became popular was dramatic. The popularity of music hall performers declined as the intimate
singer became popular. These jazz crooners would have been unrecordable before the vacuum
tube. One of the most popular singers in this century, Bing Crosby, was the first to develop a
microphone technique and had an innate ability to “use” and “work” a microphone. The records
made with this new technology gave the impression the performer was sharing personal moments
with the listener as though they were being “overheard”. This intimacy was perfect for the
increasing number of consumers who were listening to music by themselves. Not only could the
listener occupy a solitary space, but with a needle drop they could share it with the musical spirit
of their favourite song stylist as they too seemed to croon alone.
A Nobel discovery

The next major breakthrough in amplification came in 1948 when three Bell lab scientists published a paper that provided a peek hole into the future. In 1956 they received the Nobel prize for inventing the transistor which would lead to the invention of the integrated circuit (IC) which was patented jointly by Texas Instruments and Fairchild in the late 50s. Little notice was taken of the IC until it became an important part of the miniaturisation required by the space program.

In 1955 Sony brought out the first transistor radio and included an earplug speaker. They were so light compared to tube type portable radios that the public hesitated to buy them until Sony started weighting them with lead. Vacuum tube designs were rapidly converted to transistors since they were soon cheaper to make, smaller to carry, more efficient, eventually more reliable, and generally had less distortion and noise compared to tube designs. This last point, however, raised much debate in the music production industry where, for so many, rock and roll had become synonymous with distortion. The distortion of tubes was greater compared to transistors, but tubes sounded more musical.

Subjectively comparing transistor models to their tube amplified predecessor seldom fared well for the “improved” model. The manufacturers (read this as electronic engineers), couldn’t understand what the music producers were on about. In every other electronic based industry, the transistor was accepted as a superior improvement over the tube. But to the sound person, it was not a matter of specifications but how the device sounded. There was a certain elusive warm quality that only the tubes provided. In the late 60s, in trade publications and at audio engineering forums, debates raged between manufacturers and production people over the issue. In the early 70s, Russell Hamm came up with a reason that seemed to explain some of the difference between the two realities. He objectively analysed the quality of distortion associated with the tubes and transistors. His results brought him to the conclusion that one of the reasons why tubes sounded better, even though their total measured distortion was higher compared to transistors, was that tube distortion more closely paralleled the most common even harmonic musical intervals. Many subtle parameters play a part in why vacuum tube amplification is preferred but Hamm measured the quality of harmonic distortion and found that tubes created primarily even order harmonics (2nd, 4th, etc.), while transistors were mostly odd order harmonic distortion (such as 3rd, 5th, and to a lesser degree 7th order). “The odd harmonics [primarily found in transistors] produce a ‘stopped’ and ‘covered’ sound, while the even harmonics produce ‘choral’ or ‘singing’ sounds” (Hamm, 1973, pp 267-273). His theory has weathered the years and has been accepted as the explanation for why tubes possess “that sound”. Many solid state distortion devices now have “tube” settings that attempt to approximate that unique type of distortion that is the sound of rock and roll but to this day most musicians prefer guitar amplifiers with vacuum tubes and most larger studios prize their tube amplified pre-amplifiers, equalisers, compressors, and cherished “tube” amplified microphones. And of course guitar amplifiers with vacuum tubes are often preferred over transistor circuitry. The sound of the tube distortion when the amp is overdriven remains “the sound” for many guitarists.

By the 80s, professional audio product manufacturers who had stopped making tube amplified equipment began to once again sell certain older models. In the 90s several small companies have developed new tube designs while other companies have followed the designs of the past. These products are more expensive than solid state designs but audio people will pay top dollars for them. One of the obvious problems is that there are very few sources of tubes. Advanced western countries stopped making tubes decades ago, so the only source has been factories in Russia, China and Slovakia, and the occasional carload of new old tubes that are discovered at the back of some military warehouse. Quality control of tubes made today is also a problem since the quality is not what it once was before tubes became a technology of the past. Quality control is a critical issue since most amplifiers require that tubes operate in sets. Poor quality control means that two tubes of the same model number could be very poor matches. In the late 70s “Groove Tubes” appeared on the scene. Groove Tubes found sources for tubes, then tested, and matched them into sets of similar characteristics. The company is still in business and most musicians are willing to pay a premium price for the sound they deliver. Besides continuing their tube sales, the company now manufactures a variety of tube equipment and microphones. At least a dozen other companies are also making tube processors and microphones. One of these companies has a tube device which is used to make digital recordings assume the warm quality of analogue tape.
The tributaries of technology

The intellectual and experimental connections that led to the development of records, radio, magnetic tape, disk and optical recording, amplification, electric guitars and computers in music delivery and production have come from many places. Technologies that began well separated have now converged in today's popular music industry. The integration is well advanced but a reflection backward to the various origins has many starting points in the past. In all cases the roads back into these histories continue beyond the horizon to somewhere prior to these points. Nevertheless, to explore the beginnings of these various technologies requires a decision to start from a justifiable significant point. Only a sense of completeness by the reader of the material will validate these choices. There are many ways of presenting this material but tracing each path from this starting point to the point of integration seems the most contiguous. However, this approach necessitates a periodic digression to some strategic horizon from where the path has come. From these crests the stories will unfold and amplify as they move toward the media we know today.
Notes: Chapter two

1 The description of the process by which a product is commercialised, brought to market, and the pitfalls encountered comes from the author's experience as a product manager and manager of new products for both Fostex and ABC DIGITAL where he had a high degree of involvement with R&D teams and manufacturing.
SECTION II
A PLACE FOR LISTENING
The speaker and cabinet

An essential component in the overall development of music reproduction was the amplified speaker. Without it, sound could not be electronically generated for listening. While one might say that the speaker is no more essential than the player or amplifier, it is quite different due to its direct interaction with the listener. The specifications of players and amplifiers can be evaluated by more or less objective methods, but speakers, while having many measurable parameters, are judged ultimately by listeners' subjective taste which is affected by the environment in which they are in. It is worth reiterating that a key component of the pop music product, the sound, is created, evaluated, affected and consumed through this most subjective environment made up of speakers, cabinets and the acoustic space they occupy. Identical speaker systems will sound different depending on the acoustics of the room and where they are placed in it. Since external factors play an important part in how a reproduction system will sound, there is considerable subjective opinion about which speakers are best, what sounds good and what sounds bad.

Speaker cabinets are the most visible and potentially intrusive part of a sound reproduction system. In most homes they are considered a part of the furniture and must fit the decor. There are thousands of speaker designs to meet customer requirements for size, cost, finish, sound, construction, etc. In addition to commercial designs, starting in the late 50s, there was hardly a single issue of magazines such as *Popular Electronics* that didn't feature plans for do-it-yourself cabinet constructions and thousands of Hi-Fi enthusiasts built them. Unlike amplifiers, tuners and (CD, cassette, record) players which are manufactured by a few dozen multi-national corporations, speaker systems are made by thousands of companies. The speaker (described as "raw frame") components are made by a hundred or so manufacturers. The speaker system manufacturers choose various combinations of components and design enclosures that they feel work best with those components. The consumer electronic industry is practically built on the marketing of speaker systems which of course sell the sound of the amplifiers and players. The profit margin is in the speakers since it is more difficult for the consumer to shop around and compare price. The commodity is the total stereo system but the speakers sell the sound.

Due to the vast number of speaker/cabinet designs, and the variability of environments which affect performance, every person's listening space is unique. This means that everyone hears the sound of a recording differently. Such variety in the listening experience has confounded music producers from the beginning of music production. In almost all other forms of manufacturing, producers know the conditions under which their product will be used. Such is not the case with recorded music since producers have no way of specifying how their music sounds in any given homes. Further, they can only trust that the speakers and the environment in which they are listening while they create their productions is comparable to competing product from other producers.

This chapter describes the development of the speaker and addresses a number of issues related to the listening environment of both the consumer and the producer. It also explores the impact of several major listening products. We begin by setting the stage in which the listening environment has developed.
locking out the cacophony

There was a desire in turn-of-the-century society, to create a place in the home that could isolate the family from the chaos and cacophony of the industrial age clanging and banging out on the street. The record player followed by the radio, provided a means of blocking out this wading noise. Since that time, the noise of 20th century life has increased to where, in any city, there is little silence. Music has become an isolation bubble that covers up external distractions, to create for the listener a time and place to be alone, to think, to work, and conduct other activities. No one can choose when to listen to the neighbour's stereo or a passing ghetto blaster or a thunderous car stereo. A thumping speaker system in the next apartment cannot be stopped from pushing a bass line through the wall into an adjoining apartment and the neighbour's only patron (short of calling the police, or wearing earplugs) is to "mask" it with some other type of equally loud sound (although depending on the size of the speaker and the type of building instruction they may still feel the floor shake). Playing their own "tunes" is the only substitute for silence, the only means of overriding the sonic will of others. Muzak and other similar services are institutionalised the use of music in work and public places.

Some believe "canned" background music is a covert intrusion on a democratic right to hear or not hear what one wants to hear (U.S. Supreme Court Reports Oct. 1951, Vol 342-343 p.p. 369-1080). Portable stereo on the other hand provides an overt means to dominate a sonic space. As Lull (1992) put it,

Music creates an alternate space that masks the present condition of unwanted urban sounds. It allows young people to control and localise their space from their elders. The alternate space may have some permanence in their bedroom, or portable in their car or in the few feet around their ghetto blaster. (p 24)

Such independent control does not necessarily mean independent taste. In fact, it seldom does. Saul Bellow wrote in "Mr. Sammler's Planet" of Sammler walking through Central Park on a summer's day and feeling that an all embracing and inescapable PA system had been set up. Just the moved out of range of one stereo, another would come into prominence, each tuned to the same station, all drowning out whatever sounds of nature may have survived in the park. These sources of sound seem to have brought their owners together in some way and even when they went their separate ways they were still united by the continuously transmitted signal.

Lisenberg, 1987, p. 82) Over the years some large outdoor concerts have been simulcast by cal radio stations. Although the sound coming off the stage is clear and loud, there are those in the audience who have ghetto blasters tuned to the concert station and turned up full. The crowd is bathed in the sound from the stage but these people need the control and familiarity of their own space filling sound generator.

Sound events often are tied to specific time, for instance a stereo going on when a teenager next door gets home from school, theme music to the 7PM news being heard from across the hall, a distant carillon signaling certain days and times. Our society has conditioned us to respond to time structure to such a degree that we cannot block out sound events even when the room is stone silent. We pay attention to TV schedules, the business day, and when our nearest relative (or kids) get home, etc. Playing a record, or listening to the radio, focuses our thoughts to a time which is now, and of our choosing. The music isolates, for the present, the listener's place from the outside world. Stravinsky called music "the sole domain in which man realises a present." (Lisenberg, 1987, p. 44) We are so dominated by musical sound that many of those society have an aversion and an uneasiness with silence, or the natural sounds that surround them. There are few times one can go to a country picnic area and hear birds, streams, or the rustle of the trees because of the sonic domination of portable stereos. Amongst the "silence" of the country, music easily overwhelms the indigenous sound.

The first speaker

Alexander Graham Bell's work at MIT in the 1870s set the stage for the design of the modern speaker. In 1877, Ernst Wermer, patented a design for the German company Siemens, which is used in most contemporary speakers. It had a coil of wire at the rear of a cone. The coil of wire is positioned near a magnet. As the current was reversed in the coil, the cone was attracted to the opposite poles of the magnet, hence would vibrate in sympathy with the changing direction of the alternating current in the winding (sound is an alternating current). The design was theoretical at the time, since the amplifier had not yet been invented. Around the turn of the century, a rather remarkable method of amplification appeared which used electrically controlled valves and compressed air. Two pneumatic speaker systems were marketed in the U.K., the Stentorphone, and the Anteophone. One such system was installed in Bexhill, England, sound 1913, which could be clearly and intelligibly heard two miles away. The first amplified speaker design was patented in 1925 by Chester Rice and Edward Kellogg working for General Electric. For the rest of this century, speaker manufacturers have been fine tuning that basic design.
The producer’s speakers

For music producers, the speaker on which they evaluate a recording and blend the sounds is probably the most critical component in the process of music production. Theoretically, for producers, it doesn’t matter what kind of speakers they use as long as they know how their creation is going to sound when it is heard on millions of different home systems. But how can anyone really do that? The best producers can attempt to do is make their recordings sound roughly comparable to the recordings of their peers. In an attempt to come up with some point of reference, be it in a rather ad hoc fashion, a small number of speakers have gained a wide consensus of acceptance throughout the music production industry. In this way, a common, albeit subjective comparison has developed. Since mixing music is entirely subjective, the only thing that producers might hope to rely on is that the speakers they hear in one studio are roughly comparable to those they hear in another studio. The worst thing that can happen to producers is that a recording to sound fantastic in a certain control room and terrible everywhere else. Such things do happen.

The sound of the records through any historical period is coloured by the speakers the producers are listening to at the time. When records of two or more decades ago are heard on today’s speakers, they don’t accurately portray the sound that was heard when the industry’s consensus of monitoring taste was based on speakers no longer used. There have never been that many “accepted” studio speakers, but in any given period of time, a majority of the industry has used essentially the same speaker, with some variation provided by various studios “tuning” (with equalisation and structural design) to their particular taste. The reason is obvious. When a music creator goes from one studio to another, he/she wants the same point of reference with no surprises. Any studio that has monitors that are radically different can be assured that most people would be uncomfortable working there. Until the 70s, taste in speakers was often specific to continent with European studios choosing speakers of European origin and U.S. studios choosing primarily U.S. designs. With the proliferation and internationalisation of multi-track and the number of acts that are recording gypsies, the last 25 years have seen studios throughout the world homogenise their taste in monitors.

A few of the first studio monitors used for music mixing were originally designed for the film industry and followed designs that evolved from the beginning of sound. In the mid 60s to mid 70s it was not uncommon to find in music studios, large “Voice Of The Theatre” monitors that were common speakers in smaller movie theatres. These speakers, as music production monitors, have gone the way of the dodo bird. One series of speaker design that has been around since the 50s has weathered the advances in technology: the Altec-Lansing 604 series. The 604 is a coaxial speaker with the tweeter positioned in the middle of the woofer thus achieving what is essentially a single point sound source. In most multi-band speaker systems the woofer is mounted several inches from where the tweeter is located with the result that someone sitting relatively close to the speakers, as is the case in a production studio, often has a hard time determining the (single point) origin of the total sound. The biggest studio monitors that use more speakers increase this perceptual problem. The first 604s appeared in the late 50s and over the years improved versions of the design have updated the original model. Another manufacturer, Urei, developed a similar speaker and when both companies were purchased by Harmon Industries a few years ago, the line was amalgamated. It continues to be an extremely popular speaker. In Europe, Tannoy took a similar coaxial approach. The Tannoy design first appeared in the mid 60s, has been improved over the years, and remains a most popular large studio monitor.

Along with the large studio monitors, production studios always have a pair of small speakers that attempt to represent how a record will sound on home “bookshelf” speakers. These speakers are often mounted on the top of the mixing console and generally used during the mixdown process. By sitting close to these small speakers, the effect of the control room’s acoustics is minimised. This is referred to as “near field monitoring”. In the 50s and 60s there were no small speakers specifically designed for studios. The record makers of this period would have a demo record cut and then play it on the studio’s KLHs or AR entertainment “combos”. These systems were very popular with college students because they were latched to the turntable and could be easily carried. Some KLH and AR speakers were also moved into the control rooms. Then, through the mid 60s to early 70s, the JBL or Electro-Voice bookshelves were popular. For the last twenty years the Yamaha NS10s have been the most popular studio bookshelf speaker. Others by Tannoy, JBL, Roland, Auratone and Tannoy are relatively common, but none of them compare with the popularity of the NS-10s which for nearly two decades have been a de facto standard.

The NS-10s also have some remarkable mythology attached to them. There was a view that the original NS-10s had a harshness in the high frequency range. The word got out that one of the most successful music mixers in the U.S. (his name has been lost in Rock antiquity) had determined that two layers of double ply toilet paper taped over the tweeters made all the difference
the industry there was hardly a studio that didn’t have the “modification”. One of the trade publications commissioned a review of the modification with the reviewer concluding that the paper changed nothing. Nonetheless, he use of two sheets of two ply dined hard. An enterprising sound engineer who was an acoustician “wannabe”, announced and began to market acoustically correct toilet paper. (In the 70s there were some very successful snake oil studio designers, this was one of them.) People bought it. Twenty five bucks a roll. One studio had several sessions with a band known for their reponsity for cocaine. Before the studio manager had wised up, the group had mistakenly loaned their noses through several hundred dollars of acoustic tissue. In later versions of NS-10s ales people claimed the correction introduced by the 2-ply tissue paper had been incorporarted 1 the updated model.

More popular than even the NS-10s is the Auratone “Cube” speaker that appeared in the early 60s. The “Cube” is a small air suspension enclosure (an air-tight wood box) holding a 4-inch full range speaker. The company brought out this small high performance speaker for the music studio market and it was quickly embraced. Since its sound has become a “standard” by which all things are compared, most serious music makers have a pair. Today this speaker is probably the most common speaker found in recording. How something sounds on these speakers remains the acid test of how it will sound on small systems and through a cheap car stereo. Auratone now takes a range of small to medium sized monitors, but none of the rest of the range have had the impact of the original “Cubes”.

The producer’s listening space

Musical sound is a subjective creation and the perception of what is needed in the sound and the decisions made are based on what comes out of the production space’s speakers. But how sound is intimately affected by the room they are in. Essentially, the best speakers will sound bad if the room they are in is acoustically poor. Production spaces if properly designed can be built to achieve accurate reproduction. Since the mid 70s, an increasing number of mixers use sound spectrum analysers to “look” at a sound and to evaluate the performance of the monitors they are using. While such machines cannot make judgments, they provide validation as to what is being heard. There have been producers who have become so befuddled by the differences in sound between speakers in different control rooms that they are unsure about what might be the best mix to release. Eventually, all have to accept that every place will sound slightly different and the best that can be expected is that a production sounds as it should in the final place. A very successful producer of the 70s wore a cowboy hat all the time, including in the studio. It provided a cover for his receding hairline. Eventually, he took some therapy and earned himself off wearing the hat. Unfortunately, he discovered that his mixes sounded wrong without whatever effect the hat had on his perception of the sound. Coming to terms with this he continued to wear the hat when he mixed in order to maintain the way he heard things.

In many cases the final adjustment occurs in the mastering process (when the record is cut, or the CD is formatted) when some overall equalisation and dynamic changes to the complete mix are added. Most producers see the mastering stage as the last place that the record can be worked on. The “mastering” engineers brings “a new set of ears” to the process. There is also a universal view that they have fine tuned many different projects and are well suited to match the overall sound to contemporary norms. They can be more objective compared to anyone who’s worked for months on the project. Here too, there is a trust that the mastering engineer has the best monitoring environment. With this in mind, recordings are occasionally remixed due to an adverse opinion by a mastering engineer. The abilities of certain sound mixers and mastering engineers to know what is sonically right moves beyond their ability to make the right creative decisions, into the realm of technological mysticism. Those who have been anointed as having it all of course not deny they possess such a gift since this belief held by their peers and customers ensures their future success.

The listener’s hearing place

The listening experience for most people is with little awareness of the technology involved. They are not preoccupied with the stereo’s technology, but with the opportunity which it provides for them to have access to their favourite artists. Yehudi Menuhin (1979) said in an interview with Glenn Gould:

There is no greater community of spirit than that between the artist and the listener at home, communing with the music. I would even go so far as to say, the most important thing technology does is to free the listener to participate in ways that were formerly governed by the performer.
But the consumer's listening space bears little resemblance to the environment in which the production was created. The average living room has an overabundance of sound-absorbing drapes, furniture and carpet, and the proportions of the average living room are seldom ideal. Hence, home hi-fi designers also consider where the speakers will be used and compensate accordingly. Home stereo speakers are often placed in a location that is not best suited for listening, that is, at ear level. Most are sitting on the floor and possibly acting as coffee tables next to furniture. Most home owners buy speakers based on how they fit in with the furniture, not just how they sound. To be sure, they want good sound to heighten their experience but it must be conveniently packaged and affordable. Interestingly, the most popular high priced hi-fi speakers are never found in studios and the home hi-fi enthusiast would never consider using the monitors used in production spaces because they seem too "flat" compared to the extra boom of the bass and sizzle of the high frequency that comes out of most hi-fi speakers. Were such speakers used in production, the music producer would be deceived into thinking that there was adequate bass and treble when, in fact, what they were hearing was an aberration of the speakers.

The hi-fi enthusiasts

The first generation of "ultimate" playback systems appeared in the late 50s when enthusiasts first developed an awareness and genuine hunger for sound reproduction technology. They would fill the hi-fi stereo shows that were held in most major cities in an effort to decide what the best system was and what they could afford. Their growth as a market coincided with the introduction of stereo records and triggered the production of a great many successful recordings focused at the stereo enthusiast. Byron Werner, a Hollywood sound effects expert, coined the phrase "Space Age Bachelor Pad Music". Lanza (1994) remembers these records:

This music arrived just when feral man was going soft, pampered by urban technology and dainty white collar duties. His greatest pacifier was the stereophonic incubation chamber, where proper speaker placement became as essential as air vents. (p. 124)

Several of these albums broke new ground in the art of integrating location recorded stereo effects with orchestral studio recordings. Some of them were mood/environment records that used sound effects such as rain, thunder, water falls, and an endless number of "from speaker to speaker" extravaganzas with approaching and passing trains, planes, roller coasters, race cars, and so on. Technologically these were very advanced recordings. At the time, with the exception of these records, the stereo LP was almost exclusively being used for classical music. Many of the techniques in these stereo spectacular records would eventually find their way into mainstream pop music production.

The Electro-Sonic Orchestra, conducted by Dick Jacobs, released an album called Presenting A New Concept In Sound. This album featured a conventional orchestra that was recorded with electronic pick-ups attached to every instrument instead of microphones. "This is electronic music. Not the weird machine-made sounds usually associated with the term, but music based on popular melodies, and played on conventional instruments that have been ingeniously electrified" stated the liner notes (cited in Lanza, 1994, p.124). Dean Elliott's Sounds What Sounds, and Jack Fascinato's Music From A Surplus Store were just two albums of many that presented music that would stand as a precursor to what would be possible with the invention of samplers. Automobile sounds, axes, coffee cans, dog barks, frog croaks, trowels, putty knives and so on were musically a part of the compositions which primarily used traditional instruments. The stereo placement and panning of the instruments were an important aspect of each of these recordings. Fascinato's work featured a specific thing on each cut.

'Olly Boyd' paired a centre stage trumpet with the rhythm squeezing of two needle nosed oil cans. 'Sweepy Time' adorned its pizzicato strings quartet with a drone of a G.I. scrub brush that's dashing furiously from side to side [and so on]. (Lanza, 1994, p. 126)

These records not only sold well with the growing number of stereo enthusiasts, but they were used to sell countless stereo systems. No matter how small the listener's accommodation might have been, the infinite space of recorded music could overlap and open the confined space the listener occupied. The two spaces would conflate to create an environment with no walls to restrict the many worlds that could be presented between those stereo channels. As Stockhausen (1989) put it at the time, "This means that one is completely swallowed up in the process of listening, thereby becoming aware that there is space" (p. 67). Spatial relationships and cause and effect are both part of the physical real world and music can transport listeners, as though in a time machine, to places they've been or never been.
The impact of the car stereo

The introduction of convenient tape playback systems (in particular the Philips cassette), and FM stereo transmission gave consumers a reason to turn their automobiles into credible listening spaces that could provide tunes as background while they were literally on the move. From the early 70s, car stereo receivers and playback systems became increasingly important to the consumer and a significant commodity. Several reasons explain this widely popular, long running trend. First, people spend a lot of time in their cars and expect to have a stereo on wheels that rivals their living room. Secondly, for many, their living accommodation may be rented, so the car they own, and the stereo it holds, is their most significant possession. Thirdly, for many, the car stereo is an important status symbol. Lastly, the car may be the only place they can turn on a stereo and listen without retaliation or retribution from neighbours or authorities. Some car stereo installers now sell systems based on how many blocks away they can be heard. At a recent Consumer Electronics Show in Chicago some car systems were generating in excess of 135 dB SPL, which is twice as loud as standing at the end of a jet runway. Separate heavy duty generators are now common in those cars outfitted with these very loud stereos, otherwise when there is a bass note the car tends to stall.

The car stereo has become the common ground between listener and producer. Many producers evaluate their work in their cars, in some cases making final judgments on mixdowns. At CBS Studios in San Francisco, a closed circuit stereo FM transmitter had been installed that broadcast through a loop into the adjoining parking lot. Any car in the lot could pick up this transmission. Final mixes were often given the acid test by everyone going to the parking lot and listening to how the mix sounded from their car stereos. A common problem that was encountered using the car stereo as a criterion was the perception that the centre balance of the stereo image was skewed since everyone in a car is sitting in front of one or the other of the two speakers.

The walkman revolution

In the 1980s, the personal stereo was one of the top three must-have fashion accessories, along with the digital watch and roller skates. In 1989 Sony produced its 50 millionth Walkman. Since its introduction there have been dozens of copycat products and the numbers of such machines would be by now, in the hundreds of millions. Imagine that many people worldwide “walking to the beat of their own drummer, slinging along off-key to a song only they can hear. What a movement!” (Giscard d’Estaing, 1993, p.138). Headphones, and the Walkman live music listeners the opportunity to move inside their favorite music. The “Walkman” has been one of the most successful consumer products ever made.

The two elements that make up a “Walkman”, a small cassette player and small headphones, started out in the mid 70s as two different projects within Sony. One group of inventors were working on a small recorder but started by first developing just the player to eliminate some of the electronics and weight. Another group had been working on making a set of good sounding headphones that weighed less than 50 grams. Neither group knew of the other’s endeavours. In the late 70s, the honorary chairman of Sony, Masaru Ibuka, was touring the Sony research and development facilities and visited both teams. When he tried out the player he thought it was real but the headphones were too heavy and he asked them if they knew about the small headphones that had been developed by the other group. By the spring of 1979 the two were put together. Ibuka suggested the product to Akio Morita, chairman of Sony. Morita knew that his children played music in the house, in the car, and everywhere they could except on the street. He concluded a small portable cassette player would have a market. In late 1979 the prototype of the “Walkman” was introduced to Sony dealers. Surprisingly, a large majority of the dealers were not enthusiastic. None the less, Sony made enough prototypes to test the market. While the dealers remained unsure, their children and store personnel took to the units. Some were given to college students for test-drives. On the street, when people saw them, they stopped those that ad them and asked where they could get one. The presale of the units was phenomenal. Just before the release of the product, it was officially named “The Walkman”. There had been disagreement on the name by the U.S., English and Australian dealers who pointed out that it was ad English. The English wanted to call it “The Stowaway”, the Americans “The Soundabout”, and the Australians would have called it “Freestyle”. Morita would have none of it. In 1986 the Oxford English Dictionary included “Walkman” as a noun in the English dictionary. Now there is Diskman (and again several copycat CD players), and it appears it too will be equally successful.

Miniature headphones are a key product contributing to the personalisation of music. Headphones “could be considered the phantasmal ideal the Victorians sought when they redecorated their domestic space to achieve seamless disassociation from everyday life” (White, 1994, p. 60). Headphones have allowed people to hear their music without disturbing those around them when they exercise, fly in planes or do just about anything. They provide an isolation without intrusion, unlike the ghetto blaster. The Walkman brought the listener closer to the music with the
result that the listener was able to hear more of the subtleties of the production, in particular stereo placement and separation and reverb effects. This in turn stimulated the producers to become more stereophonically aware and expand their use of the stereo image.

The suggestion might be made that headphones might be used by producers during the process of creation since they provide a means to eliminate the effect of the listening environment. This is true, but another factor then becomes prominent: the interaural phase and time differences between headphones that are separated by the width of the head compared to speakers that are a couple of meters apart. Music recorded and produced on speakers has been created from a wide stereo spatial perspective. On headphones, the same sonic images confuse the brain causing sound that should be coming from a panorama in front of the listener to seem emanate from above the head. Only recordings made with microphones mounted in a dummy head will be accurate when heard on headphones.

The unfortunate aspect of the headphone revolution is that the close proximity of the speakers to the ears and the extreme loudness they are often operated at, have caused considerable numbers of people, in particular the young, to develop hearing disabilities.

Consumer participation

The Karaoke appeared in the early 80s and took the technology a step further in the democratisation of music production and reproduction by letting anyone pick up the microphone and sing along to a prepared recording. While the background recording may be fixed, the “singer” has a direct relationship with the listeners. As Attali (1977) observed in this phenomenon:

"The consumer... become(s) the producer and... derive(s) at least as much of his satisfaction from the 'manufacturing' process itself, as from the object he produces. He... institute(s) the spectacle of himself as the supreme usage." (p. 144)

Over the years the Karaoke has in some places become formalised. Many clubs that feature Karaoke use it as only one aspect of their entertainment and those that visit these clubs are fully prepared to perform. They have rehearsed with their own copies of the backing tracks and attended vocal classes so they can deliver a professional performance. Their status with those they are with is enhanced if the quality of their performance is very high.

The listener's authority

For a substantial number of people the size of the home or car stereo is a direct reflection of their success (real or imagined). To fill a space with tunes satisfies their desire to control their personal environment at the exclusion of society’s environment. It is also an indicator of being with it and having made it. It is no less so for those who have less. The young and the poor might have neither a car nor a permanent home but most will have a portable “entertainment” system better known as a “Ghetto Blaster”, “Boom Box”, or “Third World Briefcase”.

To these people the immediate space around them is a commodity and they intend to fill it with sound over which they have control. The fact that they can impose their music on passersby is not a byproduct but a statement that they have the sonic power to dominate the surroundings. Most of the time these boom boxes are full blast and distorted. The need for a volume control seems superfluous since they are either off or full on, as are the tone controls. In order to achieve portability, the speakers can never be large enough to reproduce an undistorted bass sound, so one might say this distortion is a means for the owner to cater the sound to his/her taste.

What of this distortion?

Well it makes the sound funky, and funky is the thing or thang which should occupy the space. To describe what funk is, or what it is to be funky has filled books and discographies. The word and its intention has been included in countless lyrics, band names and song titles. It has been transformed from subject to object through its application by such acts as James Brown, Sly Stone, Confunkshun, De Funk, Instant Funk, Funk Pump, and of course George Clinton of the Parliament/Funkadelic group. Ellenberg (1987) has a particularly interesting description of funk:

Funk suggests the following: music, having started out as ritual, having then become a thing, now becomes a thang. The difference is profound. A thing is what you possess, a thang is what possesses you. A thing occupies space, a thang occupies time and preoccupies people. A thing, above all, is private; a thang can be shared. As thang, music is again communal and celebratory. Again it is spirit; again it is ritual. (p. 83)
However not many of those walking down the street with their blaster on their shoulder would see themselves doing anything more than groovin' to James Brown.

**Summary**

A listening space was essential for recorded music in the first place to be created by producers and secondly to be heard by the consumer. The listening space for music producers provided the means by which they could judge what they had recorded. As the technology became more advanced and electronic, the accuracy or predictability of the monitoring system became more important. The monitoring system is the window through which music producers evaluate and sculpt their sonic visions. Over the years the speaker systems that have been used in studios have played a significant role in determining "the sound" of popular music.

As music became a commodity, so did the hardware by which it could be reproduced. The speakers and associated cabinet designs, more than any other part of these playback systems, were the most subject to personal taste. The creation of stereo reproduction stimulated the production of records that were geared to satisfy this rapidly expanding market. The size, cost, type, design and general sophistication of consumer audio equipment became a topic of conversation at cocktail parties among a rapidly growing number of hi-fi enthusiasts who were willing to spend significant dollars on their passion. The market for reproduction hardware further expanded as the public found more of its time was spent in the automobile and car stereos became an important pasttime for people on the road. The proliferation of battery powered portable stereos also grew and completed the occupation with sound of every previously quiet space. Reproduction systems became a commodity of status, a method to dominate acoustic space by people who had little power over or ownership of anything else. For those moving through this pace who wanted to maintain some control over at least the area between their ears and their rain, the Walkman found a market that was looking for such a product, and a new word was added to the English language.
1 Diagram of a sound reproduction environment.

2 This case is described later in chapter eleven.

3 Comparison of coaxial to conventional speaker system design.

4 Musicians who have been listening to loud music through a long session are not aware of how loud they are talking by the end of the session because their threshold of hearing has shifted upward. By the end of the session, their ears are considerably less sensitive than when the evening began due to blasting headphones. Outside the studio, when they play the session cassette in the car stereo, they crank it up, roll down the window (so that everyone leaving can hear it one more time) and off they go. The next day, after their ears have recovered somewhat, when they start the car, and the stereo comes on at the level of the night before, they are jolted by the blast. Such is also the case with fans who sit too close to the speakers at rock clubs and concerts.
Chapter four

THE TECHNOLOGICAL EVOLUTION OF THE RECORD INDUSTRY

The two most important inventions contributing to the commodification of music were the gramophone/phonograph and the magnetic recorder. For the purposes of this introductory paragraph, the gramophone and the phonograph have been considered a single invention since the former evolved out of the latter to eventually replace it. Both were very inscribing, groove based systems. The magnetic recorder and the gramophone provided both a method to record and a means of reproduction. The gramophone/phonograph was the keystone innovation on which the record industry was invented and the magnetic recording extended that process. The introduction of the magnetic recorder marked the beginning of modern record production and by no coincidence, the birth of rock and roll. Magnetic recording also decentralised the production process and contributed to the success of the independent labels.

The invention of the phonograph

A good place to begin an exploration of the technological development of the record and the industry it spawned is in the early 1860s. This was when a Frenchman named Leon Scott, working at the Massachusetts Institute of Technology (Cambridge, Massachusetts), came up with a device called a phonograph for tracing vocal patterns. A thin hog's bristle quill was attached to the centre of a compliant diaphragm at the back of a tapered horn which concentrated the sound. The other end of the quill was a sharp fine point. A piece of smoked glass would travel past the point as a sound entered the horn causing a wavy line that corresponded to the sound vibrations to be scratched into the soot. A later version of the device positioned the stylus against a cylinder of heavy paper coated with soot. The cylinder was rotated by hand, and if someone shouted into the horn, an image of the vibrations were captured on the paper.

There was no provision to manufacture Leon Scott's device as it was not a marketable product aside from its scientific applications, but it did point the way towards later invention. In 1877 a French inventor, Charles Cros, proposed the Phono-Graphos. He never had the money to build his idea, but it was much closer to what would become the gramophone. Cros described a method for recording on a round flat glass plate. He also suggested a means of playback. Like Scott, Cros failed to commercialise his idea because he could not see a wide market for the Phono-Graphos.

By the 1860s, telegraph and Morse code had become widely used. Two major problems were that the messages could not be stored and they could not be transmitted very far without requiring the weak signal to be listened to, copied and repeated by an operator. One of these young telegraph operators was Thomas Edison. In the late 1860s he figured out that you could take a magnetically actuated stylus and vibrate it up and down to emboss a waxed paper disc. To repeat the indented message the disc was flipped over so that the indented dots and dashes were now seen as a series of bumps of two different lengths. A "playback" stylus rode over the bumps, and, as it moved up and down, would make contact with a switch that repeated the original message. This was the first of a long line of commercially successful inventions by Edison whose inventiveness was only matched by his ability to develop his ideas into commercial products.

One day Edison heard his telegraph repeater operating at high speed and noted it sounded somewhat like music (Edison was not a particularly musical person). He took the same horn and membrane type "microphone" that Scott had invented and mounted it on a screw mechanism. This was made to travel across a revolving cylinder that had been wrapped in tin foil. When he cranked the cylinder and talked loudly into the horn a continuous groove was embossed which represented the sound. He then took the cylinder and played it back on a similar mechanism with a lighter and more compliant stylus and diaphragm. The first working model of the phonograph used an up and down motion called "hill and dale" recording and was patented in December 1877. Edison's first recorded words to himself were "Mary had a little lamb". The quick success of his invention had as much to do with his marketing genius as it did with its ability to record and playback sound.
Edison believed the phonograph would be used for archival purposes, not as a means of playing distributed duplicates. Edison (cited in Attali, 1977) wrote,

We will be able to preserve and hear again, one year or one century later a memorable speech, a worthy tribute, a famous singer, etc... We could use it in a more private manner: to preserve religiously the last words of a dying man, the voice of one who has died, of a distant parent, a lover, a mistress.(p91-92)

Within the scientific intellectual community, the phonograph was seen as a means of preserving truth and maintaining cultural stability. A prominent magazine of the time the Electrical Review (1888) speculated,

Had Beethoven possessed a phonograph the musical world would not be left to the uncertainties of metronomic indications which we may interpret wrongly, and which at best we have but feble suggestions; while Mozart, who had not even a metronome, might have saved his admirers many a squabble by giving the exact fashion in which he wished his symphonies to be played.. (May 26, p. 8)

In 1887 Edison licensed to Jesse Lippincott to franchise the phonograph as a dictating machine. He went about setting up 33 franchises across the U.S. All went bankrupt pursuing this misconception of application except for the District of Columbia franchise. The D.C. operation quickly realised that the device was not suitable for dictating when, after renting a hundred units to Congress, not one of them was returned because they were evaluated as unsuitable for Hansard purposes. The only precursor of the record's ultimate commercial success was the common practice to use the voice to demonstrate the quality of the recordings. Naturally a few demonstrations were sung, and of course some instrumental accompaniment was added. By and large however, the first companies involved in phonographs saw the device as a business machine.

It was seen as a tool for documentation, dictation and sound analysis for historical and scientific purposes and office, court, and hospital reporting. The phonograph was soon being used by researchers for anthropological and cultural field studies to document the oral histories and ceremonies of indigenous people. Some of the earliest phonograph recordings of indigenous people's oral histories and ceremonies were done of the Torres Strait Islanders. Many publications speculated on how it might have been if there had been a recording available of great events of the past and how in the future there would be such recordings. There were also descriptions of famous people making mistakes and these too became part of the record. There was speculation that in decades to come, sound production would allow the removal of anything undesirable. Unfortunately the anticipated market had several problems with the device's capabilities. The amount of time that could be recorded on each cylinder was very limited. The recording and playback machine, out of technological necessity, evolved into different machines to optimise performance thus eliminating the notion that one machine could do both. The machines were so bulky that portability was out of the question. Other Edison licensees began commercialising cylinder phonographs in other applications more suitable to exploit the features of the phonograph, and the Washington D.C. franchise followed suit. A market grew in amusement arcades, carnivals, amusement parks, nickelodeons and in other public and semi-public establishments.

In a considerably less noble application the phonograph would find a market in whore houses. Recorded music became a common backdrop for amorous endeavours. Although there were probably many times when the privacy of a theatre box provided a place for discrete interludes accompanied by music, and just as likely the hedonist might occasionally find a piano player in the salon of their favourite whore house, a client needed to be a bit of an exhibitionist to perform while a live musician chorused him on. Records (and then radio) provided music without the musician thus eliminating a physical presence and a source of inhibition. Then the public began to buy them. In general these playback applications required a ready supply of pre-recorded material and in 1890 the D.C. operation began to sell pre-recorded cylinders under the Columbia label. But as Chew (1976) pointed out, the replication process was not suitable for high volume:

The primary difficulty in commercialising prerecorded material was the difficulty in duplicating a program. To produce a batch of 200 recordings of a march it had to be played 20 times in front of a battery of ten recording horns. It was clear that if the phonograph was to prosper in its role as public entertainer, the recording process must be centralised, some form of duplicator must be produced, and the instrument itself must be simplified and cheapened to put it within reach of the average citizen.(p. 14-15)
The gramophone

A German inventor living in the U.S. solved the duplication problems associated with the cylindrical shape of the Edison phonograph. Emil Berliner would have been aware of Scott's invention and it is widely accepted that he knew of Crox's patent. Berliner's approach used a round flat plate as a recording surface. This approach made duplication significantly easier whereas records could be pressed much like waffles and not very different from the way records were made until the CD came along (in fact CDs are also a pressed medium). In 1895, Berliner formed the Berliner Gramophone Company and began to sell a hand driven player. An associate of Berliner's, Eldridge Johnson, incorporated a wind-up spring motor and the modern gramophone was complete. The two of them started the Victor Talking Machine Company in 1901 for the purposes of manufacturing gramophones and producing records. Berliner's foreign rights agent travelled to London in May 1898 in order to raise enough funds to establish a recording and pressing facility. To pay for an expensive patent war with Columbia, Berliner sold his patent rights in Britain and Europe to a group of English investors called the Gramophone Company. The initial catalogue of records was pressed by Berliner's brothers in Hanover, Germany. During W.W. I the Hanover operation became Deutsche Grammophon which would evolve into Polygram.

In 1902 Columbia and Victor pooled their patents and put aside a legal case that was pending. This freed them both to put all their efforts into promoting their products. Between 1902 and 1906 The Victor Company, in order to stimulate record sales, gave away models of the Type P Premium Player when a customer purchased several records at once. Columbia began selling disks in the U.S. in 1901 but Victor quickly became the dominant label in America. In 1902 Gramophone manufactured the first 78RPM record and In 1907 a double sided disk was issued. In 1912 Edison introduced the diamond tipped stylus which further improved the reproduction quality. "By 1917, both Columbia and Victor were emphasising the ability of their machines to supplant a dance orchestra at the most elegant and stylish affairs" (White, 1994, p. 58).

The beginning of field recording

The exclusive patent rights that Edison, Columbia and Victor had, ended in 1917, but they continued to dominate the record industry though others were finding opportunities at the fringes. The growth of independent production accelerated with the introduction of the vacuum tube to the process which made recording easier and more portable. By the beginning of the 1920s, regional, ethnic and culturally different music was beginning to be recorded by travelling field recordists who carried their equipment in the backs of their cars. They would set up in hotel rooms, bars, and music halls and record the best local performers. The artist was paid a small fee and the recordists/producer would press records and attempt to sell the recording to the big city record companies. Initially, these recordings had little impact on the music industry but would have a significant influence on future generations of musical artists. Music that had never before been written down, documented or copyrighted was now being codified for future generations. Did the recording of ethnic and regional blues, hillbilly, or folk music change this music? Of course it did. The recording process forced a honing of these songs into a structure that was just long enough to fill a 10 inch, 78 rpm record. This restriction became a catalyst in formalising the structure of the ethnic song. As Attall (1977) writes, "Recording stabilised the musical work and organised its commercial stockpiling" (p. 141).

It also immortalised forever those emotions that previously were conveyed only in the presence of the blues, hillbilly, or folk singers' performance. These recordings captured the music of the people, in particular black music, as well as hillbilly (later called country and western) and folk. Music which only existed as oral histories was now quantifiable and directly comparable outside of a public performance. This music now had stable roots from which others would build. Once created, the records provided a means of musical recollection of the life and times of these popular performers. Recordings also changed the standards of ethnic composition and performances. When this music was entirely by oral delivery, cliche and borrowed music wasn't a problem for the performers since those who were listening would seldom have heard the original source, and if they had, it was unlikely they would have been able to make comparisons from memory. The commodification of the performance allowed aficionados of the music to quickly compare and know when they heard someone play a stolen classic.

Throughout this century, the records of blues, hillbilly and folk artists of earlier times have been available for all to hear, providing a starting point for later performers to build on in their times. While this ethnic and regional music continued to evolve as an oral tradition, it was no longer necessary to follow these singers from one gin joint, music hall, or saloon to another in order to hear what they had to say. Once the records existed, the music could be discovered by each new wave of performers. Through the lyrics and performances of these songs, the recordings captured an impression of the lives, times and places of these singer/songwriters. Bessie Smith learned to sing the blues by going on the road with Ma Rainey, but Billie Holiday could...
listen to Bessie's records, and Aretha could build her music on what she heard in the records of Billie and Bessie. Not only have late 20th century singers been able to look through the phonographic window to the past, so too have instrumentalists. Eric Clapton (and so many others) could sit with Robert Johnson and pick up classic licks, even though Clapton was born seven years after Johnson died. Few pop music artists are void of influences from artists of the past. Records have connected all the times into a continuum, but with all the times of the past available at the same time just by playing a record.

As Frith (1992) observes:

Popular music came to describe a fixed performance, a recording with the right qualities of intimacy or personality, emotional intensity or ease. 'Broad' styles of singing taken from vaudeville or the music hall began to sound crude and quaint; ... [This change also coincided with a different type of music entrepreneur, the record producer, who, unlike the music hall operator, had little contact with the audience or any experience with trying to please the public on the spot.] For the record industry, the audience was essentially anonymous... (p. 58).

In Europe... in the beginning... on the road

In Europe, right after the turn of the century, armed with a portable recording system Gramophone's talent scouting technician Fred Gaisberg travelled all over Europe and into Asia looking for and recording every form of folk music and pub entertainer. In the beginning "serious" opera stars were loath to involve themselves with such gadgetry, but just when phonograph records were in peril of becoming an exponent of all things rustic, exotic and vulgar, legendary Italian tenor Enrico Caruso was signed in 1902 by the Victor Company and recorded by Gaisberg. (Actually Caruso was signed to the Gramophone and Typewriter Co. Of Italy. He would later sign directly with Victor.) He would have over 40 top ten hits. This marked a turning point for the fledgling HMV-Victor record label which now had the opportunity to market high culture into the home. It made ownership of a gramophone not only acceptable but essential by the best families. The record labels promoted operatic arias that were short enough to fit on a record and they soon became accepted as examples of popular music. Enrico Caruso was a famous opera singer long before making a record, but the recordings he made between 1913 till his death in 1921 made him an international figure and extremely wealthy. His voice became known to millions of people who had never been to an opera and almost everyone with a gramophone had a Caruso record. He was the first artist to have a successful recording career. The Gramophone and Victor owed their success and survival through their infancy to Caruso's popularity.

Further development of the recording process and the medium of distribution, the record, became a matter of perfecting the original invention. The amplifier was invented and introduced to the process and new materials and techniques were introduced but there was little change to the original concept. The story of these improvements are more appropriately related to the medium and so are described in chapter eight.

The expiration of the Edison- Columbia- Victor gramophone and phonograph patents in 1917 meant that dozens of companies entered the market. Record players were built for every taste. Some had features that today make one wonder what the designers were thinking. The Ko-Hi-Ola for instance, was a phonograph with a built-in grandfather clock, a storage area for records and a "special" secret compartment. As the ad for the unit described, "The Ko-Hi-Ola is more useful than the ordinary phonograph, more ornamental than the usual grandfather's clock and has exclusive features not found in other machines" (McCarthy, 1971, p. 15). There were many manufacturers of phonographs. Most machines had some unique sales feature that had little to do with the sound. Most were commercial failures as were the companies which made them.

Phonograph players remained mechanical devices for sometime after electric recording began in the early 20s, but in order to hear the extended response of the electric recordings, larger horns were needed. The need for better reproduction equipment to hear the improved record quality pushed the development of electric record players so that by the mid 30s the large playback horns were disappearing. This was made possible by the development not only of amplification but a low cost stylus and cartridge that generated an electrical signal that could be amplified. The stylus was now connected to a piezoelectric crystal that when twisted back and forth along the modulating groove would generate an easily amplified alternating current.

Beginning in the 1920s, the gramophone became a centre piece for an evening's entertainment with friends. It was a more social instrument compared to the radio which was also becoming a part of the modern home. No one knew for sure what would be on the radio, and if they did they had no control over it. On the other hand the person running the gramophone party had control
of the material played. There could be discussion about what was heard and how it differed from other recordings. Fearsall (1996) observes,

"There were "formalities connected with putting on the records, winding the machine up, and changing the needles, (which) gave guests the feeling that listening to the gramophone was as cosy as participating in a musical soirée" (p. 104).

For two generations to come, such record parties would be social events, but the nature of the event would change. By the fifties, a party goer would be younger and come with a "thumb full" of 45s and the player would be set up in the garage where there was enough room to do and demonstrate all the latest dances. What made the party a good one was if the participants brought with them enough of the latest releases.

The birth of magnetic recording

The history of primary invention and innovation in recorded sound will now focus on the development of magnetic recording. Magnetic recording was not a factor in the development of the record industry for nearly 75 years until the second half of the 20th century. However, over the last 45 years, the music industry can attribute an overwhelming majority of its production evolution to the development of this technology. The tape recorder was also a key factor in the growth of independent production and the success of the small labels that appeared after 1950. This in turn provided the catalyst that nurtured rock and roll. Tape recording was particularly suitable for recording small self-contained pop acts and its use in this manner became more and more prominent as multi-track became the mainstay of pop music production.

It was in the 1880s when Oberlin Smith, president of the American Society of Mechanical Workers, first suggested that a signal representing sound could be recorded on and then played back from magnetised particles attached to some sort of moving tape. He created a recorder and a playback system and demonstrated it by recording a telephone conversation. But Smith was unable to develop his idea further most probably because no method was available for amplifying the very weak signal. It would be nearly twenty five years before DeForest would file his patent for the vacuum tube. In the late 1890s, a Danish engineer Valdemar Poulsen, while working for the fledgling Copenhagen telephone company, began some experiments in magnetic storage. He discovered that when he drew a pattern with a magnet on the side of a hardened steel tuning fork and then dipped the fork in iron dust, when the fork was removed from the dust, the red particles remained attached to the pattern.

In 1898, Poulsen made his first recording. The nonsense words "Yacob, Yacob" were chosen because they were distinguishable in the quiet non-amplified playback. That year Poulsen took out a Danish patent and applied in a number of other European countries. In 1899 he applied for a U.S. patent. The patent included a well thought-out drawing which showed parallel magnetic pole pieces rotating around a stationary cylinder. The pivoting head pieces were held in place by a bow-shaped frame. The pole pieces were perfectly opposite one another, separated by only the thickness of the magnetic cylinder, with one of them rotating around the outside of the cylinder, the other around the inside. There is no record that this device was ever built. Poulsen demonstrated a different design of his invention at the Paris Exhibition of 1900, but little interest was generated. From then on Poulsen put most of his time into being a celebrity inventor, a personality and a writer. In one article he wrote about an idea suggested by E.S. Hagemann, where someone could record on one area of the cylinder and then play it back while recording on another area of the same cylinder. Essentially he identified multi-track recording. Poulsen went corporate in 1903 and became the spokesperson and part owner of the American Telegraphone Company. The promoters immediately raised five million dollars and later capitalised millions more. Superlatives and amazing promises of wonderful equipment and great earnings abounded. The patent for the first commercial device had been applied for in 1903, but because the company was doing so well raising money, it waited until 1909 to release a product. By 1911 the company had ads featuring Phoebe Snow, a famous model of the time, as a delighted secretary enthralled with this new fangled dictating machine. Only a few of the American Telegraphones were made and most were sold to experimenters who had some special application. This unit was not amplified and as such, simply did not perform well enough to impress potential buyers.

The amplifier that De Forest invented was a natural for the magnetic recorder. It could boost the signal before it was recorded and raise the low level signal when it was played back. About the same time that DeForest sold his patent to Western Electric for film sound and disk recording applications (see chapter two) he became interested in magnetic recording. After some work on the project De Forest realized (as Poulsen had) that magnetic storage media fails to respond to
low level subtle changes. De Forrest encountered the problem of hysteresis. Once the magnetic "domains" have reached an equilibrium of attraction whereby opposite poles are magnetically bonded, they will resist being pulled apart. To magnetically realign, they have to be exposed to an external magnetic field that is overwhelming strong and magnetically opposite to their present alignment. However, at the point that the existing magnetic bond breaks down, the magnetic realignment will dramatically change and quickly realign in a disproportionate fashion. This is called a hysteresis loop.3

AC bias as a method for overcoming the hysteresis phenomenon in a magnetic system was recognised as far back as 1896 by Marconi and others working on radio transmission. It was known that by adding a constant high level, high frequency tone to the transmission signal, the electromagnetic resistance or hysteresis, was overcome and the magnetic transfer characteristics became more linear. Put another way, in the case of magnetic recording, the recorded signal would more accurately represent the influencing input signal regardless of the input signal's level. This high frequency signal is referred to as "AC bias" (AC=alternating current). In 1902, Marconi used AC bias in the detector circuit of his wireless receiver. An engineer at the U.S. Naval Research Laboratory, A.J. Carlson, was working on improving the sensitivity of radio transmission and lowering interference noise. He discovered that by adding a 10,000 cycle tone to the radio signal the transmission was substantially improved. He applied for a patent in 1921 to incorporate high frequency bias in a radio transmission system. These improvements in radio transmission and reception meant that by 1927 Morse code telegraphy was fading into history. Carlson had been using an American Telegraphenes recording machine to record and retransmit wireless but had not made the leap of understanding to realize that AC bias would have also improved the magnetic recording quality of the machine. Curiously, it would be some time before AC bias was used in magnetic recording systems. It would seem the inventors involved in magnetic recording had little contact with those involved in inventing and advancing radio transmission (Giscard d'Estaing, 1993 p.p. 199-201).

In the early 20s, Fritz Pfleumer, a German inventor, began to study magnetism in an effort to discover a cheap magnetic medium. By 1927 he had perfected a way to apply magnetic particles to paper tape. I.G. Farben, a large chemical company (now BASF), was interested in what he had developed because it had just invented a way to make superfine iron dust and was looking for something that it could be used for. Farben had also developed a stable acetate film that could be made into a considerably more durable tape compared to the paper that Pfleumer was using. Farben and AEG Telefunken (Allegemine Electrische Gesellschaft, the German equivalent of the General Electric Company) entered into a joint research and development agreement to make a magnetic recorder (the Magnetophone) that would work with the tape Pfleumer and Farben were developing.

In 1932, Meyer and Schuller published a turning point paper, "Magnetic Recording on Steel Tape", that described the recording process for the German Lorenz-Stille recorder. For years the BBC pursued the development of steel tape recorder technology. These machines were frequently used for rebroadcasting speeches such as King George V's Christmas day messages. The steel tape travelled at a very fast speed and the head wear was severe. The machine had extra heads that could be engaged in case the heads failed in mid-playback. The reels were 80 cm across and weighed so much that a small block and tackle was needed to change reels. For safety reasons, they were installed in small "bullet proof" rooms and it was suggested that no one be in there when the machine was operating because if the steel ribbon broke in the middle of playback, it would slice and shatter, sending razor blades like shrapnel flying all over the room. For splicing, a small blow torch welder was used. The machine was not convenient to operate.

In 1935, the first German Magneto phone from the Telefunken-Farben project was introduced. This model had two important innovations. First, the machine used thin acetate film tape with a coating of magnetic powder on one side. This made it easy to edit, unlike steel tape. Secondly, because the emulsion was coated on only one side, the playback and record heads were different from any previous machine and were like modern heads with both of the electromagnetic poles in contact with the same side of the tape. They were shaped like a ring with a slit on one side to separate the poles and concentrate the magnetic field across the gap.4 This machine was significantly more advanced than any other previous design but it continued to have problems related to nonlinearity of the recorded signal.

Dominating those difficult domains

By the late 30s, in different parts of the world, research into the use of AC bias in magnetic recording was independently progressing. In Japan, K. Igarashi had been using high intensity, high frequency current to erase recorded tape. Nagai, Sasaki, and Endo continued this work by adding the same high frequency current to the audio signal going to the record head. The "old"
sound was erased as the "new" sound was recorded. This idea was in the right direction but still not perfect. It eventually became clear that if some high frequency bias was good, a lot was not better. When the bias was too strong, it would erase the lower level audio and the higher frequencies of the audio range before the tape could move away from the influence of the erase/record head. The bias signal was "self erasing" the audio signal. Nor could the erase process occur at the record head since the amount of bias signal needed to erase the tape was substantially greater than that needed to achieve a good recording.

About that same time, Walter Weber of the German broadcasting network came upon a record circuit in an early Magnetophone (called a Tonescriber) that had accidentally gone into high frequency feedback. The feedback was essentially an AC bias signal and it improved the recording but the improvement was somewhat masked because the machine had DC bias as well. Weber's team arrived at a couple of important conclusions. DC bias was counter productive but AC bias was an effective means of linearising the magnetic transfer characteristics so a bias amp was added to the record circuit. Secondly, it was determined that the best sonic quality was achieved when the record bias level was slightly greater than that which was needed for maximum audio output or sensitivity. While the first commercial recorder to use high frequency bias was a wire recorder manufactured in 1941 for the U.S. Navy by the Armour Research Foundation (University of Illinois, Chicago), the breakthrough in tape recording came about 1942 when a German Magnetophone was introduced that used high-frequency bias in its record circuit. During the war, magnetic recording research in the U.S. was put on the back burner but in Germany, tape recorders were seen as powerful production tools for propaganda so their development continued (Jones, 1992, Camrus, 1985, Giscard d'Estaing, 1993, Mullin, 1981, Lubin, 1991).

In England, toward the end of World War II, a young U.S. Army engineering officer Jack Mullin, was assigned to the RAF communications research department. He was looking into ways of filtering out the high levels of radio jamming signals that the Germans were beaming across the English Channel. He often worked late into the night while listening to classical music on the BBC. When it went off the air he would then tune in to one of the German classical stations which stayed on all night. The sound quality of the German transmission was quite good so Mullin figured that Hitler must have people playing all night, every night, continuously. Mullin imagined that Hitler could do that. Right after the invasion, Mullin was part of an army engineering unit which was assigned to research and report on any German communication or transmission devices which the Allied forces came across as they moved toward Germany. Members of Mullin's unit came across several tape recorders, but all were designed with D.C. bias and weren't good for anything other than recording phone conversations, which is what they were used for.

Playing a hunch in Germany

On bombing runs to Dusseldorf, many U.S. planes experienced near engine failure when they came near a certain German transmission site. As soon as the site was in Allied territory, Mullin, another engineer Lt Speckelmeyer and a driver, made the half-day drive to investigate the source of this mysterious radio signal that could stop engines. They found a nine-storey, enclosed tower, with every floor stripped clean with the exception of the basement which held two huge diesel generators. Whatever it was that could stop aeroplane engines had long since been removed by the retreating Germans. A RAF officer who was also investigating the tower shared Mullin's interest in sound and described a tape recorder he had seen and heard in the studios of Radio Frankfurt. The RAF officer said the machine was exceptional but Mullin initially discounted it, figuring the machine was no different to the other Magnetophones he'd seen. He figured the Englishman was making his comparison to the 78s that were played by the BBC. However his curiosity got the better of him and he decided to investigate. What he found astounded him. The machine looked like the machines he'd previously seen but the sound quality, signal to noise, etc. was nothing like anything he'd ever heard. Speckelmeyer had a camera so they photographed the entire manual and took several rolls of tape back to Paris. From the drawings, Mullin was able to recreate the circuit in the machines at his Paris headquarters which then worked as well as the machine he'd seen in Frankfurt. The tape was 1/4" wide and the machines ran at 30ips. Mullin found this unusual since Germany was a metric society. The tape, Luvitherm I, was made by I.B. Farben, and had magnetic oxide impregnated in the tape (not a magnetic coating). Over the next several months, during his travels through Germany, he was able to pick up fifty reels of this tape.
The three heads (erase, record, and playback) were small horseshoe shaped electromagnets which directed the field across the small gap between the tips of the pole pieces. The tape travelled past the gap. The back of the horseshoe formed a yoke that ran through the core of a winding of very fine wire. While optimised for each of their purposes, a similar head design was used for each of the three heads. In 'record', the alternating magnetic field (bias and audio) was directed between the gap in the record head and influenced the tape as it travelled past. In 'playback', as the tape travelled past the gap in the playback head, the tips picked up the magnetic difference between the two points on the tape. This difference was amplified for the tape's playback. The fundamental design of these heads was similar to all heads that would follow. For stereo and multi-track, several of these wafer thin yoked windings are alternately stacked with razor blade thin magnetic shields between each layer.

Mullin figured out how AC bias was being used to make recordings of such quality. He wrote a report about the machine and tape and, as was the procedure, it was forwarded through the military to the Department of Commerce in Washington. It wasn't seen as having any military application so the information was released to the public. No one seemed very interested.

Mullin took two machines apart, left the electronics behind, and shipped the transport (except for the heads) back to his mother who lived in San Francisco. He figured, he could build the electronics from components in the U.S., and if any of the transport parts got lost, he could rebuild what was missing. But he could not remake the heads, so he hand-carried them. If the rest of it never made it back to the States, at least he would have the heads. He would later comment, "At that point I knew so little about them, just what magic they might hold." He built 18 boxes just small enough to fit into 18 slightly oversized mail bags.

At the same time, Richard Ranger, an engineer who had been stationed at Ft. Mannmouth, New Jersey, where all of the reports from the various investigating engineers were collected and evaluated, found Mullin's report of particular interest. During the occupation, Ranger visited Mullin's unit a few times and, in 1945, on his way back to California, Mullin spent Thanksgiving at Ranger's home. Mullin showed Ranger the heads, and told him more about the machine. Before the war, Ranger had manufactured musical instruments and now decided to manufacture recorders.

When Mullin got to San Francisco the first thing that he wanted to do was say hello to his mother and count those boxes. They were all there. Mullin got the two machines rebuilt and running and started using them at Palmer Sound in San Francisco where he worked as an engineer/recordist. Palmer had been doing film sound for some time. Once the tape recorders arrived, rather than recording all the takes onto optical sound film, they would record everything on the tape recorders and then transfer the good takes to film. This streamlined the process by substantially reducing wasted photographic film and allowing immediate and intricate editing before transfer to film. Mullin got in touch with the chairman of the Institute of Radio Engineers (San Francisco chapter) who was impressed and requested a presentation at one of their programs. On May 16th, 1946, Mullin and Palmer demonstrated the machine and explained how it worked. A recorded program was later played at a meeting of the IRE held at the NBC studios in San Francisco. At the program was Harold Lindsey, a sound enthusiast who worked for Ampex, a company that had been making motors and electronic assemblies for radar systems. The military had bought large quantities of Ampex assemblies during the war, but with the war over, radar was at a stand still. Lindsey took the idea of Ampex becoming a manufacturer of tape recorders to the chairman of the company Antonoff Poniatoff, who was also a sound enthusiast.

In Chicago, through the early 40s, research at the Armour labs had continued, aimed at discovering the best magnetic emulsion. Hundreds of magnetic powders were made and tested. Cube shaped particles worked well, but the best were discovered in 1945 from the hydrogen-reduced variety. An electron micrograph showed that they were acicular or needle shaped. Since then, elongated magnetic particles have been used in all recording media. Marvin Camrus, from the Armour Research Lab, came to California during the fall of 1946 to present a paper on "magnetic" film to those attending the SMPTE convention (Television eventually became a part of the SMPTE organisation to form the Society of Motion Picture and Television Engineers - SMPTE). He had taken some clear film and painted on it a magnetic emulsion the lab had formulated. Mullin and Palmer decided to drive down to LA to hear Camrus speak. At the last minute, Palmer suggested they take one of the recorders along. The SMPTE convention wasn't large, as it is today, so it was very easy for the word to get out about this machine. Mullin set up his machine in a room at the Hollywood Roosevelt Hotel. Mr Poniatoff was also there and after the demonstration he made plans to talk with Mullin about manufacturing the machines in the Ampex plant in San Carlos (Lubin, 1991, Mullin, 1981).
The road to radio

The IRE demonstration in San Francisco had also caught the attention of the producer of the Bing Crosby show which was transcribed on disk in Hollywood. A few people from the recently formed ABC radio network were also at the SMPTE convention. Crosby was at the time negotiating a new contract with the ABC (America). The ABC network had just become independent from the National Broadcasting Corp. network. Up until the late 1940s, there had been an NBC RED and an NBC BLUE network. For a few years previous, NBC had been fighting anti-monopoly laws to retain both networks but was eventually told by the Supreme Court that it could not own two different communication networks. NBC BLUE was separated and sold to become the American Broadcasting Corp.

While producing his radio shows, Bing would occasionally make mistakes that he considered bad enough to stop the recording, necessitating a restart of the 15 minute segment. The orchestra (and everyone else) would have to play it one more time. When he saw the immediate playback and editing capability of the Magnetophone, he recognised that its use would substantially reduce his production time and costs. Tape also allowed other things to be done that were impossible on either record or optical film mastering. Multiple takes could be quickly edited together and tape could be easily duplicated.

Between 1945 and 1947 Ranger scoured Germany for some of the machines and any documentation he could find. He kept Mullin abreast of what he was doing, and an agreement was reached for Mullin and Palmer to be the west coast reps for the Ranger machines. By the summer of 1947, Ranger had built two machines and had intentions of manufacturing tape. Mullin had been in contact about what had happened at the SMPTE and both Crosby's and the ABC's interest in the Magnetophone. In August of that year, Ranger rode the train to California to demonstrate the new machine to Crosby's people and ABC radio. For the recording demonstration the original Magnetophone was also set up. On playback, the Ranger recorder was obviously inferior compared to the original Magnetophone which was superb.

Ranger had made a disastrous design change from Mullin's original drawings and had returned to a design using DC bias. He had not understood the significance of the AC bias. After the demonstration Ranger told Mullin and Palmer that he could put no more money into the design. There was only one thing that Mullin and Palmer could do. They broke off the business arrangement with Ranger and told Ampex that they would like to work with them. Ranger's day with recording destiny had slipped through his fingers. Ranger turned to inventions for film and invented the centre track pilot tone that bears his name viz. Rangertone. Crosby invested $50,000 in Ampex, which by this time had nearly shut down. Ampex people who were interested in the project remained and several new engineers were added. Mullin told the half a dozen or so Ampex people all that he knew about the Magnetophone. In April of 1948 the first Ampex tape recorders were delivered to Crosby. Shortly thereafter, ABC got theirs and over the next year and half, NBC, CBS, Mutual and the rest bought them. The first fifty recorders were basically copies of the German Magnetophone.

Half way across the country, in Minnesota, 3M had been following Camrus's work and was aware of the developments that were going on at Ampex. Based on the Armour research, 3M began making magnetic tape around 1947. The magnetically coated acetate tape which it created was fine tuned to work well on the Ampex machines. By 1949, all of radio and by the early 50s record production, had switched from transcription and disk cutting for original master recording to tape. No other technological shift of such magnitude has occurred as quickly (Lubin, 1991, Mullin, 1981).

The birth of modern recording production

So Crosby had his recorder for producing his programs. One of the segments on his show had guest musicians perform. One of these guest players was guitarist Les Paul, who had been experimenting with do-it-yourself record cutting and a form of overdubbing. He would cut one record, then, while cutting onto a second disk, play back the first record, while mixing it with another part. He would perform the procedure several times adding a new part with each new recording. The process was crude and there was little margin for error since the records used for cutting were soft and would deteriorate quickly with each playback. The sonic quality of the first recordings would quickly deteriorate and lose quality with each generation of copy. Nonetheless this layering of sound achieved a unique quality that no one had previously heard and heralded the beginning of modern music production techniques. When Paul was introduced to, and began to use the Ampex recorders in Crosby's studio, the results were significant. He could make a high quality recording and play it back as many times as he needed without deterioration in order to perfect and record the next part. All of the technical advantages of tape that Crosby saw as a means to reduce his production costs, were seen by Paul as a means of complete creative control over his music. Les Paul approached Ampex to build him an 8 track recorder that used one inch
tape, which he installed in his home studio in Connecticut. He began to use the machine to produce recordings that featured vocals by his new wife Mary Ford. This musical partnership would mark the beginning of multi-track pop music production. Paul would play all the parts, and she would sing multiple tracks of vocals.

Les Paul was the first to apply in a practical fashion the process of sound sculpting in music production (the film industry, using optical recording had been layering sound since the early 30s). No longer was the recording strictly documenting a performance. It was now an integral part of the creative musical process. He could hear every part in his head and then would play them all as he heard them. Les Paul and Mary Ford changed the way popular songs would be produced and ultimately changed how nearly all sound recordings would be recorded. He surely wasn’t the only one doing it, but he was the most prominent and successful of those who were first and became an example for others to emulate. Les Paul and Mary Ford had 28 hits between 1950 and 57. The best known are “How High The Moon”, “Mockin’ Bird Hill”, “Vaya con Dios”, and “Tiger Rag”. In the same year that Les and Mary started having their overdubbed hits (1951), Pati Page harmonised with herself on a smash hit of “Tennessee Waltz”. There have been so many who have followed Les Paul, but he was possibly the first to realise that he controlled a time machine which could hold each overlapping moment that he conceived and played.

The evolution of the multi-track

Everything was now in place for a monumental shift in music production. Tape recording had been commercialised and multi-track recorders had been invented. The impact in the record industry was swift. From the beginning of recording, the major labels had controlled the production studios and the production process which also meant that they tightly controlled what got recorded and ultimately heard. “With tape, the chain was broken. Recordings did not need to be made in fancy studios for big bucks. They could be made cheaply and anywhere”(Gillen, 1994, p. 106). Almost overnight there emerged a long list of independent labels that were releasing country and western, blues, jazz, and of course rock and roll. Among them were Atlantic, Imperial, Mercury, National, Chess, Aladdin, Savoy, Elektra, Vanguard, Blue Note, Prestige, Folkways and Sam Phillip’s Sun Records (to name just a few).

The first Ampex recorders were mono and used a “full track” head that recorded across the entire width of the 1/4” tape. Essentially, the wider the track the better the signal to noise (e.g. lower tape hiss). The faster the tape speed the better the signal to noise and frequency response. As tape recording and tape technology improved, more tracks could be squeezed into the same width of tape and wider tape formats were developed. Stereo came along in the late 50s and two tracks on quarter inch tape became known as half track. In the early days of stereo, half inch three tracks were manufactured for the studios so that a left, centre and right track could be recorded. The mixing of a “hard” centre track became industry practice during the early days of stereo recording mastering to ensure that the sound in the centre was accurately positioned in the sonic image. During the record’s mastering the centre track would be mixed equally to the left and right channels. During this time period, the 1/2” 4-track also began appearing in studios. It had the same track width as the 1/4” 2-tracks. It was primarily developed for mastering stereo recordings (left, centre, right) and at the same time provided a separate track for vocals (4).

Aside from the machines made for Les Paul and a few others, multi-track production didn’t become common in mainstream production until the introduction of 4 track recorders. By and large, the music industry saw multi-track and the “overdubbing” technique associated with this sound as being unique to Les Paul, and not a general tool for music production. In the early 60s the Beatles and the Beach Boys changed all that. That being said however, there were other producers in the 50s using the recorder in innovative ways. One of them used the technology to create recordings that were impossible to make without the tape recorder’s ability to record at one speed and playback at another. Ross Bagdasarian had been making records as a song writer and arranger. He had a particular knack for writing novelty songs. In 1958 he had a hit with “Witch Doctor” in which he sonically conveyed a shrunken head singing. By recording at half speed and playing it back at normal speed, the sound went up in pitch by an octave. The same year he invented an alter ego, David Seville, and introduced three small friends to sing a Christmas song using the technique of his earlier hit.20 “The Chipmunk Christmas” was enormously successful, as were many Chipmunk sequels. “The Chipmunk Christmas” record sold 3 1/2 million copies in five weeks. The Chipmunks, Alvin, Simon and Theodore, made eight chart albums representing over 30 million albums, the most recent being Chipmunk Punk in the early 80s produced by Bagdasarian’s son (Clarke, 1990, p. 1051), and of course they’ve been featured in a long running TV cartoon show. The technology provided the means to create something unique. It’s creative implementation, using Bagdasarian’s clever concept, was one of the first of countless subsequent record productions to use production technology to create something that the public had never heard before.

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By the late 60s, 1" 8-track was common. A 1" 12-track was also introduced in the late 60s, but the technology (electronic and tape) was not good enough for track widths that were so narrow and the machine was a failure. By 1970 major studios had 2" 16-track recorders. Most commonly these were Ampex MM-1000 machines which used a 2" tape transport that Ampex had developed for its first video tape machines. The electronics were Ampex's first generation of solid state circuitry. Mullin was recruited by 3M and developed an entirely new transport design that used constant tension. The 3M iso-loop eliminated the problem of the tape tension changing as the tape moved between the playback and take up reels. Better motor designs and constant tension improved the frequency response and speed tolerances over the length of the tape. Constant tension also lowered wear and tear on the tape and was standard on new machines by the mid 70s.

The 2" 24-track became viable, partly because of a new generation of tape and the invention of tape noise reduction which reduced tape hiss and increased the dynamic range that could be recorded. Gauss, a company specialising in tape duplicators, displayed an experimental 3" 36-track machine in the late 70s but it did not sell. In that same period, there were several 2" 40 track machines manufactured by a small company in L.A. (Stephen Electronics). These machines were popular with an elite group of engineers. Other manufacturers of multi-track during this time included Scully (who had earned a reputation for disk mastering equipment), Studer, Telefunken, and toward the end of the 70s, MCI (who were bought by Sony in the late 80s). But it was the 2" 24-track that became the industry standard for analog multi-track. When producers needed more tracks, it became common practice to synchronise two or more of these machines.

Running parallel to the development of analog recording of sound was the development of digitally recorded sound. The following chapter takes multi-track into the medium of digital recording and its unique impact on the production process, in particular the digital sound sampler that has moved popular music into what some describe as its post-modern period.

The democratisation of multi-track

In the first instance, multi-track allowed the ascendancy of the self-contained band that would play all the parts in the production (with the addition of “sweetening” instruments such as strings and brass). All the instruments and vocals could be recorded on individual tracks and easily manipulated and mixed after recording. Multi-track formed the foundation and liberating force for modern contemporary pop music production. This equipment and the techniques developed, changed how music was conceived and produced. As common practices emerged, an increasing number of sessions had individual musicians in the band recording their parts in turn rather than as a group. Eventually, many musicians decided they could play all the parts as Les Paul had. In the 1970s, this meant that many musicians had a goal to produce their own sessions (usually in co-production with an engineer). But as the technology became more powerful and complicated, the producers and recording engineers assumed more control of the recording process due to their mastery of the technology, which ultimately affected the production outcomes. It became obvious to many artists that control over the production of their music meant they needed a direct control over that technology. As the decade progressed, the artist/producer/engineer began to appear. Leading this movement was Todd Rundgren, Larry Carlton, Frank Zappa, Alan Parsons (Alan Parsons Project) and Tom Sholz (creator of the band Boston). These musicians were prepared to take on what was a significant learning curve in order for them to competently operate what had become extremely complex equipment. Over time, an increasing number of artists acquired this knowledge and know it is common for artists to work alone or synergistically with a like-minded collaborator to produce and engineer their own musical creations.

The emergence of "semi professional" studios

At cross purposes with the desire of the artist for master quality production facilities was the escalating cost of professional multi-track equipment and the associated hardware to operate it (consoles, signal processors, speakers, studio acoustics, etc). What appeared to satisfied this market was a range of semi-pro multi-track products that utilised smaller machines and narrower tape. The broad label of semi-pro formats have come to mean machines that provide four track on quarter inch tape, eight track on half inch tape and sixteen track on one inch tape. The broad label of personal multi-track formats have come to mean machines that provide four or eight track on 1/8" cassettes, eight track on quarter inch tape and sixteen track on half inch tape. These semi-pro formats were first introduced by TEAC/Tascam in the early to mid 70s. Other companies entering this market were Otari, Akai, Yamaha, and Fostex. From their inception, the driving force for the development of these affordable formats was their use in demo studios and by home recording enthusiasts. Since musicians were their target market, they also had to be
imple to operate. In their infancy, no one considered them competition to the professional formats. But, while the quality could not rival professional studios these smaller machines provided access. It is worth noting that even in the beginning of the semi-pro revolution, critically acclaimed recordings were made on these small formats. Some of the cuts on Bruce Springsteen’s 1982 album “Nebraska” were recorded at his home on a 4-track cassette multi-track machine. Through the 70s and increasing through the 80s, many regional hits were produced on such machines.

For someone who had a home studio, the need to book a few hours in a commercial studio to o a demo was a thing of the past. From the late 70s, the home demo studio became the place of reaction for demo tapes submitted to record labels and music publishers. This marked the beginning of a shaking out and restructuring of commercial recording studios. Only for very special projects would independent artists need a commercial facility. Those with well equipped home studios began to offset their investment by doing demos for others. Through the 80s, improvements in electronics, transport design, cheaper and more sophisticated signal processors, etcher tape and noise reduction, elevated the technical performance of these “semi-pro” studios where they could deliver professional quality results. The development of computer controlled music, MIDI, and advances in low cost digital recorders pushed an increasing number of commercial studio operators to the wall.

In many cases the manufacturer’s effort to improve the record production made semi-pro gear more technologically advanced than the professional format machines. Some of the original first generation manufacturers of multi-track tape recorders (Ampex, 3M, and Scully) stopped making audio tape recorders all together and MCI/Sony, Studer, and to a lesser degree, Otari, and ascom found it increasingly difficult to sell their “professional” machines to a diminishing number of commercial studios. It was hard to justify the cost of these machines compared to the smaller format machines which delivered comparable quality and, in many cases, more “user friendly” features. Those manufacturers who focused on the musician-oriented production studios continued to push hard at the boundaries of recording technology. Digital format multi-tracks have vapourized the notion of semi-pro and pro multi-track formats. This new generation of machines is affordable enough for anyone to buy and yet satisfies all but a few of the needs of professional studio operators. In groups of 8 tracks, any number of machines can be operated in tandem to provide all the tracks someone might want for any size of production regardless of audio size.

There are now dozens of major manufacturers bringing to market a never-ending stream of newer priced, innovative, high quality, easy to use recording and music production equipment. The invention and rapid proliferation of digital recording, digital samplers, keyboards, sound modules, affordable digital signal processors and MIDI has accelerated the movement from large studios to musician-oriented music production spaces that, in many cases, are in the artist’s converted garage or extra bedroom. Affordable music production technology has given artists the means to produce a commercially competitive product which is exceedingly localised in that they may only have distribution off the foot of the stage, or out of their instrument cases while busking. Such technology also allows the production of music which can compete on the world market to be created anywhere and the internet provides access to a global market. Given the right conditions, local product can become international product and its distribution and popularity have no bounds. Grossberg (1984) explains the key point of transition that moves local music into the realm of international product:

Music is produced locally, out of a local community with a set of shared experiences and perhaps a shared, albeit unconscious ideological representation of the world. Hence, as music, there is a sense in which rock and roll must be seen as “folk art”. What gives rock and roll the appearance of mass art is its reproduction as an object (p.228-229).

The appearance however, as Grossberg states, is not merely a matter of mass production and consumption, but the reasons behind the production followed by the reception and hoped for acceptance by the public at large. Singer/songwriter buskers who are selling a home grown music production, are no different to any other craftpersons working on an open market. They become a music commodity and potentially pop stars as soon as what they are selling is artistically acceptable and accessible by their local consumers. The goal of such artists is that they and their product will gain the necessary recognition to cause a record label to notice them, contract them, mass produce their product and market them.
The home/project studio threat

Today, the productions created in the best of these small facilities rival the big studios and as a result, the number of commercial studios has been declining since the mid 80s. In the 90s, one after another major studio has closed its doors with only a few major studios remaining to cater to large budget productions. The overwhelming majority of production now comes from "project studios" so named because the owners are more involved in producing products which they sell rather than renting studio time.

By the late 80s, in places like L.A., there were hundreds of project studios competing with the established commercial facilities. In self defence, the commercial studios banded together and took action against home studios that were operating commercially. These home studios were generally in areas that were not zoned for commercial business and seldom held a business license, so, as such, should not have been operating as a commercial business. Nor did they have the overheads associated with such things as handicap facilities, adequate parking, business tax, commercial rates on electricity, insurance, etc.. The commercial studio owners decided to make one home studio a test case by turning in Secret Sound, owned by Chas Sanford, to the L. A. Dept. of Building and Planning. Initially the city concluded that the studio was used solely for Chas's own projects and was not in violation of any zoning restrictions. When the commercial studio owners presented a six page colour brochure for Secret Sound, the case was reopened. Other proof included rate cards, receipts, album credits on records of someone other than an act they were strictly involved with, etc. The dilemma for LA county is that its zoning laws do not allow for anyone to use their home as a principal place of business of any type. Needless to say the county looks the other way unless it is pressed.

The late Frank Zappa (cited in Michaels, 1989), who recorded most of his albums in his home studio commented,

If you carried that to its ridiculous extreme, it might have an adverse effect on people who paint at home, sculpt at home, weave at home. Theoretically, if they need strict enforcement of all enterprises in the home, they could shut Hollywood down(p.60).

As the chief zoning administrator Frank Eberhard admitted, "I think the broader implication is that the law needs to be changed"(Michaels,1989, p.60), to allow for commercial activities that don't affect the character of the neighbourhood. Since most of the commercial studio owners know most of the home studio operators, the issue is very personal. While many commercial studios are now fighting to survive, their heavy handed approach was not going to change the trend toward home studios and was more likely to back fire on them. As Robby Buchanan said, "As a free lance keyboard player, I work in these studios a lot. As a producer I book them to mix. I would not want to go work in somebody's studio that closed my studio down" (Michaels, 1989, p.60). The L.A. zoning department found itself being used as enforcer for commercial studios. This was a role it was not happy with since home studios in the L.A. area have, over the years, become part of the character of the community which has a goodly number of high profile musician voters who are often called on to support one or another politician or movement. The debate calmed when both sides were brought together and some guidelines were established about operating commercial home studios. Nonetheless, project studios have dramatically affected the commercial studio business. Those that remain either cater to the top end of the market and have moved into other areas such as film and TV scoring, or they have found a niche which supports the "nut" of their operation such as in-house production ventures. Such is also the case in all recording centres throughout the world.

Access and equity

Studio skills in production and engineering have become as important to the musician as the playing of an instrument. These abilities allow them to create a product from their music that they can market. It is obvious that in the 90s, such direct control and access is essential for the development of a successful career in the music business. While any given person may be more skilled in engineering, or production, or musicianship, or songwriting, most professional music creators are able to handle most aspects of the entire process. Production and engineering training is now a part of all contemporary music programs at the university level, and a wide range of private production schools offer various types of courses in music production engineering. Some of these are also providing training in video and multimedia as it applies to music production. Hundreds of thousands of people who are not career musicians but who find recording a recreational outlet, are also becoming skilled at operating the equipment in their home studios. For them their investment is no different to that any other hobbyist might make for the tools to pursue their pastime.
Ultimately, music production is about the sound and the song. If that is there, the public has no particular awareness, nor does it care, where or on what the music was made, and nobody asks if the production was over budget and created in an expensive studio. It either excites the performer and ultimately the consumer, or it does not. When it comes down to it, it really is that simple. Big budgets and big expenses don't make big records — it's great songs and imagination, with a little magic mixed in. Since the 1980s, thousands of albums and sound tracks have been recorded in project facilities. Needless to say, the quality of these facilities varies from simple 4-track recreational demo systems to facilities that rival top-of-the-line installations. Many of these started out small and grew into significant installations. The subject of production techniques and the evolution of sounds and what creates them is further explored in this paper.

While access and technical skills may provide empowerment, it does not automatically mean that someone will then have the artistic skills required to compete at the highest level of commercial music production. The tools are only tools. Without the illusive knowledge to creatively apply the technology, the producer will be mediocre and no different from millions of others who share an understanding of technical skills but have no artistic taste. Music production is much like desk top publishing. All the wiz bang tools in the world won't make someone's work great, but in the hands of the right someone, a minimum of tools are enough to create magic. This theme is picked up in the conclusion of this paper.

Summary

In this chapter we have seen how recording began as a means of documenting and preserving historical and cultural events. It has fulfilled this objective but in a way quite different from that conceived by the pioneering inventors of recording. The development of records and recording, like many other 20th century innovations, was soon driven by commercial and political forces. Recorded sound and particularly popular music, became a mass marketed consumer product and from the seed of its invention grew several huge industries. The primary one involved the producing and marketing of pre-recorded product. In close association with the media producers was the consumer electronics industry that manufactured the devices that played this product. Over time the film, T.V., radio, background music and the like would also use the recorded product as an essential aspect of their creations. These presentation industries are the subject of later chapters of this paper.

The development of magnetic recording not only took sound and music production to a new level of quality, it also dramatically changed the status quo of the record industry and stimulated the rapid growth of independent labels. Production facilities began to open and flourish far from the traditional recording centres and location recording became common. These were significant factors in creating the climate from which rock and roll emerged. The unrelenting development and perfecting of sound recording and production equipment has changed the musician-creator's role from strictly a performer, to a sound sculptor and musical technologist sometimes more comfortable in a recording studio than on a stage. The recording has become the benchmark by which we judge musical artists' success and talent - their studio efforts representing the standard by which we judge their live performance.

Finally, it is the record which has commodified popular music. Now each generation of popular artists can build on the work of earlier artists. Regardless of the obscurity of artists during their lifetime, if a recording was made of them, their work remains available for review, and in some cases recognition far beyond the wildest expectations of anyone involved in the original recordings. The gramophone, records and the magnetic recorder have turned popular music from an oral tradition to a product, and the popular musical artist from primarily a local performer with little identity or lasting significance, to an international personality with the power to set trends and dictate styles not only with regard to music but in nearly every area of modern life.

Ancestor of the phonograph
Incorporated on Jan. 1, 1889, by Edward Easton as the Washington D.C. franchise of the Jesse Lippincott's North American Phonograph Company. It was one of 33 franchises set up to lease and service phonographs. All of them failed with the exception of the D.C. franchise. The survival of this one company was due to its astute pursuit of alternate markets and because it began to sell recordings on the Columbia label (named after the District Of Columbia). By 1891 it had 200 titles in its catalogue and was the largest record company in the world. In 1900 it opened a London office and by then was selling both Edison cylinders and Berliner disks. Due to financial problems during WWI (1922) the U.S. operation was forced to sell its British subsidiary to the local manager Louis Sterling. A year later U.S. Columbia also failed and the British operation bought it from receivers to get access to the recently developed electric cutting system that was only available to U.S. companies. The company was reorganised in 1925 and went international, operating under different names in different countries. In the U.S. it was known as the General Phonograph Company Inc. The company in the U.S. invested in broadcasting by taking over United Independent Broadcasters and renamed the U.S. operation the Columbia Phonograph Broadcasting Co. During the depression in the 1930s, the company again had financial woes, and in particular, the performance of the U.S. record operation was poor (sales were 69% of 1927 levels). The broadcast network had potential but was equally unprofitable, so bad sales and the likelihood that it was in violation of antitrust laws due to this 50% interest in the Victor Talking Machine Company in the U.S. caused the company to divest its U.S. interest in Columbia. Columbia U.K. was merged with HMV (the U.K. operation of the Victor Talking Machine Company) in 1931 and the company was renamed the Electrical and Music Industry (EMI). The U.S. radio network continued as the Columbia Broadcasting System and became profitable during the next decade. The U.S. Columbia Records was sold to Grigsby-Grunow, a manufacturer of refrigerators and radios. This company went bankrupt in 1934, and Columbia was sold to the Brunswick label.

The American Record Company had been formed in 1929 through the merger of three small labels, Oriole and Perfect, Romeo, and Banner. ARC acquired the Brunswick label (started in 1916) in 1931 and changed the name of the entire company to Brunswick Record Corporation which it was at the time of the Columbia acquisition. CBS bought Brunswick in 1938. CBS deactivated the Brunswick label and reactivated the Columbia label, later selling Brunswick to Decca in 1942. Outside the U.S. the Columbia label would remain EMI's flagship pop label until the early 50s when CBS pulled out of its overseas arrangement with EMI. We'll return to the EMI, HMV and Victor Talking Machine Company connections subsequently.

In 1900 the Gramophone Company bought the rights to Francis Barraud's painting of his dog Nipper sitting in front of a phonograph. The artist was paid £50 for the painting and £50 for the copyright providing he changed the phonograph to a gramophone. Barraud painted a gramophone right over the original. The name of the painting was "His Master's Voice" which became a trade mark and label for the Gramophone Company. When Berliner visited London he asked to use the image as a trademark in the U.S. Berliner, Victor, then RCA have used Nipper. In Egypt, India and Moslem countries it was not used by HMV because dogs were considered unclean. In India a listening cobra was substituted for the dog on those records with Indian artists. In Italy it was never used because there, a bad singer is said to sound like a dog. Victor also used the logo for releases on its Japanese subsidiary which was sold to Japanese interests before W.W. II. JVC (Japanese Victor Corp.) continues to use the logo.

HMV and The Victor Talking Machine Company maintained an ownership in each other for 50 years. Johnson sold out to bankers Seligman and Sprayer in 1926. During the depression record sales dropped through the floor. The Camden New Jersey pressing plant was converted to making radios. Victor dropped most of its artists though many later appeared back
on the label through the HMV connection. In 1929, the Radio Corporation of America bought Victor from the lawyers. RCA had no intention of continuing the record operation but wanted the company for the radio manufacturing facilities. When ASCAP began to claim that the radio industry should pay royalties for air play which eventuated in the first arrangement with the NAB (1932), RCA realised that the Victor catalogue was a gold mine and decided to continue the label using the pressing plants that it had acquired along with the radio plant. The RCA-Victor label was begun.

3 See diagram of magnetic hysteresis in Appendix 1.

4 See diagram of a magnetic head in Appendix 1.

5 This quote as well as the details of this entire section come from personal interviews with Jack Mullin by the author in 1980 and 1981.

6 The term "transcribe" was uniquely used by radio to describe the process of recording to disk a radio program. Pressings would be made and distributed to the affiliated stations. Radio networks now distribute their special programs on limited run CDs. For instance the ABC (America) network issues a 4 CD set each week for a 4 hour top-40 radio show which is used by many of their affiliates.

7 Of note: one of the young grade students at Ampex was Ray Dolby, who went on to become synonymous with tape and film noise reduction. With Crosby's backing, Mullin established a research laboratory to develop video tape recording. This group was the first to demonstrate in 1950 a video image from a tape playback. By 1954 impressive colour was demonstrated by Ampex which became the standard format for colour television in North America (NTSC). Ray Dolby was also a member of the team that brought colour TV to fruition.

8 See noise reduction in Appendix 1.

9 The invention of synchronisers and their importance in music production will be covered in chapter 7.
The development of digital recording

Digital technology and computers are now fully integrated within all aspects of music production and delivery, and in many cases they have replaced the sound of acoustic instruments - drums, piano, horns, string sections, etc. with the notable exception of the guitar. In the 1980s and 90s, digital has become the method by which nearly all things happen "in between". The sound we hear is analog, as is that which enters the microphone, but when the sound enters the mixing, processing and storage systems, it is "digitised" into a series of ones and zeros that represent a specific audio level at the instant the signal is sampled. Only at a point just before the audio output stage of the digital system is it turned back into something we can hear. When this is reproduced at the same rate it was sampled, it is perceived as a close representation of the original sound. Most people believe this representation is so good that there is subjectively little difference between the original and the digitally stored reproduction.

One of the most significant tools born from digital technology has been the sampler, a digital recorder specially designed to record short segments of sound. Without question it is the sampler that has allowed the sounds of pop music from past generations to become so integrated into the music of the 90s. Samplers have made possible the creation of music without the need for traditional musicians, instruments, or places to record them. They are an extraordinary tool that was initially marketed as a means of storing and playing the sounds of recorded instruments, but which has become an essential device in the production of rap, scratch, or other forms of hip hop music. The sampler in concert with the myriad of keyboards and sound modules that use samples has most affected the sound and production techniques of today's music. Samplers have provided the means for older music to be literally deconstructed and reconstructed into something new by the present generation of music producers who create what some have described as post modern pop.

With digital technology and sampling, the actual sounds that are used have become commodities. The sound sample has become a stand-alone entity to be reused and manipulated. Samples are now bought and sold just like any other recorded product. There are now volumes of sampler CDs that contain nothing but small segments of sounds which are used by samplers. Samples are also available and downloadable via telephone through the Internet. The user of the sample may have no idea who made the sample or how it was made, nor do they care.

Digital technology has also affected the delivery of popular music. With the introduction of CDs, the record industry had the opportunity to revitalize itself. Not only was it able to reissue and remarket its back catalogues, but new products became available. Multimedia is now the buzz word and a great deal is being invested by the industry to integrate images with music into various forms of interactive product. The information superhighway has also provided a means for all participants in the music industry, both large and small, to have direct global contact with the consumer. Everyone can have a Web page that anyone anywhere can access via the telephone. Musical products and the artists who produce them can be seen and heard anywhere in the world via the Internet.

The beginnings of digital technology

Digital (or more accurately identified binary counting), has existed since the birth of math, but we might pick up the history of digital recording with Morse's telegraph patent of 1838. Morse used a binary code of dots and dashes to represent the letters of the alphabet. As described previously, to facilitate telegraphic transmission a binary recorder was invented by Edison so that messages could be coded prior to transmission, and to record incoming messages
for re-transmission. This machine can be considered the first digital recorder. Pulse code modulation,1 the basic form of a digital signal, was invented by Paul Rainer in 1926. In the mid 30's in Germany, Konrad Zuse developed the first programmable computer. The concept of "PCM" appeared to disappear for a time and then was reinvented in 1939 by H.A. Reeves, and rediscovered during W.W. II by Bell Labs (Giscard d'Estaing, 1993, p137).

While there were other computer design and digitising research projects occurring throughout the world, the Bell Labs made many significant break throughs. Audio was first digitised at the Bell Labs as early as the late 1920s with the aim of overcoming the limitations of analog transmission. In 1939, George Sibbitz at Bell designed and constructed the first binary computer. Nearly all this research and development was for improving calculations for various government and military applications. At the top of this list during the Second World War was code breaking. After W.W. II computer development accelerated. In 1953 IBM began selling its first production computer, designed for scientific applications. In 1954 the IBM 650 was introduced which was the first mass produced computer and had an extraordinarily long life lasting into the late 60s. In 1957 IBM and Burrough's Business Machines brought out small and medium sized business computers. 1957 was also the year that UNIVAC and Philco introduced the first transistorised computers. These computers were very expensive and had limited usage outside of military, government and university applications, but in 1965 Digital Equipment Corp. introduced the PDP-8 for $18,000. It had only 4K of memory and could only run one program at a time, but it was the first step toward mass-produced minicomputers.

The problems to overcome for digital sound

Digital storage of sound was not practical until two obstacles were overcome. The first was a means of storing the large amounts of data required to generate high quality sound. Secondly, because sound must be continuous or it goes out of existence, the sheer power and speed of processing had to be high enough for the processing to occur in real time. In other words, the processing had to be completely transparent, with no pauses in the digital audio's output, otherwise the sound is interpreted. The data involved for a single high quality mono channel requires a constant data transfer rate near one million bits (1s and 0s) a second. It was many years before his sort of deterministic real-time power and storage capacity was a reality and then it was only available to the military and a few university labs. It was not used in music production until the early to mid 80s and even then it was very expensive. A third problem was that analog to digital and back to analog processing required intricate and exceedingly precise circuitry. These convertors "sample" the incoming analog sound, and in real time, convert it into digital data. On playback the digital data is returned to an analog signal, again in real time. It was not until the development of third and fourth generation large scale integrated circuits that such convertors were available that were both affordable and sufficiently accurate.

The first commercial digital recording was made in Japan by Denon, a subsidiary of Nippon Columbia on September 14, 1970. An American saxophone player Steve Marcus and a group of Japanese musicians recorded a session directly to a digital recorder. One of the first companies to offer digital recording as a service was Soundstream, a small company that had developed its own recording and editing equipment. Soundstream operated from the early 70s to the mid 80s from a research lab in Utah. Most of its work was either classical recording or sound restoration such as the Doors "An American Prayer" album discussed earlier. In the late 70s, Ampex, 3M, Mitsubishi, Mitsubishi, Sony, Studer, MCI, and through the 80s most other major manufacturers of analog recorders entered the digital recorder market, most with their own format. All of these machines used tape for storage. Through that period, debate raged as to which of the formats should be accepted as the industry standard. Needless to say, each manufacturer hought their approach was the answer that the others should adopt. While the machines were impressive, they were very expensive and plagued with the instability associated with first generation technology. A few of the premier studios acquired them to maintain their position of leadership, but by and large, studios stayed with their analog machines. The high cost of the digital machines could not be justified since music producers were not willing to pay higher studio rates when the quality of the analog machines was more than adequate. Nor were the labels willing to pay more for a digital master. There was also a nagging concern over compatibility and reliability. Music producers didn't like being "locked" into a certain system, or a specific studio. And there were those who simply didn't like the sound of digital (more on this in chapter five). During the 80s, the majority of these manufacturers ceased production of reel-to-reel digital recorders. The remaining few established a common standard to allow tapes to be interchangeable. At least that was the desired outcome. In fact, reel-to-reel multi-tracks continue to be plagued by problems of incompatibility even between machines made by the same manufacturer. The more the tape had been played, the more likely it was that the data would eventually fall to bits.
During the mid 80s, several of the home recording music products companies such as Roland, Akai, Alesis, Sony, Fostex, Fairlight, and New England Digital were developing digital recorders as an extension of the work they were doing in digital signal processing and sampler technology. Most of these second generation digital recorders used hard disks for storage and tape for long term storage. Starting in the early 90s, most of them aggressively brought to market low cost digital recorders. These hard disk systems have evolved into something more closely resembling computers than tape recorders. Besides the purpose built products, there is a proliferation of low cost, high quality audio cards that can be installed in a fairly basic computer that is equipped with a large hard drive. The elimination of the linear restrictions of tape opened up entirely new techniques of music production in the areas of editing and processing. Of the many advantages of random access storage, two procedures are particularly useful. Individual tracks can be shifted in time against the rest of the recording and a certain section can be recorded once and then used in other places of the production without re-recording it. The music of the 90s reflects the wide use of these new techniques. To some degree the issue of storage has also been addressed. The amount of data required for accurate reproduction has been reduced due to advances in data compression technology that extract data that is not needed for accurate storage and decoding. Secondly, the cost of large volume storage has dropped along with other computer products. Not directly related to storage, but still a factor in the number of recording tracks that are required, is the introduction of the MIDI and its implementation in thousands of products (MIDI is fully explored in chapter six). In most cases, MIDI-controlled productions only need recording tracks for those sounds that are acoustic in nature—usually the vocals and guitars.

In the last couple of years, affordable cassette tape-based digital multi-track recorders have also become common. While the hard disks are more reliable and access is instantaneous and random, their disadvantage is the time it takes and cost of digital backup so that projects can be stored while the system is working on some other project. The digital cassette tape formats are easily removable, relatively cheap, and storage is only limited by the length of the tape. The tape-based digital recorders look much like video recorders. Most of these machines have limited tracks but can be interleaved, which means that several can be synchronised to increase the number of available tracks.

**Sampling**

The process of sampling and digital recording have had a somewhat parallel development path. Samplers having emerged from university based computer music departments, through the development of digital recording. The sampler differs from the recorder in that the sampled sound can be pitch-shifted by a MIDI controller, most commonly a keyboard, or sequencer (the development of electronic keyboards is fully explored in chapter six). The first commercial sampler appeared toward the end of the 70s. The Australian manufacturer, Fairlight, brought to market a computer that could sample sounds and then play them under the control of a keyboard. The Fairlight provided a range of features, sampling was just one of them. A feature of this early sampling keyboard was the inclusion of one of the first sequencer programs. It could only control eight parts at a time, nonetheless, it was ground breaking. The first sampling keyboard appeared in 1981 when Emu Systems brought out the Emulator, which followed its first success, a sample playing drum machine, the Drumulator. Throughout the 80s, there was an explosion of sampler keyboards and stand alone samplers. In the early to mid 80s, pre-recorded sounds stored in the memory chips of various drum machines, keyboards, and sound modules delivered the sound of the first wave of techno-pop. To varying degrees, these sounds could be manipulated or shaped. The variety of functions and capabilities of the present generation of samplers now provides total control of the sound entity. What is possible today is only limited by the imagination of the creator.

**Samplers under fire**

Samplerists not only captured original sounds but also went about reusing the sounds of other artists previously recorded. The use of previously recorded sound fragments in a new pop music production goes back to the 50s when a number of hit novelty records used small segments of other records. Some of these records had a spoken news bulletin type script that connected the recognisable song bits (usually a segment of the chorus) into a story. The most successful of these records were about flying saucers or monsters that were invading the country and wreaking havoc along the way. The best known of these was "The Flying Saucer" (Part 1 a hit in 1956, part 2 a hit in 1957) by Buchanan and Goodman. In late 56 they also had a hit called "Buchanan and Goodman on Trial" which used the same formula as before but now the script was a 3 minute Perry Mason type court room drama. The very first sampled record to be a hit may have been Don Charler's "Singing Dogs" in 1955 which was edited from hundreds of barks to make the dogs perform the melody of "Jingle Bells".
Several 60s and 70s songs (in nearly their entirety), have been reissued with additional drums and bass and become hits all over again. The majority of those who buy these reconstructions are too young to remember the first time the record was a hit. Petula Clark's 1965 hit "Don't Bring Me Down" was a hit again in 1984 with the addition of a heavy backbeat. Medleys have always been popular but in 1981 a record made of ten Beatles songs (plus a few bars of "Sugar, Sugar" and a witch song named "Venus") topped the charts. This record had begun as a bootlegged record of dited together Beatles songs that were mixed with overdubbing and hand claps. Obtaining the rights to the originals was out of the question, so in order to create a releasable master, all of the songs were recorded with a great deal of effort to sound like the originals (vocally and instrumentally). Beadle (1993) observes:

Part of the reason for the success of 'Star on 45' (or "Medley" as it was called in the U.S.) was that for all their 'classic' status, Beatles' songs remained stubbornly outside the disco experience... 'Stars on 45', of course wasn't aimed at either trendy DJs or trendy consumers. But it very shrewdly caught hold of a market somewhere in the middle, young enough to enjoy disco, but old enough to feel a nostalgic yearning for old Beatles songs. (p. 62)

Modern music that heavily relies on samples, and in particular identifiable samples, has all the attributes of what in other forms of art would be called postmodern. As Lull (1992) observes, contemporary popular music reveals a blending of technological sophistication with the confusion and contradictions of life in the postmodern world(p. 10-11). Beadle (1993) comments, both literature and music lean heavily on quotation and reference back to previous tradition when they are transforming themselves into something modern or postmodern" (p. 156). Forty years of rock and roll music has provided more than enough material for these constructions. The sounds can come from anywhere. They can be from original recordings made by the innovator, or material recorded from broadcasts, or off records or CDs. Lull (1992) continues:

Rap and house music embody and produce perfect postmodern themes - songs that don't begin or end. The hook is a riff, sampled and recycled. Lyrics are sounds. Sequences match grooves and beats, not words. The Roland 900 drum machine ensures that house sounds the same. Video accelerates the chaos. Melodies disappear. Deejays make music. Popular music today may be the perfect sound track for life at the end of the twentieth century - a choreography of musical and cultural impermanence that matches the quickening pace and uncertainty of the times. (p. 11).

Sampling in the extreme takes what has existed and pulls it apart into "useful" components which are reused (over and over again). Samplers have made that which was old, new again. In some of this music there is a desire to use recognisable bits of the past which recontextualise the listener's memory of those familiar sounds. Such is the case in a high percentage of successful hip hop music. Beadle (1993) cites some interesting examples,

The act "A Tribe Called Quest" are tied forever to Lou Reed's 'Walk On The Wild Side', "The Dream Warriors" to Quincy Jones and Count Basie (from 'My Definition of a Boombastic Jazz Style', and 'Wash Your Face In My Sink'), and "FM Dawn" to "Spandau Ballet's" 'True'. (p. 230)

'Pump Up The Volume' topped the charts in 1987. It incorporated all the technology available to the samplerist. Beadle (1993) considers this recording:

...a watershed in the history of pop music. It could be said fairly to be the hit record which marked pop music's advance into modernism, which acknowledged that the old-fashioned staple of its diet, the song, had just about run its course. It announced the arrival of an ironic view of recorded sound itself. "Pump Up The Volume" was the careful consideration of recorded sound, acknowledging that this rather than any musical system, is the basis of pop music, and an attempt to see what happened if you broke that down to its constituent elements and then started to rebuild the same basic structure in a recognisable but different manner. (p. 141-142)

"Pump Up The Volume" was a studio production having no association with rap or performing live. The original club version had much more space, less things going on at a time than the record with a notion that the DJs would create their own version and play it as a background under other records.
A victim of sampling

The Godfather of soul James Brown, has been the subject of countless sample grabs. He has some rather strong views about sampling. Frank Doyle, a New York music production engineer, recently took a horn blast from a James Brown song and turned it into a lush, mellow tone for a love ballad. "I didn’t feel at all like I was ripping James Brown off" he said. But that's not the way James Brown sees it,

Anything they take off my records is mine, ... "Is it all right if I take some paint off your house and put it on mine? Can I take a button off your shirt and put it on mine? Can I take a toenail off your foot? — is that all right with you? (Miller, 1987, p. 1)

Issues of copyright continue to plague and vex those in the music business. More than a few of the samplers have found themselves the defendant in legal action due to their unapproved use of others' recordings. What royalties they receive are taken from them. The problem for most of them is that at the time of conception they have no resources, responsibility to an establishment, or the inclination to obtain rights for the use of the samples. It is only when the recording becomes popular that the rightful owner becomes aware of the breach and that there is any financial reason to pursue the issue. The latest generation of samplers have become smarter and many do obtain rights before they begin to mass market their reconstructions. For some, however, the whole idea of having to obtain rights goes against their philosophy which embraces aspects of the urban guerrilla. They believe they have a right to use anything which is available and can't understand why the original artist isn't simply flattered by these new constructions. But with varying levels of hostility and aggressiveness, most artists who are the targets of samplers share the view of James Brown.

The disembodied quality samplers can create has caused critics to question the authenticity of such constructive music. But pop music is always reinventing itself. Those who analyse it sometimes see it stagnating and believe that the stagnation is within an evaporating pond. But these lulls are only ebbs in the river's flow. There is no shortage of water (or talent) and eventually taste and the music business will move from the ebb to the next new sounds and artists who create them. The prominence of rap, house and new age techno pop music has caused samplers to have a particularly high profile, but this has much to do with the fact that this style of music appears so dominant in the market place. The current chart ratings must be tempered with an understanding that this music is not selling in quantities comparable to chart toppers of earlier years. And, contrary to Beadle's implication that the pop song is on the way out, on any given week a majority of the top five or ten records still remain traditional "pop" or rock songs. Doubtlessly these records use samples in some fashion or another but in an integrated fashion that doesn't bring attention to themselves. The sound samples augment other sounds which the producer uses in the production. In many cases, the producer may be able to create similar sounds through conventional recording techniques, but having found a certain previously sampled sound that is exactly what they want, will use it out of convenience.

As for samplers replacing traditional rock and roll, there is no indication that fewer people are taking up the guitar, in fact, guitar sales have been on the rise over the past few years. And, despite the availability for several years of high quality drum machines and electronic drums, acoustic drum sales have not fallen through the floor, nor are their fewer drummers on stage.

Mastering the technology

The sampler has mastered the techniques of composition by decomposition. The best of them have developed an ability to hear what parts in other recordings will fit into what they have in mind - what hooks, riffs, certain notes, fills, breaks, and vocalisations might be deconstructed then reconstructed for their purposes. Since samplers can play a recorded moment in a variety of pitches, a single sound can become the root of an entire chromatic scale. While keyboard skills are required, more important is the ability to edit and have a concept of how the bits will sound when they're all connected together, overlapped, and reprocessed. No meaningful lyric or recognisable purpose or theme may be necessary to create collage or pastiche that is commercially viable. A beat and some sort of catchy and repetitive hook is needed, but the success of such product in the 90s attests to the public's appetite for music that is anything like a traditional pop song - an organised noise that, in the case of successful creations (e.g.- commercially popular), forms one half of the music clip which the public finds intoxicating enough to buy. Nor do the images associated with the music need any particular purpose except to provide attention-getting visual movement. However, those who create musical collage by sampling, void of rapp ing personality, have a major problem by the lack of a front person who can be identified by the public. In the video clip generation, the need for a personality has forced many successful samplers to use their "singers" or even some other pretty faces to front the production.
Samplerists have the opportunity to add a new dimension and dynamic to popular music that will take the medium onward. Sampling can take pop music's past and use it in such a way to create something that is more than a regurgitation of a nostalgic sound bite. While groups will continue to play live, an increasing number of sound producers are exclusively creatures of the studio. Those who have a disco DJ background will continue to perform, but most of what they will be prepared prior to their "performance". Some drummers will no longer play acoustic drums at live performances, they will strike pads which trigger samples. Each sample will be edited to perfection. There is that word again - perfection. In such control, in such perfection, is there any soul?

digital: but what does it sound like?

The music industry has a long history of sound awareness. The introduction of digital recorders did not mean the rapid decline of analog machines. For one thing analog machines were well established and reliable before digital recording came along. Probably even more important, there was and continues to be a reasonable percentage of music producers who prefer the sound of analog machines.

Shortly after the digital recorder started appearing in music production studios, there was concern by some audio people that the digital process somehow affected the sound. There seemed to be something missing in the playback. Some nuances of the sound seemed to be lost in the process. At first, this observation was most often noted by classical musicians, engineers, and producers who would have otherwise appreciated what could be described as distortionless recording. There was a perception that some of the highest harmonics of the sound were missing from the reproduction.

The digital process, at its most common sampling rate (44.1KHz), has a band width that only ends at about 18KHz cycles, which is the highest sound in the audible human hearing range. However, above this audible range, there are sounds which the human ear cannot necessarily hear but which, in their absence, are perceived as missing from a known sound. Such very high harmonics are in the sounds of violins, cymbals, bells, and a wide range of other acoustic instruments. While high quality analog recorders do roll-off above the audible range of human hearing, they do it more gradually so the integrity of these very high harmonics is maintained. Digital recorders, sampling at 44.1KHz, roll off very steeply. It is for this reason that professional digital recordings use sampling rates of 48KHz and higher, but in the beginning of digital recording, 44.1KHz sampling was believed to be adequate. Unfortunately CDs are standardised at 44.1KHz so these highest inaudible harmonics are always lost. New and improved versions of Ds will use a higher sampling rate in order to extend the high frequency response, and this will in some way to enhance upper harmonic reproduction.

Another common concern of those who use digital recorders is the automatic use of error correction. This process uses digital encoding which is part of the digital software and is stored in the audio data to correct for errors and drop outs during playback. Through the course of the reduction, as the digital tape or disk is repeatedly played, there is an increasing possibility that the integrity of the original data will become corrupted and significant drops outs begin to appear. As this happens the software will increasingly rely on the error correction data. This problem is more common in tape-based systems but exists in all digital media. Some engineers believe that they can hear this operating and the effect it has on the sound.

Kinesiological effects of digital

While the use of a higher sampling rate seemed to solve some of the problems, there was another issue that came to the forefront at the 1979 convention of the Audio Engineering Society. New York. At the meeting, a paper was presented by John Diamond, a well-known kinesiologist. He was also a member of the AES and an avid audiophile. For many years he had used classical music in his treatment rooms and had written several papers on the positive effect of music on muscle conditioning. His interest in high quality sound had motivated him to replace some of his music collection with digitally recorded masters. He was alarmed to find that his patients responded quite differently when the music originated from these digital recordings. Diamond found that most patients exhibited a weaker muscular response when listening to digital recordings as opposed to the analog productions. Diamond began to explore reasons that might explain that he had observed. By the time he presented his paper, he had done extensive research and had come to a remarkable conclusion which was sure to disturb the proponents of digital audio. He suggested that the ear and the means by which the brain processes sound sensation is placed under stress by the nature of the digital signal. Diamond theorised that this stress was due to the ruggedness of digitally generated sound that was made up of stair steps (albeit small) compared to analogs smooth continuous analog signal. The digital was more difficult to process compared to analog. He suggested that this might have some type of long term effect as digital recording became increasingly popular.

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Diamond's theory was presented at a time when digital recording was just being introduced to mainstream music production and at a point when manufacturers were attempting to get the industry to replace their analog recorders with digital ones. Needless to say, Diamond's paper had the potential to ring all sorts of alarm bells among the manufacturers. It raised the issue: what would a pop music producer want to make recordings that had the effect of making listeners feel weak and uncomfortable when they heard them? A large group of digital audio engineers and sales people attempted to stop Diamond from presenting his paper at the convention. Failing that, they packed the room and tried to hoot him down. Others in the room insisted on fairness and the hecklers grudgingly quieted down. Diamond said that it was not his intention to stifle the advance of the technology, after all, he was extremely interested in high quality sound and had been enthusiastic about digitally recorded sound. He was simply raising issues that no one seemed to have noticed and it was his hope that a solution could be found to the problem that he had encountered. At the end of his presentation, questions from the skeptics overwhelmed any other inquiries. Very quickly the issue of proof was raised and he suggested that the most vocal should come to the front of the room where a demonstration had been prepared. In several cycles of blind tests the skeptics were horrified to find that they reacted to the digital/analog comparison as Diamond had predicted. That presentation dominated discussion at the convention. The paper was available at the convention but was never published in the AES Journal. One magazine ran a small follow-up article after the convention, but all of the other trade press ignored it. One publisher quite blatantly considered that the subject was too controversial and that it would affect his advertising. John Diamond continues to operate his clinic and often writes articles that appear in new age magazines, but none of them expand on the issue he raised in 1979.

The case for analog multi-track in the 90s

The 90s have brought affordable digital recording into the mainstream of production right down to home studios, multi media practitioners and hobbyists. Nonetheless, analog multi-track will most likely remain viable for some time to come. For those involved in music production, there is a significant number who continue to prefer analog recording as their primary storage medium for acoustic instruments such as drums, guitar and voice. The specifications of the professional analog 24-track recorder, equipped with the latest in tape noise reduction, rivals the signal to noise and dynamic range of digital but without the artifacts associated with digital. Most analogists will also use digital devices such as sequencers, sound modules, digital processors, keyboards and samplers in sync with their analog recorder. In the end, whether a master is recorded digitally or not has little impact on the possibility of a song becoming a hit or not.

To the average record buyer, the sound of either process is the same. Good production and good music continue to be the ingredients that make the difference. That being said, the expansion of digital recording will continue due not only to the advantages associated with digital such as no hiss, minimum generation loss in transfer, extended dynamic range, better lower frequency response, random access editing and so on, but also such systems are now less expensive than comparable high quality analog machines.

The case for CDs

There continue to be some people who remain dedicated to vinyl records as a superior reproduction medium compared to CDs. While these few bemoan the demise of the record, there is little debate among the vast majority of the public. CDs are the go. They are nearly indestructible in the course of normal use; they can withstand significant mishandling; and they are cheaper to manufacture. Vinyl record manufacture in all but third world countries has dropped to a trickle and no major label is now pressing them. In most non CD countries, cassettes remain the currency of delivery. The aberration in all this is the disco DJ professional who continues to buy records. Most dance music is still issued on record since this medium is the only one well suited to manual control by the DJ for their scratch and tempo merging effects. No CD system has such direct and continuously variable control.

Summary

There is little doubt that digital technology has furthered the commodification of popular music. Samplers in production have created an entirely new product: the marketing of collections of sampled "sounds". Digital technology utilising the information superhighway has provided a means for popular music from any corner of the globe to reach a global consumer without the need for major label distribution. The product range has also expanded, with most musical artists interested in interactive media and all record labels active in developing and marketing multimedia products. The CD, the latest form that the retail product has taken, has been heralded as nearly indestructible, and which maintains its sound quality through countless playbacks. With the introduction of the CD, the record industry experienced a form of rediscovery with all previous product from the beginning of recording, reissued on the new media. The reissuing process...
had the added benefit of archival recovery of material that would have otherwise deteriorated or disappeared. These recordings have become a rich source of sounds for the samplerist whose reappraisal of them in new productions has created what has been referred to as postmodern pop.

But the tools and even the process of digitally recorded and transmitted sound has its critics. The use of samplers are criticised by a wide range of people for many different reasons. Some find such music inauthentic or simply not as creative as earlier forms of pop music production. Other critics have no problem with the use of samplers, but with the people who use them. They feel those who sample sounds must acknowledge ownership and pay copyright to the original artist when samples are taken from existing recordings.

The digital process in both production tools and the CD has also been called into question by those who believe the sound is adversely affected by digital techniques. In the case of the production industry, this has resulted in many continuing to prefer and use analog recorders. It would seem that while digital methods are the way of the future, and many of the analog systems are being replaced by them, analog systems will continue to be used for some time to come.
Notes: Chapter five

1 See Appendix 1 for explanation of PCM.

2 See Appendix 1 for explanation of digital sampling.

3 The development and impact of synchronisers is discussed later in chapter seven, and Appendix 1 has an in-depth explanation of time code systems.

4 Australia Music Industry statistics.

5 See Appendix 1 for explanation of aliasing, and other points of digital distortion.

6 For a full explanation of a roll-off filter refer to Appendix 1.

7 There are a number of books which delve into musical sound and human hearing. Two that describe the above mentioned phenomenon are:

Pierce, John R., (1963) *The Science of Musical Sound*. New York: Scientific American Book. In the Science of Musical Sound, John Pierce shares with the reader his joy in the discovery that physics and mathematics can be sources of insight into the understanding why we hear music as we do. He takes the reader on a guided tour of scientific research into music: from the classic investigations of Pythagoras and other Greek philosophers; through the basic discoveries of Galileo and his contemporaries, and the advances in the nineteenth century by Helmholtz; to the current field work and experiments by eminent acousticians, psychologists, and composers. This book also offers views into the frontiers of modern music and discusses the work of many contemporary composers. This could be considered a first book on acoustic for the non-specialist, written from the viewpoint of contemporary electronic and computer generated music. John Pierce was a principal member of the team at Bell Labs who invented the basic techniques by which computers generate musical sound.

Winckel, Fritz. (1967). *Music, Sound, and Sensation*. New York: Dover. This book relates closely the field of physical acoustics to how we hear and the overall area of psycho-acoustics. It approaches the topic from both an aesthetic as well as a psychological point of view. Most importantly it relates sound and how we hear with music. It is the first book to explore the idea that the ear has a "window of uncertainty" as it relates to changes in loudness, pitch, and time variation. It explores how the brain relates to rhythm and musical perception. It also discusses how our ears and brain respond to pitch, harmonic and inharmonic components of sound and the effect of music on the listener. It has an excellent chapter on the effect of the environment on what we hear, for instance the difference between reverb in different types of space. There is quite a bit of math, but it is still readable even if the reader has little or no background in mathematics. Definitely an advanced book. A valued addition to the library of anyone who is interested in the nature of sound, and the human perception of it.

8 In 1979 the author was Managing Editor of Recording Engineer/Producer Magazine and attended the N.Y. AES convention and Diamond's presentation. He was unable to report on it due to the position taken by his publisher. He often wonders if the condition which Diamond observed was an aberration of early digital recording or is something which still occurs.

9 See Appendix 1 on technology for explanation of error correction.
The adoption of electronic musical instruments

The development and use of electronic instruments and their amplification is a primary factor that separates popular music of this century from music of previous centuries. In this century some electronic instruments have been assimilated and adopted into modern classical music, but by and large these applications have been considered novelties, or "modern music" within the tradition of western classical music. Since they were not embraced by western classical music scholars, training for electronic and amplified instruments was generally left up to those who had developed them. In the early part of their development, these people often had formal training which was adapted to the electronic instruments. But as the century progressed and electronic instruments moved from experimental systems to mass produced products, an ever increasing number of electronic instruments were being played by musicians with little or no formal training. The simplicity of composition and the self contained nature of popular music made it possible for these self trained musicians to be successful.

In the area of live performance, amplification provided popular music with a means to be heard by larger and larger audiences. It also expanded the sonic possibilities that artists could employ in presenting their songs since the instrument and its amplifier/speaker provided many more sound textures compared to earlier acoustic instruments. In turn, the sound of the instrument affected the musicians' style of playing, their performance personae, and even the very songs they created. With the introduction and development of the electric guitar, the sounds of electrified hillbilly, country, and rhythm and blues merged and melted into an amplified extrapolation that would form the roots of rock and roll.

This chapter starts with the development of the electric guitar and bass. It then covers the unique nature of the guitar amplifier and speaker which is integral to the guitar's sound. The second half of the chapter then traces the beginnings of electronic instruments and the various innovations that have occurred over the last fifty years. It is through this period of time that the musical instrument industry has become a large, dynamic force bringing to market tens of thousands of different products for the popular music artist. Constant technological development and innovation has been a key to the success of these companies. They have found that the popular music artist has an insatiable appetite for innovative new equipment and the sounds they generate. The endless array of new sonic features which each subsequent model can create, have played an important part in the constantly evolving "sound" of popular music. In the last half of the 20th century, the instruments and associated amplifiers and processors are the ultimate source of "the sound" of popular music.

The electric guitar

Today, there is a seemingly unlimited number of electric guitar designs. Each guitar is unique. Its shape, the electronics used, the neck and body design, the materials used, and the way it is adjusted will affect the sound of the instrument. Guitar players choose the guitar they play based on their personal taste and the style of music they are interested in. Often, guitarists choose their instrument based on who else plays that model of guitar. Few guitarists own just one guitar since one instrument is seldom the best choice for all styles of music, but they will have a favourite that best matches the genre of music they play. Endorsements by famous guitarist have become a common tool for selling guitars and such endorsements are worth big bucks for both the artist and the manufacturer.

Many guitarists are so attached to their instrument that they may decline to allow others to play their guitar and will never allow it to be checked as baggage when they travel. Probably one of the most famous guitars is Lucille, B.B. King's guitar. Here's how he recalls naming it, which provides a good example of the anthropomorphic behaviour that musicians have toward their instruments:
I was playing down in a place called Twist, Arkansas, in 1949, I guess, and two men started fighting. There was a tin of kerosene that was being used for heating, and in the course of the fight one of the men knocked it over so the whole building caught fire. Course, everybody made a rush for the door, including B.B., but when I’d got outside I realised that I’d left my guitar inside. So I rushed back in, and just as I got safe again, the roof fell in. Well, we found out the next day that the two men had died in that fire, and that the fight had been started over a chick. And her name was Lucille. So I called my guitar Lucille to remind me to never do a fool thing like that any more. (B.B. King cited in Connolly, 1969, p.15)

B.B. King has in fact owned many different guitars but each is given the name Lucille. B.B. King’s story of Lucille goes further. He claims that he was once in a car accident and the car rolled over several times and Lucille prevented him from being crushed. In his 40 year relationship with his guitar he says,

Sometimes when I’m blue, seems Lucille tries to help me, calls my name.... She’s just like a woman, and that’s the only one I’ve had that it seemed I could depend on. I’ve been married and each time separated from my wife, but Lucille never separates from me. (B.B. King cited in Connolly, 1969, p.15)

B.B.’s feelings toward his guitar are not unusual.

The evolution of the electric guitar

Unlike the acoustic guitar from which it gets its general design, the electric guitar does not require a sounding box, although many electric guitars do have hollow bodies and some are essentially electrified acoustic guitars. The electric guitar (and electric bass) are simple electronic devices. The pick-ups are located in the centre of the body just below the strings. The pick-up is a magnet with copper wire wound around it, a separate coil for each string, with all coils combined to a single output. An electric guitar must have metal strings as opposed to nylon strings as found on many acoustics. As the strings are played, they vibrate above the pick-ups which generate a current in the pick-up coils. This signal goes through a few selector switches, tone and volume controls and then on to the amplifier. A key to the electric guitar’s design is its rigidity. The body, and in particular the neck, must be very strong to withstand the force of the tightened metal strings and to achieve good sustaining notes and feedback. The neck of an electrified guitar is reinforced with a steel stress rod. Most guitars have more than one pick-up since the sound changes, depending on where the pick-ups are positioned along the strings. The selector switches choose which individual or combination of pick-ups will be used and how they will be connected to the output.

The electronic principles that are used in an electric guitar were discovered in the early 1920s. In the U.S., sometime between 1920 and 1924, Lloyd Loar invented the first microphone to be adapted for a guitar. At the time he was employed by Gibson, but they were not sure of the market. One of his designs was an electric double bass with a 5 foot long narrow plank for a body. Loar left there and started his own company in 1933. His innovative designs established what would be the direction of electric guitars, but the company was small and the instruments were not widely marketed. In 1934 he filed a patent for an electric guitar designs with a solid body.

Loar made a leap that would characterise design philosophies for decades to come. Instead of seeing electricity as a way to enhance a guitar’s acoustic resonance, he sought to isolate its purely electric qualities so as to create something radically new. (Trynka, 1993, p.19)

DeArmond is credited with developing an efficient guitar pick-up in 1930. In 1931 Rickenbacker used these pickups in the “Frying Pan” which was a Hawaiian guitar that was played sitting down, with the instrument on the lap. These instruments were made of aluminium and moulded backlite. About the same time, the first “guitars” to use these pick-ups were introduced- the electric Dobros. The dobro guitar was first made in 1930 and quickly became a popular instrument with blues performers. The body was metal with the front looking like a hub cap was attached to it. Its design increased the loudness of the instrument. It was commonly played as a slide guitar. The cut off neck of a bottle was placed over the middle finger of the fretting hand which allowed the musician to smoothly slide from one fret to the next and create a characteristic blues sound.

From the 30s onward, many different people developed guitars with electronic pick-ups. The first recorded amplified electric guitar solo may have been played in September 1935 by Eddie Durham on The Jimmie Lunceford Big Band’s ‘Hitting the bottle’. By 1935 the first solid body
guitars were being made by the U.S. manufacturer Rickenbacker. The model was called the Electro Vibroa Spanish Guitar and was also made of bakelite with the pick-up magnet surrounding the strings. This made it heavy and cumbersome to play and it was not particularly popular. In the mid-30s, Walter Fuller joined Gibson and designed a pick-up that did not require a bulky yoke around the strings. This design first appeared in early 1936 in a laptop electric, and later that year in the Spanish guitar ES150. This guitar was essentially a standard guitar with a pick-up. It took several years for it to become a successful product, but an early proponent of it was the legendary blues player T-Bone Walker.

While Rickenbacker and Vivi-Tone had both had solid body guitars on the market, neither were widely marketed. It was in the late 40s that the modern electric guitar with its solid body would capture the imagination of popular musicians. There are a couple of versions as to who designed the modern electric guitar. One of them is that it was first developed in 1947 by Paul Bigsby who was asked by country singer Merle Travis to build a guitar from an idea he had. Travis was a regular on the Pasadena (California) “Hometown Jamboree `Town Hall Party” radio show. He was backstage and got the idea for the guitar and drew it on the back of a program. He reasoned that with pick-ups, the hollow body wasn’t necessary and a solid body would provide more sustain.

Another version of the story involves Les Paul. By the early 30s Paul was already a well known jazz musician, and by the late 30s he was performing on some of the biggest radio programs in the U.S. In 1934 he had made an experimental electric instrument with a maple top and no sound holes. In the late 30s Paul built several different electric “guitars”. One used a railroad rail, another was made from aluminum. In 1941, due to his close friendship with the owner of Epiphone, he was able to have a guitar built that was basically a 4"x4" block attached to a neck, with all the necessary hardware mounted on the board. For cosmetic purposes he attached a standard guitar body around the post. In 1949 he took a solid body design to Gibson, who manufactured Les’s favourite guitar. They called it a broomstick and wanted nothing to do with it. In the following two and a half years, Fender entered the market with a successful solid body design. Gibson had a rethink, contacted Paul and built his design. Les gave it his name and the instrument went on to become one of the most famous and successful guitar designs ever made. (Clarke, 1990, p. 900)

Sometime in 1938 or 1939 the Slingerland drum company introduced a solid body electric guitar of a Spanish design. It is in catalogues of the period but only a few were sold. Little is known about its origin, but the few that exist are acceptably playable with good output. They would have to represent the earliest comparable design to a modern guitar, though Paul, Fender, Travis and others were probably unaware of them.

The company to firmly establish its business around the electric guitar and its amp was started by Leo Fender and Clayton “Doc” Kauffman. Both were inventors, instrument makers and hillbilly musicians in Anaheim, California. The K&F company was started in the late 30s but in 1946 Kauffman decided to leave the company and Leo continued on and renamed the company Fender. In 1948, Fender, whose name would become synonymous with electric guitars, began to market the Broadcaster, and in 1950, due to a copyright conflict with the name, changed it to the Telecaster. The “Tele” in its quasi-original form is still sold and remains a popular model. As Keith Richards puts it, “Its amazing the way that Leo Fender got so much right when he invented the Telecaster. And they still do the job now! So to me they’re like a plumber’s favourite wrench” (Trynka, 1993, p.7). Fender’s most popular model, the Stratocaster, was designed by Fred Tavares and released in 1954. It too remains a popular model. Fender’s genius was in taking a completely new approach to guitar making. Acoustic guitars required skilled craftsmen to make them but solid body electric guitars did not. He designed and built a guitar that was simple to manufacture and cheap to sell. It was basically a slab of wood for the body, a simple neck design that had the fret board made right on to it, all the electronics simple and easy to get at, and the hardware elegant in its simplicity. Leo Fender did to guitar making what Henry Ford had done to automobile assembly. Fender turned the guitar into a low cost consumer product.

While the conventional electric guitar has not gone through major change since the establishment of the solid body, several innovations have come along. Through the 60s to the 80s, innovations in electric guitar design were in the areas of materials and electronic design - such things as different approaches to pick-up design and the use of space age materials such as kevlar and graphite. Kevlar is used in bullet proof clothing, and graphite in missile cones. Both materials are light weight and extremely rigid - features that are highly desirable in a solid body guitar.
In the beginning the manufacturers believed that hillbilly and jazz music was the market for the electric guitar. But blues musicians embraced it and added distortion to the sound. It was "loud" hillbilly musicians like Bill Haley, who would push guitar amp distortion and the sound of rock and roll into the mainstream of pop music. The electric guitar is now made by dozens of companies featuring hundreds of models. Some are copies of such guitars as the Telecaster, others are completely fresh in their approach. The prices range from several thousand for hand built guitars of the highest quality, to instruments that can be afforded by nearly anyone. Despite the overwhelming amount of high technology in music performance and technology, no keyboard generated sound has yet matched the sound of the electric guitar and a cranked up amp, and probably never will. Young people who want to play rock and roll still gravitate toward learning the guitar. They're cheap, any one can learn to play one, and the recording artists on the radio provide life style models worthy of emulation. Most rock songs are simple to play, and thousands of song only require two chords (possibly three).

The electric bass

There had been a few attempts at designing an electric bass. In addition to the above mentioned experimental design by Loar, Rickenbacker had designed a slender standup that was featured in its 1936 catalogue. Neither of these designs had any success. Acoustic basses remained common in early rock and roll bands. The departure came in 1951 when Fender introduced the Precision Bass and an amplifier to go with it. Like the Fender guitars it had a simple design and construction. It was revolutionary in two ways. First, it was played like a guitar and not resting on the floor like a traditional bass. This gave the bass player the same freedom of movement that the guitar player had. Secondly, it was fretted, unlike the double bass. The fret board allowed less experienced musicians to accurately play bass. In other words, young musicians could master the electric bass much more quickly compared to an acoustic bass. The increased definition of the fretted electric bass sound was also a catalyst for the development of a new approach to bass line composition and performance. As multi-track developed, bass guitars quickly gained popularity in studios due to their ability to be directly connected to the studio electronics without the use of speakers. From the very beginning, they had more versatility and punch than an acoustic bass and could be more easily isolated and controlled. From the late 60s Fender's Precision bass was so popular that the bass channel on the mixing desk or on the track of the recorder was simply called a Fender. The Precision is still the bass of choice for many players, but they are very heavy, and many bassists have turned to light weight basses that use quite different materials such as graphite and other space age materials.

The guitar amplifier

While studio monitors and their associated amplifiers must provide a point of comparative reference and as such, there is a requirement for them to have a minimum of inherent coloration the guitar amplifier and speakers have no such requirement. In fact, the guitar amp and speaker are expected to provide distortion although this was not always the case. Guitar amplifiers of the 50s were designed to deliver a clean, crisp, distortionless sound. There was seldom a spec of distortion on records by Buddy Holly, The Ventures, or The Shadows. The desire for louder sound caused many musicians to push their amps into distortion, and in many cases the "edge" created by the distortion became part of the sound and used by blues players such as T-Bone Walker, Buddy Guy and B.B. King to name just a few, and pop artists like Chuck Berry. In the early 60s there was a need for guitar amps to be louder than those offered by Fender and Vox. Working as a repair technician in Jim Marshall's London music store, Ken Bran suggested that they could manufacture an amp that was louder and cheaper than those that were coming from the States. Marshall introduced the first 100W amp in the mid 60s. Distortion moved more into the mainstream of rock and roll with guitarists like Clapton, Hendrix, Richards and Page and became an integral part of the rock guitar sound. The amp design was also changed to allow distortion to be created in the pre-amp stage of the amp, while still running the output at a controllable level. Some of these amps have become legendary and have been an important reason for the sound of the acts which used them. Some have appreciated in value and are as classic as the guitars. Marshall, Fender and some other manufacturers have attempted to maintain the original designs in products currently available.

The Vox amps were made famous by the Beatles and without question contributed to their sound. But it is no wonder the Beatles could not be heard over the screaming crowds. Each of them played through a single 50 watt Vox amplifier that used four 12" speaker. The PA was seldom more than whatever happened to be installed in the venue with a bit of help from some small PA columns. The Marshall amplifiers made a similar sonic contribution to bands like Led Zeppelin and Jimi Hendrix. They were the first amplifiers to use matched sets of six and eight higher output vacuum tubes. The Fender amplifiers probably found their greatest period of distinction during the Dick Dale and the Deltones, Jan and Dean and Beach Boys period of the
50s. The Fender amps (Champ, Princeton, Twin Reverb, Super Reverb) seem to have always been the preferred amps for the studio guitarist. They were small enough to easily carry from one session to another and could still sound big when they were miked. The Fender, Marshall and Vox amps have influenced the sound of what we think all other guitar amps should sound like.

The amp itself was initially a straightforward design. The first thing the guitar amp manufacturer added to the design was the inclusion of a cheap spring reverb to add sustain to the sound. The Accutronic spring reverb was the first installed in the bottom of the open-back Fender Twin Reverb, and nearly every other manufacturer soon included a spring reverb. A front panel control allowed a variable amount of reverb when it was activated by a footswitch. The reverb sound of these devices was unmistakable, and while a spring reverb could produce mechanical problems that caused it to make a thudding sound if it was physically jarred, and sounds like a racquetball court when something percussive was passed through it, they were used for years in every type of guitar amp. Soon after the introduction of reverbs in amplifiers, Fender introduced the tremolo effect which soon became common on most amplifiers of the period. Tremolo makes an amplified sound dynamically pulsate without changing the pitch. The tremolo effect usually has two variable controls: one of them adjusts the frequency of the pulsations and a second adjusts the dynamic range between the loudest and quietest portions of the pulsations. Tremelo was also controlled by a footswitch, and while not as useful as reverb, was common on most amps in the 60s and 70s. By the mid 70s, inbult tremelo and reverb was on the decline except in those amps that were classic designs.

The first transistor guitar amps appeared in the mid 60s, and transistor amps have been sold ever since. A great many models now include digital processors and a range of other features. The variety of signal processors that are now available, and wireless systems that free the musicians from the wire that connects them to the amp have become a common part of the gear which a guitarist or bass player will take with them to a performance. It is worth mentioning that tube amplified guitar amps continue to be the amplification of choice for most musicians who can afford them.

Another common denominator for many guitarists is the "Celeston" speakers which are in an overwhelming number of amplifiers made by a number of different manufacturers. Ken Brann, the engineer who headed the introduction of the Marshall amplifier, acknowledged that "without Celeston we couldn't have accomplished half of what we did" (Trynka, 1993, p.84). One of England's first loudspeaker pioneers was Cyril French, the founder of Celeston. He began production in 1924 to supply the growing need for speakers in record players and radios. The company eventually made speakers for musical instrument amplifiers as that industry grew. In the beginning, Celeston was probably unaware of the desirability of speaker distortion. It had spent decades trying to build distortionless speakers, but it was quick to understand that speaker distortion was a key part of the sound of a guitar amplifier. By the late 60s, Marshall had become one of its biggest customers. As Celeston's promotional material states, "The paper edge cone of the classic G12 and its resonate break up characteristics are the starting point from which many of the modern guitar loudspeakers have been developed" (Celeston 1995 speaker catalogue). This speaker was first introduced in 1969 and continues to be sold. It possesses a distortion characteristic that has come to represent the sound of rock and roll. If an amp doesn't come with them, it is common for a guitarist to replace original speakers with the Celestions in order to get that sound.

Changing amplifier needs

Guitar amps got bigger and more powerful during the late 60s and through the early 70s. A number of venues played in required substantially greater power. Many guitarists believed that to get a big sound in a studio required the big amps they used for live performance, but producers soon found that a small amp created a big sound but easier and was easier to get controllable feedback and the right sort of distortion. Many find that they can get "the sound" by running direct through some sort of speaker substitution device in combination with a small amp. Steve Miller and Carlos Santana are just two guitarists who use a small amp to record while using large amps on stage. With the improvement in house and stage speaker systems, many guitarists have also gone to smaller guitar amps for live performance which are miked and amplified by the P.A.

Innovations in guitar accessories

Two innovations of some significance in guitar design have been the introduction of the "whammy bar", and the "humbucker" pickup.

The "whammy bar" allows the guitarist to change the tuning of all the strings with a spring loaded lever at the end of the guitar and the pickups. Using the "whammy bar", a sustain note or chord can have its pitch raised or lowered. It was a featured sound during the surf music of
the 60s in particular those instrumentalists by the Ventures and Dick Dale and the Deltones. Kaufman had invented the first vibrato tailpiece in the early 30s, but it was not used on an electric instrument until the mid 50s when Fender added it to its Stratocaster. The “humbucker” was introduced in 1956. Invented by Seth Lover and Ted McCarty, it was a more powerful pick-up that was less sensitive to external magnetic interference. This pick-up also provided more sustain and allowed for greater distortion which suited the high powered amps that were coming on the market by the late 60s.

During the past few decades, an abundance of performance processors has also been invented that adds any number of types of distortion to the sound coming out of a guitar amp. In the 60s, most of these guitar oriented processors were custom inventions, often commissioned by prominent players. Later, these effects became commercial products but in many cases they were fine tuned for the professional guitarist. By the 70s, the quality of the commercial product had improved substantially and customisation became less common. Most of these processors are categorized as "stomp boxes" or pedals because they are often in the form of a small box designed to sit on the floor. The guitarist presets the controls that are on the side of the box and then turns it on and off with a footswitch mounted on the top. Most guitar players have an array of stomp boxes that are connected one to the other which makes any number of combinations of sounds. Two are particularly noteworthy. The first "stomp box" to gain wide acceptance was the fuzz-tone and the second was the wah wah pedal. The first fuzz-tone effects pedal was the WEM "Pep-Box" which was first marketed in 1963. Charley Watkins of WEM recalls that "they hit the scene like a bomb, and everyone wanted one. It was an exciting sound as if your speaker cone was being torn apart... At the time there was no other way of getting this effect" (Trynka, 1993, p85). In 1963, Hold Me by P.J. Proby was one of the first chart records to use a fuzz-tone, but the record to place fuzz-tone effects at the top of any guitar players shopping list was the 1964 Rolling Stones classic Satisfaction. Interestingly, Keith Richards dismissed the prominence of the fuzz effect as a gimmick. Distortion pedals have been sold by a variety of different manufacturers but essentially they all do the same thing which is to add a hard edged distortion. Since 1963, countless guitarists have used them.

Used skillfully, the Wah Wah pedal can make the guitar sound as though it were speaking. The Wah Wah is a type of tone control that is operated by foot. As the pedal is rocked back and forth a notch of frequencies are enhanced. The wah wah is a favourite pedal effect of rhythm and blues and soul musicians and was often used by Jimi Hendrix. One of the first recorded examples of the wah wah was on Cream’s 1967 hit “Tales of brave Ulysses”. This unit has also been built by a number of different manufacturers but the two most often used have been the Vox and the Cry Baby.

The perfect guitar sound

Of the various elements which make a recording, after the vocals, the guitar solo often takes the longest time to reach a point where everyone (in particular the guitar player) is happy with the performance. There are very few guitar solos that are not compiled from several “best effort” takes. The sound which is desired, and the sound which is achieved, often becomes a life long quest for the guitarist. This often involves endless hours in experimentation in the studio and at home, looking for the formula to get that sound.

A good example worth sharing happened some years ago with session guitarist Ronnie Montrose. Ronnie Montrose played lead guitar with the Edgar Winter Group in the early 70s, also for Boz Scaggs and Van Morrison as well as having a successful band of his own in the mid 70s. When he had come to the studio previously he had arrived with stacks of amplifiers, but this time he had only his guitar and a small road box. From it he pulled out a small metal utility case holding a hand built “custom” tube amp, and hooked it up to a four inch speaker installed in a small roughly made particle board box. Then he sat the speaker under the console, turned it on, plugged in his guitar and began to make noise (i.e. distorted guitar). “It won’t be that loud under there”, he reassured the up until then amused but now concerned engineer. The engineer brought in the mike he intended to use, but Ronnie suggested using one he had—the companion to an early Bell and Howell tape deck, last seen by the engineer many years before in a high school A/V department. The mike once had a connector that would only fit into the machine it came with, but Ronnie had replaced the obsolete connector with a professional connector. Because it was Ronnie, the engineer was willing to see how it all sounded. Ronnie started playing along with the track and getting into his “sound”. The engineer stuck his head below the console to get an idea of how the little amp and speaker sounded compared to the sound coming through the Bell and Howell mike. Well, the mike did work, sort of. During rewinding the engineer diplomatically said to Ronnie, “See there’s an awful lot of distortion there?” Ronnie smiled and replied, “Yeah, I’ve been looking for that sound for years”. Knowing how to play the game, the engineer unhesitatingly volunteered “Yeah, its great”!2
MIDI Guitars

In the 70s, the expansion of synthesizers in popular music presented a need for a guitar that could be used to control the expanding range of sound generators that were appearing on the market. This was not an easy feat since the guitar created an almost infinite range of subtleties—thus interpreting this information and interfacing this data with a synthesizer was extraordinarily difficult. In the late 70s the first guitar synthesizers appeared on the market but to solve the problem of accurate note and feel interpretation required changes in the basic design of the guitar which tended to compromise the “guitar” portion of the instrument. Few guitarists were willing to accept this compromise. Smaller companies that entered this market failed without exception. Only Yamaha and Roland, two of the largest technologically driven musical products manufacturers persevered. The development of the MIDI (Musical Instrument Digital Interface) specifications in 1983 gave a boost to the development of a guitar controller, but years of development were required before a guitarist friendly MIDI interface was perfected. In the mid 90s there are now several companies making either guitars that have inbuilt MIDI interfaces, or electronic packages that can be retrofitted to standard guitars. The guitarist now has wide open access to the infinite world of MIDI controlled devices and interfaces. This now seems like an appropriate point to leave the electronic instruments of guitar and bass and move into those of electronic keyboards and sound modules.

Electronic Keyboards and Other Sound Generators

This century has seen the birth and growth of electronic music. Many times, these instruments have taken on the names of their inventors including Hammond, Wurlitzer, Baldwin, Everett, Theremin, Buchla, Oberheim, Kurzweil and Moog to name but a few.

The first synthesizer was demonstrated in 1902 by its inventor Thaddeus Cahill. In 1906 a completed version was installed in a Broadway theatre in New York. The instrument was called a “Telharmonium”. It was designed to be broadcast over the telephone. It had cogs or rotors that spun in a large electromagnetic field to generate the notes. The number of teeth on the cog determined the pitch of the note. The Telharmonium had an eight octave range. Because it predated the invention of the vacuum tube, it was massive in order to generate enough signal for the speakers of the time. The entire cog assembly was mounted on an 11 inch diameter steel shaft that was 60 feet long, and was driven by a 200 horsepower motor. The instrument weighed over 200 tons. Two things contributed to its demise. First, it generated such a large electromagnetic field that it interfered with the entire New York City telephone system, and probably more significantly, in 1906 DeForest patented the vacuum tube, which became widely manufactured by the early 1920s. The brute force method of generating a signal was no longer required.

Early in the century, interest in electronic music acted as a catalyst for the establishment of electronic music departments within several universities. By the early 30s, New York’s Columbia University, The University of Illinois in Chicago, The University of Toronto, and Princeton all had programs. In Europe, by the 30s, the University of Cologne had people involved with electronic instruments such as the Trautonium. The Trautonium was invented by Friedrich Trautwein, a professor of acoustics. It used subtractive synthesis, a new idea at the time. Pitch was controlled by a ribbon device operated by the right hand, and harmonics were added by the left hand controlling a series of buttons. The unit was commercially available from Telefunken by 1933. It was used into the early 50s.

In France, the Ondes Martenot appeared in the early 30s. Resembling a traditional instrument, it had a keyboard in addition to an array of electronic buttons and a ribbon strip for vibrato and glissandos. Several modern compositions were written for the Martenot. Also in France, the Givellet and Couplenex organs were invented. These two devices are notable because they were both controlled by a punched paper tape, a method which anticipated programming techniques for later synthesizers and computers. These instruments were not widely accepted primarily because of their lack of keyboard and general difficulty in playing. By the early 40s, Bonn University was developing a system that, by 1948, included an artificial voice. Bonn was particularly interested in a device that Bell Labs had developed - the Vocoder, an instrument that is still used (the Vocoder was used by jazz great Herbie Hancock on his late 70s album Sunlight). After attending demonstrations of the Vocoder, the Director of the Institute of Phonetics (at Bonn), physicist Werner Meyer-Eppler, became increasingly interested in electronic music and synthesis in general. In the early 50s he published probably one of the first books to be written on the subject, Electronic Tone Generation, Electronic Music, and Synthetic Speech. The BBC began its Radiophonics department in the early 50s which became famous for the scores that were created for shows like Dr. Who. Most other national broadcasters established similar departments.
By the early 50s, Italy, Sweden and Holland had schools of modern music, and by the early 60s most major universities had electronic music departments. Some of them contributed major technological breakthroughs. One of the most commercially successful developments to emerge from a university was FM synthesis created by John Chowning working at Stanford in the 70s. This process was bought by Yamaha and implemented in its famous DX series of products. In the first part of the 20th century, many of the large communication companies were also involved in electronic music. RCA developed jointly with Princeton and Columbia, the first modern synthesizer, the MK I, which was demonstrated in 1955. The various elements of the synth were compatible and could be programmed to interact with each other. This was a considerable improvement over all earlier systems. More importantly, the synth could be programmed by a punched paper tape. In 1959, the RCA MKII was installed. It was the first synth to use digital programming, though it still used punched tape for storing the sequence. It could also process external sounds from microphone or tape.

The beginning of electronic keyboards

The Telharmonium was the predecessor of the Hammond church organ which was invented in about 1930 and was commercially available by 1935. Similar to the Telharmonium, the Hammond used a spinning rod with spokes to generate the notes. The number of spokes increased as the pitch went up. The Hammond survived many rivals introduced in the years after 1935. Everett and Wurlitzer both produced electronic keyboards that used electromagnetically activated reeds; Baldwin and Vierling used frequency division of oscillator generated frequencies; Compton employed rotating electrostatic generators. Several other methods were used by less successful manufacturers. The most successful of these was the Neo-Bachstein piano which resembled a grand piano but had no metal frame or soundboard. The strings were miked and the sound electronically amplified much like an electric guitar.

Thousands of Hammond organs were installed in churches in the late 30s through to the late 60s when they began to face competition from organs that used less expensive sound generators. Jazz and then rock musicians in the 60s brought the Hammond sound into commercial music. The Hammond, amplified by the Leslie speaker cabinet which it commonly came with, added to the distinctive rock sound of many records of the period. The jazz organist Jimmy Smith is legendary in his playing of the Hammond and Booker T and the MGs had many late 60s hits featuring the Hammond/Leslie combination (Green Onions, Time Is Tight, Hang 'Em High to name three). Another group that featured the Hammond was The Doors who used this instrument and its speaker as a prominent part of its records. A third example is as the featured instrument in Procol Harum's 1967 record, "Whiter Shade of Pale". Before the invention of digital effects, the Leslie speaker was also used with all sorts of other instruments because of its unique ability to acoustically create a characteristic pitch modulation (the doppler effect described earlier).

The Leslie speaker cabinet also possessed a certain grinding distortion that gave the impression of power and loudness and could create a dramatic stereo effect. The Leslie had two speakers. The treble speakers faced upward, and the bass speaker pointed downward. Rotating horns positioned over the speakers focused the sound and caused it to come toward the listener and then go away as the horn rotated. With stereo mixing techniques the Leslie directed the sound between the microphones to create a dramatic stereo effect causing the sound to swirl between the left and right speakers and at the same generate the pitch shifting doppler effect. The spinning horn could be switched on and off at appropriate times in the music and the rotation speed could be adjusted to match the tempo of the music. In the 70s and 80s, guitar players such as Santana, Joe Walsh (James Gang, Eagles), Adrian Balou (King Crimson), Steve Miller and many others used a Leslie cabinet to achieve a certain guitar sound. These cabinets are seldom seen except where they began, in churches, but a new generation of smaller versions have now come on the market. Little electronic boxes have functionally replaced the Leslie, but nothing matches the full blast sound of one of them with a guitar running into it.

In the late 50s, the Chamberlin and Mellotron were introduced. These two instruments were made by different companies but essentially their design was similar. They outwardly resembled a small home piano/organ. Inside however, was a bin of short analog tapes of various instruments such as violin, trumpet, string section, etc. Each tape had two to three tracks so a variety of sounds was available. The tapes were prepared by recording each note from whatever instrument, or group of instruments were required. There was a playback head for every note, and all were attached to a strip that could be shuttled by a lever so that the heads would line up with one of the three available tracks on each tape. When a note was "played", the key activated that tape which would play for five seconds. As soon as the note was released, a spring would quickly pull it back into the bin and ready it for play again. These keyboards were not high tech but by the late 60s to early 70s, they were well perfected and reasonably reliable. They became an
The integral part of the sounds of those acts which were making thematic albums so popular during this period. They allowed for the first time, a self contained band to take the sound of an "orchestra" on the road. The Moody Blues and King Crimson were probably the most successful bands to widely use the Mellotron. Their albums were heavily orchestrated and their live performances, using the Mellotron, could produce close to the same sounds. The Beatles generally used live orchestration but not always. The Mellotron provided the eerie flute and string qualities heard on "Strawberry Fields For Ever".

The industrial effect of the Mellotron and Chamberlin was significant. They were the first such instruments to threaten the established orchestral session musician. In England, where both machines were made, some studios were confronted with union action. These two machines would start the slow decline in string and horn "sweetening" sessions. Eventually, electronic keyboards would eliminate such sessions for most production.

The cornerstone of modern synthesis

It was in 1964 when the cornerstone was laid for modern synthesis. That was the year Robert Moog published a paper entitled "Voltage Controlled Electronic Music Modules". That same year he constructed a voltage controlled tone generator. Before Moog's voltage controlled amplifiers, the settings on a synth had to be changed and reset manually, or through some electronic switching. By using a voltage, the entire control process could occur more quickly and was reasonably more accurate. It also made it possible for any number of functions to be simultaneously controlled. Voltage control opened the door for the manufacture of affordable synthesizers. Over the next decade, computer music moved out of the lab, the avant-garde, and the university, and into the average musician's awareness.

During the pre-digital days of voltage control it would take hours to set up a certain patch using dozens of sound modules and patch cords and the result had to be transferred to tape, because in most cases only one sound could be created at a time. The front cover of Walter Carlos' Switched On Bach (1969), and the back cover of dozens of albums of the early 70s illustrate the physical complexity of those studio set-ups which made the early synth almost exclusively a studio tool. Walter's album was a significant album due to its commercial success.

Early pioneers of pop synthesis had to be patient and diligent and were often hired to provide technical assistance to those who just wanted to extract the sounds that were available. Because voltage controlled systems were prone to drift, a set-up would require frequent adjustments and retuning. The more complex the patching, the less stable the sound. Digital control of the sound generators would eventually provide the solution to all of the shortcomings of voltage control.

The first attempt at a portable synthesizer was marketed by Moog in early 1970 but it was not a particularly easy machine to operate, nor did it have a wide range of easy to access sounds. By the end of the 70s, affordable microprocessors were beginning to control the operation of many analog keyboards and were starting to be used as sound generators in some of the first digital keyboards. Some manufacturers had developed modular systems that used digital means to communicate between units so that satellite modules could be connected to a control keyboard. Crude sequencers were also appearing which could "playback" what had been programmed into them. In most cases this programming could be done by simply playing the synth keyboard. The development of sequencer controlled electronic instruments created the means to not just capture a performance, but perfectly reproduce it again and again. By the early 80s, sequencers had advanced where several parts could be overlayed and simultaneously reproduced as long as the synth had enough discrete "voices". The sequencer provided a master memory, capable of playing all the parts, all perfectly in sync with each other.

Dozens of companies had entered the synthesizer market. Some were large corporations such as Yamaha, Roland, Akai, Technic, Korg, and Farfisa, others were small such as AMS, Kurzweil, Sequential Circuits, Emu Systems, 360 Systems, Linn, Oberheim, Fairlight, and ARP. The cleverness of the design allowed some of the smaller companies to compete with the large Japanese conglomerates, others over time did not make it or were bought and absorbed by the bigger companies. The speed at which the features in one instrument would be superseded by another was often measured in months. A company's survival was dependent on each new model not only being better than its last but having more features than all the other comparable products on the market. Products were rushed to market in order for manufacturers to maintain their piece of the market, but hasty introductions were sometimes disastrous for the manufacturer and the consumer (as the earlier described events leading up to Linn's demise would indicate).
By the mid 80s, digital technology included not only control of the sound but the generation of the sound. Many keyboards and sound modules became programmable sample players. This technology became a new form of music in the hands of early techno bands such as Kraftwerk, Devo and Gary Numan and disco producer Giorgio Moroder particularly his score for the film Midnight Express. These artists began to amalgamate the elements of pop, rock, new wave and disco with sequencer controlled synthesisers which would form the foundation for the next wave of pop artists like Prince, Madonna, and countless others. Some of these artists began to develop their own sequencer programs and to work with manufacturers in order to achieve more control.

Unfortunately for the musician consumer, the technology was advancing so rapidly that new products were seldom compatible with the previous model. New instruments quickly made older instruments obsolete, primarily because there was no method for interconnecting the devices. As digital instruments moved through the 80s none of the manufacturers had come to terms with developing a universal communication system. A few small interface companies began to make specialised intercommunication boxes that bridged the data link between different synths. Probably the most successful of these was programmer/manufacturer J.L.Cooper. His experience in mastering the different approaches taken by all the major manufacturers and the means by which they could communicate would prove to be a key factor in what he would become involved with.

Sequencing

By the late 70s, most manufacturers had some sort of sequencer to make their sound modules or keyboards march in sync at so many beats per minute, and could start, change or stop the sequence. Between each musical beat were pulses. Linn and Korg used 48 pulses per quarter note (ppqn). Some felt a greater number of pulses were necessary for potentially better detailing, so, Fairlight ran at 584 ppqn and Oberheim at 96 ppqn. Others felt fewer pulses were adequate and easier for the computer to handle, so Roland, Sequential, and E-Mu all used 24 ppqn.

About 1983, Sequential Circuits brought out an early version of what would evolve into a standard specification. In mid 1983, at the National Association of Music Merchants convention held in Chicago, the first MIDI conference was convened and a consensus was agreed. A standard specification would be developed to provide a common communication between all future electronic music products. J.L.Cooper was given the job of defining the specifications. He knew all of the major players, their concerns, and their approaches. He was also trusted to do the job well, and was seen as an interlocutor and not a competitor since he was not in the business of making keyboards but interface systems. This set the stage for the development of the MIDI specifications.

The 1.0 MIDI specification was developed and quickly adopted by several major manufacturers- Yamaha, Roland, Korg, Sequential, and Kawai. Recognising the benefits of a common computer communication system, within months of the publishing of this landmark document, nearly all of the other manufacturers accepted the specs. In the beginning, a few manufacturers who were not involved in the original specification had objection to various details of the system, but by the mid 80s virtually all music product companies had adopted the specifications. The creation of MIDI also established a MIDI organisation to continue the development of MIDI so that future technological advances could be included (IMA- The International MIDI Association).

At the start of the MIDI revolution, both the manufacturers and the software developers had a first generation shakiness out and getting it right phase. The devices had to not only communicate in the same digital language, but with the same accent and intelligence to understand and to be understood. The initial specs were added to, and in many cases simply clarified by the IMA. Musicians breathed a sigh of relief. With MIDI implementation as a standard feature, the fear that something bought today would be obsolete tomorrow was substantially reduced and with this confidence, more equipment was purchased for ever expanding systems. MIDI has existed for more than a decade and today there is hardly an electronic instrument or computer based sound production device that doesn't come with a MIDI interface.

Since its inception, the International MIDI Association has defined MIDI time code systems for real time (as opposed to musical time) control of devices. In the 90s, additions to the original MIDI specifications were created for lighting control systems, multi-track machine control, and automated mixing consoles. A range of other standard MIDI protocol (standard file transfers, signal processor control, etc.) have emerged from the organisation, all of which further contribute to an increasing compatibility and connectivity between all MIDI products. The MIDI specification was also a significant factor in the rapid expansion of this equipment into the music performance area by making it possible to preset entire sets of material and quickly change from one song to another. The specifications also allowed an innumerable number of small software developers to design computer based software products such as sequencers, patch librarians,
scoring/publishing packages, specialised controller applications for signal processors, motion control systems for robotics, and so on. While the hardware is now dominated by a few large corporations, the major software companies are relatively small operators. The accessibility of the MIDI language and the wide range of cheap custom chips that use the MIDI protocol also meant that manufacturers of non-musical products are using MIDI to control all sorts of other devices.

The sequencer has caused an interesting ownership problem for record companies and producers. Prior to sequencers, the produced sounds were fixed to a recording medium, first a disc, later magnetic tape. The record label under contract paid the artist for the production and on completion, the final master and all other recordings (multi-track, outtakes, etc) were turned over to the label. The sounds were fixed, and could later be accessed by the label. With sequencers the artist can turn over a mixdown and the materials that have been recorded, but those sounds which have been sequenced only exist at the time of production and mixdown. In order for the label to have "ownership" of them they need to have the sequencer program, all the relevant set-ups, the operating details and hardware requirements, and an identical configuration. Many opt to transfer all the sound to multi-track tape before the set-up is dismantled for good.

The influence of the avant-garde

There have been a long list of electronic composers, who, within their following are not only famous but considered to be geniuses. Some have attained legendary status such as John Cage, Karl Stockhausen, Pierre Henry, Milton Babbitt, and Pierre Schaeffer to name a few. In truth, with some significant exceptions, they have had little impact musically on contemporary popular music, except that some of them were responsible for the development of certain aspects of the technology before its widespread commercialisation started in the 60s. On the other hand, popular music has had little impact on the art world where electronic music of the avant-garde has played an important role in 20th century modern art. Starting in the early 50s, electronic music/sound installations were appearing at some of the most prestigious modern art museums in the world. Modern jazz dance programs performed to electronic compositions of avant-garde composers have also been common since the 50s. The one area where popular music and the avant-garde have converged is in the area of performance lighting. In the 50s and 60s, the avant-garde composers were the first to integrate lighting effects with their music. Much of rock and roll performance lighting was built from these performance works.

Mackay (1981) observed:

"Looking back at the use of electronics [in music], it is apparent that most developments took place at extreme poles of the musical scene. On one hand by members of an avant-garde creating music of almost unprecedented incomprehensibility and on the other hand by the most popular musicians in history. (Mackay, 1981, p. 63)

If there was any period of time when rock music was influenced by avant-garde electronic composition it was during the sixties when it was common in a reasonable percentage of albums oriented rock. This period has since been named the progressive rock era and included eastern traditional instruments, western classical music, third world philosophies, psychedelia, happenings, and pop art. An example was the use of recorded tape fragments that were randomly reassembled on the Beatles' Sgt. Pepper album, another was the use of drones and persistently repeating figures in another Beatles song "Tomorrow Never Knows" (from the Revolver album). In the early 70s, while most avant-garde composers recognised and in some cases reveled in their eclectic obscurity, a few of them wished to have at least a little of the success and recognition given their pop music contemporaries. During this period, record sales were booming, so even obscure releases were commercially viable. Small labels that marketed art music began to appear and some avant-garde composers were released on major labels. As soon as record production of such music entered the picture, some interesting associations developed between the avant-garde composers and certain members of the pop community who had an interest in the avant-garde, or perhaps, they were always a part of the avant-garde and their passing interest in pop generated their commercial success and high profile. A case in point is Brian Eno who, while a member of Roxy Music, was also producing avant-garde composer Steve Reich. Brian Eno was a friend of Salvador Dali and Dali was a devoted admirer of Roxy Music. A few marginally successful pop acts appeared in the 70s who had more than a passing association with the avant-garde: The Mothers Of Invention, The Grateful Dead, Can, Tangerine Dream, Strawbs, Argent, and of course John Cale and The Velvet Underground. In retrospect many of these acts are now considered significantly more influential than they were at the time.
But is it music?

Yehudi Menuhin (1979) bemoans the direction that popular music has taken toward computers when he describes the technology as:

"a cheap way to avoid engaging musicians, and as corrupting as artificial fruit flavour, debasing our natural tastes. [He believes] our world has become a sounding board for man made sounds, amplified to suffice and suffocate us; urbanised populations are divorced more and more from the sounds of nature and the living performances of music. (p. 288-289)

Menuhin seems to believe a computer makes what is heard less musically valid, and not in the same league as music created by the "small muscle athlete". The author is of the view that if Bach and Beethoven were alive today, they would have embraced the potential of MIDI control. The power of the computer would have given them the ability to accurately create a representation of their music. Some early 20th century composers had such an opportunity with the introduction of the reproducing piano. They were fascinated with its ability to exactly reproduce how a composition was intended to be played. As a result of those early days of "automated" music reproducing systems, we are able to hear, for instance, how George Gershwin played "Porgy and Bess", "Rhapsody In Blue", and "An American In Paris".

Many classical composers have written music which includes instruments not found in most orchestras, and many scores require large numbers of instruments such as complete violin sections. Some are so intricate they can only be played by those few musicians capable of such virtuosity. The result is many composers through history have been positively horrified when they have heard their music inaccurately played. Often their frustration comes from the fact that all written sheet music, no matter how detailed, is subject to varying amounts of interpretation by the players, and the conductor. Up until just a few years ago a composer had to wait until an orchestra had been assembled to try out a very limited number of variations. Today they can explore an infinite number of possibilities with their MIDI controlled orchestra and hear their music as they intend, with the instrumental sounds they have in mind, rather than having to envision how something written on the piano will translate to the different instruments. By the stroke of a computer key, they can decide which instrument might best play a certain melody, or any other aspect of the composition.

Technological literacy in the 90s

The electric guitar is both simple to play in the first instance, and at its most complex, in the hands of an expert, can create the most intricate of performances. For most musicians pursuing the electric guitar, formal training seemed undesirable, or at least unnecessary. Unlike the saxophone (a modern instrument of the 19th century), the electric guitar was neither assimilated into classical music nor treated with contempt because it never made a pretence of fitting into a traditional orchestra. It was simply ignored by the classically trained establishment. While electronic music in the 20th century found its way into traditional classical educational institutions, the electric guitar was not acceptable in the conservatories of the world. Where it was found was in the hands of the self trained musician (or those with some training), or formally trained musicians who preferred it over classical music or jazz. The training vacuum was filled by a few private schools and countless education-oriented music stores (whose primary interest was in selling guitars). Finally in the 70s, a few university programs in popular music began to offer electric guitar as a discipline. From the beginning, and in general, keyboard players have had more formal musical training compared to their guitar-playing counterparts. They have usually come from a childhood of piano training.

In the last ten years, one of the biggest changes has come with the introduction into most production studios of the computer which handles all of the sequencing and control functions. As a result of MIDI, the lives of most musicians in the 90s have been dramatically changed from a relatively low tech existence to a high degree of computer literacy. Along with this higher technological sophistication, most can now confidently comprehend the manuals and operate extremely sophisticated electronic music production equipment. At the same time, many are finding that the ability to skillfully play an instrument is less important than in the past, but the ability to compose conceptually has become more important since they must rely on themselves to create all the necessary parts of a production. The computer allows any bad notes to be deleted or fixed, and only but small segments need to be played at a time and then copied. There is hardly any aspect of a production that cannot be manipulated and changed. For many musicians, reading and writing music has also become an anachronistic practice. If they do need a lead sheet or a score of their music, the computer will create it. The most unfortunate aspect of all this technology is that a vast majority of high tech musicians have little idea how real acoustic instruments sound compared to the computerised sounds with the same names. The time and
space relationships of a “live” string section synergistically playing a chart cannot be represented by a keyboard performance of a sound which is labelled “string ensemble”, nor will keyboard players capture the dimension and technique of a string section unless they have watched and heard such sessions.

Summary

This century has seen the appearance of thousands of electronic musical instruments and the adoption by popular music producers of nearly every one. Rock and roll seemed to emerge when hillbilly, country, and rhythm and blues music coalesced as they discovered a common denominator of the electric guitar. It became, and has remained, a symbol of youthful rebellion—phallic, sexy, noisy, and modern. The electric guitar provides an extraordinary degree of tactile response, and in the hands of the most dynamic performers, becomes an extension of their physical being. The history of the electric guitar, more than any other electronic instrument, evolved due to experiments by the musicians who played them. Manufacturers followed their lead. Leo Fender, a musician, turned the solid body electric guitar into a commodity and a mass-market commodity-line-constructed product that any kid could own. Fender provided affordable instruments to the garage bands from where rock and roll would emerge.

While electronic keyboards and the associated computer systems that now integrate them are less tactile, they too have had a primary effect on the creation of popular music. These instruments generate the sounds for a musical form which requires a constant source of new sounds, and, as earlier described, is judged by its unique “sound”. The “sounds” themselves are identifiable commodities held in preset memories within products mass produced in thousands by multinational corporations. The sounds which these instruments create has shaped the style and form of contemporary popular music and the persona of the artists who play them. Some critics have taken the view that such tools create music that is less “musical” compared to that made with acoustic instruments, but the majority of music makers feel there is a place for both. The computer and associated digital devices provide unheard of access for classical and traditional musicians as well as the popular music artist.

While having some of the attributes of a multi-track recorder, a sequencer is quite different. A multi-track records a performance and the sequencer replays a sequence of events with every playback. The tape stores the actual sounds while the sequencer must be connected to the sound generators that originally made the sound in order for the sound to be the same. The tape can be taken to different studios for playback, but the sequencer program can only be “reproduced” when it is operating, if not the same, at least similar, sound modules. Where the two systems are similar is in their ability to overlap sounds and events to create a sonic picture. The two work in tandem with the sequencer and recorder in sync with one another.

Finally, electronic instruments and the sequencer has changed the skills a musician must have in order to create and perform music. The need to read or write music, or for that matter to accurately “play” a musical instrument, is no longer an essential requirement for the creation of fully professional and sophisticated musical composition. What is needed by most computer based composers is an advanced comprehension of how sound interacts, and applied skills in orchestration so they can fully implement the overlapping techniques common in today’s music.

A typical MIDI production studio hook-up

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1 See Appendix 1 for spring reverb description and diagram of operation.

2 Author's personal recollections.

3 Information in this section is from a variety of sources including Clark, Deutsch, Giscard, Massey, McKay, Stern, among others, as well as interviews done by the author with those involved in the development of electronic sound generators such as John Chowning, Robert Moog, Jim Cooper.

4 See Appendix 1 for description and function of a synthesizer "voice"

5 This term is used by Frank Wilson in "Tone Deaf and All Thumbs" to refer to musicians.
Chapter seven

THE TOOLS OF THE PRODUCTION STUDIO

Common commodities shaping unique sounds

Technological development of sound production equipment has been a principal factor in the creation of popular music and the development of the music industry throughout this century. In the beginning of record production, the first inventions did little more than document the event of a performance. But even this, as has been noted, changed the structural form of popular music and the style and delivery of performance. As the “sound” of a production became a key to the success of a popular song, the tools of production gained more prominence; their creative application becoming as important as the lyrics, melody, or vocal quality. For the music producer, these processes became components from which they constructed musical productions. There are now hundreds of production equipment manufacturers who jostle for market share. There is so much similarity between many of the devices that differentiating competing products is a matter of defining subtle, aesthetic intangibles. But to the music producer whose predisposition is sound, the description often involves a coined word, which nonetheless makes these differences palpable. Ads describing these differences, have in a sense, made a commodity of sound processes. A typical ad reads:

Smooth and Intimate, dimensional and detailed...is that the sound you’re looking for? The Aphex 107 Tubessence® Thermic Microphone Preamplifier reveals the subtlety and power in both vintage condensers and popular dynamic mics. Qualities that are lost on your console’s mic preamp. Tubessence, for the long journey from microphone to CD. (Studio Sound, 1995, backcover)

Obviously it is the popularity of certain processes which stimulate a desire for the device that creates it, and for other manufacturers to quickly develop devices with similar characteristics. Specific processes have become commodities in the marketing and application of these devices and the desire to use them will determine which equipment will be purchased and which studios will have them. The sounds which these devices create may be as clearly identified as a specific preset program on a digital effect, or it might be quite beyond a layman’s description. In either case, the sound created will be tangible to those who care, if by nothing else than through some comparison to earlier recordings using the same (or closely similar) process.

The significance of these recordings may be a matter of mass popularity, critical acclaim, pop production history, personal likes, and so on. Since it is “the sound” which determines the desirability of such a device, the desired sound may come from a state of the art device, or a vintage piece of equipment. This chapter explores the historical development of production equipment, what makes each effect or process unique, and both the tangible and subtle aesthetics they contribute to sound production. This chapter in particular, refers to Appendix I where supplementary information explains the operation of those effects and process that are mentioned. This chapter begin with an explanation of “sound sculpting”.

Shaping the sonic object

The application of this technology has resulted in an emergence of what could be identified as sound sculpting within the broader term ‘music production’. Sound textures are materialised in space by music producers to create the pictures they hear. Textural experimentation using the technology has no boundary. Which sounds to use, and how they combine, bring life to a recording just as light’s reflection generate colour and shadow to give life and shape to less ephemeral creations. Rapid advances in technology provide a multitude of new processes and possibilities.

These tools and the processes they implement are frequently compared to the tools and practices used in other forms of art creation. Music production has elements of sculpting, painting, and movie making. Sound signal processors can bring form to this sonic shape by building
up and cutting away elements of the sound as they are mixed together, until the production is completed. Sound fills a space much like a block of clay. Similar to translucent colours sounds interact and overlap, hence painting also provides some comparison to the process since sonic elements are overlapped and textured as colour might be applied to a canvas. Each instrument (or in the purest sense a sound) interacts with the other sounds that are occurring at the same time with one sound emerging through the other sounds. The kick drum is heard through the bass, the voice through the guitar, the violins through the flutes, and so on. Each sound possibly causes a tinting to the other sounds that cohabit their time of occurrence.

With these metaphors in mind, the sound sculptor can easily find comparison of purpose in the application of their technology. Common terms of reference used by those working in music studios often include: .. can we get a darker sound, .. a more distant sound, .. vibrant, .. more sparkle, .. etc. Where sound production differs from the static comparisons of painting and sculpting, but has comparison to film or animation, is that both sound and film are in constant motion. Where sound differs from film, where a single picture frame can be analysed, is that sound can never be frozen. If a sound’s oscillations becomes stationary, the sound goes out of existence, into silence. Listeners can only observe sound by recollection, in reflection to earlier elements of the sound, and if they have previously heard the piece, they can anticipate what is to come. Like film (or video), sound’s most regular contextual component is elements of time. A pop production is heard as a film is seen, from a constantly changing perspective as seen through the eye of the camera. Throughout a musical production, there are ongoing background elements (snare drum, kick), some things are always moving and changing (voices, rhythm guitar), and others come and go (vocal harmony parts, solo instruments). For a time, one thing will be featured, and in the next moment it ends or moves behind a new featured sound. All the elements are heard interactively. When a guitar takes a lead it becomes louder, which moves it to the forefront, causing the listener to hear everything else in the track behind the solo. The producer forces our focus to constantly change, just as happens when we watch a movie. Verses and choruses shift our attention within the song. Different instrumental passages move us through the production. Tempo and rhythm describe segments of time in relation to musical events which are ever changing. Each moment sequentially accumulates as the song progresses from beginning to end. With each instant, the focus can change, creating moving images for the ears.

The manipulation of musical time

Time manipulation may well be the most significant product of the technology. As points of reference there are the universal continuous real time and the finite length of the recording which is relative and fixed (providing the machinery accurately operates at the same speed). The third and fourth time components are rhythm and beat, essential time references for musical sound. The fifth and sixth components of time are presentational and a part of the listening experience. The listener lives within a time frame that changes with perspective. Variation can come from where the sound originates and/or where the listener hears what is heard. Both listener and sound source can be physically moving throughout the real time period of the experience.

The application of these tools has some specific and practical technical requirements for their successful use, but their application, depending on the device, has few rules. Like other arts, the creation of recorded music is extraordinarily subjective. One person’s noise is another person’s music. A recording might be nothing more than the sounds of the ocean, or the sound of silence (the absence of sound is a sonic experience). The most fundamental origin of every conceivable sound is identified as white noise which has equal levels of all available frequencies generated simultaneously (much like the presence of every colour in the rainbow within clear or white light). Sounds might conflict when combined, others may blend wonderfully. An important aspect of music production is the creation of complex sounds that please the creator in the first instance, and ultimately will strike a harmonious chord with the public. Such complexity may appear serendipitously, or more likely will come from the producer’s conscious efforts to layer and mix a myriad of sound elements. Amateur photographers sometimes find their photos are flayed by a telephone pole in the middle of a magnificent sunset. They didn’t see it at the time of capture. For the sound producer there are certain undesirable artifacts which can accompany their finest creations such as hum, hiss, leakage and other background sounds. These can contribute to a lack of clarity in the result. An important skill that the creator must acquire is the ability to hear these detractors and minimise them.

Some of these production tools have greater prominence compared to others, depending on the type of music being produced. But pop music utilises all of them, and it is within this form of music that the latest technology is used to its fullest. That being said, unlike most other forms of media production where the old is discarded for the new, music producers will use earlier forms of technology due to the unique qualities that they bring to “the sound”.

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Microphones: the transduction from sound waves to electrons

It is through the microphone that a sound enters the technology. A microphone is technically identified as a transducer. A transducer changes one form of energy into another. Microphones change acoustic sound waves into an alternating electron flow. Microphones pick up audible colours and apply them to the soundscape. They are the windows through which we observe what we can hear in acoustic space. Microphones capture the ever changing sonic instant that passes by them. When more than one microphone is used, it is their intermingling that creates the overall sound, hopefully with harmonious results. Microphones are selected to enhance each instrument's essence by bringing out the desired "best" view of each sound source. Of course, a great vocal mike won't necessarily be great for everything else (however, it will probably be suitable piano, guitar, violin, etc.). There are also many microphones which are not suited to vocals, but are good choices on for example drums, or guitar.¹

In the recording process, the microphone is probably the most critical element in how a singer or an acoustic instrument sounds. Its evolution through the 20th century has changed popular music from a style representing a live performance, to one with an intimacy which only an amplified microphone could provide. They have also changed the live performance which was once limited to how loud a performer could sing. Rudi Valli's megaphone helped him get his voice above the orchestra (it also made him sound like his voice did when played on the gramophones of the time), but microphones allowed the softest singer to be as loud as required. With modern technology such voices can fill stadiums. There are very few people in music production who don't use microphones. Even in the most computer controlled, non acoustic production studio, samples and vocals are recorded using microphones. The microphone is where the sound is changed into electronic energy. It is what captures the essence of the performer. Through the microphone the ghosts enter the machine and the magic of the performance is captured for all time. Hopefully the performer's hidden soul is revealed through the microphone.²

The performance of a microphone goes beyond its subjective specifications. All things considered, a great many microphones have comparable specifications, their identifiable differences being primarily subjective and a matter of taste and industry consensus. Richard Kaplan (1979), a collector of microphones and a successful producer, once said the best microphone for a given singer is the one that, when they hear themselves through it, they feel as though they're on a cloud, surrounded with an aura, like they're wearing "golden slippers". (p. 89). Which microphone can create such golden slippers? For some it may be an old, rare, condenser/tube microphone such as the Neumann U-47, M-49, AKG C-12, or Telefunken ELAM 251 and 252. While others may find it in a newer model such as the AKG 414, or Neumann U-89, TLM-170. Every singer's golden slippers will vary with who they are and how they hear themselves. Experienced recording musicians, in particular vocalists, often have a favourite mike, and that's what they want to use. They find comfort and confidence in that mike. If they believe, really believe, that a certain mike can catch their spirit, and capture their soul, then maybe it can.

An engineer, some years ago, set up in front of a blues singer what the engineer considered to be one of those "magical" microphones. After the singer listened to a playback, he said "No that's just not me." The singer went to his things in one corner of the studio and began to dig around in an old road box of cords, power supplies and so on. After a minute or so he came up with a wooden jewel box that had inside it a funky old microphone that appeared to have been run over by a truck. As the engineer hooked it up, the singer told him the mike had been used by his major influence, Elmore James, when he made his legendary 1961 recording of "Shake Your Money Maker". The engineer got levels and another take was begun. The singer gave it his all. There was distortion in the sound, years of screamin' vocals had left the mike with no brilliance, and the amount of gunk in the windscreen had robbed it of some clarity. None the less, it didn't diminish the excitement of the performance. That mike placed the singer in the aura of his idol's spirit and he sang his butt off. What came through the speakers moved everyone in the control room. That mike was his sound - it captured the magic of illusive soul.

But a microphone can only pick up what it hears. If the sound that's entering it is not happening, neither a great microphone, nor any amount of creative audio processing will fix it. At the same time, a good sound can't be fixed later if it is 'heard' by an inappropriate mike. Microphones can make small things sound big, big things sound small and contribute to the creation of countless illusions. Some years ago the BBC released a Halloween record with sounds of heads being guillotined and bodies being hacked apart. The record caused quite a stir and offended many listeners. When questions were raised about the origin of the sounds, they had to demonstrate the powerful effect that was created by hatcheting a cabbage in front of a microphone. After a few drinks down at the corner pub, slipping a hot bar stool along with a favourite record may not seem like the socially right thing to do, but in the studio, heard through a mike with some reverb, it may create just the right sound. There are countless examples of percussion

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sounds that have been created by non traditional instruments. Guitars are often the subject of illusion, with large amp sounds being created by Lilliputian speakers.

Acoustic drum sounds rival guitar in the degree of difficulty in achieving the sound desired by the drummer. It is not uncommon for an act to book the first session of an album project just to get the drums to sound the way they want them. Like all other instruments, the best microphones chosen will only sound right if they hear the right sound in front of them. Drummers can get a great drum sound on just about any set of drums provided they know how to tune them. A few years ago there were two sessions booked in the same studio. The first was a morning booking for a commercial ad agency. They had three hours to record and mix three 30 second spots. The second session was a rock band of some note. They had booked the rest of the day and night to get "drum sounds" for an album that was to start the following day.

For the agency date Hal Blaine (studio drummer extraordinaire) had been booked. Before the first session both sets of drums showed up. The set Hal was to play was from Studio Instrument Rental and was not one of his regular sets. In fact, it was one of the worst sets the engineer had ever seen SIR deliver. The heads had so many dents, they looked like the surface of the moon. The band’s roadies showed up about the same time with a large set of expensive “custom” drums. By the time Hal arrived his set was all milked. He apologized about the kit that had been delivered but, he explained, his other three sets were at the other studios where he was booked later in the day. From his bag he pulled out a roll of duct tape (otherwise known as gaffer’s tape) and started tuning the drums while the engineer headed into the control room. The engineer almost suggested using the rock band’s kit, but when the faders were raised, the junk set with the lousy heads sounded pretty good and got better as Hal worked with them. Ten minutes later recording began. Three hours later everything was done and Hal left. The “heavy” rock drummer arrived, and work began on getting drum sounds (needless to say heavy drummer commented about the “piece of junk” set that Hal had just been playing). Six hours later things had not gone well. The engineer suggested the exasperated drummer take a break while he would work on the drums. While the drummer moved out to the lounge for a smoke and to commune with nature, the engineer moved out the “custom” set and moved in the set that Hal had tuned. By now the rock drummer had returned to the control room. Because of how the studio was laid out, he couldn’t see the set. Just the engineer’s head and the cymbals. The engineer was playing time and went around the toms a few times. Through the talkback was heard “Great”. Hal was called in the next morning to tune the custom drums.

There are dozens of interesting modifications and variations to drum sounds. Ringo Starr used to bang his snare through a towel (preferably the thick ones stolen from expensive hotels). There have been periods when everyone taped leather wallets to their snare (often containing mail order prayer cloths), then came the use of industrial strength tampons, followed by dozens of other “everyone’s doing it”, “in” things. One engineer would only use a key case that came with a Mercedes Gullwing.

Early microphone development

Alexander Graham Bell had been working with deaf mutes and was attracted to the research, as earlier described, that was going on at MIT in the 1860s. On seeing Leon Scott's sound vibration drawings, Bell concluded that such a device would be perfect to show those who couldn’t hear, what their speech looked like. At MIT, Bell reviewed the work done previously by Helmholtz, Oersted, Sturges, Faraday, Volta, and the rest. Bell was able to take many of the previous centuries' observations and isolated electroacoustic phenomena and connect them together. In about 1875, Bell took two metal bars and wrapped wire around each of them. He set them out of magnetic reach of one another and then connected them in series with a battery. Attached to the front of each of the windings was a thin metal diaphragm with the freedom to vibrate close to the coil. Bell attached a sound gathering horn to the front of one of the diaphragm and a sound projecting horn to the surface of the other. When he spoke into the sound gathering horn, the metal diaphragm vibrated and altered the magnetic field of the nearby electromagnet. This caused the current flowing through the wire to fluctuate in sympathy with the slight changes in the magnetic path. The undulating current travelled to the second winding and caused a corresponding fluctuation in its magnetic field, causing the diaphragm near the second winding to sympathetically vibrate. Bell had invented the microphone and speaker, essentially the telephone, and electronic sound transmission became a reality. Bell patented the telephone in 1876 and became a giant in the field of communication and a legendary figure in history.

Microphones (and speakers) made it possible for people to communicate between two points. However, the points had to be reasonably close to one another since, prior to the invention of amplification, the signal the microphone generated dissipated quickly.
As identified in the earlier chapter on recording, the pioneers of sound technology understood that microphones were one of the first things that had to be perfected to achieve high quality transmission. In the early days, the principal microphone manufacturers were all large communication labs such as Western Electric, the BBC, Bell Labs, CBS, RCA, various national broadcast/telephone entities, and key universities. Significant performance improvements were being made as far back as the 1920s. In the early 20s the Western Electric "Eightball" was the first mike to break the 8000 cycle barrier. This microphone resembled a black eighball; a two inch chrome ring surrounding a black grill covering the opening on one side. RCA was the first to bring out microphones that were widely used in the developing radio, record, and film industries (RCA 44 and 77 ribbon microphones), which was a key factor in the rapid improvements in sound in these three industries. The RCA mikes were used widely for many years. By the 40s, RCA ribbon mikes were capable of a 16KHz bandwidth. Advanced versions of these models are still made. By the early 40s, a new generation of small specialty companies as well as a few national broadcasters, had designed and manufactured microphones. Larger companies also began to market microphones designed for them by these smaller manufacturers.

Microphone types

There are three common microphone designs: the ribbon varieties, moving coil and condenser microphones. The first two of these use magnetic principles and are passive devices with no internal amplification. The third uses "capacitive" principles and all such designs have an amplifier within the microphone. While all three designs are used for all types of applications, the moving coil microphones are the most common type to be found in PA applications and the condenser is the most common design for studio microphones. Many microphones physically look the same but sound quite dissimilar because of differences in enclosure design (the housing), transducer type, design, and construction of the capsule (the moving element which responds to the sound). In the case of condenser microphones, difference in the design of the internal amplifier is also a factor in the sound (sometimes a lot, sometimes a little).

The directional characteristics of the microphone, referred to as its pattern, are primarily affected by the design of the housing around the capsule. Some early microphones provided different patterns or directionality by physically attaching rings and other implements around the microphone's opening. Today, most manufacturers use the same capsule mounted in different housings to create a line of mikes, each with a different directional pattern created by the design of the housing. There are three most common patterns. The first of these is cardioid, which refers to the heart shape of this pattern, and is primarily directional toward the front of the microphone. Second, bi-directional microphones (also called figure 8) let the sound enter the microphone to both sides of the capsule. They are "live" to sounds directly in front or on-axis to either side of the capsule, but they reject sound coming off axis to the capsule. The third pattern is omni or omni-directional. This pattern picks up sound coming from every direction.

Microphones: subjective/ objective opinion

While microphones in general have been continually improving, one cannot assume that each new model replaced or even improved on an earlier model. A few of the older models hold up to comparison as exceptional, while some of the successors have not satisfied the test of taste. Consequently, a few of these older studio microphones are viewed as fine instruments, each possessing a unique quality. Some of the older, rare ones are now priceless to those who prefer them, and have gained a widely held reputation among music producers. Microphone spec sheets can help provide some information, but they can be deceptive due to the subjective nature of a microphone's performance. One mike may have worse specs compared to another, but can sound "more musical" when on a specific instrument or voice. The acid test is still how it sounds. Microphones are sometimes chosen based on who else uses them. One person might be inspired in front of a certain microphone because someone they know and admire also uses that model of microphone. For this reason, after musical instruments, microphones are probably the most heavily endorsed music production tool. Some mikes are widely accepted as popular for certain instruments, vocals, or applications, but there are always a few who don't find that specific mike to their liking for that purpose. There will always be some who love the sound of a vintage mike, and others who love the quality of the latest designs. Each opinion is valid, and, if it matters, both hits and lousy records have been made with all of them. To come full circle, mikes are like guitars — unique in that each has a certain sound that might be the best choice for a given day's situation, but always no better than the sound that enters them. (The ultimate mike suitable for every voice and instrument was found by Hercules who wrapped it in a golden fleece, but it was lost at sea on his return voyage. We have yet to recover or reinvent it!!)
In search of the obsolete

A story about a microphone worth telling is that of the Neumann U-47. It pairs up the mystique of tube distortion with a unique microphone design. This interesting case study involves a 50s microphone that will always represent a legendary sound in rock and roll. It continues to be a centre piece of microphone collections in the most prestigious studios.

The Neumann U-47 is probably one of the most desirable of those legendary microphones that can create those "Golden Slippers". It was first introduced soon after World War II ended. Its condenser design uses a vacuum tube (VF-14) that was basically obsolete before the war began. It's a short, squat, black, metal jacketed tube that is not only ugly but its distortion component is reasonably high. It is very harmonic — if you rap the side of it, it makes its own noise. After W.W. II, in Germany, the Neumann company was getting itself back on its feet. Tubes were scarce because no one was yet manufacturing them in Europe. This forced Neumann to use whatever it could find. The company bought a warehouse of old VF-14 tubes figuring that it wouldn't run out since the broadcasting market, for which the mike was targeted, was relatively limited, and the U-47 was planned as a limited run product since much better tubes would soon be available. To the manufacturer's surprise, it turned out that the mike became the rage in emerging rock and roll pop studios. Since there was a finite number of VF-14 tubes in the warehouse and as failed tubes were replaced over the years, the supply was eventually depleted. Neumann then tried in the late 70s to convince everyone that a modification it had invented using a Nuvistor tube would still achieve the same sound. Of course it did not. For a period of time, if a U-47 was sent to Neumann for repair, and it determined that it was a bad VF-14, it was automatically replaced with the nuvistor modification. Studio owners were shocked when they discovered, "the sound" was gone from their repaired microphone.

Then the U-47 FET was introduced, a "much improved" design on the original, so said Neumann. It was transistorised, did not require a large bulky external power supply, had less distortion and so on. A lot of first timers and give-anything-a-tries bought it. But nobody loved it. It paled beside the original. It wasn't bad, it wasn't particularly good either, and it definitely wasn't the same as the classic U-47. The obvious problem was that there appeared to be no substitute for the VF-14 tube.

The tube's unique design had much to do with its original purpose. Hitler had his people create an inexpensive radio designed and built for the masses, which was called the Volksradio (the people's radio). Hitler wanted a radio in every household (circa 1939). They were seen as strategic to the propaganda machine of the Reich. The way the German engineers cut down the cost of the radio was to use a very simple power supply. Unlike common tubes, the VF-14 used a 55 volt heater (the wire that glows and heats up the internal components of a tube). Most tubes use 6 or 12 volt heaters and start with 6 (6V6 or 6AL6) or a 12 (12AX7, 12AU7). The Volksradio design connected four of the VF-14s in a row (electronically called 'in series') so they could be directly plugged into the 220 volt mains power.

The Volksradio was not a lasting design. After the war, more advanced technology was available and the machinery that had made the tubes had long since disappeared. There seemed to be no replacement for this unusual obsolete tube. The continued need for replacement tubes drove their price up to several hundred dollars (when you could find someone willing to sell one). By the late 70s many people were beginning to worry that the sound of these wonderful old U-47s would eventually be lost for a lack of this unique tube. Then someone discovered a dusty warehouse full of UF-14 tubes. It seemed that the four-tube Volks had a more powerful relative that used eight tubes — each using a twenty-seven and a half volt heater element. Except for the difference in heater voltage requirements, the UF tube was characteristically identical to the VF. After being slightly modified, many U-47s have been brought back from the dead with the UF-14.

The mixing desk

Through the console or sound mixing desk, sounds are mixed and blended. Using the console, selections and choices of sounds are made and manipulated. Every signal passes through the console just as every colour goes first on the palette before being applied to the canvas. Painters place colours on their palette in a certain way based on how they like to work. Then they blend and mix the dollops of colour on the palette as they address their canvas. The same is true for mixing desks. The way the desk is set up leads to a certain approach to a recording and mixdown. Similarly, the routing and patching of sound sources and external effects in and out of the console will have an effect on the course of a given session, much the same way that painters work according to the layout of their colours and the design of their palette. Mixing sound involves thousands of decisions and is not a static process. Through the course of the final mix of a song, dozens of settings may be changed in order to achieve the desired balance at any one moment in the music.
In the past, the person mixing would memorise these changes and make them every time the mix was attempted. Now, computer memory assists the process. This makes mixing much more repeatable and allows single items in the mix to be changed without changing any other aspect of the mix. The most advanced mixing consoles are fully automated, which means that all the settings and changes that occur in the course of mixing are memorised. In the last few years, the cost of this type of mixer has plummeted as a result of cheaper, high powered computer technology. These consoles often include an array of signal processing programs such as reverb, delay, compression, and gating that were once external to the mixing console. However, no one using these "everything is included" mixing desks ever gives up the array of outboard equipment which they have, since each unit provides its own unique sound.

Many producers like using automated consoles for the control they provide. On the other hand, there are a substantial number of producers who feel that such consoles forfeit good sound for the sake of control. The view of this latter group is that large scale digital processing degrades the sound, and that the best sound is achieved by using consoles that have a minimum of electronics in them. They use the analogy, "the more pipe you run the water through, the dirtier the water gets". Many try to use the best of both extremes by using a minimalist console for the recording process and a fully automated console during the mixdown. For those who want it both ways a new generation of mixing desks have an analogue signal path under complete digital control and memory.

Many acts are on the road while their albums are being mixed and completed by the producer and engineer. Others will just come in to hear "semi-final" mixes and give their input then. In many cases the quality of mixes is often the subject of heated debate among those involved. Final mixes are redone many times before a consensus can be reached. Some bands feel that they all have to be there the whole time in order to protect or defend their parts. Sometimes every member of a band has to have a hand on the knob(s) controlling their track(s). Everybody grabs their knob and pushes. The drummer wants more drums, the bass player wants more bass, the guitar player has to have more guitar, the singer, less voice (usually) and so on. If the mix ends up being done by committee, the best to be hoped for is that there will be a producer who has the right of ultimate thumbs up (or down) on the results.

Most producers attempt to be democratic with their artists, but occasionally it becomes a test of wills and the producer's opinion will usually prevail. One producer always explained that his vote was more equal than the band's. At the end of one remix session the band 'quorumed' and presented a united front which for the first time seemed to win. A couple of days later the producer elected to remix the same song (obviously wanting to bring the song up for a new vote). The band wanted to stick with the mix they had, the producer wanted to give it one more go. When it came to the vote, the band still preferred the earlier effort. At this point the producer pulled out of his back pocket several official looking documents. He explained that he had in his possession signed "absentee ballots" which assigned to him the votes of those who were interested parties in the production, but who could not be there for the remix session (the roadsies, the publicist, the lawyer, the accountant, the studio manager, the security guard, a couple of groupies, the lunch wagon driver). Basically, anyone who had been present for any earlier vote was considered a registered voter (nobody said politics was fair).

There are times when the mixer or producer ends up acting as an ombudsman between the various band members. A couple of albums were done at CBS with a producer who always worked with funk R&B bands which included a large rhythm and horn section. The producer was a very large man and would command the producer's desk with his girth. His paunch would seem to overwhelm the chair. His sessions would always proceed at a rapid fire pace with no expected delays, his trigger finger always standing by on the talkback, his voice firmly barking out his desires, while recording, his will was never questioned, and he dominated the situation. However, during mixdown, his quick attention would drift. If he had nothing else better to do he would light a cigarette, then rock and nod to the music. He would usually leave the mixer alone during the few hours that it would take for the mix to come together, though he would allow the members of the band to get involved in the proceedings (often to the dismay of the mixer). Occasionally the producer would doze off, the ashes from his cigarette would fall to form a cinder snake up his chest until the tobacco had burned down to the filter. He would slump to one side and be held in the chair only by the arms of the chair which were barely visible beneath the folds of his paunch. Out of respect (and probably fear) no one dared to move him from the console, so when members of the band wanted to help in the mix they would have to reach around his imposing body. In response to the touch of a reaching arm he would mumble incoherent advice.
Usually too strong of an accidental touch caused by a band member reaching for a fader, or even the force of his own mumbling, would wake him. Of course, he would always claim that he was just “groovin’” with his eyes closed. The mixer on more than one occasion would forget and attempt to solo the track with the “rapping”, and only after turning everything off realize that the sounds were emanating from the sleeping producer. In one case they seemed to fit so well that they were recorded and mixed into the bridge (earlier rough mixes without the mumbling just didn’t make it). Most of the time, when the mix was near completion he was gently shaken out of his day dreams so he could adjudicate any debate among the members, approve the mix or suggest changes. In one session, absolutely everyone liked a certain mix (incredibly rare). In order to prevent the producer from having the opportunity to reject the unanimous choice, the band concluded that the best thing to do would be to let him rest his eyes a while longer and play him the mix after cassettes had been made. So the band members left, the board was zeroed, and the tapes were put away.

While the mixer and his assistant were cleaning up, the participants of the next session showed up (a prominent punk band well known for their technicolour hair, safety pin body adornments, and propensity for the bizarre). The new session put some effort into getting set up without disturbing the producer. The engineer who was producing the band got up a mix and did the first few takes using headphones. At the conclusion of a fairly good take, everyone decided it was time to get an unbiased opinion. They all huddled around him and the speakers were turned up (nearly) full blast. On the down beat the “heavy weight” producer was shakin’ from his groovin’, and passed through a moment of wondering what was real. His eyes snapped open to face a motley crew of spiked green hair and diaper pinned nostrils. From reflex he lurched toward the talkback, doubtlessly hoping that pressing it would still have the effect of muting the speakers thus assuring him that at least one thing in the control room was as he had left it. Of course it did, and at that moment the engineer asked him his opinion on the mix. He never again allowed both eyes to close at once.

Inbuilt equalisation

All music production consoles provide the primary equalisation that is used in a production. This “in board” equalisation will affect the sound of the production probably more than any other element in a console. Specifications for these equalisers are never able to quantify the quality or colour which they contribute to the sound. Technically two boards may have essentially the same specifications but one will have a musicality that the other does not possess. It is common for producers to choose to work on only certain consoles that have a quality they prefer. Over the years certain boards have built reputations for this elusive ingredient with the result that a great many studios have gone to lengths to rebuild these older consoles to meet the needs of the 90s but without affecting the cherished characteristics which they have. This elusive quality of sound has created a considerable market for refurbished old style equalisers, microphone preamps, and all manner of signal processors. In many cases, these devices were once components of older mixing desks which have been repackaged by specialist audio equipment dealers as outboard devices that can be connected to a modern console. They give the producer the opportunity to incorporate those intangible qualities which such components bring to the sound passing through them.

The ghosts in the machine

To emotionally understand the ghosts in such equipment, imagine you’re a singer and you’re asked: Would you rather sing into one of today’s top of the line mixing desk, or the one that made nearly every Beatles’ record? This board was state of the art in 1960. It cost tens of thousands of dollars and is probably the finest example ever made of a tube amplified console, and possibly one of the last to be made before the transistor revolution (tube amplified mixing desks are once again being built). It was built and installed by EMI at Abbey Road, and was one of the first boards built for stereo. It had twelve inputs, four outputs, four equalisers, a couple of effects sends, and two types of equalisation, either pop or classic. In order to change the equalisation, the engineer had to lift up the top deck of the console and physically change the electronic network by unbolting it and putting in the other. That mixing desk had been installed at Abbey Road for about five months when the Beatles started using it to record their first singles. Very soon thereafter it was hardly used by anyone else because they were usually in the midst of some project. That studio had become “their studio”. During their last album and for the shooting of the Let It Be movie, the board was taken out and moved to the shooting stage. It was then moved to the roof for the memorable conclusion of the film (and the Beatles).
A transistorized and improved console was installed in the studio to replace it. The band broke up and the tube amplified board remained in an EMI storage space for several years. It was set aside and forgotten. Eventually a retiring EMI engineer acquired the board as part of his retirement package and for more years it sat in his living room in Germany covered with a tarp and neglected. Then a San Francisco studio owner, who buys and sells vintage pro-audio gear, came across it while on a buying trip in Europe. Like some mysterious legend or treasure, he discovered it while inquiring about other equipment the ex-engineer was selling. He bought the board and transported it to the U.S. where for more years it sat in a bedroom in Berkeley, waiting for someone to come along and reconnect it. Finally in 1992 it was sold to Lenny Kravitz. It took four days to return it to working order. Ironically Lenny saved the board from more than neglect. Three months after he bought it, the house in Berkeley was one of those burnt to the ground during the Berkeley hills fires of 1992. Not too long ago someone wanted to buy it for a museum, but Lenny wouldn’t sell the 35 year old board.

The multi-track recorder

In sound production, multi-track recorders and samplers are the most common canvas. They are the medium on which many of the sonic colours are fixed. These days the multi-track commonly works in conjunction with the outputs of samplers and sound modules controlled by sequencers. The development of the sequencer, time code synchronisers and automated mixers have opened the possibility to not just capture a performance and then fine tune it, but perfectly reproduce it again and again. MIDI controlled systems are definitely different to multi-track recorders, but they do form part of the overlapping sounds that the music producer has available.

As a painting is somewhat limited by the specific medium, a four track tape recorder or small sequencer system is obviously more limited than a twenty four track and fully computerised production suite. The expectations of what each is capable of achieving should and will be different. It is not a matter of big always being better. A four track may be all that's needed for a simple demo. Just as the medium will influence the type of paint used and how it is applied for various effects, each tape formula, recorder medium, sound module, sampler, and sequencer program will add varying degrees of their own unique character, while still remaining under the control (or at least guidance) of the music producer's intentional decisions or pragmatic acceptance of the events that pass during the creative process.

Many other aspects of the contribution that multi-track, sequencer and synchroniser technology has made to popular music are explored in other chapters of this paper.

Signal processing: The secret sauce of popular music

Signal processing changes the tonality, texture and relationships of sound in real time as it moves through sonic space. All varieties of signal processing can add to (or detract from) the sound they are affecting, from the musicality of an equaliser to the warmth of vacuum tube distortion. They provide the sonic patina through which the sound waves of each element will travel and ultimately be heard. There are now an endless array of devices which manipulate time and create sound reflections or echo (with delay), generate space and ambiances (with reverb), affect tone (with equalisation), and alter the dynamic range or relative loudness of sound (with variable gain amplification i.e. limiters, compressors, expanders, gates). These devices have been key contributors to the "sound" of records through the years. All signal processing can be divided into these four groups— delay, reverb, equalisation (EQ), and variable gain amplifiers (or VGA).

As earlier identified, all mixing desks have basic to very elaborate EQ built into them. While this EQ is “inboard”, it is still considered a signal processor. Outboard processors are usually mounted in equipment racks and connected on an “as needed” basis. This is done through "patchbays" which allow connecting and rerouting of the signal path through the various electronic components in the studio. Major studios often have vast patchbays that resemble a wall of holes. Ray Haree (producer for Simon and Garfunkel) once confided that some of his best effects started out as patching mistakes.

Patchbays provide versatility, but they can add considerable wire to the signal path, which can have some effect on the signal passing through the system. It is hard to know when any given studio has enough patchbay holes, because so much depends on individual needs. For example, at Albert studios in the south of England, they had a patchbay field so large that some of it was installed in a hallway behind the control room. Over the years they continued to add more access to every possible connection in the facility. Nothing was ever removed, only more things added. Eventually even the hallway was out of space. They realised they weren’t sure just how many patchbays they had so an assistant was asked to count how many patch holes there were after which they finally knew how many holes it took to fill Albert’s hall.

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In the first decade of electric recording, signal processing was nothing more than a little bit of equalisation to enhance the various sounds entering the microphones. Then in the late 40s, artificial reverb “chambers” were developed and reverb was added to voice, horns, and strings, and then in the 50s to the drums to make the recording sound more “live”. The 50s also heard delay/echo effects added to vocals (that early Elvis Presley sound). The first delay effects were the direct result of the invention of the tape recorder which was used to create the effect. Over the past few decades, signal processing has become significantly more elaborate, diverse, and much more than merely an enhancement or surrounding. Since the 70s its contribution has become an integral part of the overall sound. It is common for the signal processing that is used to become the most distinguishing characteristic of “the sound”. Sometimes it becomes “The sound”. Repeating sounds, such as those you hear in many modern recordings, are often, by themselves, not very musical, but by frequent repetition in tempo, they become part of the rhythm and beat of the music, by changing their pitch they become a definable melodic “hook”. Hopefully, all the individual rhythmic inclusions created by the processors will work in a compatible combination, and none of the processing will cause any of the sounds to be out of tune with each other. Today, where the “musical sound” ends and the “effect processor sound” begins is in most cases indistinguishable.

The variety of effects would seem to allow an infinite number of sounds to be used on the myriad of recordings made, however, this has not necessarily been the case. The desire of producers to make records that sound familiar has created a remarkable number of productions that sound alike. The phenomenon has been made easier by the variety of pre-set programs that come with most processors. By quickly switching from one setting to another, the sounds from dozens of records can be heard. On the other hand, as McKay (1981) points out, the “extensive use of electronic effects, far from standardising the sound, could make it intensely personal” (p. 90). This is the case once a producer moves past the pre-sets. How these devices are used can vary in as many ways as a sonic image can be imagined. There are no rules. The possibilities are endless. Signal processing is used during recording or mix down. There are no right or wrong ways of using them. However, it is equally easy to create combinations that seem to detract from the production thus making the entire image cluttered.

The search for new sounds

Modern studios often feature in their promotion the racks of signal processors they have and if they don’t have it will rent any specific item a client requests. Distinct sounds of current records often allude to which of the latest processors was used to achieve it. If a big hit happens to prominently feature a certain effect it can be assured that many other music producers will use that effect as a part of their next recordings. But a “this month’s hit sound” device can quickly become something which dates subsequent records and causes them to move into the “I’ve heard too much of that” category. Over the years there have been many devices that have made this list. These devices created unique sounds that worked the first few times they were used but they lacked versatility. The first of these might have been the Theremin which generated a musical siren effect when the operator moved their hands around the device’s magnetic field. The Theremin was invented by Leon Theremin, a Russian, in 1919. It was used in a few modern orchestral works before it was first used as a part of a recorded score. The proximity of the hands of the Theremin player to the two antenna that project from the device, control the pitch, and loudness. It was a familiar effect on the sound tracks of late 50s - early 60s science fiction films such as They Came From Outerspace(1967), The Day The Earth Stood Still (1951), Forbidden Planet(1956), and the theme for the TV series One Step Beyond. Since then, to list but a few of hundreds of “used for only a month” devices would include the Mutron, Omnipressor, Vocoder, Vocal Stressor, and Syndrum.

At CBS, producers in different studios would occasionally fight over the right to use a particular signal processor. In one case, two of them needed a device to maintain continuity in their projects. They both headed for the phones to call the head of CBS records in order to clarify which of the projects was more important. The studio eventually flew in a second unit which was rented from the manufacturer and was eventually bought since the rental was higher than the cost of buying it. A year later both devices were removed from the rack and placed in storage because no one had used them in months and the space was needed for newer processors that had arrived. Some producers have become so preoccupied with effects and gimmicks that the song is lost in all the “other stuff”. True, there are records where the effects represent nearly all of the sounds such as some scratch, hip-hop, techno-pop, and rap music, but in general, signal processing never made a hit record. The music industry continues to believe a hit song makes a
hit record. A story to illustrate this point- CBS Studios had a tradition of quality that went back to the beginning of recorded sound. But it was never known for having lots of the latest trendiest black boxes. Instead, the engineers there prided themselves on their knowledge of high quality recording techniques. One day, a new band came into the studio intent on working with one engineer in particular. While he was old enough to be the father of any of them, they all wanted the sound he had gotten on many successful albums. The guys in the band kept asking if the studio had this or that processor. The old engineer kept saying: "No, we don’t have that" to almost everything they asked. Finally, in frustration, they asked, "how did he get that sound?". The engineer just shook his head knowingly and asked them if they had any good songs. "Sure, we’ve got a lot of great songs," they replied indignantly. The engineer smiled, pointed at the outboard rack and said, “Well, don’t worry, we’ve got enough stuff here to wreck any of them!”

A producer’s perception of what effect achieves his sound sometimes defies rationale. In the early 70s, when CBS (San Francisco) first moved into its building, a new board, custom built by CBS labs, went into Studio A, but Studio B’s board was still to be constructed. To get Studio B into operation, they installed a board that had been in storage after several years of making records at CBS, New York. This board had large, mechanical, rotary channel faders. These sort of controls disappeared in the early 60s, but they were still in this board. The master level control had eight of these fader mechanisms all connected together by an elaborate gear train connected to a large round black knob on the front of the mixing desk. These controls were physically very large, so with all the linkage, it took quite a bit of effort to turn the knob connected to the eight faders. Because of their age and design the control added a certain amount of noise to any signal passing through it. The control had been labelled by one of the techs as the “funk knob” in the same way everything else was lettered on the board. Eventually, the master signal was re-routed to a more modern slide fader and bypassed the “funk knob”, which quieted down the system. At the time, the studio had a client who was successfully producing a new R&B acts. After the master fader was re-routed and he discovered the sound was no longer going through the “funk knob”, be lost all sense of reason. He went to the studio manager and insisted that the “knob” be put back in the system. That night the mystified chief engineer put the “ins” and “outs” of the “funk knob” on the patch bay so it could be patched in to the system. The client insisted that it be used, and every session he’d check to make sure it was. The mixer, who had been urging the removal of the “funk knob” explained to him that the control did nothing more than add noise, but the producer was convinced that it added a certain “funk” that was part of his sound. To make matters worse, when the new console arrived, in order to keep this producer happy, the “funk knob” and all its linkage was installed in a separate auxiliary box which could be patched into the stereo output of the new board.

Sometimes, to the horror of the producer, effects created cannot be recaptured for various reasons. While producing an album an engineer had been able to get a particularly interesting distortion on the lead guitar using a tube amplified compressor. The primary reason for the sound it was creating was that one of its vacuum tubes needed replacing. All of this was unknown to the service engineer who had a regular routine of checking all the gear and fixing that which needed it. One night he tested this compressor and quickly determined that it needed new tubes. The next day the compressor was plugged in, but the expected sound was not there. A quick check of the maintenance log explained what had happened. Fortunately the old tubes were still in the shop’s trash bin. For the balance of the sessions a sign was placed on the unit that it wasn’t to be “fixed”, and for about a year after it was repaired the bad tubes were saved in case the engineer had to go back and fix any of the guitar parts on those tapes.

While the technology is diverse, there is a great deal of commonality between the equipment found in most studios. Nonetheless there is a great deal of mystique attached to those studios that have been used to create major hit records. These studios have proven track records at delivering “the sound”. Many acts as well as labels, will record in these studios in the hope that some of the spirit left behind by successful past productions will inspire other artists as they make their recordings. Sometimes the inspiration does come, because the artist believes that it will.

No one effect stands by itself as more important than any of the others. It is the creative interaction of them all that realises the conceptions that are heard in the mind’s ear of the music producer into a sound to be heard by all. The four groups of signal processors all have an important part to play in this process. While there are many characteristic differences between equaliser devices and their application, this is not generally recognised by the average listener of pop music. Such is also the case for variable gain amplifiers, though their importance is equal to that of EQ. Reverb and echo on the other hand, are prominent and often obvious to the listener. The following descriptions of these effects, the technology that has been used to implement them, and some notable examples will better clarify their importance in the production of contemporary popular music.
Compressors, limiters, expanders and noise gates

Compressors, limiters, noise gates, and expanders are all variable gain amplifiers (VGAs). Generally, compressing and limiting reduce the dynamics of a sound, while expansion and gating increase the dynamic range of a sound. Basically, limiters and compressors reduce dynamics by restricting the loudest passages in a program. Gates and expanders increase dynamics by making quiet passages in a program more quiet. In other words, a compressor/limiter lowers the “bridge”, while a gate/expander lowers the “river”. VGAs are liberally used by most engineers for creatively re-shaping the envelope of a sound. Compression, or limiting is usually used while recording, but it may be used during mixdown, and gating or expansion is usually used during mixdown. In application, a single VGA is generally used to affect only one sound at a time. It would be unusually for a kick drum and a bass, or other unrelated combination of sounds, to be processed through the same VGA unit. However, a single compressor might be used to smooth out an entire string or brass section. That being said, it is common practice to add a little bit of overall compression to the entire stereo program right before it goes to the mixdown recorder or during mastering. Variable gain amplifiers, to varying degrees, colour the sound passing through them. This may or may not be heard as desirable. Again, it is the ears of the music producer that make such decisions. As with equalisation, the design of the VGA and the type of amplification used contribute to each device characteristic sound. For this reason most music studios will have a collection of models, each of which is the unit of choice for a certain application.

Equalisers

Equalisation modifies the loudness of specific frequencies in the sound. It is probably the most common type of signal processing. As previously mentioned, it can be packaged as an external device but it is found in almost all mixing consoles, usually one per channel. How elaborate the EQ section will be is usually a function of the cost. Equalisation can enhance a certain tone, but not create it. Selecting the best EQ setting is dependent on the nature of the sound. For sounds in space (i.e. acoustic instruments or voice), the type of microphone and where it is placed in the environment will also affect the EQ. EQ is best used as seasoning, and is most effective when it is enhancing a fundamentally good sound. EQ is not solely an additive process, but a subtractive one as well. Since we hear one sound through another, in order to distinctly hear specific elements of one sound, space needs to be created for it by reducing or removing unnecessary tones, undertones, overtones, dissonant harmonics, and any noise, hum, rumble, or hiss in the total sound. EQ is used to open space for the essential elements of each overlapping sound by reducing the nonessential components of other sounds. The best sound mixers approach EQ as though they’re filling a gallon pail of sound. If the bottom of the pail is filled with a lot of low frequency rumble on voice tracks, synthesisers or acoustic guitars, for instance, there is little room for anything else. Clarity and definition is achieved by seeking the impression or essence of the sound. For example, most acoustic guitars have a significant low frequency component which sounds good when it is played by itself. But if they are part of a production including rock guitars and a bass, the acoustic will tend to wash out the low end clarity and definition of the bass. This particular problem is aggravated when too much reverb is added to the acoustic, causing a cavernous rumble which clouds the whole track. By rolling off much of the low frequencies of the acoustic, it will sound somewhat thin when it is heard in isolation, but within the mix, nothing will seem to be missing and the bass will have definition. The mind fills in the nonessential missing parts, and those instruments that need low frequency will retain their clarity.

Equalisation is very interactive in and of itself. For example, drums are usually recorded using several mikes placed throughout the kit. Looking at just the interaction of two of these mikes, the one on the snare, and the one on the high-hat, one quickly hears that equalising the microphone on the snare also alters the tone of the high-hat, since the snare microphone also picks up some high-hat “leakage”. Realising that most sessions use as many as seven to ten microphones on a set of drums, all of them will be picking up certain amounts of the entire kit as well as the one drum (or cymbal) they are principally miking. Equalising any one of them will affect, to varying degrees, the total sound of all of them. A surprising number of bands go into the studio, set up the drums to get a drum sound, solo the snare drum microphone, and spend hours attempting to get a snare sound. This isolated approach is often a waste of time (and completely debilitating for the drummer), because as soon as the overhead microphones above the cymbals are turned on, the overall sound of the snare will change.

Types of EQ

There are three fundamental designs for an equaliser: program, parametric, and graphic. Each is appropriate for specific applications, and none of them are appropriate for all applications. A program equaliser is the simplest with a fixed or switchable single frequency that can be attenuated or boosted by a certain amount. Parametric or sweepable equalisers provide continu-
ously variable boost or cut of several overlapping, sweepable frequency bands. Graphic equalisers are most commonly used in P.A. “speaker tuning” applications. They have several controls, one per frequency, with several controls per octave.

The alteration of the frequency response of a sound passing through an EQ is described by the shape of the equaliser’s “curve”. An EQ curve describes the frequency vs. loudness pattern of a particular equaliser. The most common curves are roll-off, shelf, and pass band. The roll-off curve, at a specific frequency, begins to reduce the sound at so many dB per octave. A shelving equaliser will roll-off and then stabilise or flatten out at a certain frequency point. The pass band curve creates a peak or dip in a sound’s frequency response. There are dozens of different ways of achieving the same equalisation specifications, but some designs will sound better than others, and nothing on a spec sheet can subjectively indicate the musicality of an equaliser. Nor does price necessarily mean an equaliser in an expensive mixing desk will sound better than one in a less expensive mixing console. A wide range of design and component variables will determine the quality of the sound.

Since EQ is also used as a function of the storage medium, as such, it can also affect the sound (more so on analog signal). For instance, when a tape is recorded, within the machines electronics there is added to the signal a specific amount of high frequency boost, and when the tape is played back the signal is filtered through a complementary amount of high frequency cut. Some of these EQ curves are world-wide standards, some are national and some are better than others. This equalisation is not adjustable by the user, but is incorporated to better utilise the characteristics of tape, records, or film. Other common curves are the RIAA EQ for records, the Academy filter used in optical film sound, and several tape EQ specifications depending on tape speed and track format. Most EQ standards are established by committees who, at the time the standard is established, are acknowledged as authoritative in that field. In some cases, a de facto standard becomes established by the first person or company to use that medium, and then with possibly some modification, it is adopted by a standards committee convened by an appropriate industry.

There is one last fixed EQ that bears mentioning. Fletcher and Munson were two doctors who, in 1933, presented a landmark research paper on human hearing. They took a large group of people and subjectively measured their threshold of hearing and how well they heard different frequencies at different loudness. Fletcher and Munson illustrated this with what they called the equal loudness contours, which showed that when humans listened to music at low levels their ears are less sensitive to both low and high frequencies. The loudness switch on most home stereos is there to compensate for our hearing when we listen at lower levels. The loudness switch boosts high and low frequencies to provide a balanced response when the system is played at lower average levels. A loudness switch should not be on when listening at higher levels, because it improperly colours the sound, although some people leave it on all the time for the additional woof and tweet it provides. Thus the notion of hearing something without any EQ, and based on a perfectly flat frequency vs loudness curve does not take into account that our ears are not “flat” and that we hear things differently at different levels. This is a considerable issue for mixers who must arrive at a compromise balance that will sound good at both loud and soft listening situations. If they listen loudly they may not add enough highs and lows for the mix to sound good at lower levels. On the other hand, if they mix at a low level the sound may be too boomy and topsy at loud levels.

Reverb and echo sounds

While all signal processors are important in the creation of the sound tapestry, through the years reverberators and delay devices have generated the most obvious sounds in popular music. The ears of the average listener reverb and echo (created by a delay) are the most clearly identifiable characteristics in “the sound” of most recordings. Reverb and delay devices have also undergone the greatest advancements with the introduction and development of digital processing. The sound these devices have created could be debated to be some of the most important aspects of a record’s appeal, since they are imagined by the listener to add power, excitement, definition, and expanses to a record.

The effect of acoustic reverb on the musical performance

The acknowledged effect of reverb on music goes back to the beginning of song. In most ancient writing, there are accounts of singing or chanting and the experience of the reverb in the space where the event was occurring. In Greek times this was the reverb generated from reflections off the back wall of an amphitheatre. Since that time the creation of the music has been affected by the spaces in which it has been performed. For example, Norman and Gothic cathedrals were large with stone walls and floors. The reverb was long and voluminous, and the music of the time was written to best use this type of reverb. The music that was heard in these spaces were slow tempoed, had little polyphony and primarily whole notes, thus the reverb would reinforce the sound. While complex music became popular some time later, there is some
thought that if musicians of this earlier period were experimenting with rhythm, melody, and chord structure, they would have found this music unsuitable for these spaces of long reverberant time. Quicker tempos and the reverb of previous notes would conflict with those presently being played.

As the primary venues for music changed from large spaces to medium size spaces, from cathedrals to castle halls of royalty, to drawing rooms of the rich to public theatres, the composition of music also changed with the development of harmony, faster tempos, and more complex lyrics and melody. Similar musical change occurred when music started being written for the intimacy of records. Unlike the live experience, record production allows any style of reverb or echo to be added that is appropriate for the music. Or put another way, music producers can surround their music with a reverberant space of any size, characteristic or proportion. In the beginning of recording this was done by physically changing the reverb characteristics of the space where the recording was made, but by the 30s reverb chambers had come into usage and reverb could be added in the recording process. As signal processing technology has matured, the proliferation of reverberators has multiplied to a seemingly unlimited number.

The difference between the sound of reverb & echo is reasonably obvious once the attributes of the two are identified and compared.

Echo causes a sound to be clearly repeated at a regular interval. Subsequent repeats may generally decline in loudness, but each of the repeats will be the same "distance" apart. A delay device creates echo. Such acoustic experiences can be heard by creating a sharp percussive sound inside a long reflective hallway or passage way. Delays have been used since the 50s to thicken a singer’s voice. Its hard to say where it was first used but it was popularised in the recordings engineered and produced by Sam Phillips at his Memphis Sun Studios with Jerry Lee Lewis, Roy Orbison, Carl Perkins, and of course Elvis Presley. The application of echo to voice, guitar, snare drum and nearly any other sound as the production might dictate, has become a common element of the sound of rock and roll. It was a unique and characteristic sound in the fifties and helped add to the excitement in the recordings of those hillbilly rockers that sounded black but were acceptably white.

The perception of reverb on the other hand, is experienced by first hearing the sound coming directly from, let’s say an auditorium stage, and then, after a certain amount of time, the loudest reflection from the nearest hard surface is heard, then come reflections off the next-nearest hard surfaces, then the next, and the next, and so on. All the reflections are as regular or random as the geometry of the enclosure. Eventually, the reflections are so dense that the decay merges into continuous non-distinct reflections until it has completely faded away. Reverb provides a means of identifying the size and acoustic characteristics of a room, and as such, reverb effects create space: the illusion of a room in which a performance is occurring. The bigger the room, the more complex the variety of hard surfaces, the more elaborate and sustained the reverb created in that room. Generally, the most pleasing reverb sounds are those with reflections that are random.

Delay effect

Tape delay was often referred to as “slap echo”. It was not particularly difficult to create after the introduction of tape recorders. The delay time was determined by how long it took the tape to travel from the record head to the playback head. Tape delay with multiple repeats was achieved by feeding some of the slap echo back to the input of the delay recorder. This sound is prominently heard in the 1956 recordings "Heartbreak Hotel" by Elvis Presley, and Gene Vincent's "Be Bop-A-Lula". Before digital devices made the tape delay obsolete, studios would leave a recorder running all the time to provide the effect. Outside of having to constantly clean the tape delay recorder, the main problem was remembering to rewind the tape. More than a few producers went berserk because they were almost to the end of a mix when the slapback recorder ran out of tape and they lost their echo.

The popularity of delay on the voice and guitar in early rock and roll records necessitated the invention of something that could be used to create that sound at live performances. It had to be small, cheap, portable, and simple to use at a time when musicians were still very low tech. The Echoplex delay device hit the market in the early sixties and never had a real rival. It was a type of recorder that used an endless loop tape cartridge, which eliminated the problem of tape run out. A conventional tape recorder has one playback head, but an Echoplex had two heads and sometimes more in order to achieve a more complex delay effect. The output of one or more of the playback heads could be fed back to the record input for a repeating "echo". One of the playback heads could be moved along a channel in the face plate to adjust the distance between the record and play heads in order to fine tune the delay time. Later models had a variable speed control which provided additional time delay variation. By the late 70s digital delays had
made the *Echoplex* obsolete but well into the late 80s there was a small company in Maine that was hand building them for those few people who still wanted “that” sound.

Digital delays of every variety and price range are now available. Most music producers have several of them since different sounds will require different delay settings. Delay effects are fully adjustable to create custom sounds, but they come with dozens of commonly used pre-sets. All such devices allow the delay time to be swept or “time modulated” from a short delay to a longer one. When the swept delay is combined with the undelayed signal, several different commonly heard effects can be created. These swept delays are known as phasing, flanging, chorusing, and the doppler effect. The difference between the four is the maximum amount of delay time being swept. Phasing and flanging have a short maximum delay, and, as the delay time increases, the effect moves from chorusing (subtle pitch variation) to a doppler (severe pitch variation) type of sound. 

When a very short delay is added to an undelayed signal, some frequencies in the sound will be reinforced or boosted while others will be diminished. This is caused by the constructive or destructive interaction of closely similar sound waves. When the delay is continuously swept, the frequencies of reinforcement and cancellation will also be continuously changing. Swept time delay occurs in reality space when a microphone that is positioned near a hard surface picks up a crashing cymbal. As the cymbal sways after being struck, the direct and reflected distances change so the frequencies of cancellation and reinforcement also change (ie—sweep). This effect is often desirable and was probably first experienced when drums were first placed in small “drum booths” in order to isolate them from the rest of the band. The close proximity of the glass in the booth’s windows) to the cymbals will create the conditions for phasing to occur.

The term “flanging” goes back to a technique that was used when the effect was originally created in the late 50s. It involved, amongst other things, putting slight pressure on the “flange” of the holdback reel of a tape recorder. Flanging can be heard on Toni Fisher’s 1959 hit “The Big Hurt” and the 1967 release “Ichycoo Park” by the Small Faces. “Phasing” provided a more dramatic effect through the use of the variable pitch control of one of the recorders instead of the physical restraining of the holdback reel. One of the most memorable examples of tape recorder phasing was created in certain sections of The Eagles’ 1977 song, “Life In The Fast Lane”.

If the maximum time of a sweeping delay is long, chorusing is created causing the pitch of the output signal to go up as the delay sweeps toward the shortest time, and down when the sweeping delay moves toward the longest time. This occurs because the wavelengths of the frequencies entering the delay are expanded as the delay is increased and contracted when the delay is decreased during the period of time the signal is held in the delay. This effect creates vibrato or pitch modulation and is heard in nearly all popular recording on one instrument or another. Some degree of vibrato is commonly added to guitars and violin sections.

If the maximum swept time is very great, a “doppler effect” is created. Such time modulation does happen in reality. It can be experienced when standing near a railway line and hearing a train blow its whistle as it passes. The pitch of the train’s whistle goes up as it approaches, then down as it goes away. The pitch of the whistle remains constant to those on the train, but to the person on the ground the sound waves are being compressed and then stretched as the train passes by them. Perhaps the best example of this effect is created by the Leslie speaker cabinet which has frequently been used for organ and guitar sounds. The doppler effect, as created by the Leslie speaker, is heard on the Booker T and the MGs, 1967 recording of Hang Em High, and the 1969, Time Is Tight.

**Reverberators**

Most pop recordings are seldom recorded in true stereo, so reverb becomes “the glue of multi-mono”. Reverb brings sound to life. It gives the impression of power, adds drama, size and depth. It changes the edges of the sound and identifies the boundary of the image. It provides depth in the sonic picture, and constant contrast and comparison of the direct sound to the surroundings in which the music is played. Reverb does not occur when there are no boundaries, or if the boundaries are extremely close and absorptive, or are so far away that the sound has dissipated before returning to the listener. When sound is made within a confined space, a reverberation can occur. Reverb is an organic phenomenon that provides a locality of the general sonic scene. Reverberant reflection is essential for the recording of most acoustic instruments since the reflections provide a source of vibration that significantly contributes to the instrument’s sustain.

As MacKay (1981) puts it, “echo and reverb are the old war horses of rock records, described by one studio musician as ‘the opium of the producer’”(p. 32). There are basically five different
ways of creating reverb in a recording. The first, which is natural room reverb, is the simplest in
principle, the most straightforward, and the oldest. Natural room reverb is generated in the
room in which the recording is made, providing the room does in fact have a reverberation.

Most wooden acoustic instruments, such as acoustic guitar, violin or piano, get a certain
amount of their natural sound from a sympathetic resonance with the reverberation in the room
in which they are played. When there are no reflections and a lack of reverberation, these in-
struments will vibrate with less complexity and sound lifeless. For this reason, most studios
today, even little ones, are fairly "live". In the early days of multi-track recording there was a
paranoia about leakage from one instrument to another which resulted in a whole generation of
studios (in the 70s) that were oppressively non reverberant ("dead"). Contemporary studio
designs have reversed this approach and returned to designs of an earlier period, where the
recording space (or at least a portion of the recording space) is live and reverberant.

Beyond the natural reverb of the recording studio, acoustic reverb has been featured in a
great many recordings. Three excellent examples were produced by Roy Halee. On Art
Garfunkel's 1973 solo album Angel Clare, a twenty second acoustic guitar part was recorded at
Grace Cathedral in San Francisco. It took producer Halee a week to get what he wanted. The
studio moved a multi-track, mixing desk, speakers and such into one of the rooms to one side of
the cathedral. He set up the guitar in the middle of the chancel (where the altar is) and posi-
tioned mikes near it, with many other microphones scattered throughout the huge building.
Each of the various microphones were recorded on a separate track and the preferred combina-
tion was chosen during mixdown. The recording was done in the middle of the night to keep the
city noise (and the cable groans and dingy bells of the California street cable-cars) from invad-
ing the cavernous space and wrecking the recording. In the final mix the guitar initially has a
close proximity, but as it continues, the space around it emerges and the part seems to soar as it
approaches the end of the song. Another Halee production, "Bridge Over Troubled Water" (by
Simon & Garfunkel) prominently features a unique snare drum sound which was accomplished
by recording an additional snare drum part from inside a reverb chamber. This created an
explosive reverberating snare drum which added so much to the thematic impact of the song.
For "The Boxer" from the same album, on one Saturday at CBS in New York, when the rest of
the building was quiet, Halee opened the doors to the skyscraper's freight elevator shaft and lowered
a few microphones down many storeys. The drummer set up and played his snare next to the
gaping shaft. The snare was recorded with a close mike, as well as the reverb coming down the
shaft. The effect dramatically illustrated the desolation of the song's character in this classic
production.

In many of these cases the reverb sound was created by enveloping the players in the reverber-
ant environment to create a sense of drama and depth. In fact, an entire style of music and
dozens of acts have come out of (and been created within) the reverberant halls, stairwells, and
alleys of Philadelphia and New York. Though it may be true that the heart of rock 'n roll is
Cleveland, its soul was found further east in the public housing projects. Those formidable
monoliths, which to so many represented the depersonalisation of the urban poor, provided rich
sonic reflections to those who cried out their personal appeal. Dion and the Belmonts, The
Persuasions, The Four Seasons, The Chordettes name four, trace their roots to singing in hous-
ing project stairwells. Their sound was created and based on how their voices sounded in the
bleak reverberant spaces of tenements. They had no instruments except their voices, and the
sound they made with the reverb that engulfed and surrounded them. This style of sound con-
tinues today with acts such as All Four One, Boyz II Men and Colour Me Badd to name three
groups of the 90s who have embraced this retro style of "stair well" singing.

Reverb chambers

Obviously, natural room reverb is somewhat uncontrollable and is not easily applied to spe-
cific elements of a recording. Beginning sometime in the 1930s, sound studios began to build
reverb chambers so they could have more control over reverb. A chamber is an extremely reflec-
tive room that has a microphone (or two) and a speaker inside it. Sounds that need reverb can
be fed into the chamber from the console, and the output from the microphones in the chamber
are remixed into the console so the reverb can be added to the mix. While there are some
guidelines as to what is needed to make a good sounding reverb chamber, building a great cham-
ber is not easy and many have been built that did not meet expectations. In the early 60s, good
sounding echo chambers were as much of a draw for a studio as the recording space itself. Four
of the best chambers ever built were the ones at Goldstar Studios in Hollywood. These chambers
created the "Wall Of Sound" for which producer Phil Spector was famous. As MacKay (1981)
points out,
Spector's great achievement was the way in which he showed that a record need not sound in any way like a live performance, indeed that commercial success could be greater if the studio's potential could be exploited" (p. 90)

Spector's hits with The Crystals, The Righteous Brothers, The Ronettes, and Tina Turner's classic "River Deep-Mountain High" all had his distinctive sound. Many other top artists of the era also used the Goldstar chambers, including Sonny & Cher, The Iron Butterfly, The Beach Boys, and Herb Alpert and the Tijuana Brass. The Goldstar chambers were so popular that the owners built two copies and leased them to other studios who would run high-quality telephone lines to Goldstar in order to use them, or if they were close enough, string their own lines.

Chambers are part of rock and roll legend but today very few new chambers are built. Only the biggest and generally older studios still have reverber chambers which were built before the digital reverb revolution. They occupy so much expensive square footage, and the unpredictability of how they will sound after they are constructed prevent most from installing new ones. There are simply so many digital devices which come close to a chamber sound and which provide so much more control of the results. Still, most producers who have used the best reverber chambers will agree that they are hard to electronically rival. Chambers were, and still are, magical. At the turn of a single knob at Goldstar, magic would emerge and hold and enfold the artist within a special warm cloak of indescribable reverb.

Spring reverberators

In the 30s and 40s portable spring reverb devices were invented that could be used with early electronic instruments. The first lot of them were not suitable for high quality studio applications but were primarily used in church organs and Hawaiian guitar amplifiers. These devices use long pliable springs. Spring reverb is generated by the rotation of a spring by a mechanism which is similar to a mechanical level meter on which one end of the spring is attached. At the other end is a pick-up. In the 90s there are no companies still making studio quality spring reverbs though the guitar amp variety is still made in China. They were too expensive to build and digital devices have superseded them. However, the spring reverb sound was and continues to be an important part of rock and roll.

With the introduction in the late 50s and early 60s of the Fender Champ, Princeton, and legendary Twin Reverb guitar amps, reverberation became a uniquely integral part of American pop music. Before distortion was in, reverb gave solid-body guitars bigness, and the rock n' roll public ate it up. Consequently, reverb and tremolo (a dynamic pulsation of the sound) was poured like molasses over many of the hit recordings of the period, particularly the many hit instrumentals of The Ventures ("Walk Don't Run", "Perfidia", "Hawaii Five-O", etc). Spring reverbs have been built into nearly every lead guitar amp ever made up until very recent times. Even with the availability of digital processors in guitar amps, the spring reverb is still available in several classic models. $25,000 worth of digital reverb has no substitute for the unique rock and roll sound coming from $10 worth of springs.

Plate reverberators

In the late 50s to early 60s, EMT (a Germany company) Introduced the echo-plate which was the first studio-quality reverberator that was particularly well-suited to pop music. It had a brightness and percussiveness that provided an extra edge of excitement ideally suited for the upfront sound of rock n' roll. Reverberant plates were excellent on drums and provided a bright, crystalline, snappy sound. Even today, many studios have plates in addition to digital reverbs because they create a constant-density, infinitely-random-and-reflective sound. Reverb for reverb, a plate reverber's density of reflection is significantly better than any of the digital reverbs because the reflections are infinite. The plate sound is so identifiable that most digital devices have one or more "plate" settings which approximate the quality of a plate (but cannot create the same sound density since they use mathematical algorithms with finite reflections).

The EMT's enclosure resembled a small pool table standing on its side. Inside this wood box was a 1/64" sheet of steel stretched from its four corners on a metal pipe frame. Inside the housing was an amplifier that drove the voice coil/driver mechanism which caused the plate to vibrate (much like a speaker). These vibrations travelled to the edge of the plate and then reflected off the perimeter much like a pond that has a stone thrown into it. The ripples travel to the boundary of the pond and then reflect and interact with subsequent waves from other stone throws. While a reverb chamber creates three dimensional space, a plate reverb generates two dimensional space. The complex vibrations are sensed by a pickup which rides on the surface of the plate. This signal is then amplified and sent back to the mixing desk. The original plates had one pickup, but when stereo came along a second pickup was positioned elsewhere on the plate. In the mid 70s, EMT also manufactured quad versions with four pickups.
Digital reverberators in the 90s

Digital delay devices passed through their infancy in mid 70s. By the early 80s, digital delays were advancing nicely and there were some professional digital reverb devices which provided quite acceptable reverb. By the middle of the decade the quality was quite good, and since then they have continued to improve and go down in price. Digital processors are now more accurately called multi-processors because they have a wide range of programs that include reverb, delay, equalisation and dynamic control effects and include a range of features that were previously unavailable in non digital devices. The demise of mechanical reverb and delay devices has been the result of advances in technology, however, as in so many other aspects of musical sound in the 90s, there has been a new-found appreciation of mechanical reverbss because they create a density and smoothness of reverb not found in the digital domain.8

Synchronisers and interlocking systems

SMPTE/EBU Time code systems, in particular synchronisers, are one of the few essential high technology production products void of subjective opinion. While personal taste, specific function and cost determine which brands someone might prefer, their operation and what is required of them is very clear cut. Time code and synchronisers are the means by which MIDI devices, mixing desks, computers of every variety, video, and audio recorders are able to operate in a synchronised fashion, thus any number of machines can provide nearly an unlimited number of tracks. The same technology is also used to control live performance lighting, amusement park rides, and multimedia productions since it provides an accurate time interlock between all the various elements of the production. SMPTE/EBU time code can be recorded on nearly any type of analog or digital recorder and is commonly used in all other types of "real time" audio storage system. It is a unique combination of computer numbers that can be read forward or backward by a time code reader.

As far back as the early 30s, the film industry had developed a sprocket system to interlock optical audio film reproducers to the picture film. When the picture was filmed the camera and audio recorder motors were both locked to the same mains power line frequency.10 During playback, a generator, connected to one of the picture projector's sprockets, created a line frequency which, when amplified, would drive the motors of all the slave audio reproducers called "dubbers". In the mixing phase of a film, rooms full of dubbers would be played in sync with the picture, each one playing back a single track of dialogue, music, or sound effect. To rewind the system the film was played backwards, and all the reproducers would follow, thus, remaining in sync with the picture. There was no fast forward or rewind. Modern film chain systems now have a rewind and fast forward of six times normal play speed. This method of interlock is called a "selsyn" system and continues to be used throughout the film industry. However, since the 50s, optical sound film in production has been replaced with magnetic film. Today, for television production and for certain types of applications in the film industry, multi-track tape recorders are also interlocked to film using time code.

Time code was invented by NASA to time reference computer telemetry data to individual picture frames of film and video tapes. It was first used in the early 60s to document the world wide tracking network that had been set up for the Gemini and Apollo space programs. The code represents a consecutive series of time addresses representing a twenty-four hour clock to an accuracy of about three milliseconds. This real-time "clock" locked all the stations around the world to a common 24 hour clock of hours, minutes, seconds, and picture "frames", each address identifying a specific picture frame. In order to satisfy the needs of NASA the code had to be robust enough to be recorded and played back via the analogue audio track of the video tape. The code characteristically sounded like a huge swarm of locusts. This sound was used in the movie classic of the early 60s, "The War Of The Worlds" as the sound of the approaching alien ships.

During this same period of time video tape was being perfected. In the beginning video tape editing involved physically cutting the tape. Magnetic dust would be sprinkled on the tape to find the correct vertical scanning angle so that a razor blade could be run between two frames of the video image. This was difficult, tedious, and not particularly accurate. If the cut was made in the middle of a frame the picture would have a disturbance during playback. This would cause the picture to vertically roll until it could relock itself to a complete picture frame. By the early 60s, electronic editing systems were available that maintained frame sync by no longer cutting the tape, but by a transferring process of assembly from the original source material onto a master record machine (as it is done today). These early editing systems used the video "control track" to line up the edit points.11 This editing technique made possible accurate editing between individual picture frames, and the picture and sound could be separately edited. Unfortunately, the editors still had to match up the edit points by trial and error, which was very time consuming. In 1967 a synchronisation system, using a modified version of NASA code, was introduced...
by EECO/Convergence Corporation. The synchroniser could lock two or more video machines in an accurate and 100% predictable fashion using a track of time code recorded on the video tape on each machine. For the first time individual and specific frames could be located and specified for editing. The synchroniser "read" the code on the tapes and then controlled the tape handling and capstan speed of the slave deck(s) plus automatically initiated the record functions of the assembling video deck.

Several different competing systems soon appeared but none of them used the same time code language. In 1969, the Society of Motion Picture and Television Engineers convened a committee which standardised the code and gave it a name, SMPTE code (pronounced Semite). They established the frame rates for US television (NTSC) (30 frames/sec) and 35mm film (24 frames/sec), and shortly afterward the European Broadcast Union (EBU) adopted the same system but with a frame rate appropriate for SECAM and PAL (25 frames/sec).

Early time code applications in music production

Synchronisers were first used in audio record production starting in the early 70s when high budget, thematic albums seemed to require an increasing number of tape tracks. The synchroniser came to the rescue allowing two or more multi-tracks to operate as one thus providing any number of tracks to be available as long as the production could afford the machinery. The desire for more audio tracks justified the numerous problems associated with these first crude synchronisers.

When Roy Halee, in 1968, was producing Simon and Garfunkel's "Bridge Over Troubled Water", 16-track on 2" tape was a couple of years away and synchronisers didn't exist. In order to get enough tracks Halee used two 8-track recorders. Once the first 8-track was full, Halee made a rough mix of the tracks to a single track on the other 8-track tape. Then, while listening to the mono guide track on the second reel filled up the other seven tracks. When it was time to mix, two 8-track machines were positioned side by side and using a gerry-rigged tape path for the second machine, the playback speed of the tapes on both machines was controlled by the capstan of one of the machines. It worked, but the overworked capstan motor overheated a few times. There was always some slippage, so they never got through an entire mix before the two tapes drifted out of sync. Halee would mix a portion of the song until it was obvious that the tapes were out of sync, physically sync them up somewhere previous to where they had stopped, and continue the mix. More often than not, the two machines would respond differently and sync would never be achieved, and so they would try again. Then Halee would splice together all the mixdown fragments.

In 1970 Halee moved from New York to San Francisco to head the new CBS studios that were opening there. These studios had 16-track but in 1972, when he began production on Art Garfunkel's first solo album, Angel Clare, he was sure he would need more than 16-tracks. Having lived through the sync problems on "Bridge" he turned to the newly invented time code system. This first adoption of a video sync system for audio purposes was not particularly elegant, partly due to the synchroniser and partly due to the tape machine which was not designed for slave operation. It had no chase ability, so the machines had to be separately rewound and parked within a few seconds of their sync time code points. Then both would be put into play and the capstan of the slave varied by the synchroniser until the two tapes were "locked" to the time code on each of them. The system did work when it was working but it was prone to daily failure. Very quickly, in the course of the album's production which lasted over a year, a second synchroniser was purchased for back-up. The sessions were usually in the morning, and in case of a synchroniser failure, there was a standing plane reservation on an afternoon flight to L.A. so that the synchroniser could be repaired and returned late that night as a backup for the following morning session.

That same synchroniser opened the door for other artists to record portions of their albums at their home. In 1975 Steve Miller had at home a small demo studio with a 1" 8-track. To record his guitar, all he needed was a couple of microphones and a headphone mixer. He often worked out his parts at home without engineers hanging out waiting for something to happen, and would then re-record them in the studios. Often he preferred what he had recorded at home to what was redone in the studio. While recording the albums Fly Like An Eagle and Book Of Dreams he decided to use the synchroniser to eliminate redoing the parts in the studio. After the basic rhythm sessions were recorded at CBS, time code was recorded on both the 24-track and an 8-track. They were then sync'd up, and a rough stereo mix was made from the 24-track to two tracks of the 8-track. Steve took the 8-track tape home and recorded five tracks of guitar till he was satisfied. He would come back to the studio, the 8-track would be locked to the 24-track, and the guitar parts transferred to the 24-track. If he wanted to add more guitar, a new rough mix was made on a new section of 8-track and he would be on his way.
The human synchroniser

During the early days it was not unusual for a producer to discover that the time code had become corrupted during countless rewinds and plays of the tape and that the synchroniser could no longer read the time code. More than one project was completed by a human sync system. The music guide track on one of the tapes was fed into one side of a set of headphones and a mix of the music on the other tape into the other side of the headphone. Then both machines were cued up to the same point. When everyone was ready, both machines were simultaneously started and the hapless engineer who was attempting to keep them in sync would use the variable speed control on one of the machines and try to keep the two mixes from the two machines in the centre of their ears. Needless to say, such effort fell in the category of a high stress procedure. Today time code systems and synchronisers are common in even small home studios. Most multi-tracks (digital and analog) now offer them as a built in option and nearly all MIDI installations use time code to interlock a sequencer to a multi-track recorder. They are inexpensive, easy to use and reliable. Many home studios now use time code interlocks to video to produce music and sound effects for film and T.V.

Summary

To the layman, the modern production studio appears to resemble the flight deck of some type of spaceship. Electronics of every type surround a control panel that holds an overwhelming number of lights, meters, knobs, and sliders. Computer screens abound, providing access to complex sound manipulators. Coming from all of this is an infinite number of sonic possibilities as the producer strives to find that unique “sound” that the public will embrace. Audio production studios have evolved from a place where a “live” performance was documented, to a place where sound is sculpted and constructed from sonic components to create a unique product. Unlike other types of media that drop older technology in favour of the latest innovations, sound producers prize a significant number of vintage sound generator and processor devices for the qualities they have. Some of these qualities are so characteristic that modern digital multi-processors have presets that attempt to create the attributes of these vintage devices. The manufacturers of production equipment, have in a sense, made a commodity of sound processes. On the one hand the proliferation and variety of production oriented devices has made it possible for an unlimited combination of unique sounds to be created. On the other hand, since such products are now sold by the tens of thousands, with different manufacturers including similar preset features in competing devices, it is equally possible for totally disassociated productions to have similar sound. This possibility is accentuated by the common practice of producers to attempt to make their productions sound like currently popular releases. Still, the availability, affordability, and sophistication of the technology has allowed a proliferation of production with the possibility that the smallest local studio can sonically compete with internationally known facilities. The desire for new sounds has turned production equipment and the sounds they create into commodities, bought, sold, collected, and used by music producers.
remains the method for syncing and editing semi-professional and nearly all industrial and domestic video systems. Referring to the drawing of a section of recorded video tape, the point at which recording begins varies with format due to differences in head placement. Specific location of longitudinal tracks and the existence of a time code track varies with specific video format.

12 See Appendix 1 for time code and synchroniser description and diagram of operations.
SECTION IV
THE MEDIUMS
OF DELIVERY
Chapter eight

THE MUSICAL PRODUCT

The commodification of popular music eventuated with the development of a medium of delivery that was easily duplicated and affordable. As was earlier described, the pioneers of recording did not initially see the phonograph as a consumer product or primarily a playback device for pre-recorded entertainment. It was some time after the introduction of the phonograph that they began to record and release musical product, and only after they recognised that there was a market for the device among a growing number of small entrepreneurs who were making recordings and playing them for a fee in penny arcades and nickelodeons. The original big three, Edison, Columbia and HMV, were primarily interested in selling phonographs/gramophones and viewed record production as a means to that end. Later, others recognised the record as the primary product. The record was a perfect commodity since all releases were physically the same and identically replicated. At the same time, each title was artistically different, and as such, a new product to the consumer. Repeated new purchases did not require previous purchases to become depleted or worn out, or even that the consumer grow tired of them. The record industry quickly discovered that once consumers had acquired a desire for recorded music, they would continue to buy new releases of their favourite artists. Committed record collectors would have more records than they could ever play in a single sitting. Records were also relatively cheap to manufacture, and the players, at least in the beginning, were affordable, simple to use and easy to maintain.

This chapter begins with the commercial progress of this medium by identifying several milestones in record sales. Intermeshed with the financial health and growth of the record industry is the interaction during any given period between the major labels and the independent labels referred to as "indies". This interplay was a key factor in the commercialisation of ethnic and marginal music and is an important thread throughout the history of the record industry. It is the indies who promoted blues, country, and ultimately rock and roll.

The history of Edison's original medium of delivery, the phonograph cylinder, is then described followed by the development of the gramophone disc which was the medium of delivery for most of this century. Tape based products are also the subject of this chapter together with the most recent innovations in digital methods of delivery. The chapter explores some of the effects that changes in the medium have had on the record industry and music production, and includes descriptions of several delivery innovations which were commercial flops with suggested reasons why the public rejected them.

Early sales milestones

One means of evaluating the development of this technology through its early period of record production is by looking at the number of records and players that were sold. The numbers provide a quantifiable measure of the impact that records had on the distribution of popular music through the first half of this century (this information comes from a number of sources including various Billboard statistical publications, Stark, 1994, White, 1994, Pearsall, 1976, Vaughan, 1992, Read. & Walsh, 1976, Clark, 1990, etc.). In the beginning, the three manufacturers of records, Edison, Columbia, and Victor, sold their records and players exclusively through their own shops. As time passed, the Edison label faded and Columbia and Victor moved away from this approach and established ties with retail marketers. Very early in their history the record companies realised that they needed to do more to promote their records than merely making them available. They began running in-store record launches for the public. Essentially, these get-togethers were not unlike a modern equivalent except the public was invited, whereas today the media would be in attendance.
With few exceptions, the record industry (and radio) presented swing or jazz bands and artists from vaudeville, opera, or light classical stage. The first dance record to have phenomenal sales was Paul Whittman’s “Whispering” which sold 1.8 million copies. Today, having a million seller is pretty impressive, but in 1918 it was extraordinary. The profits from this record as well as several other Whittman orchestra recordings, established the resources that would allow Victor to become one of the world’s largest record companies. By 1921 the fledgling record industry was selling in excess of one hundred million records.

A depression hit the economy that same year and all aspects of the entertainment industry were affected (records in particular). There was also a feeling that radio, though in its infancy, was a real threat to record sales. For many of the smaller labels this meant their demise. However, one label concluded that its survival lay in carving out a niche market. The Okeh label unwittingly became the collector of the ingredients that would spawn rock and roll. Instead of attempting to compete with the major labels, Okeh concentrated on black music in the first instance and then hillbilly and folk music. Equipped with a portable record cutter, Ralph Peer went to Atlantic to record whatever he could find. One of the acts was Fieldlin’ John Carson who performed “The Old Hen Cracked and the Rooster’s Going To Crow” and “The Old Log Cabin In The Lane”. Peer was not impressed but nonetheless, the label decided to release the record which promptly sold half a million copies and established that there was a market for this music (Vaughan, 1992, p. 12-13).

In 1922, Isham Jones, a popular Chicago bandleader, recorded “Wabash Blues” for the Brunswick label, which sold 2 million copies. In 1924 Vernon Dalhart, an opera singer with a falling career, tried a hillbilly song called “The Prisoner Song”. It became Victor’s biggest selling record in the pre-electric era selling over 6 million copies. In 1925, “Let It Rain, Let It Pour” became the first hit hit song. The improved quality of electric recording introduced in 1925 significantly contributed to its success. It was almost exclusively distributed through nickelodeons, the forerunners of the jukebox. In 1927, Peer was in Bristol, Virginia and recorded two acts which became legends. The first recordings of Jimmie Rodgers and the Carter Family were made on the same day. Peer sold both acts to Victor and Rodgers quickly became the biggest artist in 1928, and remained so until his death (from tuberculosis) in 1933 in a recording studio. Rodger’s style brought the first influences of black blues into hillbilly music. The Carter family became the fountain head of a dynasty which continues to this day. Their music brought folk and hillbilly music together.

By the mid twenties, dance music on record had become a part of the popular culture. Gramophone, a British magazine which appeared in 1923, began to write about the record industry, review the latest releases, and chronicle those who made records. In the first issue was an article titled A Note On Some Dance Records by James Caskett, a pseudonym for Christopher Stone, who would become one of the first broadcasters to attain fame as a pop music disc jockey. His words in 1923 ring true today:

Every month new and more exciting dance records are produced which, as they weary us, we discard for newer and still more exciting ones... The gramophone is most convenient; no need to be careful of the life of the records, you can wear them out and get the latest. (McCarthy, 1971, p. 44).

By 1927 sales in the U.S. had reached 130 million records and upward of $75 million dollars in revenue. Through the great depression of the 30s, many record companies that had been successful before the crash simply disappeared. The worst year was 1932 when total sales throughout the U.S. were around 6 million copies or $5.5 million. Things were so bad that some companies would press quantities as low as 25 - 50 copies of certain records. However, the jukebox industry grew during the depression. As the depression was coming to an end, the survivors of the record industry began to see sales pick up and, from 1938 to 1942, revenues rose as sales ramped up to 140 million units in the U.S. The growth of the record industry continued through W.W II and was only limited by the availability of the raw materials that records were made from. There was a shortage of shellac. The majors had been releasing a few “coloured”, jazz, and hillbilly artists but they were seen as a fringe product. When the shellac shortage occurred, these ethnic acts were dropped and the majors only released their middle-of-the-road pop product. The musicians strike of 1942 also had an impact on record production during W.W. II.

While a few independent record labels such as Okeh were able to survive the depression and W.W II, by the early 40s a few majors controlled the record industry. Independent distribution remained virtually nonexistent. The independents found their only definable customer base in the quickly growing jukebox industry which had a need for regional and ethnic records. Retail outlets were almost exclusively controlled by the major labels, and radio, when it played records,
tended to play middle-of-the-road product that was produced by the majors. The independents struggled with the shellac shortage, but at least in the market they were pursuing, they had no competition from the majors. Some of them were exceedingly inventive in solving their raw materials problems. Capitol Records was a small independent started in 1942 by songwriters Buddy DeSylva and Johnny Mercer and record store owner Clyde Wallach. Capitol couldn't get its records pressed because of a lack of shellac. Mercer started buying old records at 6 cents a pound, grinding them down and reusing the material. The story goes that Mercer signed one band leader despite a lack of talent because his father owned a shellac warehouse (Cimino, 1992, p.57).

By the late 40s, the independents who had dominated the R&B and country market, began to seriously worry the major labels. The "indies" were starting to have an impact on the pop charts. With the incipient rise of the baby boomer, the majors realized it might not be so marginal any more (Gillen, 1994, p. 106). During and after the war there was a major relocation going on in the U.S. as country people who were looking for work were moving into the cities, and those living in cities in one region were moving to cities in other regions. The independent labels were finding a niche selling all sorts of music outside of what the major labels considered as pop. The independent movement was also helped by the appearance and growth of a network of independent distributors catering to the retail and jukebox trade. The establishment of BMI during this same period was also a source of support for independents since the fledgling collecting society was interested in developing new acts, publishers, and labels that were not already with ASCAP. Such was the case with most R&B, country, and independents product. From these labels and the artists they recorded, would come the rock and roll revolution.

The emergence of the independent label will be picked up later in this chapter, but first let us turn to several innovations in the delivery mediums that appeared in the late 40s, and had a significant impact on the success of the "indies", the rise of rock and roll, and the further commodification of popular music.

The ascendance of the "indies"

We now return to the growth of the music industry, and in particular, the importance of the independent record label. In 1948 both the 45 and the LP were introduced. There was also a major shift in production with the wide spread use of the tape recorder. The transistor radio, the baby boomer teenager, the proliferation of the juke box, the changes that were happening in radio due to the shift of major advertisers to TV, and the low production costs of the self-contained hillbilly, blues, R&B (Rhythm and Blues), and rock and roll acts were just a few of the ingredients that gave small labels opportunities to grow. The "indies" were quick to respond to these changes in society, music and taste and were able to do so right under the sleepy eyes of the majors who were slow to respond to the new pop music phenomena. The majors believed that rock and roll was a marginal passing fad, and without exception not one major label was headed by someone who recognised that this music was the future and would dominate the second half of the century.

The increasing number of independent record pressing plants insured a regular supply of product so that a small label could respond to a fast moving release. The cheap cost of pressing a thousand 45's caused an explosion in independent labels who could get a record on local radio and into independent shops for an investment of a few hundred dollars. Most of these labels were no more successful than the acts they recorded, but some became majors or eventually were bought by the majors for millions of dollars. 1953, was the year of the first rock and roll hit record, "Crazy Man Crazy" by Bill Haley & the Comets. As Morris (1994) writes,

In the ten year period following W.W. II, a group of fast moving indie labels keenly read the barometer of mass taste and issued music by groups and artists who would virtually define the currents of popular music through the first rock 'n roll era. (p. 132)

In 1953, record sales in America exceeded $200 million dollars (52% - 78rpm, 28% - 45rpm, 19% - LPs). Companies were bolstered by the volume and decided to drop the unit price of the LP from $6 to $4 (in the U.S.) with the result that within a six month period in 1955 LP sales had gone up by 40%. By 1958, it was estimated that 70% of record sales were to teenagers who were buying popular rock and roll music and a high portion was from independent labels who were responsible for 31 hits that year. In 1959, indies accounted for 59 of 89 "top 100" records. From then into the 70s, when most were gobbled up by majors, on an average, 37 chart hits were from smaller labels. It took some time for the majors to respond to this new situation, but in 1955, when RCA bought Elvis Presley's contract from Sam Phillips for $40,000, the statement was being clearly made that rock and roll, rhythm and blues, and country would no longer be marginal to the majors. Nor would the indies be considered fringe dwellers, rather, they would.
become a source of new trends and mass market artists. Major labels became active in acquiring and assimilating the successful independents.

It is no coincidence that the golden age of rock and roll coincided with the golden age of the independent label. However, the momentum of the independents was slowed by certain business practices that some of them were engaged in. Morris (994) comments:

To a certain extent, scrutiny of alleged payola activities helped to stifle some of the feistier indies, and, by the early 60s, with tamper pop acts prevailing again on the charts, the pendulum was preparing to swing toward England's so-called 'British Invasion' acts. (p. 136)

One of the U.S. indies even saw this coming. Chicago based R & B label Vee Jay Records licensed and released in 1963 an unknown act's first album "Introducing The Beatles". Capitol, who was by then primarily owned by EMI, refused to release the first Beatles' album and only after extraordinary pressure by EMI did it start to release Beatles' records. The sixties was a dry period for the independents with the notable exceptions of Herb Alpert's label, A&M that launched the string of Tijuana Brass/Brazil '66 hits and the most successful indie of them all - Motown.

By the mid fifties, album sales had also passed single sales. A Billboard article in early 1960 quoted several label bosses who felt the situation was caused by the increasing number of low cost tape recorders on the market (Gillen, 1994, p. 108). Taking the attitude that "if you can't beat them join them", with the introduction of the 8-track cassette in the mid 60s, RCA began to sell pre-recorded tapes. When the Phillips cassette came on the market a few years later, pre-recorded tapes became even more popular and by 1983 LPs represented 61% and cassettes 34% of the album market. Another factor in the explosion in album sales was the introduction of stereo records in 1958.

Through the early seventies, corporate rock (Journey, Aerosmith, Blood Sweat and Tears, Chicago, and many more) and disco was king. Music production was increasingly technology based and essentially cheap to produce. Many independents successfully entered a booming record market. Labels were so confident of sales that they would press enough records to earn a gold or platinum record which at the time were awarded based on records shipped, not on those sold. This practice also helped a record move up the charts since records shipped was a component in determining chart placement. The record stores didn't mind since the labels had a policy that allowed record stores to return for credit all records that were not sold. Basically the store only had to pay for the records it sold. In the late 70s, the disco trend slowed without creating any sustaining artists. No new trends filled the vacuum and the world wide economy slowed down. Prior to 1979, the industry had enjoyed a twenty year period of uninterrupted growth. In that period annual sales had climbed from $1 billion to $4 billion. Then, between 1979 and 1982, sales dropped by over 20%. Some labels did not adjust to this and rapidly found themselves in financial trouble due to practices that in any other business would have been considered mismanagement but which had been accepted in the record industry due to the extraordinary cash flow and apparent profits that had been occurring.

One example can serve as typical of the bad management of the period. The RSO label had been enormously successful in the early to mid 70s with two soundtrack albums, "Saturday Night Fever" and "Grease", both of which had several hit singles. The label decided to invest in a movie adaption of "Sgt. Pepper's Lonely Hearts Club Band". The movie and the album featured a number of high profile performers including Peter Frampton and the Bee Gees. The album was also produced by George Martin, the producer of the Beatles. The movie and the album came out in 1978. The label was so confident of the film and record's success that a million albums were shipped to coincide with the movie's release. Not only was the movie a flop but the album was as well. The label got back more records than it pressed since it seemed the counterfeiters had also misjudged the market. The counterfeit product was of such a high quality that the label could not distinguish the original from the copy and had to honour all the "returns". This story is excessive but typical and accurately describes the bravado of the record industry of the mid 70s.

Several practices changed after the late seventies. The labels tightened their "returns" policy and stopped shipping excessive numbers in order to get "Gold" record certification or to drive the record up the charts.

The R.I.A.A. (the certifiers of Gold/Platinum records) and those who made the charts (Billboard, Cashbox, Radio and Records, etc) began to place less emphasis on shipping figures for establishing charts and turned to sales figures from key record retailers. Providing the stores were submitting accurate information, this method of ranking was more accurate. But the precursor to sales was generally radio play. Over the years, and periodically recurring, members of
the radio industry have faced payola charges - in other words being paid for playing a record (more on this in the chapter nine). The chart makers have had to assume the watchdog role of trying to keep the radio reports accurate. It has not been easy for them since there are an endless number of ways that a music director can be corrupted. Still, just because a record gets airplay doesn't mean the public will buy it. There are countless examples of records that were "turntable" hits.

By the mid 70s another completely different genre of music was appearing from the indies. Rap may have evolved from Jamaican reggae but it was dramatically urbanised in New York clubs. It was also considerably more technological and less organic in its production. The indies were the first to release punk and modern rock. These styles were briefly supported by the majors but not sustained as they were by many indie labels. By the beginning of the 80s, the trend was for certain albums to sell huge numbers with the result that one album might carry an entire label's product. An example was Michael Jackson's (1982) Thriller album which would eventually sell 40 million copies. However, by and large the brakes were still on the train. Runaway budgets and profits would never return to the heady days of the late 60s to mid 70s. In 1983 Walter Yetnikoff, President of CBS Records, said about the CD, "It could be one of the things to save this industry" (Gillen, 1994, p. 108).

Through the 80s, greed ruled and record companies were bought and sold on a grand scale. Any independent of consequence was quickly gobbled up by one of the majors. The labels had started out being run by new invention entrepreneurs, then music people, then by promotion people, then by lawyers, then by accountants, and eventually faceless multinationals. But the business was now big business. In March 1993, Billboard ran a headline, "CD Sales Push Music Sales Beyond $10 Billion Mark In RIAA 1993 Figures". That broke down to nearly 500 million CDs in the U.S. and 1.4 billion CDs worldwide. Since the technology of tape had been cited as a reason for declining sales, it was only appropriate that technology should come to the industry's rescue.

The cylinder succumbs to the flat disk

The medium now used for the distribution of popular music has evolved considerably since Edison introduced his cylinder in 1877. Edison's phonograph patent described the process as "the mechanical storage and reproduction of sound." And so it was. The description provided no indication of the cultural impact the record would have or how it would change the creation and delivery of popular music. Edison was a cold business man who invented devices for a profit. Still, he must have had an awareness of a recording's ability to capture the essence of the human soul that seemed to materialise during playback. In many Edison Recorded Music Catalogues of the 1920s was the slogan "The Phonograph With A Soul" (Schwartzman, 1993, p. 64).

Unfortunately the Edison phonograph had three failings. First, the "hill and dale" grooves limited the loudness of the recording. It must be remembered that this was before the invention of the amplifier. If the signal was too loud, the stylus would first embed itself in the cylinder and then come up off the surface. Secondly, it wasn't all that easy to mass produce the grooved cylinders. For many years, to achieve acceptable quality, each one had to be made as an original recording and could not be duplicated from a master. The quality was also so unpredictable that every one of the cylinders had to be played and checked before going to market. Lastly, the $2 price tag was out of the reach of the average person.

The gramophone and the flat record invented by Emile Berliner solved the problems associated with the phonograph. In 1887 he obtained a patent for his system and cut his first recording on zinc coated platters. By a process that had recently been perfected called electroplating, the "positive" masters could be nickel plated. A "negative" of the grooves was left behind on the hard nickel surface when this plating was separated from the master. These negative plates became the stampers that were installed in a press. The records were pressed much like waffles, and not very different from how records were made until their death at the introduction of the CD. A blob of malleable slate dust and shellac were placed between the stamper surfaces and the two plates of the stamper were pressed together.

Recording had no set speed until the early 1890s when Berliner established a standard play speed of 78.26 RPM. Berliner also improved the groove design by switching from "hill and dale" recording to a lateral (sideways) movement which enabled the record to have more output. As soon as the gramophone and flat disks were introduced they began to erode and overtake the phonograph and cylinder recordings. In general the public continued to call the new gramophone a phonograph. Edison began manufacturing flat disks in about 1913, but continued to make cylinder recordings until 1929. The Edison disks however, differed from the Berliner disks because they continued to use "hill and dale" groove modulation. During this period many players were available with two different sound boxes so that both groove types could be played.
Another source of variation between record manufacturers was the amount of pre-emphasis equalisation during cutting and complementary de-emphasis that was required during playback. For the first several decades of record production, all the labels used similar but slightly different equalisation. This caused considerable confusion for the consumer because some records sounded better than others. Record EQ wasn't standardised until the 50s when the Recording Industry Association of America convened a conference and a pre/post emphasis standard was agreed on for 78 RPMs (called the RIAA curve). Different standard curves were also defined for the 45RPM, 33-1/3RPM, and 16-2/3RPM records. Without question the application of this EQ contributed to the “sound” of records.

The record continued to evolve. By 1912, double sided records were common. The first long play records were made in 1926 by the Edison company in an effort to halt declining sales. They were able to get 24 minutes on a record by retaining the 80 RPM speed typical of Edison recordings but using a much finer groove pitch. Reducing the disk rotation speed was not an option until a better material was developed for record pressings. These recordings had 400 grooves per inch which made them the finest grooved records ever commercially available. A player needed a special adapter and stylus in order to play them. The fragility of the grooves and the low output due to the fineness made them totally impractical. The next to tackle the limited play time of the standard 78 was RCA Victor who issued several long play records starting in 1932. Like the Edison recordings, the lack of players that could play the RCA releases caused their quick demise.

By the early 30s, Muzak was already a major producer of programming and was particularly interested in finding ways of making higher quality records that lasted longer. Since its business was not selling records but playing them, extending a record’s life before replacement had a significant economic benefit. Muzak was also interested in making better sounding recordings since an important marketing advantage for it was the quality of its programming. It began to issue its recordings at 33 1/3 RPM with a vertical excursion groove rather than the horizontal ones used by the record industry. Since it only made records for its own needs, there was no problem of compatibility or delivery. The advantage was a substantial increase in the play time for each disk and its records could not be played without a special reproduction cartridge.

Shellac/slate records were both fragile materials that easily shattered and had a surface that was noisy to the playback stylus, particularly at slower play speeds. Muzak may have been the first to press vinyl records but by the early 40s nearly all labels had moved to the petroleum based plastic which was both quieter and considerably less prone to break. Initially, record labels primarily used polystyrene instead of the more expensive vinyl. The polystyrene was also softer so it required less heat in the pressing process, but it did wear out more quickly compared to vinyl. It was common practice for the records that were sent to radio stations to be made of vinyl, while polystyrene was used for consumer product. In later years, only consumer 45s continued to be pressed on polystyrene.

The introduction of 45s and LPs

The switch to vinyl made it possible for Columbia Records in 1948 to introduce the 12” long play unbreakable record. The new record had much finer grooves and rotated at the slower speed of 33-1/3 RPMs which allowed up to 22 minutes of sound on a side. Longer records could be made but the overall loudness was reduced. For classical recordings this was less a problem since their overall loudness compared to other records was less important. In the same year RCA introduced the perfect medium for pop music, the 45, which could comfortably hold 3-4 minutes of music. The 7” 45 had a 1” hole in the middle which was designed for the rigours of jukeboxes. RCA initially rejected Columbia’s format and of course Columbia saw no place for the 45. As time would attest, there was a market for both, and both companies would soon be selling both formats for specific purposes. The concept of the album and single emerged. As Attall (1977) observed, “The 78RPM record disappeared and 45s took over, thanks to the jukebox. An enormous, unified, standardised market was developed, centred on high school styles” (p. 104-105). There was an attempt in 1961 to move to a single speed when several labels released 7” 33 1/3 discs called “little LPs” or “compact sixes” (three songs on a side), but they failed in the market place.

Since neither 45s nor 33-1/3 were compatible either groove wise or by rotation speed with 78s, the labels had considerable concern that their new formats would sputter and die unless the new records were aggressively marketed and low cost players were immediately available. At the beginning of the record industry, labels had shops that only carried their product. Over ensuing decades, record companies remained involved in some aspects of the retail trade but primarily moved to wholesaling of their product to independent and chain stores. When the LP and 45 appeared, and their sales potential was fully realised, record labels decided to return to direct
marketing of their catalogues, this time through mail order record clubs. In 1955 the first record club was established by Columbia and very quickly, RCA followed suit. Consortiums of labels were established for the purposes of direct marketing records. Every popular magazine had ads that offered five free albums for the commitment to buy five albums at retail over the following year. To ensure that the hardware would be available for these new formats, Columbia and Philco sold a $30 turntable, tone arm, and cartridge for existing machines. There were also big discounts on the new 45 and LP players. RCA-Victor brought out a 45 player for $12.95 for the teen market, and taking a page out of their past, had a long running campaign that gave the player away with each enrolment in the RCA-Victor 45 record club. The gamble paid off because by 1951 30% of record sales were LPs. In 1953, Columbia Records began to market a portable three-speed phonograph which sold for $30. By 1953 it was estimated that there were 24 million turntables in America capable of playing the new formats. The development of phonograph cartridges and stylus design had also progressed. The heavier and less precise crystal cartridges were replaced on higher quality systems with magnetic cartridges that had less distortion and did not require as much pressure in the grooves. This improved the frequency performance and reduced the wear on the record. The desire for "hi-fi" was driven to a certain degree by the fact that records sounded better on the radio than they did on most home systems due to higher grade equipment at the stations. The consumer had an appetite for better sounding reproduction systems. The following year, Motorola started selling the first hi-fi record players and Philco introduced the first record player without a built-in radio.

Mono to stereo

Stereo was a sonic advance that had captivated the public for some years. Stereo was perceived as a means to achieve realism in a recording. It made sense that two channels were needed to deliver different sounds to the two ears, but it was difficult to find two experts to agree on what realism was achieved in stereo production. In pop music it evolved into the illusion of a sonic panorama with most of the sounds being monophonically miked and then positioned between the two speakers by "panning" into a stereo field. Some early experimental stereo records were produced by British EMI in 1933 using dual grooves and specially designed two headed tone arms that would play both grooves at once. These records were impressive but commercially and technically impractical. Hi-fi enthusiasts who purchased the first stereo tape recorders were the first consumers to experience stereo when several labels began to sell pre-recorded stereo tapes. Tape duplication made stereo distribution possible in the early 50s when Ampex invented a high speed duplicator (16 X normal speed) that could make 10 copies at a time. It cost $20,000, $5,000 less than a record press. RCA and Capitol purchased them immediately.

With pre-recorded hi-fi tape entering the market in 1954, there was a feeling that it might supersede records. Tape had better fidelity and could be released in stereo. This may have happened had not the first practical stereo disk cutting system been introduced in 1958 by Westrex, a leader in film sound equipment. The Westrex system made realistic stereo reproduction on records possible. The 45/45 system cut the two channels of stereo information on the two sides of the groove. The primary groove movement was rotated by 45 degrees and both lateral and horizontal groove excursion were used to create the two stereo channels. Two important points about the Westrex mastered records - they could be manufactured identically to the way the mono records had been, and they were monophonically compatible.

The record labels went about re-releasing the best selling monophonic records in "reprocessed" stereo. These generally sounded worse in stereo than the mono records did in mono due to the methods used. One practice was to take the mono recording and divide the frequency range across the two speakers which gave poor results. A more common approach was to take a mono recording and add stereo reverber, a certain amount of delay and phase shift. The most bizarre stereo appeared when the first few Beatles albums were released in stereo. The master recordings were made for mono which was how they were released in the U.K., but in America the 4-track master tapes were remixed for stereo with the drums and bass in one channel, the guitars and/or background vocals in the other channel, and most of the time the lead vocal in the centre. They sounded terrible (it is unfortunate that these stereo masters were used for some of the CD reissues).

In 1958 the first stereo/mono cartridge and stylus was sold to the consumer, the same year that Audi Fidelity, Pye, and Decca first released stereo records using the Westrex process. All the other labels quickly followed and the term Hi-Fi almost immediately disappeared to be replaced by "stereo". By 1959, 20% of the LPs sold were stereo. Once again the public saw stereo as important enough to buy more equipment.
Improvements in the mastering process

It was obvious that the material that was used for the record mastering was a critical factor in getting high quality reproduction. The material needed to be soft enough to take all of the subtleties of the groove modulation, in particular high frequencies and percussive transients, and at the same time it needed to be hard enough to hold the impression. The master disks which Berliner first used were zinc coated. This cutting surface soon gave way to a softer aluminium surface. This disk was then electroplated and the plated surface was separated from the original to become a "stamper" (a negative of the record). It was the electroplating process that required the cutting surface to be some form of conductive (metal) material.

A substantial improvement in both the mastering and pressing of records was developed by Muzak in the early 30s. It started mastering on wax coated glass disks which were much softer and as such, more responsive to the cutting stylus. The stylus was also heated so that the groove was not only dug out but would melt and smooth the groove walls as the cutting was occurring. To make the non-conductive wax surface acceptable for electroplating, Muzak developed a means of spattering or spraying an extremely fine gold surface onto the wax disk which then made it suitable for electroplating. The gold dust became bonded to the nickel plating. All other record companies adopted this method for converting master disks to manufacturing stampers. Over the years the gold spattering was replaced with silver.

The use of a wax surface created a term which came to mean a good record. The mastering engineer who applied the wax onto the glass plate would have to make sure the surface was not only smooth but that there were no bubbles below the surface which would be heard as clicks if a groove cut into one. The engineer would apply the wax with a hot knife to melt out all of the air and to smooth the surface. The expression that a "Hot Wax" was a good recording was commonly used in the 50s and 60s and came from this practice.

The master disk material was further improved in the early 30s when a French company, Pyral, started using aluminum disks coated with a nitrocellulose cutting surface (a form of acetate). By the late 30s these blank disks were also made in America by a few other companies. During W.W.II the shortage of aluminum caused the industry to return to glass platters, but after the war they went back to aluminum blanks. Such disks were used until the demise of the record caused by the CD.

Pressing runs

The quality of the pressings decline if an excessive number of records are made from a single set of stampers. Most pressing companies would retire a stamper set after four to five thousand pressings. Obviously if a record was a big seller, hundreds of stampers would be needed. As the electroplating process was perfected, and the need to make multiple stampers from the same master eventuated, this first negative was saved as a "metal master". It too was electroplated to create six to eight "metal mothers" from which several "stamper" would be made. Since so many stampers were needed for a hit record, quality control at the factory became the only way a label could ensure that all the various batches of pressings were consistent. Quality control was made more complicated by the common practice of pressing popular releases at a number of plants and having the plating done at several different locations. Many factors affected pressing quality. The master recordings could never be played before plating since even one playing would distort the soft grooves, so the first records from a set of stampers called "test pressings", were used to verify the quality of the mastering and pressing process. Most producers would request test pressings before the initial pressing run to make a definitive test of how the "real" record sounded on a record player. On occasion, test pressings were not approved and the process would be retraced in some cases all the way back to requiring re-mastering.

On occasion, an act would insist on hearing test pressings from every stamper set. Such was the case when The Grateful Dead started their own label. They had no idea how many or how quickly stampers and test pressing were generated when a record was selling well. They quickly found themselves inundated with dozens of test pressings. In the mean time the pressing plant was on hold waiting for their approval. The Grateful Dead found that even if they could listen to every test pressing, the time it took to get the test pressing and return the approval was causing disruptions in the supply of records to stores resulting in lost sales. They gave up when they realised that when their record was selling they couldn't afford to run out in the stores when customers were asking for them.

Pre-recorded tape & reusable media

Mass marketed consumer tape products first appeared to answer the need for a delivery system suitable for automobiles. Previously, there were attempts in the 50s and 60s to sell 45RPM record players that would operate in automobiles, but with little success. The mechanisms for playing records could never sustain road vibration making records nearly impossible to
play in automobiles. In 1958 RCA introduced a transportable housing using tape as the medium. RCA’s creation, the 8-track cartridge, provided hassle free tape threading that was ideal for portable systems, in particular in the automobile. Record companies also liked the fact that they were difficult to duplicate and nearly none of the players had record facilities. For some 20 years it was a reasonably successful product. The “endless loop” design of the 8 track cartridge made it ideal for an alternate application in the broadcast industry where it was used for instantaneous commercial and music playback in what the industry called “cart” machines. In a cart machine the cartridge would automatically recue to the beginning of the “spot”. These machines are now only being replaced by digital equivalents.

Consumer tape recorders were first introduced in 1946, but at $225 they were too expensive and most felt too complicated. The only people to buy them were the growing number of hi-fi, then stereo, enthusiasts. While tape had many advantages in its natural reel-to-reel state, it was not particularly user friendly. Tape recording and playback systems became a genuine consumer product in 1963 when Philips introduced its Compact Cassette. In order to ensure the standardisation of its format, Philips freely gave over all rights to the manufacturing of the design to anyone who wanted to follow its specification. Philips and Sony took a similar tack in the early 80s when they introduced the compact disk (CD). The rapid acceptance of the Philips Cassette raised speculation that this medium would cause the demise of the phonograph and records as well as reel to reel tape. Most importantly, the cassette could be played in the car where the baby boomer teenager lived, or taken anywhere else to be played (beach, park, mountains, etc.) As Music Maker magazine reported,

The teenager, the major market for recorded music, no longer has to thread a tape through a bulky and costly piece of equipment... instead, he can snap a blank cassette into a tiny portable recorder... and copy two hours of music. (Music maker,, 1968, Feb. 24, pp. 108-109)

The cassette gave consumers the power to program the tape with only those tunes they wanted. They were no longer captive to what the radio would play or what was on a particular album. Tapes could also be duplicated from tapes, off records, or from the radio. Issues of copyright infringement were starting to enter into the picture. But records kept on selling despite the music industry’s concern about this “unauthorised” duplication by the consumer which generated no additional revenue for the artist, publisher or label. The fact was that even under the best of conditions, high speed duplication of cassettes ensured that their sound quality was inferior to records. Secondly, records remained cheaper to mass produce compared to cassettes which also helped keep them booming. Eisenberg and Angus (1969) “doubted records will be displaced, except possibly by some fantastic technological breakthrough which -If it occurs- will make all present forms of recorded material obsolete” (p. 53). In the late 80s, CDs did just that for most consumers. However, the Philips Cassette did cause the reel-to-reel to be relegated to the production studio.

The introduction of digital delivery formats- CDs
The Compact Disc was first introduced by Phillips and Sony at the 1977 Tokyo Audio Fair. It took nearly ten years for the market place to catch on to this technology. Once it did however, the change from analog to digital was rapid. An important key to its success was the rapid proliferation of players including the development of low cost and portable models such as the Sony “Discman”. An essential requirement for the CD’s success was the recognition by the consumer of the substantial technical advantages that came with the CD such as no surface wear and no degradation to the sound regardless of how many times it was played. The public accepted that the benefit justified the higher cost of the CD and new reproduction equipment. The record companies also liked CDs because the cost of raw materials per disk was less than records. Over the years petroleum based record vinyl had become a substantial cost in record manufacturing. And best of all for the record companies, CDs couldn’t be easily duplicated.

In many respects one of the most important artifacts of this new technology has been the wide spread re-issue of entire catalogues. Every imaginable recording of any significance has been recovered, in some cases reconstructed and restored, then re-released on CD. Countless collections of one type or another have been released and most are issued as a series of some sort. The Blues Series, The Jazz Collection, The Atlantic Years, Heavy metal Hits, Motown Soul, Pop Hits Of Merseyside, The Summer Of 62, The English Beat, Wacky Rock And Roll Of The 60s, Greatest Gramophone Hits, and so on. For most major artists, all of their albums are now available on CD. The 90s have been the decade of the reissue and for the first time, all of recorded sound history has been available at once. New music sales in the 90s are down, but existing catalogues are finding new life. To the surprise of many labels, some of the greatest hits albums have become top sellers.
The 25 to 45 year old audience that the record companies had just about written off as lost forever suddenly was returning to the record stores in droves. The baby boomers, whose music appetites had built the record business ... were back, and with more money than ever before. They were lining up to buy jazz and classical CDs along with Sting and Dire Straits, spending $100 at a clip and paying with their American Express card. (Knoedelseder, 1993).

For the record companies this hasn't been so bad since reissues have low production costs, and copyright and mechanical royalties are generally lower. There is also little risk in CD re-releases since there is such a large pool of people restocking their collections.

Since its introduction in 1977 the CD has continued to undergo development beyond its use as a music delivery system. The standard CD does have the capacity for the storage of fixed images along with the music. These images can be viewed on a TV. In 1987, Philips, working with Sony, introduced the CDV. This CD format can deliver high quality video as well as stereo music. The CDV in the standard 5" size can play 6 minutes of picture and sound, as well as 20 minutes of stereo sound. The format was perfect for dance club single mixes. The format also specified two other CD sizes, an 8", which has the capacity for a 40 minute video, and a 12" version which has a maximum length of 2 hours of sound and moving picture. It was expected that the largest format might eventually replace the laser disks which have been available for some years. Of course the CD and the CDV can be programmed to operate as a CD-I (Interactive), giving the consumer various levels of control. As the hardware improves, new CD formats continue to be developed. In some cases the new formats supersede earlier formats before they are ever widely implemented. The latest CD formats have such high capacity that the 5" disks store hours of stereo or surround sound music, or full length movies in wide screen digital TV. Musically, the ultimate in control was introduced by JVC in 1989. The CD-MIDI (CD-M) disk has MIDI information for the control of sound generators that come with the player or can be used to control standard MIDI sound modules (drum machines, or other MIDI devices). There is also graphics information related to different instrument functions, tempo, tone, dynamics, etc. The CD-M usually contains several preprogrammed compositions which are played in real time using sound generators. Users have control over what they hear and can add or delete tracks, adjust tempo, change tone, and alter many other functions. The CD-M places in the hands of the consumer the ability to participate in a sense as though co-producers with their favourite act, in the creation of the music they hear. New generations of players will have the ability to play these multiple formats as new standards are established.

Digital tape

When domestic tape recorders and pre-recorded tape was first marketed, record companies embraced this new medium as just another means of delivery for their products. They later realised that the recorder, unlike a record player, could be used for unauthorised recording and duplication of tapes & records, live concert, or off the air programs. Issues of copyright remained contentious with each new recording technology bringing with it ever increasing aggressiveness from those who held copyrights toward those who manufactured recordable blank media. In 1987 the DAT (Digital Audio Tape) recorder was introduced to the market. Its inventor, Sony, optimistically expected it would replace the Philips Cassette. The record labels believed that this format would usher in the age of consumer created perfect duplicates. Making DAT copies of CDs would finally be an unambiguous breach of copyright since the copy would be equal in quality to the original. On this point law suits were filed, and citing copyright statutes, the record industry flexed its considerable legal muscle and blocked the wide introduction of the DAT on grounds that it would have a catastrophic effect on copyright ownership.

After years of debate, the music industry has come to the realisation that it is impossible to prevent the consumer from recording copyrighted material, so in the late 80s and 90s it marshalled its force behind the notion that blank recordable media should be taxed to pay copyright and publishing royalties that will be infringed when the tape is (inevitably) used by the consumer to record copyrighted programs. Some nations have adopted this view while others have not. Most are still reviewing it.

The DAT has become popular with the professional music producer as a viable medium for digital mastering, but the legal wrangling prevented major investment in the development of low cost DAT recorders and players. The continued high cost of the machines and blank cassettes, their incompatibility with the analog Philips Compact Cassette, and the inability to manufacture pre-recorded programs through some high speed process has prevented this format from becoming a popular consumer product. The DAT is also widely used for purely digital back-up and storage applications, though even this use will most probably be abandoned as other more robust formats become available.
Three products appear poised to pursue the consumer oriented digital recording market. The first is the Philips Digital Compact Cassette which was introduced to the consumer in late 1991. The mistakes made in the marketing of the DAT seem to have been addressed with the DCC. The DCC machines can play analog cassettes and are cheaper, as are the blank tapes. And unlike the DAT, the DCC can be mass duplicated at high speed, an essential requirement for record companies to be able to sell pre-recorded product.

Other digital products from the computer world are also appearing — the mini disk and the "flash card". Sony and others have introduced audio recorders that use a small high capacity computer floppy disk for storage. The other product is essentially a large capacity, low cost, Random Access Memory (RAM) that is embedded into a card that plugs into a small player. The low power which it requires and its speed of access have earned it the name "flash card". It is not only being touted for music applications but for everything from extremely smart credit cards to video and multimedia delivery mediums. The capacity of the flash card is expected to be high enough to accommodate six to eight hours of high quality stereo sound. The flash card will be slightly thicker than the current credit card but about the same size. These cards will require special programmable recorders and it is unlikely that they will be offered as a consumer recording product. However, they may someday replace the CD for reasons particularly attractive to record labels. Labels imagine that at sometime in the future, when consumers go into a music store, they won't select a pre-recorded recording, but will choose what music they want, purchase a flash card (or reuse one they already have that has music they no longer want), and download the music onto the card from a central storage. They may not even need to leave home but will access the material directly through their fibre-optic Internet connection with the world.

The record companies will be able to eliminate their two greatest overheads, the manufacture of pre-sale stock and stock which does not sell and must be discounted and eventually destroyed. They won't have to manufacture anything before they sell it, with the exception, of course, of promotional copies which could also be down loaded into recycled promo flash cards. They will also be able to directly bill the consumer's credit card account. Flash cards could also benefit consumers, since it would raise the possibility for a wider availability of product, and they could select a mixed playlist of artists and songs. Older music, marginal music, music that would have previously been out of stock or no longer available due to the high cost of mass manufacture could be on-line and available for single copy down loading. Only time will tell if the consumer will accept these latest innovations of delivery. Considering the public has seldom rejected a new medium, it is likely these products will be successful providing the industry is united in its embrace of these new systems and some other innovation doesn't supersede them before they gain acceptance.

Consumer product flops

As has been the case throughout the evolution of the record industry the technology of production and manufacture of music product has by necessity been quickly followed with the required reproduction equipment for the consumer to purchase. In a significant number of cases, the public has embraced these advances: cylinders to flat records, acoustic to electrically recorded records, the move from 78's to 45s and 1P's, the introduction of Hi-Fi and stereo, the Phillips audio cassette and of course the transition from records to CDs. On the other hand, there have been some costly misjudgements on the part of record companies and hardware manufacturers.

In the past Sony has been both a visionary and a big loser with new products. While the DAT has been neither a dismal failure nor an overwhelming success, in the early 70s, Sony introduced an extraordinary failure, the El-Cassette. The format used a 1/4" tape cassette that, in nearly every other respect resembled the enormously popular Phillips Compact Cassette. It's sound quality was dramatically better than the Phillips cassette but the inconveniently large size of the cassettes due to the larger tape size and the cost of the machine made it a product that consumers decided they didn't need. It was also hampered by Sony's desire to restrict other manufacturers from making the machine. Rather than having to deal with Sony's demands, the rest of the hardware industry flooded the world with the compact cassette which Philips freely licensed. The industry invested enormous resources to perfect the capability of the Compact Cassette's 1/8" tape format, and Sony eventually destroyed all the tooling for the El-Cassette in order to take the tax loss. The success of the Sony Corporation attests to the fact that it seldom blunders, but the two examples outlined illustrate that the smartest companies have occasionally introduced products that even the electronics-crazy consumer will not buy. Sony's biggest musical product success must be the introduction of the Walkman and Diskman series.
The biggest failure for the record companies was the introduction of quadraphonic sound in the early 70s and its subsequent demise. Both RCA and CBS attempted to market a quadraphonic record, each using a process that was incompatible with the other, and instead of consolidating into a single process they each released product for their system. Because of the size of these two giants, there was no clear indication as to which company would prevail, so other record companies and the record hi-fi retailers waited on the sidelines. Several other factors also confused the consumer. The RCA version was designed to be compatible with existing stereo records and to play on existing phonographs, but most releases had trouble doing so, and the CBS records never sounded right when played on standard stereo players. The consequence of this was that record stores were asked to stock stereo and quad version of the same record. The problem was compounded by the inability of the record and hi-fi/stereo to adequately demonstrate to the consumer the improved sound experience that quad could provide. Finally, at that time, most consumers had recently acquired their stereo and had just come to terms with where to place the two speakers. Two additional speakers and all the associated decoders and amplifiers was simply out of the question considering all the confusion about the two formats. In the 90s, quadrophonic surround sound has come back. This time it comes with the video image and broadcast television. Once again a number of different encoding systems are being used, but the low cost IC decoders that are now built into the domestic reproduction systems provide a selection to meet most common formats. In the two and a half decades since quad was first marketed and failed, consumers have developed an appetite for the quad experience and now appear ready to install not only the four, five, or six speakers required, but to include a widescreen TV as a central part of their home entertainment theatre. For those not ready for full surround sound a "beyond speaker experience" is also being delivered through clever digital encoding of the sound. The ears are tricked into believing that sounds are originating from behind without the need for rear speakers. In 1974 consumers were ready to embrace the notion of surround sound, but in 1974 they were befuddled by it.

Software and hardware

In the beginning of recorded music, Edison, Columbia, and Victor produced records in order to generate a consumer appetite for the players. When the record industry was opened up in the 20s after the original patents ran out, many of the labels were only involved in music production, but those few that continued to manufacture players started, in the 40s, to move away from hardware as their prime business by selling off those divisions. The exceptions were RCA and Philips who remained major manufacturers and distributors of consumer electronics. This has worked to their advantage when they have introduced new formats by strategically tying together the introduction of hardware with the appropriate software product. When RCA introduced the 45, it priced its players to just cover costs. Similarly, Philips was one of the first manufacturers of low cost cassette recorders and along with Sony, CD players when those two mediums were introduced. It is not surprising that Sony in the late 80s would see the only way to ensure a ready supply of product suitable for any new hardware or format it may introduce was to buy one of the largest holders of music product in the world, CBS Records. Following Sony's lead and for the same reason, another major Japanese manufacturer, Matsushita, acquired MCA in 1990.

The medium's effect on the message

The electronic parameters and physical limitations of the various recorded media which has been sold to the public has played a significant part in what would otherwise be creative decisions in the production process. In 1901 Edison gave Lionel Mapleson a special model of phonograph that had a particularly large horn that was well suited for picking up quiet sounds from some distance. He was the librarian for the New York Metropolitan Opera house for almost 50 years. Mapleson probably recorded the first live music performances between 1901 to 1903. Even though the machine was large and required hand cranking, Mapleson would often take the machine into the scaffolding above the stage. He used it as sort of a home recording system to capture the performances of many of the opera stars of the period. He stopped doing this as an increasing number of commercial recordings became available. His collection of cylinders is now at the Lincoln Centre Library of Performing Arts in New York.

With the exception of Mapleson's efforts, in the beginning of record production the bandwidth and sensitivity of the recording process restricted the type of music that could be recorded. Novelty records and vocals were the only sounds that were technically feasible to record, and then a few (loud) operas were recorded. It was not until 1914 that the first symphony was commercially recorded, Beethoven's Fifth which was sufficiently and consistently loud. By 1923 the frequency response of an acoustic recording had a range from 160-2000 cycles. The orchestra recordings that were remade could now use all the instruments called for in a symphonic score and all the notes would be heard, but the tone and timbre left a lot to the imagination. Popular songs, on the other hand, seemed to provide adequate performance with this response due largely to a lack of expectation about what the music should sound like.
The Edison phonograph embossed the sound in an up-and-down fashion. The consequence of this was that if the sound was too loud, the stylus would go too deep into the material and then travel too far upward thus discontinuing the groove. So the phonograph could not accommodate a very wide dynamic range. This problem was alleviated with Berliner's gramophone which cut its groove laterally. The dynamic range of the gramophone disk could accommodate music with a greater dynamic range. The unfortunate aspect of the lateral groove method was that loud bass notes created a wide excursion with the effect that the grooves had to be cut so far apart that very little time could be recorded on a single disk. The method by which this problem was dealt with was by pre and post equalisation (EQ). Essentially, when the record was recorded, the bass was reduced and the high frequency boosted. On playback the bass was boosted by the same amount it had been cut and the high frequencies reduced by the same amount they had been boosted (this is further explained later in this chapter). This pre and post EQ has been used in records ever since and without question, contributed to the “sound” of records. This inherent “distortion” is an important reason why CD reissues don’t sound quite the same as the records we remember. The pre and post record EQ is part of that sound. The exception is when the CD has been made by transferring a record’s playback to digital storage in order to create the CD master.

A whole range of other groove-related factors also affected the sound of a record and contributed to various production decisions and sound perceptions. The groove pitch of a record15, the disk diameter, and the rotation speed of the disk are the most obvious since they directly relate to the available recording time per side. Until LP’s, a record could not be longer than about 3 1/2 minutes. A longer program could be mastered on a record if the excursions were reduced, however since the excursion was directly related to the loudness of the record, the overall loudness was also reduced. A quieter average level also meant that the record would have less dynamic range and more record groove surface noise compared to other “louder” recordings. Making the grooves width narrower meant the record would quite likely skip if played on less than the best players.

The trade-offs of record loudness and groove parameters as a factor in attempting to have longer program lengths was an issue for music producers for as long as analog records were made. Producers loathed to make recordings too long since the resulting records were not as robust or loud compared to other records, and in popular music a cardinal rule was that a record must be as loud as a competing record. Music which previously had no time limited structure, such as jazz and blues, had to fit into these restraints in order to be acceptable for records. Popular songs, until records were invented, had little need for a specific structure, but the time restrictions of the medium instituted a more or less standard song form. Pop songs became well defined with most having a musical introduction, two or three verses separated by choruses, a solo and a final refrain or fade out. The notion that the ideal song length for a single was around three minutes was in the first instance more a function of the medium than of radio playlist requirements.

The invention of variable pitch however, made a significant change to the amount of time that could be recorded on disk and gave producers considerably more latitude on program length. Previous to this development, the pitch or number of grooves per inch was fixed. The pitch would be set to accommodate the loudest passage in order to prevent a loud groove with a wide excursion from cutting into adjacent grooves, however, this meant that during quiet passages there was a great deal of wasted “land” between the grooves. The invention of the variable pitch computer system which automatically cut the grooves closer together when the sound was less loud and expanded the grooves during loud passages was revolutionary. The biggest benefits of variable pitch came in the mastering of classical recordings, but the technique was used on all records after its introduction in the late 50s. If there was a substantial percentage of quiet passages, as was often the case with jazz and classical releases, the maximum time without compromising level passages or groove width was upwards of 40 minutes. On rock music, 22 to 25 minutes was the maximum due to the relative constant loudness of most rock and roll music.16 Variable pitch did give mastering engineers more control to make records “hotter” as dld improvements in cutting edge designs.

Other factors of the medium that have affected the sound

Additional distortion which became part of the record’s sound came from the nature and characteristics of the groove modulation and the mastering process. Radius distortion was one consideration. As the groove moved closer to the centre of the disk the linear length of the groove for a given moment of time was shorter.17 This meant that the groove modulations were much shorter towards the centre of the record. The result was that high frequencies tended to have more distortion as the groove moved towards the inside area. This fact became a consideration when sequencing an album as some producers would try to avoid placing a song with a great deal of cymbals or high hat for instance as a last track, since the distortion would be quite noticeable.
Another factor in mastering that contributed to the sound of a record was the result of music producers wanting their singles to sound louder (or at least as loud) as all the other records on the radio. This precipitated the practice of "over-cutting" records at a level greater than standard specifications which contributed distortion in the cutting process as well as often over driving the playback system. To the consumer this distortion was simply part of the sound of those records. By the fifties and until the demise of the analog record the skill of the mastering engineer to make a record's level "hot", while at the same time continuing to sound good, was an important consideration when choosing who would master the record (in particular 45s). The trade off was between distortion and loudness, and the best engineers (using the best equipment) could make the difference. Another factor was the common practice of mastering engineers to add compression to the signal which would reduce the loudest passages so as to allow them to raise the average level of the record. The mastering engineer would also roll off the lowest frequencies because it was felt that AM transmission and car radios couldn’t reproduce such low notes anyway. By getting rid of low bass which would otherwise have contributed to a wide groove excursion, the overall record could be made louder. It was also common for mastering engineers to add some overall EQ and make level changes to the master recording if they saw fit, when the record was mastered. It can be seen that a significant part of the overall sound of records was the distortion of the cutting process and the changes contributed by the mastering engineer. CD collections of pop singles from the days of analog records sound cleaner and generally different to the way we remember them due to the fact the CDs are often made from master recordings that do not have the processing that the mastering engineer may have added, nor the distortion of the record cutting process, or the R.I.A.A. equalisation. Interestingly, CD mastering and processing does have it own intrinsic amount of pre/post emphasis which inevitably affects the sound in some way. In the 90s mastering engineers continue to play an important role in the CD mastering process since they still may add over all signal levelling and processing through the final stage of digital mastering. They are the final arbiters of what will be heard on the release.

Another factor which affected the sound of a record due to the mastering process began with the introduction of stereo. Without going into the detail of how a stereo record is cut, there are some things which the process could not tolerate. If the left and right channels had a great deal of out-of-phase low frequency information the cutting head would have a great deal of up and down movement causing the playback stylus to lift out of the groove. To prevent this from happening, when mastering engineers encountered this problem, they would take the stereo signal below 500 cycles and mix the two channels together into a mono signal. The result was a significantly diminished bass sound. In the early 70s, when time and phase signal processors first appeared, many producers tried using them on bass sounds to create a wide stereo panorama (in particular on disco records). The effect sounded great in the studio but could never be reproduced on record. All groove related technical limitations have faded into the past since CDs have none of these problems.

The CD has changed many things in the presentation of the musical product due to its own unique collection of physical and technical parameters. Conventional CDs hold a little more than 70 minutes of program, all on one side, so the sequencing of an album is a continuous experience instead of a side A and B. Also, many artists were once restricted by the length of the analog record, but few feel restricted by the CD. Additionally, the fixed maximum length of a CD has nothing to do with the loudness of the recording and the distortion of the CD does not gradually increase with an increase in average level as was the case with records. When a CD distorts, it is not gradual. It is complete and total so CDs are mastered to never reach this point of overload. As is the case with all digital media, the distortion remains low throughout the entire dynamic range right up to the maximum level point, but when the signal goes above that point, there is nearly 100% distortion. CDs also have nearly total separation between the left and right channels so there is no production restrictions on the phase relationships of sound between the two channels. This has allowed the introduction of phase created quadraphonic recordings. The CD can also reproduce much more bass and down to a much lower range of frequencies which is quite obvious on productions created since the demise of the record. These technical factors have affected aspects of production which producers in the 90s are creating. However, the CD is not a perfect medium. As earlier described in the chapter on digital recording, the CD does not play back the highest of musical harmonics. For this reason some people still prefer vinyl records. The DJ/ disco operators also prefer the record since no CD playback system currently allows DJs the feel of manual "scratching" that they can achieve with a record.
The concept album

The development of the 45 and its reduced size had little effect on changing the length that a recording could be. However the LP had a major effect. As Marsh (1989) put it:

LPs became known as "albums" because they replaced album like folders of the several 78s that a symphony or some other extended piece would take up. 45s became "singles" in contrast. (p.x)

It should be pointed out that all records were singles before the invention of the LP. Up until the introduction of the LP, records seldom had more than one song per side, and it was clear to everyone which cut should be played. 45s appeared at the same time that radio was reinventing itself, and rock and roll was emerging. In the 50s teen music was on 45s and only serious music was on LPs. LPs had been around since the end of the 40s, but it wasn't until the early sixties that the labels began to offer anything other than easy listening, "adult" oriented artists (Sinatra, etc...), and classical or semi-classical albums.

Successful concept albums for the hi-fi enthusiast had emerged in the late 50s and early 60s, but teen oriented pop albums were not generally released. Until the 60s the cost of LP playback systems was generally too high for the average listener, and well out of reach for the teen consumer. And of course the LP was more expensive, cumbersome, and more fragile compared to the 45. By the late 50s, if a pop act had several successful singles, they would be collected into an album that may also have new cuts which were potential singles. The record labels were becoming aware of the pop album market and that even acts that were one hit wonders could sell albums, which was considerably more profitable than a single. So, the early 60s saw many albums released with one hit song and the rest of the cuts not nearly as good (described by those who knew, as album fillers). But for some of the biggest acts of the mid 60s (Stones, Beach Boys, Beatles), an album provided an opportunity for a cohesive presentation of songs that were somehow thematically connected. Successful acts began to conceive an entire album of songs from which a single(s) would be chosen or "pulled". The idea that the single was after the fact of the album had never happened before. The opportunity for narration and composition must have seemed limitless. As Harris (1993) commented in his history of the concept album, creators of popular music "who had operated under the restriction of 'scrunching' their creations into the limitations imposed by the... [single].. format, were faced with the challenge and opportunity of producing compositions which were six, eight, ten minutes or even longer" (p. 10).

To be sure these early concept albums had to have a single, but not necessarily for a mainstream "Top-40" market. By the 60s, album oriented FM rock radio was now in almost every major city in the U.S., which gave acts exposure even when they didn't have an AM hit single. In the late 60s to early 70s there were big selling albums from which there were no singles. Led Zeppelin never released a single, and the Jefferson Airplane and most of the other bands that emerged from the San Francisco scene in the late 60s never had big hit singles, but their albums went gold in some cases were on the album charts for years. This move towards album production also meant that many acts were initially signed to produce an entire album not just a single, and it was assumed that among the ten to twelve cuts on the album there would be a cut that would get air-play and possibly become a hit single. The introduction of the CD, unlike the emergence of the "rock" LP of the 60s, has not generated a new genre of popular music. "There is no genre of music which we might identify as 'CD Music' comparable to 'music at 33-1/3 rpm'" (Harris, 1993, p. 12).

The album approach to production also meant that when the collection of songs was completed, not only was it necessary to make decisions about which would be a single, but equally important was the sequence of the cuts. It was considered strategic to have the single as the first cut on the A side and an equally strong song heading up the B side. The last cut on each side was also important. Then there was the issue of pacing from one cut to another and how one song would end and the next begin. Possibly there would be no ending but a musical transition, a movement with no breaks or a crossfade. The sequencing process was not trivial for an artist who had spent months putting the material together. It was not unusual that during the album assembly stage, certain cuts would need their intro or ending remixed or at least rebalanced in order for two adjacent cuts to flow from one to the other. On one particular Dr. Hook album, the engineer and producer spent five days a week for nearly a month, deciding about the order of the songs. In the morning the producer would bring in a list of the order for the two sides. It would take about an hour to physically reassemble the cuts. The producer would come back, listen and a cassette was made. During lunch he would listen to the cassette and afterward he would produce a new order. A new resequencing would be created and that afternoon there would be another playback and copy made. The following morning it would happen all over again. Albums became such time consuming exercises that some producers or artists, having spent so much time on the project, didn't know what to do with themselves when the album was
completed. After Journey's first album was completed, the drummer, Aynsley Dunbar, would come to the studio nearly every morning for coffee and a chat. He continued to do so until the went on the road. Some became so obsessive that they built up a fear of turning loose of the project.

The artist and album art

78s and then 45s were occasionally released with sleeves featuring the artists, particularly if they were well known. Albums of 78s did have some creative packaging but it wasn't until the LP, and in particular the pop LP, that album art became a significant contribution to the presentation of the recording artist. Album art provided an opportunity for a great deal of invention that made the album jacket an integral component of the album's concept. The art work on some albums has become classic and as much a collectors item as the record - the 3D panel on the Beatles' Magical Mystery Tour, the Stones' Sticky Fingers zipper album, to name just a few. With the expansion of album art came full album credits that allowed the listener to know all the people involved in creating the music. Until the 60s only the artist and songwriters were acknowledged. Now, liner notes opened up the credits to include not only the producer, engineer, studio musicians, and soloists, but the studio used, the photographer, costume designer, girl friends, caterers, and guru. Many albums included printed record sleeves with more information, and the record label itself customised for that album.

There also re-emerged the picture disk which was a record that was pressed on disks that had art work embedded in the plastic. Picture disks have been around since the 1930s when a few records were pressed into clear vinyl sheeting that was bonded to both sides of a printed picture. Some of the most interesting was a series of French Jazz records on the Ultraphone label featuring art deco designs. During W.W. II picture records were used to promote the purchase of war bonds and there was a popular series of Franklin D. Roosevelt speeches that featured art work portraying different aspects of his life. In the era of the thematic LP, all of this expensive packaging was created to fit the theme of the music. A significant number of albums also printed the lyrics of the songs so that the listener could follow along. This last point may also reflect that with the emergence of the thematic pop album there was a view that the songs often had more substance and the lyrics had meaning outside of the music's melody. While a few artists who emerged during this period were considered poets, memorable songs in well crafted production did not necessarily mean that the lyrics by themselves were poetry. Nonetheless an unusual amount of hand writing was printed on album sleeves. While CDs have less physical space available, art work and packaging remain an important part of the CD album.

Summary

It is an interesting quirk of history that the inventors of records were not interested in manufacturing records, but in selling phonographs. It would be decades after the invention was introduced that the record industry would be born, when it was finally realised that the original purpose for the invention was less than successful and that there was a market for the machine in the area of personal entertainment. Even then, record production was only seen as a means to sell machines. Over the decades the record industry became a rich and powerful entity in itself, however, it is telling that in the last decade of this century, manufacturers such as Sony have once again seen that the key to selling new forms of technological hardware is by controlling the software that will operate on these delivery systems.

Lastly, the record has had an archival role that has documented and quantified recorded music, each new generation having access to the music of earlier generations. The technology has turned recorded music into an object which will live forever to form an almost daily history of the constant and rapidly changing personal and societal themes, feelings, styles, and views of the 20th century as observed by the popular music creators.
Notes: Chapter eight

1 Electric recording's development is fully explored in Chapter two.

2 The reason for and the consequence of this strike is explored in Chapter two.

3 The association between the independents and the juke box industry is fully explored in Chapter twelve.

4 The reasons for BMI's ascendance and a more in-depth study of its impact was earlier discussed in chapter two.

5 In the U.S. Gold and Platinum records are awarded by the RIAA (Record Industry Association of America) Gold= Singles: 1 million copies (as of Jan. 1, 89 1/2 million copies), Albums: 1/2 million copies, Platinum= Singles: 2 million copies (as of Jan. 1, 89 1 million copies), Albums: 1 million copies. Each country has a similar organization that awards gold and platinum record awards, and each identifies how many units are required for the award to be issued.

6 See in Appendix 1 in the section on EQ.

7 More on this in Chapter seven.

8 See Appendix 1 on stereo mixing and recording for a further explanation of stereo.

9 Because the nitrocellulose chip that was vacuumed from the groove as it was cut was quite explosive it was pulled down into a water filled jar. In a busy cutting room the thread was collected for a few weeks and then removed. For some reason many mastering engineers are a little strange. One such engineer loved to take the chip thread and make bombs out of it and explode them. Most of the time he did this in the parking lot, but on a few occasions he would fire one off in the restroom when it was being visited by someone. The same mastering engineer would yell into the cutting head a brief opinion of a record when it was being mastered. The cutting head, while fully electronic, would respond slightly to the yelling. The author never worked with an act that added a subliminal message, but he is aware of a couple of records which have opinions on them, courtesy of the mastering engineer, that were not those of the act.

10 The laser disk is an analog format. While not popular in Australia, it has been successfully marketed in North America, Europe and other Asian markets.

11 The success of the Walkman is described in Chapter three.

12 See Appendix 1 on quadraphonic sound for a further explanation.

13 Sony's desire to unburden itself from the CBS copyright litigation against it regarding DAT tapes may have also been a factor in its decision to acquire CBS records. At the same time CBS may have seen the sale of the troublesome record division as an opportunity to free itself from the bad publicity associated with various allegations of underworld associations between label management and the mafia which could have jeopardized CBS's lucrative broadcast licenses. In Matsushita's case, it found itself in the middle of an investigation of considerable financial impropriety and underworld buy-offs at MCA as documented in the book 'Stiffed' by William Knoedelseder. Matsushita found the MCA culture so difficult to manage it cut its losses and soon sold its shares to the largest distiller of whisky in Canada.

14 pitch= grooves per inch

15 Average groove width was 5 mill-inch.

16 See Appendix 1 on variable pitch for a further explanation.

17 See Appendix 1 on radius distortion for a further explanation.
SECTION V
DEVELOPMENT OF DELIVERY SYSTEMS
Chapter nine

BROADCASTING THE POP SONG

This chapter focuses on the development of radio as an entertainment medium and the significant role it has played and continues to play in the proliferation of popular music. Music has become intermeshed with demographics and market share. With rare exception, station management has little interest in what music is played as long as it attracts the listeners who advertising agency are looking to influence. The music is narrowly labelled and formatted so that stations can better pin point the customers their advertisers are interested in. For this service, radio stations charge a fee to either the listener, or an advertiser who wants to sell something to the listeners. A station’s ability to attract a certain segment of a listener market, and how many listeners it attracts, are the determining factors in setting the rates it charges an advertiser.

This chapter begins with a history of the development of radio broadcasting and its eventual dominance as a mass communication medium between W.W. I. and the end of W.W. II. The story then shifts to the late 40s when radio was forced to reinvent itself due to the introduction of television. During this period, radio turned to records for programming, disc jockeys gained prominence, and certain stations found the youth market and rock and roll. Starting in the 50s, the record industry and radio developed a strong symbiotic relationship. The former recognised that radio airplay would sell records, the latter that playing the most popular music would attract listeners for the purpose of selling advertising. This chapter also explores the rise of FM radio, the rise and fall from power of program directors, and the impact of payola, radio formats, and the appearance of “Top-40” popularity ratings.

The shared experience

As western society moved from the 19th into and through the 20th century, records provided a means for mass distribution of sound. The effect was to change nearly every aspect of life as it was in the 19th century. Record production brought music out of the concert hall, moved it into the home, and away from a public meeting experience. Anyone, having heard the record, could discuss it with others who had heard it, but none of them needed to have heard it at the same time. Such was the case when radio began to play music.

A significant advantage that radio had over records was that radio did not require the listener to pay attention, for when the record was over, someone at the station played another. While radio, unlike the gramophone, did not give listeners the ability to choose what they would hear, there was some sort of control since different radio stations targeted their programs to fit their chosen market. This became increasingly so as the radio industry moved into the second half of the 20th century when nearly all stations developed tight playlists and well defined formats. When listeners tune in to a station there is an assurance they will hear what they expect to hear. Radio reactivated the shared experience while maintaining as much privacy as the listener wished. Anyone tuned to a certain station was hearing the same program as every other listener, but none of the separated listeners had contact with each other. Radio created a unique bonding force in what was otherwise an increasingly isolated and disassociated life style emerging from the turn of the century. Listeners could imagine that they were part of an audience to a performance that was going out to millions of people through the wonders of modern technology. A typical evening in the 30s and 40s would see friends and families gathering around their radio to hear their favourite radio program, and the next day the program might be the subject of conversation. Often these programs would include musical performances by leading popular artists. The next day the songs that were sung were suddenly known by large numbers of people and would often become popular selling records.

Records made it possible for the listener to do other things while listening to music. But playing a record required the listener to make a conscious choice as to what they wanted to hear, and the range of music available was directly related to the number of records accumulated in each person’s own collection. Radio’s further contribution to the proliferation of music was to make it available to anyone once the radio had been purchased. Listeners could hear new songs and new artists who were popular on that very day, and styles of music that they would never
have heard otherwise. This was of particular importance for the young and the poor. For them, radio made it possible to hear the latest and the hippest music for free. Once they had a radio they could hear every song sung or record played.

In America, while records were played on radio before the 1950s the primary source of entertainment was either live or previously recorded (transcribed on to disk) programming that was produced specifically for radio. Popular artists would perform with the bands featured on each of the programs. With the decline of radio and the ascension of television (discussed in chapter ten), records became the primary source of radio programming. By the mid 50s, all large scale production had moved to television. The radio industry had to redefine what it did and who it would collectively reach. John Potts (1992) points to three inventions that gave radio the means to reinvent itself:

The transistor, the teenager, and rock and roll. From this convergence of new technologies and emerging cultural forms, commercial radio recast itself as the focus of youth culture in western societies from the late 50s to the late 70s. (p. 57)

The white youth of the 50s increasingly tuned in to those few stations that played coloured music. Radio provided a critical crossing between well-to-do white youth who felt disenfranchised from their social structure and poor blacks. This trend was key to the popularisation of rhythm and blues and soul music and a precursor to the emergence of rock and roll. This large white middle class youth movement coincided with the popularity of electric instruments, the 45 record and the transistor radio. Though heavily derived from other sources, the result was a music of their own, the beginning of rock. Rock, which became popular on radio, and which was initially deemed only marginally acceptable for broadcast, was a combination of hillbilly, folk, and black music performed by black sounding, white performers. There emerged “a syncretic product that used black despair - carefully filtered (by record labels) - to express young white hopes: rock. A (secondary and equally) precise filtering was carried out by the radio stations” (Attali, 1977, p. 105). The beginning of “the baby boomers” coming of age and the end of the post war economic recovery produced an enormous consumer demand for this new electrified product.

Pre-broadcast radio

The roots of radio programming date back to the telephone which first provided music to a distant location. In the beginning it was probably no more organised than people late at night on a party line and one of them began to play an instrument and sing while the others listened or even sang along. More than a few all night telephone operators were serenaded. The most popular display at the 1881 Paris Exposition Internationale d’ Electricite was the first organised use of the telephone to transmit a musical program, the Théâtrephone. In two rooms there were ten sets of headphones which were connected to two Paris venues. In one room the listener could hear a live performance of the Paris Opera from microphones set up to both sides of the prompter’s box. In the other room the listener could hear plays from the Théâtre Français. The President of France was so pleased with the demonstration that he had permanently installed a similar system between the palace and several Paris theatres. Soon after the Paris exhibition the King and Queen of Portugal were not able to attend a new opera in Lisbon and had a special telephone transmission installed. About the same time the manager of a theatre in Munich had lines installed between the theatre and his villa so that he could check each performance. In the 1890s subscription service was begun called the Théâtrophone Company of Paris. It provided programs from five venues for a flat fee plus a charge for each event. During intermissions or breaks in the program a piano player could be heard performing from the exchange. Coin operated versions of the hook-ups were available to the public at several French resorts. Many rich Europeans had such hook-ups and by 1896, the wealthy of London could have private connections to a variety of entertainment venues.

In America by the late 1880s, listening to music via telephone was not unusual. The Chicago Telephone Company in 1889 transmitted to all its customers a comic opera playing at the Colubria Theatre. It was so successful that other programs followed. In nearby Milwaukee concerts from the Palm Garden Resort were regular events over the telephone network. Telephone concerts from New York City were transmitted in 1890 to Buffalo, Rochester, and several other cities along the Hudson river and Erie canal. In 1912, the New York Megaphone and Music Company installed motor driven phonographs that played music to local subscribers.

All of these programs tended to be specific “one offs”. But one of them must be considered a precursor of modern broadcast media, Telefon Hirondo in Budapest. From 1893 until after W.W. I, this service broadcast regularly scheduled programs to 6000 subscribers. “For twenty years the Hirondo’s audience received a full daily schedule of political, economic, and sporting news, lectures, plays, concerts, and recitations” (Marvin, 1988, p. 223). The program guide was
published in the newspaper and listed in half hour segments. The broadcasts followed this format for nearly two decades. There was no charge for the installation, and the fee was a penny a day. Its format was very similar to what we know today as talk and current affairs radio. The broadcast was in Magyar, the language of the Hungarian Nationalist. It was a source of culture for the Hungarian elite during the last years of the Magyar's power and before the start of W.W.I.

The system was invented by Tivadar Puskas, an engineer who had worked for Edison, before returning to his native Hungary. He had been involved in the Theatrophon exhibition at the Paris exhibition. The following year he demonstrated a similar installation in Budapest and the next year his family acquired the rights to install and operate the Budapest phone exchange. The first Telefon Hirmondo programs to be transmitted from the exchange occurred in 1893. In 1894 the program system bypassed the regular telephone system which improved the performance of the distributed signal. By 1896 the daily schedule was well developed and presented by 150 people from their Budapest studios. During the war, most of its facilities were destroyed and by then wireless broadcasting had arrived so Hirmondo became a wire service for studio distribution.

Articles about Telefon Hirmondo and the programs it ran were often seen in the European and U.S press. For a brief period in 1911, an attempt was made to set up a similar service in the U.S. called the New Jersey Town Herald. Unfortunately it was plagued by bad fortune at the hands of the New York Telephone Co, who, at the last minute, changed its mind about allowing the service to operate on its lines. It was on the air for about three months. It had no shortage of subscribers, but it simply couldn't financially sustain itself through its growth cycle. Those wanting to subscribe included department stores and restaurants who found that their customers were interested in the service's news casts. As Marvin (1988) concluded, the Telefon Hirmondo and the Telephone Herald demonstrated "that the notion of transmitting regular news and entertainment programming to a large audience existed well before the advent of 20th century broadcasting" (p. 230).

The early years of radio transmission

Morse Code (dots and dashes) was first transmitted in 1897 on the English coast by Guglielmo Marconi who had patented the transmission method the year before. In 1906 an associate of Marconi, John Flemming developed the vacuum tube diode and two years later Lee DeForest perfected the triode which was incorporated into the radio transmitter and receiver. The age of amplification had arrived. The transmission of audio was developed in America by R.A. Fressenden around 1906. This was done by "modulating" the frequency of the transmission signal. Fressenden found that by varying the strength of the transmission frequency (also called the carrier) in direct relationship to the audio frequency, the receiver could decode this information and generate sound. This is the basic method of AM broadcast today. Fressenden perfected a practical method of modulation and demodulation in 1912, with the first transmission being a Christmas message to ships off the coast of Virginia. In the U.K., by 1913, there were 30 shore stations operated by the Marconi Company and several hundred ships equipped with receivers. In 1915 the system had improved to where spoken word was transmitted across the Atlantic. During W.W.1 wireless technology for military purposes leaped ahead with two-way systems becoming quite common. Radio was used to announce the end of W.W. I by the transmission from the top of the Eiffel Tower on November 11, 1918, of the words "Hostilities will cease at 11a.m." That message reached half a million troops in an instant. In 1919 the American industrial giant General Electric invested $14 million in the British Marconi company believing that Marconi's transmission method was also the most suitable system for the U.S.

Through W.W.I, radio was in a developmental stage. After the war radio became popular with the wealthy who could afford the receivers, but very quickly, technology advanced allowing the manufacture of receivers that were within the reach of a large segment of the community. Commercial broadcasting commenced on Feb. 23, 1920 when Marconi began a regular news broadcast from Chelmsford, England. On the 29th of April, concerts were broadcast from the Hague, and over the following months transmitted concerts took place at Chelmsford. The first regularly scheduled music broadcast began on June 15. In June 1920, sponsored by The Daily Mail, Dame Nellie Melba was persuaded to do a broadcast. Dame Nellie was initially concerned about having to climb to the top of the 2,470 ft tower which of course was not required. She got through four songs including "Home Sweet Home" and the national anthem. The signal was received as far as 1,200 to 1,400 miles away. In America on 2 November 1920, the Westinghouse Company began regular transmission from radio station KDKA in Pittsburgh. By 1922, there were 600 commercial stations in the US alone, and sales of radios in America were estimated at $60 million a year.

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The beginning of the “Beeb”

In America the government attempted to keep control of the airways, but Congress backed the public’s right to broadcast citing the First Amendment of the Constitution. Progress in the U.K. was much slower since the government had a more restrained view of broadcasting’s purpose, and there was no bill of rights or a legislature in opposition to the ruling government. The British government frowned on advertising and distrusted private enterprise. The Postmaster General, who had charge of the airways, considered the ether was not to be used for the entertainment of the public. However, after considerable pressure by the public, a second station was allowed and in 1922 the famous 2LO came on the air. In 1923, the BBC was founded (incorporated in 1927). Those running the BBC believed they were doing the public a favour. As Pearsall (1976) puts it, the BBC, from the beginning, was “run by strong men with nonconformist tendencies determined to not let the country collapse into a sea of drivel, and as there was no alternative the mass of the people accepted what they were given” (p.121). The press resented this monopoly. The London Daily Express declared the BBC’s control was a “cause of muddle and exasperation, poor programs, and a listening-in charge that was needless” (Pearsall, 1976, p. 121). In England the public had to pay for a license to own a radio and later a TV. This was not the case in the U.S.

Those who had been to the U.S. looked longingly at the explosion in radio that was happening there. In America the public was getting a wide selection of programming as opposed to England where the BBC was giving the public what they thought they should have. In many ways the BBC operated like Victorian music hall operators of the 1840s and 50s. They were dedicated to giving their captive audience quality as they saw it (whether the listeners liked it or not). Between 1926 to 1930 Sir Walford Davies gave several talks on the radio about “Music And The Ordinary Listener”. The BBC attempted to make classical music popular and the popular music that was allowed on the air had to fit into a narrow preconceived mould. “Only the best behaved dance bands were allowed in the brief half-hour slots, and there was barely a hint of that quality which writers on jazz of the time called ‘dirt’” (Pearsall, 1976, p. 125). Nonetheless, from the beginning, these bands were playing pop songs and responding to requests. Don Parker’s Band received an average of 700 requests a week.

The position taken by the BBC was in keeping with the view of the 1920s British establishment. Its officials knew they had the right to dictate what would be heard. Pearsall said:

An autocracy did not permit working class participation in popular music, and the power of the BBC as an extension of government policy meant that music made by and for the masses did not get a look in. (p. 134).

English pop music was heard primarily in music halls but it was heavily influenced by American pop records from the 20s through to the early 60s when pirate radio wrested control of the airwaves from the BBC and began to broadcast rock and roll. A reasonable number of records from black artists made their way to the U.K. to exert an influence on local musicians. In the 50s, when broadcasting was finally set free in England, homemade music (folk, skiffle, and rock and roll) finally began to have an impact nationally and then internationally. The pop music that was broadcast from the 1920s until the end of the BBC’s monopoly in the early 50s was middle class, professional, and thoroughly sanitised and homogenised. If there was a program of jazz it wasn’t played by a black band from Chicago. It was a smooth representation played by dinner jacketed musicians. For those thirty years a vast majority of unacceptable (to the BBC) popular records from local and overseas acts sold well without the benefit of airplay.

The emergence of the Networks in America

After W.W. I there was an incredible demand for radio receivers so in the early 20s G.E. founded the Radio Corporation of America to make radios and within 3 years had sold over a million radios at $75 a piece. The interest in radio encouraged many entrepreneurs to set up transmitters for the general public, and of course there were enquiries from advertisers who wanted to reach this new market. During the 1920s the driving force for commercial radio in America was RCA led by David Sarnoff who “transformed the wireless from a person to person message unit into an entertainment altar” (Lanza, 1994, p. 32). The Golden Age of Radio in America might be considered to have begun on November 15, 1926 when Sarnoff founded the National Broadcasting Company (a subsidiary of RCA). It was later joined by two other networks that were also being formed, the Columbia Broadcasting System, and the Mutual Broadcasting Network and the three dominated the commercial airwaves in America for the next 30 or so years. In the U.S., a typical station’s programming in 1932 consisted of 62.9% music, 21.3% educational, 11.8% literature, 2.5% religion, and 1.5% novelties. CBS was the largest network with 90 member stations, followed by NBC with 85. By 1937, NBC had 111 affiliates and CBS 97. The fledgling Mutual Broadcasting Network claimed 39.
The radio industry quickly grew up between 1925 to 1930. By the 30s, radio in America had become a power house for the entertainment industry, second only to the film industry. In the 30s Sarnoff presented a lecture where he explained that humanity had been waiting for centuries to be able to use a supernatural conduit (referring to electromagnetism) in order for one person to communicate at one time to millions of people located in different geographies and time zones. A colleague of his (and the inventor of the Radiola), Dr. Alfred Goldsmith, described radio as "the ultimate extension of personality in time and space" (Lanza, 1994, p. 32). The networks provided the opportunity for an entire nation to simultaneously hear what was happening in the major centres. In many ways network radio became a bonding and slowly homogenising force that tied people together throughout the country. "The movies and radio helped accelerate the spread of cultural literacy, a process which had begun with the printing press" (Menushin & Davis, 1979, p. 259). Despite the depression, by 1938 it was estimated that the three networks had a combined income of $69.2 million. The number of stations in America were in the thousands by the beginning of the 50s.

Broadening the distribution of radios

Radio for the masses required a cheap way of making a receiver. In 1910, Dunwoody and Pickard (both from U.S.) invented the crystal set radio that used an extremely cheap lead sulphur crystal to demodulate the radio signal to audio. The crystal and a minimum of cheap components, could be built by a radio enthusiast. These receivers were sold as kits in all sorts of magazines to tens of thousands of people. The quality was not nearly as good as the amplified receiver, but with sufficient antenna they were able to pick-up distant big city stations. Many young people set them under their beds, and listened on headphones to the world "out there" as they fell asleep.

It was estimated that one third of the U.S. furniture budget for 1924 was spent on radios for living rooms. The majority of receivers sold through the mid 50s were console radio receivers that would often include a record player that was housed in a prominent piece of cabinetry sitting at the focal point of the lounge suite in most living rooms. In England, the proliferation of receivers had grown in 1927 to 2 million privately owned, manufactured receivers, not to mention countless homemade crystal sets. This number still represented a small percentage of the public who, by and large, could still not afford a receiver and license. Radios were in the homes of the middle and upper class, since, for a large portion of the population, a receiver would cost a month's wages. The thirties would see hire-purchase schemes in the U.K. as the answer for many of those who could not afford to buy a radio outright. Meanwhile in America, by 1929 radio sales were up to $800 million dollars. The 1930 U.S. census indicated that 12 million (30%) households had radios. The lowest percentage of ownership was in the southern states where the highest percentage of poor people lived. By 1938 the percentage had jumped to 82% and by 1947 93% of U.S. households had a radio.

While the low cost crystal sets did give the young unrestricted access to the airways, they were not of the quality or portability that was needed to meet the general needs of young people at large. In the lounge, the radio was under the control of the family. For radio to be as mobile as the youth culture that was accompanying the technological changes, the radio had to leave the lounge. In 1922 the first portable radios hit the market. They were battery operated and weighed 22 pounds. This probably led to larger beach parties since more people were needed to carry the radio and extra batteries along with the picnic lunch. Needless to say, if it was portable, then it could be installed in a car. It took an 18 year old, George Frost, to cut a hole in the dashboard of his father's Model T and install the first car radio. In 1927, Philco introduced the Transistor, the first commercially manufactured car radio. The next big leap in portability was in 1954 with the first transistor radio, the pocket sized Regency which sold for $50. It was high pitched and tinny but exactly what every teenager wanted. In 1958 the first car radios with push buttons appeared, allowing teenage listeners to quickly switch between their favourite stations in search of the songs they wanted to hear. They finally had control in the portable and push button car radio.

Records and radio

Through the 20s, certain segments of the entertainment industry actively disapproved of entertainment radio and forbade their members to perform on radio. In many respects the reasons for this resistance were very similar to those cited by performers regarding records two decades earlier. Essentially, a fear of change and loss of jobs. Radio was seen as a primary reason for the closure of local vaudeville theatres and a shrinking circuit of venues, since people were sitting at home in front of their receiver and not going to the music hall. Society's shift toward film and records for entertainment was also a factor, and as music halls closed they were often converted into movie houses. In a 1930s article in Billboard it was observed:
Not only was radio initially disapproved of, the vaudeville community actually ordered its acts to stay off the air under penalty of contract cancellation. Musical, concert, and operatic managers also shunned radio fearing that 'songs plugged too strongly over the air would lose their value' (p. 121). Eventually vaudeville died but many of those in vaudeville moved into broadcast, movies, and records.

In the early days of radio, all the major networks had several bands and orchestras providing variety programming. They were also used for scoring behind drama programs. The popular dance bands of the 20s and 30s realised that if they were one of the many bands that provided programming to major stations and the various networks, they would be heard by millions of people instead of hundreds and could quickly establish a national reputation. As it is today, a national profile created by radio exposure sold records and concert tickets. The most popular of the dance bands also landed movie contracts with prominent exposure in movie musicals whose scripts were generally written to do nothing more than carry the story forward from one musical number to the next. The first step for a band was usually a program on a large local station and then a tie in with one of the networks. Advertising sponsorship was the key to such radio programs. However, during the golden age of radio, leading bands had no trouble attracting major sponsors who would give their name to the program. Chesterfield, Philco, Lux, Proctor & Gamble, Firestone, and many other companies sponsored such programs. During the depression, radio became the only free entertainment for those who were impoverished. Popular singer and radio personality Rudy Vallee was given an award by Herbert Hoover for helping America forget about the troubles of the depression. During World War II, radio was a major source of news in the absence of newsprint.

Light saloon, dinner music, and music for sleeping remained popular even when radio technology had improved. Light classical music drew one of the largest markets. Radio made it possible for a million people to hear a symphony at once. Before broadcast, decades of concerts would have been needed to reach the same number of people. And, unlike the class conscious, formal attired experience of attending a concert, the radio listener was anyone who wanted to tune in. No matter who they were, or how they were dressed, they could have a relationship with the music without any social influences.

Initially, the accelerating popularity of radio also marked a decline in the popularity of records. The practice of using records for radio programming was not wide spread. One of the problems that the record industry faced was that not only was the programming on radio available for free, but by the mid 20s, the sound of live broadcasts was better compared to records which were still being made (and played) through a mechanical process. By 1924, record sales, which were booming immediately after W.W. I had dropped to such a degree that there were those who thought the record industry would fade away. For the bands of the time, record sales were seen as less valuable compared to a regular broadcast program. However, the record industry experienced a rejuvenation in the late 20s with the introduction of electric recording and reproduction.

Records banned on radio

In the mid to late 1920s, broadcasters were told by the record companies that they could not play commercial records. There were two issues involved. The first was that radio considered that the right to play a record was implicit when the record was purchased. The holder of the copyright did not share this view, insisting that the purchase of a record did not grant the right to broadcast the record on radio. This issue would be resolved in the U.K. and America in the early 30s when the broadcasters agreed to pay a fee to the collecting societies for distribution to the publishers and writers. Secondly, the record companies initially thought records played on radio would be good for sales, but they came to fear that if records were played on radio, people wouldn’t want to buy them since they could hear them for free. As a result of these two issues, for a few years before 1930, most commercial labels insisted that radio not play their releases. To fill the void what appeared were a number of record labels that provided libraries of music which were leased to the broadcasters. The library supplier cleared the copyrights, hired the same popular artists and big bands who were on commercial labels and recorded them. Often, a library’s catalogue would contain more titles from a certain artist than those which were commercially available. In order to have proprietary security, the leasing library would use a non-standard record equalisation and would then supply subscriber stations with the correct playback EQ network to epitomise the playback. Without the playback EQ the records sounded terrible. By 1930 the labels realised that once electric recordings were available, their fear of radio was unwarranted. The new records revitalised the industry and radio play now appeared to be helping record sales to boom. The leased music libraries went out of existence once the record labels changed their policy toward radio and began giving free records to the stations.

138 ©1997 Tom Lubin
In the mid-seventies, Wally Heider, who pioneered contemporary remote recording, sold his recording studios to Filmways and then set out to collect rare recordings from the big band era featured on these leased collections. He outfitted a large van with a good quality tape recorder and turntable, collected a variety of different styluses and lots of different EQ networks of the type used by the leasing libraries. He then travelled all over America and located collectors who had these recordings and copied them. He found hundreds of such recordings and secured the rights to the best of them which he released on his record label, Hindsight Recordings. In many cases, these recordings were of better quality than those that had been commercially released.  

A voice for people on the land

In the southern and western states of America, country radio provided a voice for people on the land. It also gave what was called at the time hillbilly music, a far reaching exposure. WSB in Atlanta began to play hillbilly music in 1922. The format was to be copied in many country stations throughout rural America. The first “Barn Dance” on radio was broadcast from Chicago over WLS in 1924. The sound of rural musicians was starting to be heard in the cities. In the beginning, those who listened were recent arrivals from the country, but over time city folks developed a taste for the sounds and themes of this music. Most important for musical influence, city musicians were hearing the sounds and songs of country music.

Probably the most significant event for country music broadcasting began in 1925 when George Hay was hired by the National Life And Accident Insurance Co. to be director of their new radio station in Nashville. Hay was a journalist with the Memphis Courier before he moved north to eventually become one of the most popular announcers on radio. He was instrumental in starting WLS’s “Barn Dance” program which by 1925 had gone national. In Nashville, WSM had the transmitter power to become one of the most powerful stations in the south. One of the first things Hay did was to feature segments of hillbilly music which generated such strong listener response that he started a “Barn Dance” program at WSM with him as MC. The show found its name by an off hand comment made on air sometime around 1927. Since then, the “Grand Ole Opry” broadcast and the other activities that it subsequently established, established a foundation for country music not only in Nashville but throughout the world. Various members of the original cast of “Opry” became major publishers, producers, engineers, and promoters of country and the Nashville music scene.

In 1939, Grand Ole Opry went national over NBC and in the late 30s Opry started having audiences, but its studios couldn’t cope with the number of people who wanted to attend so in 1943 it took over the Nashville Ryman Auditorium. In 1940 the first Opry film was made. Throughout W.W. II, Grand Ole Opry hit the road entertaining the troops, introducing city folks to the sounds of country. WSM was one of the last stations in the country to maintain a studio orchestra. It was the first station in America to broadcast FM in 1941 but operation was eventually suspended due to lack of receivers until WSM-FM was opened in 1968. In 1950, Grand Ole Opry put on the air the first Nashville TV station, and shortly afterward Opry was available via syndication on TV. In 1974 Opry moved into a 4400 seat theatre at the centre of a 369 acre theme park, Opryland USA, which is dedicated to country music, in a city built on country music - Nashville.

The reinvention of radio

In the early days, radio stations would closely monitor record sales in their area, respond to request lines, and compare what was popular with other stations in and outside of their areas. In July of 1940 Billboard Magazine began its national record chart which listed what its research indicated were the most popular records for that week. Radio stations began to use such charts to determine which records they would play that week. By the mid fifties, these charts were dominated by rock and roll artists. In the early 60s, Radio New York World Wide, an international shortwave radio show, featured US releases selected by the editors of Billboard. It was designed to provide an opportunity for “leaders of the music and record industry in all nations to hear the outstanding American popular records that had been just released” (White, 1994, p. 168).

Prior to Billboard’s charts was “Your Hit Parade” which first went to air on radio in 1935 and became America’s authority on popular music. Before ‘Hit Parade’ there had been no such program, and it quickly became the definitive source by which songs were ranked as the most popular of the day. Each week a group of the same singers and the Lucky Strike Orchestra would perform the top 15 songs for that week. The show remained successful on radio until 1950 when it moved to TV. In the U.S. throughout the 30s and early 40s, television was developing but had little impact until the late 40s. After twenty five years of the Golden Age of radio, television came on strong and forced a dramatic change in radio.
Rhythm and blues, and hillbilly music—the roots of rock and roll were starting to have an impact on record sales, but since they were not products of major labels they were at the margins. In 1949, a radio station in Omaha, Nebraska began playing records in a pioneering "Top-40" format. Over the following decade, others picked up and developed this format. For radio survival, a coexistence with the record industry was essential. This relationship was mutually advantageous for the record industry that was relying more and more on exposure through radio.

In 1950 there were a third of a million TV receivers in the U.S., and it was becoming obvious that television was going to have a significant impact on radio. By 1948, the first of the radio orchestras were being laid off, and broadcasters everywhere were following the example of WNEW where Martin Block had been playing records since 1935. His show was called "The Mal Believe Ballroom." In late 1954 the trend took on bottom line proportions when television proved for the first time were greater than radio. The radio industry had to redefine what it did or did not. As Rick Sklar (the program director responsible for turning WINS in the mid 50s into the leadly pop/rock station in New York, and later making WABC the dominating force in American radio for more than a decade) recounts, "Radio people had to rethink their business and their career right down to the most basic concepts. The industry would be kept alive by determined programmers, talented disc jockeys, and the music itself" (1984, p.xvi).

The heart of rock and roll

It was during the reinvention of radio that a white disk jockey in Cleveland, Alan Freed, took the expression, "Rock and Roll", and gave it a new meaning. The origin of the term "Rock and Roll" seems to have been around since the early 40s as a common blues euphemism for sex.

Freed had noticed that white young people were asking for black rhythm and blues music at the local record stores. At the time, this sort of music and the name that described it was not acceptable on white radio. Alan Freed started broadcasting certain selections he felt would be acceptable on a show he called "Moondog's Rock and Roll Party". The radio and the Jukebox became a common ground between two groups that were otherwise isolated and disassociated from one another. Rock and roll brought well-to-do white youth who felt disenfranchised from their social structure into an association with poor blacks and their coloured music. White kids could listen to black music without being confronted by the culture that created it. Says Sklar (1984):

When Alan Freed began playing the first rock and roll music in Cleveland, there had been a distinct difference between that beat and all that had gone before. The new music was so unusual that only youthful ears could accept the change. As a result, a clear demarcation in musical preferences had arisen between young listeners and older listeners. 1944 was the last year without a musical generation gap (p.90)

Over the years that followed, whites also embraced the black culture which undoubtedly contributed to the awareness by young whites of the plight of blacks in America, and to the social climate of the civil rights period of the 60s.

In the fall of 1954, Alan Freed brought himself, his wife, Jackie, and four children ages one to ten to the Big Apple. Along with Freed came hundreds of 45-rpm singles that he piled helter-skelter in an old five-shelf supply cabinet in our office. That chaotic, uncatalogued collection would become the most influential record library in commercial radio, imitated by stations everywhere. It would change the sound of popular music and the world for generations. (p.19)

In 1955 Elvis appeared on the scene. His popularity was due to a number of reasons beyond his obvious talent. Elvis appeared at a time when the teenager and the 45 record were being invented. For the first time young people were living in a time of affluence (post W.W.II), they were mobile (even if in daddy's car) and they could choose and hear "their own" music (45s at 45 players were cheap, and radios were now in every car). Rock and roll music and pop songs were increasingly a part of popular and youth culture, and their perception by the listener that they represented a live performance diminished. Elvis was the first "acceptable" white artist to perform southern black rhythm and blues music. He had a performance style that was dangerous enough to be attractive to the teenager, but with a non threatening personality off the stage that adults were willing to accept or at least tolerate. His enormous popularity brought rock and roll music into the mainstream. A tidal wave of other artists quickly followed.

Jukeboxes that were in every teenager hangout and the new breed of rock and roll stations played the new medium of pop music, the 45 "single". The pop artist became popular on the strength of a limited repertoire of hits. These hit records and the artists who made them were well known by a national radio audience long before the act performed outside of their home region. When tours did occur, performances were nearly always sponsored by a local station ar
promoted by the DJs. When pop artists toured, they played in venues that were substantially larger than the dance halls of the past. Although nearly all singles had a dance beat and many had lyrics about dancing, there was a tendency for the audience to watch (and/or hysterically scream in adulation) and not dance (such was the case until the disco craze of the early to mid 70s, when fewer and fewer records had themes about dance).

Through the 50s, many local stations adopted a similar format but in 1960, when WABC in New York went Top-40 they quickly became the top station in the market. WABC's success further expanded formula radio. Throughout the U.S., many of the largest stations in the biggest markets moved to teen oriented pop radio. Record companies had for some years, at least to some degree, relied on radio to promote their product. The loss of production budgets for live radio broadcasting meant that radio increasingly relied on record companies for its programming to get more listeners, and the labels knew that airplay would sell more records. As Atall (1977) observed about this period, “Radio ... became the showcase, the publicity filer of the record industry” (p. 108). By 1989 the U.S. Congressional Office of Technology Assessment reported that “79% of the recorded music purchases were selections that respondents had heard before on radio or television” (Rothenbuhler, & McCourt, 1992, p 103).

Radio had become a powerful promoter of popular music, which became a double edged sword to the record companies. While the record companies embraced radio's ability to promote music, they also found themselves relinquishing control of their destiny. Those in radio now indirectly influence what artists will be signed and what records will be made. Music that does not fit prevailing radio formats and trends are seldom signed to mainstream labels. “Songwriters, artists, producers, record company executives and promoters are [all] heavily influenced by anticipation of what the radio Industry wants” (Rothenbuhler, E.W., & McCourt, T., 1992, p 104).

The Formats

In the 50s, the general managers of stations were so concerned about their loss of revenue to TV that if they had disc jockeys who seemed to capture a market that an advertiser was interested in (in this case the teenager) they were willing to let these DJs run their own programs, and in many cases they would promote them to music director for the station. The general managers didn't understand the music and seldom understood the disc jockey who had an affinity towards the music and the listeners. As profits became bigger, management paid more attention to what was happening in programming. They wondered that if adhoc rock formats could make money, maybe “improving”, systematising, and organising the programming would make even more money. Since the music director and disc jockey knew management was only in it for the money, and since they seldom spoke in demographic and market share terms, which management understood, there was an underlying distrust between the two groups. After all, the people on-air were in radio for the love of music, not the money.

In the late 60s program consultants emerged. These had successfully developed a format in one or more stations and were now offering to do so for other stations. They spoke the language of management and were able to describe how their particular approach would increase market share and raise revenues. Their presentations were full of pie charts, bar graphs, and endorsements from stations and advertisers in other markets. Stations, regardless of where they were, started sounding the same. For local musicians and small local labels, the ability to get their records started on their home stations was beginning to become difficult. The best many of them could hope for was to be played on a “home grown” hour in the middle of the night.

As Rothenbuhler & McCourt (1992) describe them, formats are used:

...to institutionalise standardisation and predictability. A format is a style, genre, or system that defines the musical or informational boundaries of what a station will present and its overall approach to programming... [They] are mechanisms for managing the audience and selling airtime to advertisers. Formats are selected for their estimated ability to accumulate profits, rather than to present music. (p 106).

Formats, by their nature, create a pigeon hole mentality within the record industry which tries to anticipate which acts, sounds, and songs will fit into which formats. If a record can't be matched within the first few bars of the introduction, it will probably not make it on the air. In most cases the record label will simply not bother to push it, rather, it will go with what is more clear cut. This has also caused a sanitising and homogenising of which product makes it on the air.
By the late 70s, radio had many formats but a "constant" within all of them was a large portion of "golden oldies" rock and roll. Radio programmers in the 80s believed the way to ensure that the "hits just keep on happening" was to have a healthy mix of the past. Rather than having to anticipate which new record would be a hit, it was safer to play music that had already proved its appeal. This heavy mix of "classic rock" was also more focused on the older listener. The teenagers from the 50s had a certain amount of spendable income and they were demographically very large. What radio discovered was that as rock and roll got older, so did a large body of rock and roll listeners who were interested in hearing the songs from their youth. Advertisers wanted to pursue this ageing group who were now more affluent and had established roots in the older pop music. An increasing number of stations moved from a top 40 format to top 20. Now some play the top 10 in regular rotation, and principally from older established artists, with the rest of the format being records that have already been hits - oldies. In 1988, Charlie Fox, music director for Triple M said, "We play a lot of Gold because our profits rely on how well we reflect the taste of our audience. Our research says our 25-35 target audience wants to hear something familiar" (O'Grady, 1988, p. 35). Commercial radio stations are about getting people to listen to them and making their advertisers money. The station that can earn the most money must have a high percentage of qualified buyers and users of products. The only broadcaster in Australia to resist this trend, and to continue to play new music is the ABC's Triple J network. While ratings are important to the government broadcaster, they are not the most important thing, thus it is willing to take something on and give it an opportunity to become popular. Triple J actively records new music and releases sampler collections through ABC records. As Richard Kingsmill, Triple J DJ, explains,

When you play the ratings game as severely as the commercial stations do, you don't give anything a life span. They don't look at developing anything. It works or it doesn't. So the easiest thing for a station to do is play sure-fire hits. Its just business. (Messer, 1994, p. 88)

The 90s have become "the decade of "Golden Radio" formats, of 'hits and memories', 'light and easy', nostalgia radio ...the decade in which Heritage Rock became entrenched" (Potts, 1992, p60-61). Just how many years or decades into the past this tried and true bill of fare is from, will depend on the demographic the station is aiming for. By the 90s, the playlists of many (as it applies to Australia) are dominated by a lot of Dead Guys. Queen's "Bohemian Rhapsody" or The Door's "Light My Fire" are more likely to be heard than Nick Cave or Pearl Jam. The charts which show which new music is selling and the articles seen in magazines like Rolling Stone, bear little resemblance to the playlists of the most financially successful, commercial stations.

But the appeal of Golden Oldies radio extends to the young. The wide availability of older rock has created interest and an appetite in many younger people for the music of their parents (and grandparents). The sampler and music that uses samples has been a factor in this interest. New music producers have taken so liberally from sounds, songs and artists from the past that they have contributed to the growth of Golden Oldies radio. A major reason for rekindled interest in rock of the past is the reissuing on CD of long since out-of-inventory releases. New artists are forced to compete with the reissues of thousands of previously released phonograph recordings. The discretionary dollars of older music lovers are going into reacquiring the albums of their past, and of course this has stimulated a broader application of Golden Oldies radio since store sales are monitored. At the end of the 80s, 100 of the 142 radio services in Australia played a substantial amount of adult contemporary/golden oldies music and tended to play fewer and fewer up and comers (Watson, 1990, p.7). This trend has prevailed through most of the 90s. Rob Walker, at the time head of artist development at EMI Australia, described the current market as, "a continuation of the baby boomers relentless march through the history of consumerism" (O'Grady, 1988, p. 34). Just a few "best of" collections to move into the top 20 include The Bee Gees, The Rolling Stones, Abba, Doris Day, Hendrix, Eagles, and the Beatles.

There is little doubt that "Classic Rock" formats have tied up radio playlists and made it nearly impossible to break a new act on Australian radio. The popularity of reworked earlier music has increased the difficulty for new artists and songs to get exposure. The door on radio access for the present generation of music creators is harder to open than it has ever been. Peter Davis, a night club DJ, makes an interesting point, "A lot of people have thought, "Why do I want to listen to some rap artist sampling an old James Brown riff when I can hear James Brown doing the original from 20 years ago" (Messer, 1994, p. 89). In America, the U.K., and Europe there are a great many more stations so there is also more diversity of programming. The U.S. also continues to have a vital college radio market which tends to feature a substantial percentage of new music. If the trend continues in Australia, and there is no reason to believe it won't, the significant answer for new music will be in cable radio, or in the possibility of more radio licenses. With this in mind Kingsmill concludes,
There's going to be a whole lot more competition. It's going to open up radio to a huge degree. There's going to be more specialisation. It's been happening in America and England for ages. We're so far behind in terms of 'narrowcasting'. Here radio is back in the prehistoric age. Not just the music, but the whole notion of what radio is.
(Messer, 1994, p. 89)

"Narrowcasting" is common outside of Australia. In markets where there is a proliferation of stations, not all will pursue the mass appeal formats. Many will find their success by developing a financially viable niche in the market. A station focuses its programming and advertising on listeners who want to hear country, album oriented rock, or heavy metal, for instance. Of course this requires that the stations are not in unrealistic financial debt and/or heavily leveraged, which has been the case in Australia. The price boom in the 80s of Australian media stock is still being felt in the 90s, and is a prime reason why stations are unable to pursue profitable, though narrower markets such as youth oriented new music.

The other dial: FM radio

Beginning in the 60s through the 70s, the FM band became the voice, the "tribal drum" for the counter culture. FM album oriented rock (AOR) brought focus to the protests and concerns of the baby boomers who were by then young adults heading off to college, civil rights protests, or to war in southeast Asia. Every college or university in America had an FM station that became the underscore for politics and poetry, for all night study and discussion.

Edward Armstrong was instrumental in the development of FM radio during the 1930s. Compared to AM, FM uses a different principle for transmitting radio waves and turning them into sound. FM transmission and reception use for each FM channel a range, or band, of radio frequencies at a constant signal strength for each channel. This broadcast method provides better sound quality than AM, but initially it could not achieve an adequate transmission distance. During World War II the U.S. Army used FM for the transmission of secret messages to the troops. After the war and once the secret of FM transmission was no secret, the Army stopped using it, so the U. S. Congress in 1956 authorized the Federal Communication Commission (FCC) to issue permits for commercial radio transmission. Not only did broadcasters obtain FM licences, but background music companies such as Muzak also acquired them to replace the telephone lines they had been using. In most cases AM broadcasters acquired an FM license and simply simulcast their AM program on the FM band. It was sometime after AM was well established that FM began to have an impact on the record industry.

Initially it was hoped that FM would free up the crowded AM dial. There was even some talk that AM transmission would eventually be retired and returned to government control, but in 1964 the FCC made an Important ruling that would change the direction of U.S. radio. It required that FM stations must have 50% original programming in a broadcast day. This contradicted the FCC's earlier position held in the 40s when it supported simulcasting in an effort to make the transition from AM to FM easier for the broadcaster and Listener. The AM/FM broadcasters were opposed to the ruling, since they felt that the FM band was not commercially viable on its own. FM became the place where classical music broadcast and light pop found a home. In the beginning these FM stations had such small audiences that big business broadcasting paid little attention to them. In 1976 the FCC pushed a little harder for FM to be independent of AM. It ruled that in larger cities over 100,000 people, the FM programming must be 75% original.

FM in America was also licensed to low power stations that were attached to college and university media departments. In the early 60s, literally thousands of schools applied and received an institutional broadcast license. Nearly all were just large enough to reach their immediate community of student housing. The American government placed little restriction on what these stations could do so it was from college radio and small FM counter culture stations that album oriented rock of the 60s and 70s was first heard. The interest in FM was heightened when stereo transmission was introduced in 1961. Stereo was perfect for the music these stations were playing. This separated them from AM which was limited to monophonic transmission until the late 80s (AM stereo remains a nonentity for most consumers). Much like their AM counterparts of the early 50s, the FM DJs were able to select what they wanted to play, and for nearly a generation of music listeners they were the voice of the counter culture. The FM disk jockeys and those who listened to them developed a bond of social and cultural awareness found in the music they played. As FM DJ Jim Ladd (1991) commented, "Through the music, we found comfort in the fact that we were not alone at the crossroads. Rock and roll had found a social conscience, and it was the only thing that the straight world never counted on" (p. 25). And just like AM, from the early 80s when commercial FM stations became big money makers and the broadcast corporations took notice of FM, the FM disk jockey was strangled by program consultants, playlist, formats, research, marketing campaigns and demographics. However, throughout the 60s through
to the early 80s, FM provided a "venue" for many acts who would never have a top forty hit. Albums became hits solely through FM airplay, and without singles.

The music, the message, and the medium all combined to resonate the tribal drum, which kept time for a syncopated movement of new ideas and innocent dreams. (For the baby boomers) FM radio was the sound track of our lives. (Ladd, 1991, p. 27)

In Australia, Double J and then Triple J has acted in this role. Today, it continues to address issues that flow in the youth culture's social conscience. When it was first started, it was seen as considerably more radical than today, but this may be more a matter of changes in present society than in changes in Triple J's basic philosophy. The Triple J staff is constantly undergoing change, but the ABC seems able to maintain the youth network's fundamental charter to champion the causes of the young, young at heart, and semi-radical.

Cultural and musical trend setters such as Hendrix, The Jefferson Airplane, Pink Floyd, Led Zeppelin, and countless other leading edge acts gained national (U.S.) exposure through FM. While college radio in America remains contemporary and vital, it is unfortunate that commercial FM has now become corporate, with little difference between it and the AM dial. It is equally unfortunate that in Australia, college radio has never been allowed to flourish and as such has never made a significant contribution to youth culture and pop music.

A darker side of pop radio

In the early 50s, when AM radio was reinventing itself and began to play music for teenage listeners, the disk jockey was a prominent figure in this transition. In the early days of rock and roll, it could be said that the most successful radio stations were those that played, or were expected or perceived to play the most popular music. The young listener turned to these stations for what was at the "front of hip". In all of the major markets, and in scores of secondary markets, there were disk jockeys or music directors who were charged with choosing what new music was at this leading edge. They had the power to choose if a record would get on the air or not. The music director would select additions to the playlist from the hundreds of records that were released each week. The station would have a regular rotation of hit records with a smattering of oldies and three or four up and comers. The selection was often a matter of the taste. Such personality based critical decisions were also susceptible to corruption. Few DJs or music directors would play a bad record since their credibility was also on the line, but if it was a choice between two good records and one of them had a hundred dollar bill inside the record sleeve, the decision as to which would go on the air may was compromised. Payola, or to pay someone to play something on the radio, became a part of modern language.

Throughout the last forty-five years, the record and radio industry in America has had to deal with payola allegations by no less than the Federal Communication Commission, the U.S. Congress, and the Federal Trade Commission. In 1960, these three groups began an extensive investigation of record companies, publishers, and radio stations in some 27 cities. They were looking for incidents of chart rigging, the use of "freebies" and kickbacks. While it became obvious that such practices were common, the discovery of such smoke did not easily lead to the source of the fire. There were several people and companies that could have been pursed but only Alan Freed, the high profile disk jockey who had started rock and roll radio was indicted. He was charged with commercial bribery and accused of taking money to play records. His reputation and career were destroyed. However, it is worth stating that:

Freed was believed when he bragged that he'd never played a record that he didn't like. In January 1965 when he died, Cashbox wrote, 'he suffered the most... for alleged wrongs that had become a way of life for others'. (Clarke, 1990, p. 437).

The payola scandals accelerated the development and expansion of format radio, and the declining role and power of local music directors. General Managers of stations became increasingly concerned over the impact various payola scandals would have when FCC license renewals came up, particularly if one of their employees was under investigation. For the major broadcast organisations who owned several stations, the consequences of such bad publicity could be financially catastrophic. They could potentially lose all their valuable licenses in one ruling. This made management look for other ways of programming that would insulate it from such investigations and potential indictments. Station management turned to format consultants who were more predictable and safer. A weekly playlist was provided by the consultant as part of this package which substantially restricted what music a local DJ could put on the air and reduced the opportunity for local acts to get their records heard. The consultants in some cases were no less corruptible, but at least they were at arms length to the broadcaster, and the practice did diminish local station corruption.
English radio was much more tightly controlled and there were considerably fewer commercial stations, but pirate radio was a fact of life from the early 60s. Located on ships off the coast of England and on certain locations along the coast, pirate radio provided an alternative to the BBC’s bill of fare. These stations were the first to provide the British pop music listener with an uncompromising brand of rock and roll. These stations were not only open to bribery but had no particular reason to pay copyright royalties since they were illegal in the first place. The British government had concern about them, but didn’t know what to do when the Copyright Council insisted that those who were operating from old forts should be shut down since they were not only illegally transmitting but doing it from government land. The Minister of State agreed but felt removal by the armed forces was politically dangerous in the social climate of the period because the stations had become so popular. They were ignored for years until most of them dried up due to competition from the emerging commercial stations. Payola to the pirate stations took on the veneer of a business transaction. A typical arrangement was done by Michael Jeffrey, manager for the Animals and Jimi Hendrix, when, in the 60s, he gave key pirate stations a piece of both acts’ publishing in order to get airplay in England. A piece of the publishing was a common tender of payola on both sides of the Atlantic. Dick Clark, who was never charged with anything built a financial empire on writing and publishing royalties from records he had nothing to do with other than introducing them on American Bandstand.

In the U.S., while the investigations in 1960 focused on disk jockeys, the 1972 “Project Sound” investigation looked into claims that CBS records had bribed R&B (Rhythm and Blues) stations in order to get records played. In 1975, 19 people were indicted but no one was convicted. In 1976 there was yet another Congressional investigation into payola and this time concert promoters were also scrutinised. In 1986, CBS was again one of the labels as well as MCA, being investigated for spending vast amounts of money on “independent” promoters who were under investigation for conspiracy, bribery, racketeering and close ties to the mafia. While this last investigation also failed to indict any label executive, the board of directors of these major corporations forced some of those implicated to find work elsewhere. It also curbed the practice of using independent promotion people. CBS, who had enjoyed in the past the vast profits of its record division, became increasingly concerned not only about the down turn in record revenues, but the effect of such bad publicity on its broadcast operation. For CBS, such investigations could become grounds for claims that it was not suitable to retain its broadcast licenses. As much as anything else, the decision to sell the tarnished record division to Sony was due to concerns over the effect the label’s bad publicity would have on the broadcast business.

Another area of corruption was the jukebox industry which played a significant part in the promotion of music starting from the 20s. Through the 30s into the 50s and 60s many jukeboxes were owned by the bar or restaurant where they were installed, but most were owned by jukebox operators who formed a vast network of small businesses. These people would service the machines, change the records regularly, and in return for occupying the space the owner of the establishment would receive a percentage of the take. Record labels, in particular the independents, had always reaped considerable revenues and exposure from jukeboxes, but in the 50s they began to actively pursue the jukebox operators as they had the disk jockeys. Record labels were under much less scrutiny when it came to dealings with jukebox operators because federal broadcast laws were not involved. The availability of vast amounts of cash, and the fact that labels were willing to pay big dollars to get a record in the machines made the jukebox operators a target for underworld take over. At the very least most were forced to cooperate with organised crime. Corrupt practices as to which records were installed in machines were common. “Stacking jukeboxes gave organised crime its first foothold in the music business” (Cimino, 1992, p. 8).

Music production and the medium

The technical limitations of early radio created production style and sound that was suitable for radio. Radio engineers and musicians discovered that the sound of overlapping string sections played at higher pitches had the effect of covering up the static and buzzing that existed in early broadcast. Soft passages were also avoided since they were lost in the restricted dynamic range of transmission. This affected the performances of classical music more than pop. Classical conductors were told to make softer passages much louder than they would for a concert hall performance. As radio matured, these early limitations ceased to be a factor, but other technical issues affected the production of sound for radio.
For a number of reasons, AM radio traditionally compresses its transmission. First, records generally have more dynamic range compared to the AM signal. Secondly, there is a commercial necessity to have a constantly strong signal that can be heard over the widest geographic area with no quiet passages lost in the signal noise, or in the environment that the listener is in such as the inside of a noisy car. This requires a levelling out of the signal. Thirdly, the specified output that a record was supposed to be "cut" was often exceeded in an effort to make the record sound "louder" compared to other records. Cutting increasingly "hotter" records became common practice from the 50s onwards due to the nature of the 45 and the style of music (rock and roll). Some producers (particularly those involved with independent labels) felt the sound was enhanced with the distortion associated with over cutting. A compressor smoothed out any level differences from record to record. Some stations would also add an equaliser to the entire signal in an attempt to compensate for the compression, and in many cases to establish what management would define as "its sound".

Many acts are horrified when they hear their meticulous crafted productions pushed through what is essentially very crude processing. On the other hand, consumers are often surprised when they buy a record that doesn't sound anything like what they heard on the radio. At extreme compressor/limiting settings, the music will have less attack, and loose percussiveness and clarity, the vocals will be embedded in the track, and any loud sound will modulate the rest of the track, for instance the rest of the music will seem to pulse or pump in sympathy with the kick drum beat.

Another important production consideration that was influenced by the needs of radio came when stereo replaced monophonic records. Most singles were remixed in mono for radio and jukebox distribution. Eventually, as an increasing number of juke boxes became stereo, the need for a mono release became almost exclusively an issue of radio airplay. Devices were designed to combine the stereo signal to a mono output, but most producers preferred to remix the master for a single release in an attempt to compensate for what the radio station would do to the sound. Simply combining the left and right signal of a stereo recording will create a very good monophonic sound. The reason is, anything positioned in the centre of the stereo mix will be considerably louder compared to those sounds positioned to the right or left. This usually means that the lead vocal, lead guitar, snare, kick drum etc. are too loud compared to the rest of the track, and the reverb and delay effects that are often positioned to both sides seem to disappear. There is also a problem of phase cancellation due to poor interaction of some stereo effects. These problems can be sorted out by the creation of a mono mix.

As earlier described, the LP and album oriented rock allowed the artist to create music that had little restriction on the length of a composition, however to this day, the singles market, and in particular the needs of AM radio, require selections to be no longer than 3 minutes. Singles which come from albums are most often edited from longer compositions. This editing process in itself is an art form, with people building reputations based on their ability to edit longer material into less than 3 minute singles. An early example of this, and one of the longest album cuts (17 minutes) to be edited into a successful single was Iron Butterfly's "In-A-Gadda-Da-Vida". The album of the same name stayed on the charts for three years, and the edited single made it into the top 10 [Oct. 68] (Nite, N., 1989). A number of radio DJs got their start in record production by taking an album cut and making their own edited version of a single. In a few cases, a DJ version would be picked by the record label and released nationally. In the 90s, disco DJs have taken up this practice and some of them have moved into successful careers in music production. Rather than tape, today's editors use digital workstations and samplers which provide many more possibilities in the deconstruction and reconstruction process.

Digital technology has made the process of editing much easier and provided more possibilities compared to tape editing. Digital workstations allow edits to be made instantly, and any number of combinations tried without ever destroying the original. Segments can be stretched, looped, and trimmed with the click of a mouse. EQ and effects can be added and taken away in order to smooth any edit, and small rhythm segments can be easily created. Editing in the digital domain provides more flexibility and is considerably more forgiving allowing much more trial and error creative construction. Tape editing requires a high degree of tactile mechanical skills in operating a tape recorder and handling and editing tape, and a great deal of additional hardware to do any form of signal processing, levelling, and so on.

Radio's impact on the musician listener

For musicians in the 20th century the radio has provided not only a significant means for them to present their music but for them to also hear what other musicians have done. Like the rest of the youth population, most musicians are avid radio listeners when they are young. For many, the radio remains an important source for hearing what others are doing. As Ladd (1991) quotes Don Henley:
Music changed my life. Radio, the vehicle for that music, was my connection to the world that lay outside my small hometown. During those difficult adolescent years, it was a friend in the dark; a messenger to a lover; a magic carpet; a ticket out. (p. 1)

Disk jockeys became performers in their own right and might be considered, to some degree, a precursor to the dance club DJ. Jim Ladd (1991) recounts,

We played sets of songs, audio vignettes that dealt with all areas of life, from love to politics, sex to religion. All the jocks did it differently, some concentrated more on sound and tempo, others on message and feeling, but all of us took great pride in not only what songs we chose to play, but just as importantly, how we put them together. We were creating a living, breathing art form, instantly born and instantly gone, twenty four hours a day. (p. 237)

Legendary west coast broadcaster B. Mitchell Reed once told Jim Ladd (1991) of "the joy he felt, knowing that somewhere out there he may have struck a chord in a future musician, or inspired a struggling painter, or even helped to heal a momentary wound in the soul of a young physician" (p. 273).

"Today there are nearly 12,000 radio stations in the United States programming approximately 80 distinct formats. FM is now the dominant entertainment medium, although AM continues to be a primary outlet for news and information" (Stark, 1994, p. 126). In the next ten years, radio will undergo another major change with the introduction of satellite and terrestrial digital broadcast, cable radio, and music on the Internet. It is not clear how some of these methods could affect the delivery of popular music but undoubtedly it will in some way since, from the introduction of broadcast, each new method has brought with it some change that has altered, to a greater or lesser degree, aspects of the pop music industry.

Summary
As has been pointed out, the introduction of a new technology is often perceived as a threat by an existing industry that is built on an earlier technology. Such was the case with radio, which was initially seen by the record industry and music publishers as a threat to record and sheet music sales. These two commodity suppliers came to realise that radio had the opposite effect. Air play stimulated records sales, and while sheet music sales did decline, copyright and mechanical royalties increased publisher incomes. The growth of all three of these industries had the effect of increasing interest in popular music and the artists who wrote and performed it. The growth of national networks allowed popular artists to become national figures and for songs to gain overnight, country wide popularity. The radio industry grew through the first half of the 20th century to become the most influential mass medium in the world. When the next mass media technology, television, arrived, radio was forced to reinvent itself or perish. Starting in the 50s, radio was forced to reinvent itself or perish. Starting in the 50s, due to the flight of program sponsors to television, radio and the record industry became more closely linked. Radio turned to records for programming and the record industry found radio the best means of promoting the new music that was focused on the post war teenager. Car radios, and in particular, the transistor radio, made radio the source of music for the go-go young people. Radio played rock and roll music that was released on 45s - the new commodity, affordable, easy to carry, and cheap to purchase and play.

To promote itself, radio developed DJ personalities that would closely affiliate with the popular artists, promoting them (the artists) and themselves. Rock stations began to sponsor and promote rock concerts to further their image with the listener, a practice that continues today. Radio became the source of the latest trends in music and fashion. Radio was also strategic in the growth of independent record labels. As a by-product of radio's power to sell pop records was the appearance of record charts, the record promoter, and payola. Through the 60s, the influence of DJs to pick what they wanted to play declined as the power of the program director increased. Radio stations looked for ways of ensuring that their programming would attract the biggest market share. To systematise the process of music selection through quantifiable market research, and to eliminate any possibility of a direct association with record play influencing, the radio industry turned to the most successful and business-like programmers who become program consultants of national importance to the record labels. But network programming made it considerably more difficult for local artists to get their records on the air. On the other hand, the majors could focus their resources on those few consultants. The artists played an important part in this by making sure that they were available for any promotions the label might develop. Visiting radio stations while on tour remains an important part of an artist's itinerary.
FM radio played a significant role in the promotion of countless acts and broke the strangle hold that AM radio had in promoting popular music. A great many artists have had successful albums due to FM airplay (to the exclusion of AM). FM was a prime reason for the commercial success of thematic, concept pop albums due to its ability to play stereo, its higher quality of transmission (better dynamic range and frequency response), and of course its format which was from the outset album oriented, more political, and controversial and not locked into 3 minute songs. In the beginning, the FM DJ selected the music and was a commentator on the music and current affairs - a significant influencer. Over the decades, most of the FM band has gone the way of AM, and is now heavily programmed by consultants.

Starting in the 20s, radio continued the commodification of popular music by providing the record labels with a means of mass market delivery. Radio could quickly catapult a musical artist to national prominence. A performance on radio would be heard by more people in a night than an act could see over years of live performances.
Notes: Chapter nine

1 From an unpublished interview by the author with Wally Heider Spring, 1980

2 *Hit Parade* ended in 1959 and by then rock and roll had edged out the ballad, and the pop song fan, the teenager, was more interested in hearing the *hit artist* sing the song and not the “*Hit Parade*” gang.


4 The operation of a compressor was described in Chapter seven, and Appendix 1. For its application in radio, the compressor is connected between the output of the studio and the transmitter input. This has the effect of reducing the overall dynamics of the sound. Most broadcast signal paths also include a limiter between the compressor and the transmitter to ensure that the maximum authorised power output of the stations is not exceeded. Devices that provide both compression and limiting are commonly used in broadcasting and are called *complimiters*. 
Moving pictures have made a significant contribution to the commodification of popular music and the popular artist. Records objectified popular music and provided a saleable product and radio provided a means for that product to be mass marketed nationally. While records and radio had brought the music and live performance of popular artists to the public, film, and later video, included the images and personae of artists as well as the music. Moving pictures took western popular music to the rest of the world. From the 30s, in some of the most remote corners of the world, local people were being exposed to and learning the songs they heard in American and British movies. The music, and in particular the popular songs, of the movies became key components in the promotion and eventual success of any film. In some cases the music and songs have outlived the film they were from.

There appear to be three historical points in the development of the musical film or video. The first was the release in the late 1920s of commercially successful sound films. These films were different from what had come before them. Before the talkies, films told stories with pantomime and captions, and the public watched and read. During the same period there were records that the public would listen to. The combination of sound and image created a new product that required considerably more sophistication in its production and had the potential for a much greater impact on the viewer/listener than either of the two tributary products. This chapter will describe the early development of the sound film noting several technological milestones, and the music and songs that were a part of this progression.

The second period began to appear in the mid 40s with the music film clip. This product was no longer attached to a dramatic presentation, but was produced around a song and a musical artist and was used in pay-for-play coin operated viewers. From these early forms of visual music evolved the video clip, the third sound/vision product to commodify popular music.

This chapter also explores the use of popular music in broadcast television, where it was used much as it was in radio, as a means to attract certain groups of viewers. Network television provided the widest possible means of exposure for musical artists and their songs. Television brought about the most rigid packaging of popular music, and through its puritanical content restrictions regarding musical style, lyrics, behaviour, dress, race, stage movement, sexual preference etc., filtered which acts would be acceptable for television and which would not. As television became increasingly more important in the promotion of recorded product, its written and implied codes of practice to some degree indirectly dictated which acts would be signed by record labels. From time to time, networks were also active in creating musical acts for the sole purpose of marketing a popular music product. Finally, cable T.V. provided a distribution channel for the video clip and created the environment that allowed the successful and rapid spread of MTV. MTV has created the video pop star whose product is sound and vision, both of equal importance. The commodity is now video music and the pop star has become not only a commentator on society, but a mainstream trend setter for all aspects of style and fashion.

Starting with silent movies
The silent movies were hardly silent. The first music for a film may have been delivered by balladeers who were hired to sing and narrate the screenings of a silent movie adaptation of "The Beggar's Opera". Music and songs to accompany the projected moving image predated by many years the mass marketing of the talkies. However, short films with sound were being made as far back as 1900. The first film to have sound was shown at the 1900 Paris Exhibition where there were no less than three systems being demonstrated. One of them, The Phonoscope Theatre, featured an extraordinary array of acting talent including Sarah Bernhardt as Hamlet. Popular operas were most often the subject of these early experimental sound films, but various technical problems kept sound films from becoming commercially viable for years to come.
The need for music to facilitate the action of a silent movie seemed to have been intuitively obvious to early silent movie makers since, very early in the development of the film industry, it became common practice for a score to accompany major movies. The script would code the music to the picture and the local musicians would attempt to keep up with the score. Film soon created a new style of music (dramatic music) and generated a large number of jobs for local musicians. A movie house of any size had a piano player and large theatres featured orchestras of various sizes playing appropriate accompaniment. The biggest movie houses built in the 30s were designed with large pipe organs which would play during intermission as well as through the picture.

The majority of silent movies however, did not come with a score, so the local conductor, or solo musician, would work out the most appropriate music for each scene. Many became skilled at thematic interpretation so the music would fit the images and move the story along (dramatic, comedic, historical, patriotic, etc.). Most of them drew on their knowledge of light classical music. Pearsall (1976) wrote that after the turn of the century “more than anyone else, cinema musicians were responsible for the popularity of light orchestra music” (p. 114). As a result, the public was stimulated to purchase light classical music to play on their recently acquired home gramophones. In 1919, a book of generic musical scores for silent movies was published, Music For Small Orchestras Suitable for Cinema. For some movies, when they were shown in major cities, the orchestra would be quite large, as was the case for D. W. Griffith's benchmark silent film “The Birth Of A Nation”, which was accompanied by a full orchestra score at each screening. In London, in 1922, Eugene Goossens conducted the 65 piece London Symphony to accompany the United Artists spectacular “The Three Musketeers”. In 1925 MGM released “The Big Parade” which was about W.W. I. It had a score that included a song which became a pop hit, “My Buddy”. This song is still popular in Irish pubs. Another movie that came with a score was Charlie Chaplin's 1936 movie “Modern Times”. Chaplin, who had built his career in the silent era continued to make silent movies long after the talkies had become popular. This score also had a pop song “Smile” which was a hit record for Nat King Cole in 1956.

The next technological step came with the introduction of the sound film in 1927. Talkies made redundant the movie accompanist and the local performance of music with the film presentation. The scoring and musical performance process was centralised to where the rest of the movie was made. Composers and musicians who immigrated to Hollywood and other movie making centres found new jobs in scoring and recording for film. The movie directors and producers also gained more creative control over the music, the theatre operator was able to reduce operating costs, and a consistent quality of performance was guaranteed. As an added bonus to movie goers, those theatres with large organs often continued the tradition of having an intermission performance. Radio City Music Hall in New York is probably the most famous movie theatre to continue an intermission schedule. It may also be one of the last.

Songs from the big screen
From the beginning of talkies, movies have played a significant role in bringing popular songs to the public. Warner's first success The Jazz Singer in 1927 featured vaudeville and recording star Al Jolson singing “Mammy”. Since then countless songs from the movies have become popular hits. The first screen adaptation of Broadway musicals was in 1929 with Gold Diggers of Broadway and Broadway Melody. These two movies popularised “Tip Toe Through The Tulips,” “Painting The Clouds With Sunshine” and “Broadway Melody”. Songs that were from the pre-sound film era also found their way into the new medium and became unexpected hits for the composer. “Charmaine”, a standard in many piano bars, was written several years before it was used in the 1926 movie What Price Glory?. In some cases the songs were more memorable than the movies they came from. The classic “Mona Lisa”, which has been recorded by virtually hundreds of artists and was a hit for Nat King Cole in 1950, was from an Alan Ladd film a few people remember, Captain Carey U.S.A. Another example of a forgettable movie and memorable song is the 1936 film Pigskin Parade that featured Judy Garland singing “You Made Me Love You” to a photo of Clark Gable. Of course there are numerous examples of films equal to their songs such as when in 1939 Garland sang “Somewhere Over The Rainbow” in The Wizard Of Oz. This song became an anthem of hope for those trying to struggle out of the darkest depression in the 20th century.

The types of films that featured pop songs
Film companies quickly found that a film's musical score had a life of its own and could be sold as a record product. Many film companies started their own record labels and they would use their film music product as a core to their record operation which usually included artists that were not involved in film (and television). Almost from the beginning of film sound, soundtrack and cast albums have been a part of the commodification of popular songs, light classics and opera, and dramatic orchestral music.
There are few movies made today that do not have one or more popular song associated with it. The images of the movie are featured in the singer's video clip which help promote the musical artist, and the video clip in turn promotes the movie. Some pop stars have been able to develop credible dramatic careers and with each of their movies there comes a hit song or two. Cher's most recent hit record "Sooop Shooop Song" came from Mermaids, a film she starred in. Another example is Bette Midler, one of the stars of the film Beaches of which the title song "The Wind Beneath My Wings" has been her biggest hit record. Recently Whitney Houston had one of the biggest selling records ever, "I Will Always Love You," from the movie Bodyguard in which she stared with Kevin Costner. In some cases the stars of the movie will become directly involved in the song's video clip. For Billy Ocean's video clip for "When the Going Get's Tough, The Tough Get Going", the title song from the movie Jewel Of The Nile, the three stars of the movie, Michael Douglas, Danny Devito and Kathleen Turner became Billy's white tuxedo clad backup singers. In earlier generations, a partial list of other artists who were already successful recording and radio performers who became equally successful film stars include Elvis Presley, Frank Sinatra, Rosemary Clooney, Al Jolson, Vera Lynn, and of course Bing Crosby.

Popular songs have been incorporated in roughly five different types of films. The first group, movie musicals, are usually adaptations of theatrical musicals and a constant source of pop songs. The second are those films that have a theme or title song that becomes a popular song. The third type are films which can be categorised as reenplotational in that they are low budget efforts written for young people and featuring popular contemporary acts. The fourth are filmed or video recorded concerts, and finally the singing cowboy westerns which are no longer made. All of these films have had a significant impact on popular music since the beginning of sound.

Within the movie musical category could be included the "Busby Berkley" movies which were often in revue type formats. Most of Disney's animated features would also be in this category, featuring songs such as "When You Wish Upon A Star" from the 1936 feature Pinocchio, "Zipziply Do De" from the 1946 film Song Of The South, or most recently the Peabo Bryson and Celine Dion hit "Beauty and the Beast" from the 1993 film of the same name and Elton John's "Circle Of Life", "Kings and Vagabonds", and the Academy award winning song "Can You Feel The Love Tonight" from the 1995 film The Lion King. Sometimes, singles from these movies have come straight from the score and at other times they have been redone by popular artists of the period. This group would also include movies which use popular songs of the past as an integrated component of the script such as most of the movies with Vietnam War themes, or movies that use music to position in time the lives of the characters such as The Big Hurt or Forrest Gump.

The second group of films which have a song as a title theme have been a constant source of popular records. This became more prominent starting in the early 1960s with nearly every James Bond movie for the next two decades having a popular title song by a different artist; Shirley Bassey: Goldfinger, Paul McCartney: Live and Let Die, etc. Theme or featured songs from dramatic movies would also include songs played inside of the picture such as the one Sam played for Humphrey Bogart, "As Time Goes By" in Casablanca. Probably the most successful composer of pop song movie themes would be the Henry Mancini with "Moon River" (from Breakfast At Tiffany's 1960), and "Days of Wine And Roses" (from the film of the same name 1963) to name a few. Other well known examples come from Butch Cassidy and The Sundance Kid, the B.J. Thomas hit "Rain Drops Keep Falling On My Head" (written by Burt Bacharach), and from the 1968 film The Thomas Crown Affair, the haunting "The Windmills Of Your Mind" (written by Michel Legrand). These are but a few examples of pop songs that have been written for and introduced by a film.

The third group are those films that are made for the youth market and feature acts which are popular at the time of production. The beach movies of the 60s, and all of the Elvis movies would fall into this category. What many believe is the song which started the rock and roll revolution was used in the 1955 movie The Black Board Jungle. Bill Haley's "Rock Around The Clock" was released some time before the movie and experienced fairly good sales, but shot to number one shortly after the release of the movie which had the song playing behind the opening credits. In the following year, Hollywood introduced its first films strictly for the rock and rolling teenager with Rock Around The Clock (featuring Bill Haley), Shake Rattle And Roll (featuring Fats Domino, Joe Turner), and Rock, Rock, Rock (featuring Chuck Berry, LaVern Baker, and Frankie Lymann). Dozens of such movies have been made over the past four and a half decades. Some of them have become classics such as The Blue Brothers, Let It Be, Help, and This Is Spinal Tap, but the majority are less than memorable, except for some cultural or historical significance.

Filmed concert and on-tour documentaries have been produced from almost the beginning of rock and roll. The Encyclopedia of Rock On Film lists hundreds of them featuring nearly every act that's ever had any success. Probably the first production to have a significant impact on youth
in America was the T.A.M.I. show (Teenage Awards Music International) which was recorded on video tape then transferred to film and released in theatres. This 1965 film featured outstanding performances by Chuck Berry, Bo Didley, The Supremes, Marvin Gaye, Smokey Robinson and The Miracles, Lesley Gore, Jan and Dean, The Rolling Stones, and the best footage ever shot of James Brown and his big band. Over the years certain concerts have become significant examples of the pop music and culture of the time. These include *Lot The Good Times Roll*, a documentary of rock and roll from the 50s, two Rolling Stones films: *Gimme Shelter* which documents the tragic outcome of the Altamont concert and served to mark the end of the love generation and *Let's Spend The Night Together* which is a remarkable documentary of the 1984 U.S. tour of America. The 1969 *Monterey Pop Festival* must be included as significant since this was the first full length concert film and in many respects marked the beginning of a national awareness of the peace and love generation. It featured Hendrix, Joplin, The Mamas and the Papas, Eric Burden And The Animals, Jefferson Airplane, Scott McKenzie, Country Joe and the Fish, and Otis Redding to name just a few. And the film that brought the concert that named a generation, *Woodstock*, needs no further comment.

The last group of films were westerns which featured singing cowboys. These westerns were only made for about ten years from the mid 30s to the mid 40s, but in that time literally hundreds of them were released. They were low budget productions shot in the California desert and in what is now the heavily populated San Fernando Valley. Tex Ritter, Gene Autry, Roy Rogers and Dale Evans, and the Sons Of The Pioneers were the most popular of the cowboys (and cowgirls). These films took America and much of the rest of the world past the end of the great depression and through W.W. II. Later Autry and Rogers had successful TV series basically doing more of the same. The popularity of these movies, and the growth of western swing in Texas, changed the image of hillbilly music and ultimately given it a new name "country and western". As Vaughan (1992) comments,

Country had always relied on a bedrock of sentiment and nostalgia but the (film) cowboy took it even further. Their wistful visions of times past, rolling prairies and tumbling tumbleweeds would stay with country music throughout enormous musical changes over the coming decades. (p. 23)

While the historical accuracy of such Hollywood cowboys and girls is virtually nonexistent, their look is the image of country and western music as we know it today.

The development of film sound

From the turn of the century to the late twenties, the development of film sound and record/gramophone technology was closely interrelated. Once optical sound became well established, the two methods of disk/groove and film/optical modulation would continue to have an association but more through adaption. The film industry in particular developed early in the process methods of interlocking sound recordings to picture, invested heavily in improving the recording and reproduction process, and industrialised the post-production approach to sound production (the adding and manipulating of sound after the vision is photographed). Things invented for the film industry were modified for the music industry and vice versa. Later when radio and TV came along, adaption of film and sound equipment would occur in these industries as well.

As previously mentioned, recorded sound that would accompany film predates by several decades sound that was a part of the film. In 1889 one of Edison's proteges, Laurie Dickson, presented Edison with a demonstration of a film with sound. It was a silent film that was shown with the accompaniment of sound from a crudely synchronised phonograph record. In 1896 Charles Pathé used long playing records and mechanically synchronised a Berliner gramophone to the projector. That same year Oscar Messter took this approach one step further by using several synchronised gramophones in an attempt to make the unamplified sound louder. In 1907 Carl Linnennl of Paramount Pictures used a German invention called the Synchroscope to lock a record playback to a silent film. In 1906 Edison introduced the "Cameraphone" for synchronising a camera to a phonograph recorder, and in 1908 its playback system, the "Cinephone", was available. The record would play at a standard speed and the projectionist would adjust the speed of the film in order to maintain sync. The system was not very good and the sound was always ahead or behind the picture. By 1913 Edison had perfected the "Kinetophone" so that moving pictures could be projected on a screen. To have sound, a phonograph and horn were placed behind the screen. In order to achieve sync, a long cord and pulley system ran between the projector and the phonograph. This was equally unsatisfactory since the cord frequently stretched, slipped or broke all together. The public was tolerant in the beginning and amused by the numerous incongruities of lost synchronisation but the system did not improve and the public lost interest. *Variety* wrote, "The talking, instead of enhancing the picture,
simply annoys... the verdict was that the Edison pictures are out-and-out flops." The headline read, "Talking pictures booed in Union Square Theatre" (Thrasher, 1946, p. 4). None of these approaches were successful due primarily to the short time the record would play, the inability to maintain synchronisation, and the limited response and loudness of the still mechanical reproduction system.

Between 1903 and 1910 there were several methods attempted to solve these problems. Developed in France, the Chronophone attempted to make the playback systems louder by taking the output of the record player and mechanically amplifying it using valves and compressed air. Many inventors were at work on methods of mechanically locking the projector to the phonograph. None of the systems which appeared before amplification were successful. While Edison would continue to work on synchronising records with film, the amplification breakthrough came from another lab.

Those discoveries that had grown from Bell's telephone inventions would play a far more important role in giving film a voice. In 1912, Lee DeForest was finally able to convince the labs which Alexander Graham Bell established, Western Electric Co, that they should continue the development of the amplifier tube which he had patented five years before. Dr. Harold Arnold, the chief engineer at Western Electric, saw enormous potential for the amplifier in telephony. Two years later, Arnold decided that electrical recording should be developed as a laboratory tool. The lab was starting to get good results when World War I broke out and the entire sound project was put on hold until after the war. During the war a lot of other experiments in the area of amplification were conducted. This work was useful when the recorded sound project was resumed. One of these components, the Thelofide photo cell, was used for communications during the war, and later was used as the sound reproduction cell in optical film playback systems. The Thelofide cell was used until it was replaced by photodiode cells.

In the early 20s Western Electric built its own sound studio and set about shooting several in-house demos as it developed its process. It was so committed to sound recording that it created two teams simultaneously working on the problem. The one group was interested in using an electrical process to improve disk recording and playback. During disk recording, sound coming through a microphone was amplified and a stylus was electromagnetically controlled to vibrate laterally and cut a groove on the blank master. On playback, a stylus travelled along the groove, and this motion was converted into electrical energy which was amplified and reproduced by a speaker. One aspect of this development was the choice of record speed and disk size in order to provide enough time per record to match one reel of film. The disk diameter chosen was 16", rotating at 33 1/3 RPM (the speed LP's would later adopt). Western Electric's work included improving the method by which a disk could be synced to a film. The other group explored a means of filming sound and making it a part of the same medium that held the picture. For sound on film, the sound coming through a microphone is converted into a variable light beam which is photographed by a type of film camera. The sound is later reproduced as the now developed film passes between a photocell and a beam of light. The changes on the surface of the photocell are amplified and reproduced by a speaker. Their development required designing a new film path so that a smooth and continuous film travel would be maintained across for the sound reproducer mechanism of the projector while freezing at a regulated rate the movement of the image during each frame's projection onto the screen.

Western Electric believed that disk recorded sound for film had some advantage over a new optical process in that the mass duplication of records had been perfected, while film sound processing was entirely new. It was this fact that made it decide to first introduce a system using records in sync with the film. In the long term however, it believed that the film should contain both the picture and the sound. While the recording and playback mechanism in both processes was different, the amplifiers, microphones, and speakers were nearly identical in their requirements. These three elements represented a common ground of development that would be needed before either of the processes were commercially viable. Western Electric made significant improvements in the DeForest amplifier design. The lab's E.C. Wente developed a high performance condenser microphone in 1916. The company had already gained extensive experience in speaker design and public address through its work in expo and convention installations, and in 1926, Wente headed a team that developed an efficient moving coil speaker suitable for large systems. Western Electric was well placed to dominate the film sound and record mastering business.

(The historical information that makes up this chapter comes from a variety of sources. In addition to those which have been referred to as sources of quotes refer to Burke, 1978, Fielding, 1983, Giscard d'Estaing, V.A., 1992, Richards topical Encyclopedia, 1962, Williams, 1987).
Optical recording prior to Western Electric's involvement

We will return to the work at Western Electric later but first, the early history of optical recording is worth exploring. The development of optical recording has a history as long as disc recording and predates the appearance of silent movies. Initially, those developing optical recording did not specifically see its application as synchronised with moving pictures. Rather, an optical process was considered a more elegant, less crude, method for recording sound compared to the mechanical groove of the phonograph and gramophone. In 1878, Professor Blake of Brown University, using a vibrating mirror similar to the one Alexander Graham Bell had used, made optical recordings of speech sounds on a moving photographic plate. In 1879, Bell was able to transmit sound by talking along a modulated beam of light which was picked-up by a light sensitive device (selenium cells). He also photographed the sound. This approach became the starting point for many experiments. In 1880 Charles Edgar Fritts filed a patent for a process to photograph sound on light sensitive paper and later reproduce it by means of a photocell. While the literature was voluminous, no experimental hardware or demonstration was developed.

In 1885, Bell filed a patent for recording sound on round flat photographic plates. The system used a constant intensity light source that was projected through a small opening which was modulated by an ingenious method. Just above the place where the light went through the stationary glass aperture which covered the opening, a tiny jet of ink was directed against the surface. The ink jet was attached to a sounding board which picked up the sound. As the sounding board vibrated, the ink nozzle would jiggle in sympathy with the sound. This flow of ink would modulate the light that was striking the photographic disk.

In 1887 Eugene A Lauste, a Frenchman, joined Edison. He spent years working on various projects related to motion picture. In 1888 he had read an article about Bell's work with selenium cells and reasoned that it should be possible to have the optical sound on the same film as the picture. It was not until 1900 that he had an opportunity to work on his idea. He worked for several years on the development of optical sound and in about 1905 moved to England. In 1906 he applied for a patent that showed a well thought out approach. To modulate the recording light, Lauste used a rocking mirror and a constant intensity light source. Unfortunately this system was too sensitive to camera vibrations. In 1910 he began working with light modulators which proved successful. In 1901 Ernst Ruhmer, in Berlin, started publishing the results of his work in photographic sound reproduction. He worked on it for 12 years. Toward the end of the decade, some of his Photographophon films were brought to America and shown to William Fox of 20th Century Fox. Lauste also worked with Ruhmer in Berlin and then returned to the U.S. in 1911. While there, Lauste made what is probably the first motion picture film with sound made in the U.S. He had to return to the U.K shortly thereafter. Lack of capital, the outbreak of W.W. I, and the unavailability of the amplifier halted the development of sound on film for nearly a decade. The Tobis system of film recording was introduced in Germany in 1918. It used a modulated light source for recording and a photocell for reproduction. This system was first used by the large German film producers U.F.A. and Klangfilm. In 1923 a Danish system was used by Gaumont in France and British Acoustic Films in the U.K. It was also in 1923 when Lee DeForest demonstrated his Phonofilm system. In England, Phonofilm was demonstrated in 1924 at the Empire Exhibitions at Wembley but theatres resisted sound. It was costly and nothing they had seen, or more appropriately heard, had used sound effectively.

In the U.S., the industrial giant General Electric had also become interested in film sound. In 1921, GE's Dr Charles Hoax demonstrated a sound on film device that had grown from a radio code recorder that he had developed. Hoax also determined that a narrow optical track would provide acceptable performance. The outcome of this work was to conclude that the sound track could exist on the edge of the film without taking up an unacceptable amount of the picture area. The first movie to use the GE system, now called Kinemophone, was a Paramount picture about the air force during W.W. I. The picture was first shown in 1927 and travelled to key U.S. cities with all the sound hardware needed to show the film. Westinghouse, during this period, was also working on speakers and photocells. In 1928, RCA established the Photophone company to provide optical recording and reproduction systems. Both Westinghouse and GE had an arrangement whereby RCA acted as the sales outlet for products developed by the two research and manufacturing companies. Several eastern theatres were equipped with the Phonofilm system, but the public reaction to the first sound films was so bad that William Fox, in 1924, ordered them removed from seven locations.

In 1920, Theodore Case patented a fast acting photo-cell system and two years later discovered that one of the tubes that he had used for a wartime communication system was particularly suitable as a modulating light source for optical recording. He also continued to improve the response of the photocell. From 1922 to 1925 Case worked with DeForest, with the result that
several experimental pieces of equipment were built (primarily in cooperation with the projector and camera company Bell & Howell). Toward the end of 1925, Case and DeForest had a parting of the ways but both continued to independently develop film sound. In 1926, Case showed his system to William Fox. Fox decided to license it and prepared a strategy to exploit the system which he called Movietone. Fox also negotiated an agreement with Western Electric to provide the amplifiers and speakers. In early 1927, Fox began showing newsreel type short subject sound films. They were first run before the silent film, What Price Glory? The Movietone newsreel series continued for decades to come. Movietone brought contemporary history alive and created a taste for vivid journalism. In May 1927 Fox released Seventh Heaven with a fully synchronised film score. In 1929, the making of silent films by Fox was discontinued. Later, when the Western Electric light valve was adopted by the industry, Fox switched from the Case system.

Returning to Western Electric

Western Electric had been trying to get the film industry interested in what it had developed. It showed its system to Nathan Levinson who had been employed by Warner Brothers to equip its Hollywood radio studio. Levinson went straight to Sam Warner who made the trip back east to see and hear the Western Electric system. He was convinced of its viability and set up a special demonstration for his brothers. When an orchestra appeared and music filled the projection room Harry Warner couldn't contain himself:

That's the answer to sound pictures, no wonder this thing hasn't taken hold. It hasn't been done with showmanship. Think of it! Now we can bring fine music into small (theatre) houses that can't afford orchestras. We can bring symphonies and opera and great performers into every town in the land and all over the world. Put the finest music by the best talent on the screen. By giving a voice to the screen, people from the four corners of the earth can be brought together through this visual and vocal medium. (Thrasher, 1946, p. 46).

Warner Brothers took the plunge into sound even though the rest of the industry, with the exception of Fox, remained disinterested due to the public's reaction to what they had previously seen and heard. Vitaphone was the name Warner's gave to its version of the Western Electric process.

The first Warner sound presentation was shown in New York in August 1926. It was a collection of Vitaphone shorts featuring the great artists of the day. There was an introduction of the film, followed by Don Juan with John Barrymore. This was Warner's newest and best silent film which also had a complete film score recorded by the New York Philharmonic. The sound program was a great success. Much of the success of the shorts had to do with the work that was done to make the artists respond to the camera and not act like they were playing to a concert theatre. But getting the artists to change their live concert style of presentation and work to the camera was not easy. A typical example was the reaction of the violin virtuoso Misha Elman to the new media. Says Thrasher (1946):

He would chin his violin, lean back and look at the top balcony. Patiently, Heller (musical director for Warner Bros.) would explain that the camera would take care of that and his face would be in front of every member of the audience no matter where they sat. Again and again, Elman would say, 'But I always look at someone in the top balcony when I give a concert'. (p. 47).

During the winter of 1926, Warners released two other silent films with full scores (The Better' Ole and When A Man Loves) and packaged them with a collection of Vitaphone shorts. They too were successful. The Vitaphone score for The Better' Ole was a medley of war songs and demonstrated the effectiveness of popular as well as light classical scoring. Elsie Janis, a popular artist at the time, sang the same numbers she had sung in her war time tours and was accompanied by members of the 107th regiment. With the exception of Fox, the industry remained unconvinced and considered sound films a fad that would pass. On October 6, 1927 The Jazz Singer was released. The short speeches which Jolson delivered were ad libbed between two songs which were being recorded. On hearing the playback Sam Warner decided to leave them in. Of the many strategic decisions he made, this may have been one of the most far reaching. It was the first time that an actor had delivered dialogue from the screen. The public was electrified, they wanted talkies not just synchronised sound. The film industry was now convinced. By the end of 1927, the other big producers, MGM, First National, Paramount, Universal and Producers, had evaluated the two major systems and had selected the Western Electric system. A construction boom began in Hollywood as all of them began to construct sound stages. Western Electric was contracted to supply all of the technical expertise and sound recording hardware to the studios. The movie companies were coming to terms with which silent artists might have a suitable voice.
and make it into the age of talkies. Many actors with European accents simply packed their bags and travelled back to Europe where talkies were also beginning to be produced. The one thing rivalling the sound stage construction boom in Hollywood was the marked increase in direction instruction. In order to keep up with the demand, Western Electric went from 180 people involved with developing film sound in 1928 to 2400 installing it by the following year. It also set up ERPI (Electrical Research Products Inc.) to handle the demand for film sound equipment, design and training. ERPI ran courses for everything from sound recording techniques in Hollywood to sound film projectionist training in every town that had a few theatres.

RCA was equally busy during this period. It purchased a chain of theatres (B. F. Keith and Orpheum), a film production company (Film Booking Office) and organised "Radio Keith Orpheum" - RKO. The new company went about equipping its locations with the RCA system. The company made many pictures using the name "Radio Pictures". Photophone was also licenced to Pathe and Mack Sennett. One of the first features made by Pathe using Photophone was King of Kings directed by C.B. DeMille. The variable area optical recording system that GE had developed won preference over the variable density approach that Western Electric used. The consequence of this was Disney switching to Photophone in 1933, Republic in 1935, and Columbia and Warner Bros. in 1936.

Western Electric, RCA and the film companies who were working on developing the practical application of film sound had to confront the changes that were required in the production process in order for sound to be recorded. In Edison's early sound work, the recordings were made and then, those on camera would lip sync to the sound. But for sound and picture to be simultaneously recorded the set had to be quiet. The practice of yelling directions and several productions occurring within ear shot of one another was over. The original reason why film makers came to California was for the many days of sunlight, with most sets being built outdoors. But the sound of birds flying by, or trucks driving behind the set could not be tolerated once the need for good sound became an issue. The sound stages became a necessity.

The equipment of film production that had been developed for nearly fifty years also had to become quiet. Everything from lighting to the camera itself needed to become quiet. The silent film industry had developed a lot of skill with camera movement, but the talkies had the effect of, at least initially, stifling mobility. Actors could only move from one microphone to another. Within a couple of years, techniques were developed in sound booming of microphones and in post production dubbing that would make the use of sound no longer an impediment to the visual performance, but for a while, the image took a step back in order for sound to take a step forward. The talkies did eliminate the on set musicians who were there to get the actors in the mood. On the other hand, there was a whole new industry to develop sound with music editors, scoring composers, copyists, music producers, and studio musicians and engineers.

In the theatres

The public access to sound films was rapid. During 1928, over 1000 theatres installed Western Electric or RCA sound systems. By the end of 1929 nearly 5200 theatres in the US and 1800 overseas were equipped with sound systems, and 40 production sound stages were in operation. By 1930 there were about 13,500 theatres equipped with sound. Interestingly a high portion of them had both disk and optical playback. It would be some years before it became clear that the optical medium would prevail. Standardised early in the process were the sound performance criteria which the manufacturers of sound equipment and theatre sound contractors would aim to achieve in the playback system of a theatre. This was done to ensure that all films would sound the same regardless of the theatre’s equipment. The specifications were created in the early 30s by a working party convened by the Motion Picture Academy and was attended by sound people from the major studios. The specifications included the sound characteristics for film sound mixing suites at the film studios to ensure they too matched the theatres. The Academy's specifications included an equalisation characteristic that was introduced during the audio transfer to the final master print. This was called the Academy Filter. A complementary equalisation was introduced in the theatre playback system. The Academy filter improved the performance of the optical sound process. Through the years, the characteristics of this filter have been redefined by the Academy in order to achieve better performance due to improvements in the technology. It is not a part of the recording and playback systems of modern formats such as those developed by Dolby.

Through the years, the film industry has introduced many different sound formats such as Sensurround and Cinerama to name just two. In all cases these more exotic formats are used on special movies that feature multi-track surround sound coming from 3 to 6 locations in the theatre. In most cases these multi-track soundtracks are provided on separate magnetic or optical film, and are played back from a sprocketed sound reproducer that runs in sync with the
picture. Films with elaborate sound are seldom heard outside of major cities where a few theatres are equipped with the additional equipment. With some films, the special equipment travels with the film and is installed only for that film. Up until the late 70s when Dolby introduced its optical stereo system, the vast majority of movies that had been made were released in mono and with standard optical track width (as used in mono), the Dolby process improved the frequency response and dynamic range of the optical medium. By the mid 80s Dolby had developed a surround sound system using the same optical track area of the film. The Dolby system has become widely accepted in theatres and is used on more films today than the original Academy system. It is now in a digital format that provides five to eight channels of surround sound. These surround formats are now an integrated feature of the home entertainment system. Many videos and broadcast programs have surround sound encoded in their audio, and with the right decoders, customers can have their widescreen TV hooked up to their surround sound speaker systems for an enveloping home movie theatre experience.

The appearance of the music clip

The second phase in the commodification of popular music in moving pictures came with the emergence of the musical film clip. Predating the introduction of talkies, music clips had their origin as experimental short subject films. As previously mentioned, the first of them appeared at international exhibitions starting in 1900. From 1905, the French film maker Gaumont produced a number of short contemporary operatic sound films and continued to work on sound for film until it was finally perfected. Some of the most contemporary and creative music films during this developmental period were made in the early 1920s by German artist Oskar Fischinger. He produced several abstract short films that were shown while a live jazz and classical score was performed. In 1934 he produced Composition In Blue, which had swirling colours and pulsed with rhythmic geometric patterns. Video historians believe that his work represents the cornerstone for modern video clips. Fischinger was also involved in the 1940 Disney movie Fantasia which was the first full length film to have animation created to preexisting music. Prior to, and for several years after this movie, Disney released the highly popular Silly Symphonies and Warner Brothers released the Looney Tunes cartoon series.

The first distribution of visual music to a wide market outside of theatres came in the late 40s with the introduction in arcades of the film jukebox. The Panorama Soundie was a two ton, coin operated machine which featured a 20" rectangular screen at the top of an enclosure that stood taller than a record jukebox. Customers heard a song and watched a black and white film that was projected onto the back of the translucent screen. Each machine had only one film so several machines were lined up at the arcade in order for the customer to have some variety. A number of jazz, pop, and R&B artists made soundies. Some of the machines had films that were excerpts from feature films, but most of the clips were stylised for the tunes. These clips also found their way into theatres to be played along with cartoons, previews, and newsreels. By the early 50s the Panorama Soundies had died out. The high cost of the films prevented operators from changing the films regularly so the public lost interest in them. Also, TV was coming on strong, and the machines were difficult to maintain. The film jukebox came back on the scene in the late 50s and early 60s when a French firm introduced the Scopitone. These machines played 16mm colour films and had a capacity for 36 different titles. They weighed a half ton and used a 20" translucent screen similar to the Panorama machines. The Scopitone clips were generally more conceptual with less of an emphasis on a performance. In the beginning, the Scopitone was very successful in Europe, but much like its predecessor, after its novelty wore off, it faded away and by 1967 completely disappeared. The machines had little penetration in America where it was particularly difficult to get the French spare parts. Artists who made Scopitone clips included Johnny Halliday, Petula Clarke, Dionne Warwick, Frank Sinatra and Paul Anka.

Video jukeboxes using video tape loops, then laserdisks, have been around for sometime but with little commercial success. The future for coin operated video music delivery systems may lie in computer based CD ROMs that are interactive and cheaper to manufacture, operate and service. Rowe International, one of the largest manufacturers of record jukeboxes in the 80s and 90s, introduced a video jukebox in the early 80s but did not find it particularly successful. It continued to work on the idea but video is now on CD-I and CD-ROM. Rowe admits "that visual music has yet to take off at the retail level" (Russell, 1994, p. 194).

Broadcast video pop

The third phase of the commodification of visual music came with the development of television. Unlike the film music clip which seemed to have little sustained appeal, the public took to video music clips and the performance of pop songs on TV as soon as television sets began to
appear in living rooms. As early as 1948 in the U.S. there was a 15 minute program called "Face The Music" which featured the show's regulars performing the hits of the day. A year later, big band leader Paul Whiteman began hosting "TV Teen Club" which continued until 1954. As mentioned earlier "Your Hit Parade" moved from radio to TV in 1950 and continued until 1959. It too featured a cast of regulars that sang the top songs of the week. Many popular artists of the day also gained exposure singing their songs on the many popular variety shows broadcast during the 50s and 60s - Steve Allen, Jack Parr, Ed Sullivan, Milton Berle, the Dorsey Brothers, and many more. Some of these programs were hosted by pop artists Dusty Springfield, Frank Sinatra, Nat King Cole, Jimmy Dean, Captain & Tennille, Sonny and Cher, Roy Clarke, Paul Revere and the Raiders, Perry Como, Andy Williams, and more.

In Australia, Our Hit Parade went on the air in 1958. "As was standard at the time, the show featured cover versions of popular songs performed - or rather mimed by local artist. (Stockbridge, 1992, p. 69). As Stockbridge points out, this format reflected "a general absence of Australian material" (p. 69). An Australian version of American Bandstand was also begun in the late 50s and lasted to the end of the next decade. Another copy was Six O'Clock Rock based on the British 6-5 Special. Both of these shows often had visiting overseas artists as guest MCs and Australian acts performing live in the studio. Throughout the following decade a long list of shows were tried, many on the ABC network. Most were short-lived, but at any given time, there was one or another pop music show on the air. In 1979 the ABC began nationally broadcasting GTK which was more of a life-style program with popular music as a featured segment. There was a high percentage of Australian pop music, and to the benefit of the artists, the ABC frequently would shoot a cheapy video for the act that could be used for other things. Through the 70s, other youth life style programs also featured pop music, but as Stockbridge (1992) notes "rock music had not, at this point, been provided with a specifically separate position" (p. 71). The 80s and 90s in Australian television moved closer to what was happening in America. Over thirty different programs existed at one time or another during these two decades. Most were rock clip oriented. About half of them attempted to include in their formats, clips that were out of rock clip oriented. About half of them attempted to include in their formats, clips that were out of rock clip oriented. About half of them attempted to include in their formats, clips that were out of

Probably the most significant pop music TV show to appear in America began in 1952. The format for Dick Clark's American Bandstand was simple. There was a semi regular collection of kids that would come together each afternoon and dance to the latest releases. On each of the shows was a segment featuring a popular performer who would lip sync to his/her current hit record. The show evolved into a once-a-week Saturday afternoon affair that lasted with Dick Clark as MC into the mid 80s. In the beginning and for some years afterward, it originated from Philadelphia, a fact which contributed to the success of a number of small "Philly" labels that got national exposure on Bandstand. Dick Clark eventually relocated the show to Hollywood. In the U.K., Jukebox Jury and Top Of The Pops appeared in the late 50s to bring pop acts and hits of the day to British youth. In 1963, the BBC got in the act with Ready Steady Go! which, unlike earlier music shows, favoured live rather than lip sync'd performances. In the U.S. Shindig and Hullabaloo were broadcast during the 1964 and 1965 seasons. Both programs featured artists lip syncing to their records. None of these early programs focused on the expanding R&B and soul music market. Don Cornelius believed there was a market for a show similar to American Bandstand but featuring soul artists. He raised the money for the pilot which originated from Chicago and aired in October 1971. The show was called Soul Train, and is now seen in nearly a hundred TV markets including England. Before MTV, this show, like no other, set the trend about what was "hip" and "in" in clothes and dance. The dancing on Soul Train was always innovative and remarkable. Cornelius (as cited in Stern J & M, 1992) recounts,
Twenty years ago every region of the country had its own style. But now dancing - at least street dancing - has become a universal language, and I think that's due to television in general, and 'Soul Train' in particular. (p466)

Though a few crossover artists appeared on the show, the majority were soul artists from James Brown, Aretha Franklin, and Chuck Berry, to the hottest "rappers" of the day. It was also the first place that labelled sportsware was seen and sculptured afro haircuts.

"Sitcom" pop

T.V. "sitcoms" have also played a significant role in the proliferation of popular music. The most successful was possibly the first. It is unlikely that any one anticipated such popularity would come from what was nothing more than a scene from one of the show's scripts. Following on from a success on radio The Ozilie And Harriet (TV) Show appeared in American living rooms in 1952 and ran for several years. The public watched the Nelson boys, David and Ricky, grow up, and when Ricky was old enough, he showed them he could sing. In 1957 he sang "I'm Walking" as part of a show about him becoming a performer because his girl friend loved Elvis. It became a top 20 hit. His music segment at the end of the show became a regular feature. Ricky Nelson had 57 top 100 hits and many of them were in the top 10.

Examples of other music-oriented shows are two which were concocted for T.V. The Monkees hit the airways in 1966. A great deal has been written about this program and the music that came out of it. The program and the act was totally manufactured and all of the hits were performed by studio musicians, primarily songwriters Tommy Boyce and Bobby Hart. Each episode included at least one music video segment. Nearly all were in the style of the Beatles' movie Help! (directed by Richard Lester) which had been released the previous year. In a two-year period the Monkees had 5 number one hits. The other show of some significance was The Partridge Family (1970) which had singing as an integral part of the story line about a musical family. The Partridge Family, featuring one of its stars, David Cassidy, had several hits (sung by Cassidy and Shirley Jones) which were launched by exposure on the TV show. Cassidy later went solo and had several more hits.

The modern music video

The mid 60s provided lots of opportunity for labels to present their acts on TV, but often, an act wasn't available at the time of broadcast, so an increasing number of labels produced video/film clips. In the U.S. these clips were seldom used on TV. But as it turned out, in the U.S. programs such as Shindig and Hullabaloo only rated for a short period and were off the air by 1966. In the late 60s through the 70s there were very few outlets in the U.S. for video/film music clips. Only American Bandstand and a few local dance programs remained along with the late night weekend performance programs Midnight Special and Don Kirshner's Rock Concert. In the U.K. and Europe, pop clips were frequently used in variety programs, in particular on Top Of The Pops.

In the 60s some British pop acts began to experiment with images for their music. These were fully scripted concept clips shot to fit the music. Most notable was the Kinks' "Dead End Street" (1966), The Who's "Happy Jack" (1966), the Beatles' "Penny Lane" (1967), "Strawberry Fields" (1967), and "Hey Jude" (1968). These clips marked the beginning of as Russell (1994) puts it "a quirky and ground breaking art form. In most cases, the musicians were pictured in bizarre sequences that deviated from the norm" (p. 194). In the States some labels remained committed to developing clips for the best of their pop stars despite the seeming lack of program outlets, and in any case the clips had proved to be effective, internal promotion tools. Many acts were filmed or video taped for the sole purpose of presentation at sales conferences. Beginning with the disco craze in the 70s there was also a growing number of dance clubs that played video clips and this was seen as an important promotional outlet by the labels. Some of the videos we see of pre MTV acts were made for these purposes. Warner Bros was the most active and named Van Dyke Parks as Director of Audiovisual Services. He had produced video clips for many of Warner's acts including the offbeat Captain Beefheart clip "Lick My Decals Off, Baby" which was one of the first clips to be used as a commercial for a band's album.

In 1975, a promotion clip of Queen's "Bohemian Rhapsody" was produced. It was shot in four hours and edited in a day, but it had a unique stylistic quality that went with the operatic aspects of the song. The clip made its way onto Top Of The Pop in the U.K. and Midnight Special in the States. Its showing had immediate results and was considered key in giving the single a 24 week run on the charts and ultimately a position in the top ten. From then on, inexpensive music clips were produced for most artists who had any type of budget. Most were done for under $10,000 with a minimum of production and post-production. In 1977 Warner set up a video production/
promotion division for the purposes of getting its videos into college student unions and commercial nightclubs. By the early 80s, video in nightclubs had become an important aspect of artist promotion. There was also a growing network of closed circuit video programmers who assembled and distributed music clip reels.

Cable TV and MTV

Cable TV opened up the video market because there were suddenly dozens of channels in every cable network. Cable operators needed to find niche programs for all of these channels and one obvious format was the music video clip program. The first music video program appeared in 1969 in Atlanta, Georgia and ran for a year and a half. The Music Connection was an all weekend program of spliced together tapes of different versions of the same songs. A DJ provided voice over intros. News, weather and sports were texted across the bottom of the screen. A decade later, the emergence of MTV, and the expansion of music video programs, became the catalyst for new acts to increasingly emerge from TV and the video discos. Video artists began to break on MTV before radio began to play their music. This first group of video artists would include Tom Basil, Adam Ant, Culture Club, Haircut 100, A Flock Of Seagulls to name a few. Madonna and Prince were two of the first to become superstars through the video. Video images meant that the artist's music was only one aspect of his/her persona. Artists now had the ability to become leaders in fashion. While popular musical artists had, in the past, affected fashion trends, the video meant the statement could be extremely focused, and reinforced with every replay. Suddenly there were significant outlets for music video clips and their value was obvious. As a result, budgets for such productions rivalled that which was spent on the music production. As Billboard pointed out at the beginning of the video clip revolution: "Unlike all other art forms, music video clips exist to sell product. Regardless of their look, regardless of whether or not the artist makes an appearance, virtually all are advertising for albums and artists" (Pott, 1983, p.3).

In the 70s, Mike Nesmith, former Monkee, had become a critically acclaimed video artist. In early 1981 he created and produced for the fledgling Warner Cable "Pop Clips". Later that year Nesmith received the first video clip Grammy for his long form music clip "Elephant Parts". In August 1981, Warner Cable transmitted its first MTV program to 2 million subscribers.

MTV not only revitalised the record industry and crossed over to other media and advertising outlets, but most importantly it constituted a 'community' for consumption. This sense of an MTV community was accomplished by the 'look' of the channel and its format. (Schwichtenberg, p. 121)

It started with a $20 million dollar budget and a few clips. "At the time, the labels were sceptical about MTV, but soon entire music video departments would spring up to service the new promotional medium" (Gillen, 1994, p. 108). Exposure on MTV generated immediate increases in music sales.

I had 15 copies of the Buggles' LP sitting in a bin for eight months", a Tulsa, Oklahoma based retailer told Billboard. "Once Video Killed The Radio Star' appeared on MTV," he said, "I sold out" (Russell, 1994, p. 196).

In 1981, EMI invested $200,000 to shoot three video clips on location in Sri Lanka for Duran, Duran (including the early MTV favourite "Hungry Like The Wolf"). Then in 1983, $150,000 was spent on Michael Jackson's "Beat It". The video paid off. The song was from the Thriller album which had sold 3 million units prior to the release of the video. As soon as the video appeared on MTV, the album started moving at the rate of 200,000 units a week. Michael Jackson was the first black artist on MTV. Previously MTV had not shown anything but mainstream white artists. His reputation as a video artist was further enhanced when the clips for "Billie Jean" and later the 13 minute, million dollar mini film, "Thriller" appeared on MTV.

By 1983 MTV and music videos had become an integral part of pop culture and record sales. The cable channel was profitable in two years of operation, far surpassing all expectations. "The network had created the 'MTV Generation,' and the term 'MTV' was used as an adjective for 'hip', 'cutting edge', and 'stylish'" (Russell, 1994, p. 202). Since its introduction, MTV has undergone several changes. MTV has moved toward what can be described as a life style format with a number of non music segments, and away from 24 hour continuous music clips. One of these segments, in its own right, has established a whole genre of pop music albums. The MTV "Unplugged" programs have been responsible for several number one albums including Eric Clapton, Tony Bennett, Nirvana, and Led Zeppelin (Robert Plant and Jimmy Page). This has happened in part because the original MTV generation is now in its 30s, and, with babies of their own, are unable to attend concerts as they once did, and will turn to MTV for video concerts.
Over the years MTV has been criticised, most recently for some segments of its life style programming such as the Bevis and Butthead cartoon series. Other past practices that have come under fire have included the exclusion of clips from black artists with the notable exception of a few who were well established in mainstream pop such as Michael Jackson. Also MTV had so much power that it could insist on exclusive rights to show a clip. This policy was objected to by the labels as well as TV stations and small video clip providers. Even though in 1987, MTV won an antitrust case, the policy has since been modified.

In the 80s, a wide range of music video programs were developed. Some were successful, others were not. The broadcasters also found that clips did well in some time slots, not in others. NBC ran a late night clip showcase, Friday Night Videos, from 1983 until 1993. In the mid 80s The Black Entertainment Television Network started running R&B clips on its Video Soul program. Country video clips from Nashville based TNN and CMT have been growing in popularity since their introduction in 1983. 1983 was also when Playboy TV created its all adult oriented sexy and uncensored Hot Rocks cable program. In Canada “MuchMusic” appeared in 1984, and in 1985 The Box started on the Jukebox Network to become a key outlet for rap and hiphop music. The Box is the first cable service to allow viewers to program the playlist for a fee. As cable services have expanded world wide, narrower and narrower niches of the music video market have been targeted. In 1993 Z Music began which features contemporary Christian music artists. Another is the Americana Television Network which telecasts blues, jazz, bluegrass, folk, and country. The MTV style format has expanded internationally to include Germany’s Viva, Sweden’s Z-TV, and France’s MCM. MTV has also expanded into Europe (from 1987), Brazil (from 1990), and developed a Latin American format (1993).

Video music programs have become such a significant factor in determining song popularity and general music trends that radio programmers consider video playlists as well as other chart ratings when they make up their playlists. Similar to the practice of making monophonic singles mixes, the versions released to radio are often different to what is heard on the video clip. On radio, Michael Jackson’s “You Are Not Alone” is slightly faster, and has a significantly more dominant hi-hat and drum beat. The music on the video clip is more gentle and ballad-ish.

While video programs continue to show new talent, most of them now use a sizable percentage of music clips from the past. This interest in images from the past is an extension of “Golden Oldie” programming, and has caused vast amounts of film footage and videos of artists from previous decades to be found and edited into useable “classic video clips”. Most recent is the 30 year-old Beatles’ song “Baby It’s You” which primarily uses mid 60s film footage of the band playing, and coming and going from the BBC.

Video clips as consumer products

While many music video clips continue to provide new and innovative images and advance the interplay of music with vision, most now fit into a formula that provides an easy means of categorisation. Frith (1988) identifies three types of video clips: performance, narrative and conceptual. The first is a real or staged “live” performance that is lip-synced to the record. The second may have the performers singing, but much of the video will be scripted like a film, and clearly follows the theme of the song. Conceptual videos use images that may not necessarily directly relate to the song, but which are selected and paced to evoke a response and engage the viewer.

As such, conceptual videos are associative (rather than casual, like narratives) because they present sets of images loosely related through the dynamic interplay of music and movement. This type of visual music proffers suggestive resonance to be linked together in our musical experience of a concept. (Schwichtenberg, 1992, p 124)

Clearly identified styles of video production, musical content, and images (visual content, topic, artist portrayal, etc.) furthered the ability of the music industry to commodify the video clip and music related videos into consumer products. Sony began in 1983 to experiment with selling “singles” video clips for a reduced price. These tended to sell best with controversial artists and when the programs contained material that could not be found elsewhere such as back stage footage or interviews. Heavily hyped artists such as Prince, George Michael, or Madonna have had financially successful video singles. In the area of long (movie length) music videos, well known super artists with dedicated followers have sold well. Garth Brooks, Ray Stevens, New Kids On The Block, Metallica, Abba, endless Elvis Presley titles, and the Beatles videos have all sold well. In the 90s most major tours are available on a commemorative video during the time the artist is on tour. Direct marketing of videos through cable channels has been quite successful for companies such as MOR Music TV and MaxMusic. These merchandisers also sell a wide range of other music products (oldies music clip compilations, T-shirts, tour jackets, stereo systems, music related games, related multi-media products).
Many music/video artists are now developing interactive programs that contain music clips as well as video games featuring the artist. These products also allow fans to program the playback of their choosing. The CD's application in video and interactively has now created the multimedia audio/video artists. Todd Rundgren, Michael Jackson, and Madonna have all signed multimedia deals and are now, or will be, developing interactive music videos. Warner, BMG, Sony, EMI and many independents have all begun work on how to best turn musical artists and assets into multimedia productions. Geffen, Sony, A & M and again many independents are also converting their existing musical resources into interactive video games.

The future may provide through cable systems, direct access and realtime playback of any video contained in what would be a large, audio/video centrally stored jukebox. Someone could select a song, or create a playlist, and without making their own copy could simply play those selections and be directly billed for the service. Or if they want their own copy to play on a portable system they could use the same information super highway and download the program to a video storage medium of their choice and again be directly billed for it.

Summary

The technological development of sound film, television, and video tape recording and their distribution, internationalised the music and virtually made a product of the personae of popular music artists. Dramatic music provided an entirely new avenue for the creative efforts of popular musicians. From film and television grew an entire industry involved in scoring and editing music for film and television. Outside of dramatic music and scoring, film and television has been directly and indirectly responsible for promoting throughout the world the latest trends in popular music and the youth culture that associates with it. The popularity of surf music was established before the release of the first beach movies, but the beach movie brought surf culture, its music and artists to places that had never heard of surfing, much less surf music. In most cases, the producers of movies and television have followed musical trends and created stories that capitalised on these trends. They have on several occasions established unknown musical acts, and initiated a pop music entity (such as the Monkees) and subsequent associated trends in style.

The development of film/video visual music was a key innovation for the further commodification of popular music and the artists who create it. The music clip was initially the software in a visual jukebox, a natural extension of the record juke box. These clips quickly became useful as "in-house" marketing tools that were shown to record distributors and promoters. Their importance increased when broadcast television stations started using clips on some of their pop music programs. With the spread of cable TV, music clip programs began to appear, and the video clip began to have a significant impact on record sales. The appearance of MTV and all other music clip programs have made the music artist a video star. Music video now has the power to break unknown acts, and in many cases play artists that radio will not play, such as most rap music product. The consumer's appetite for visual music has caused many record companies to form video/film divisions that market video product that are collections of clips, live concerts of well known artists, and movies that feature popular music. This trend toward the integration of sound and image has developed a new generation of pop music artists who see themselves as creators of multi-media, not music alone. The rapid expansion of computer technology has provided the delivery platforms that are needed for the successful commodification of these latest innovations.
Notes: Chapter 10

1 Scott McKenzie's only hit was "San Francisco (Be Sure To Wear Some Flowers In Your Hair)"
BACKGROUND MUSIC:
AN ENGULFING COMMODITY

All types and styles of sounds and music exude from the walls and ceilings of the spaces we pass through. Popular music occupies a unique place because of the "time and place" seasonal quality of any given song. Popular music in its original form (e.g., the hit version) is heard from countless background sources such as shopping malls and trendy shops. The same song will also be produced in a version appropriate for application in hospitals, hotels, and elevators. We hear it at work and in most public places with or without our consent, consciously or subconsciously. At the end of this century there will be very few who can remember when this was not so. In any of the westernised cultures, this background has become continuous and seamless.

There are few commodities that are unseen and void of opaque physical form, but background music is just that. This music that surrounds, that is beyond our control, is such a commodity. Born during the age of industrialisation, it was developed and sold to improve assembly line efficiency. No other delivery method is so all pervasive, and some would say intrusive. Vast resources have been invested by industry into the effect of background music on people. A science has now been made of the methods for programming music so that it is sequenced and paced to help people do other things—work, play, eat, queue, shop, convalesce, etc. Background music has become the subject of countless papers addressing specific issues such as efficiency, its effect on the industrial workplace, cultural and social ramifications, and the like. This chapter touches on some of these issues in particular as they apply to the delivery of popular music and the effect that background music has had on the music producers. The chapter will touch on the technological contributions that the background music industry has made in improving and developing the delivery mediums of records, tape, telephone and non-commercial radio.

Background music has become a part of 20th century western civilisation and its universality knows no comparison. Commissioned compositions of no distinction were once the most common background music but now popular songs are produced in a style acceptable to a given background music format. But when a Beatles song (or any other known song/artist) is played by a background music orchestra it is nonetheless a Beatles' songs. More than likely, if listeners are familiar with the song, they will not only sing along in their mind's voice, but recall the original and all that is associated in their own lives with the original. Background providers have commissioned countless music creators to produce these programs. Many of these producers have also had successful careers in commercial popular music. This chapter will touch on some of those who have been successful in both background and commercial music. Obviously those who produce music are also travellers through this wash of sound, but for them it may have a creative influence of some consequence. This chapter explores the various effects of this technology on the listener and the music producer in particular.

A surrounding of sound

Background music surrounds us no matter where we are. It is never too loud, never jarring, never too soft (except of course in music and other youth oriented shops). It is always there and we expect it will be. If it is not, we are uncomfortable. A common role of background music in the lives of so many people is a sort of "company". Its existence behind whatever they are doing makes them feel comfortable, secure, or simply not alone. Lanza (1994) says,

'Psychoanalysts might say that it displaces our attention from music's manifest content to its more surreal latent content. Hearing it we are inspired to frame an otherwise disordered and boring existence into movie scenes whose accompanying soundtrack alternately follows and anticipates our thoughts and actions. (p. 3)
Most will also agree that background music enhances or at least makes bearable the experience of any repetitious task, or ones that don't require undivided attention. Young people often claim that they can concentrate on their homework better if the radio is on, or when they're plugged into their CD player, and maybe they can (though most parents will probably disagree).

The successful use or failure of musical wallpaper (as Frank Zappa described background music) to achieve some goal, depends on an endless variety of conditions. However, it is widely accepted that it distracts from analytical work or memorisation (unless the music is extremely simple i.e. no rhythm, melody, or repetition), or is so familiar that the brain finds nothing new in the music. On the other hand, creative work can be stimulated by appropriately selected background music. English author Sir Compton Mackenzie found that playing chamber music occupied those areas of his brain that were not involved in writing, and prevented them from creating thoughts of their own that would distract him. An interesting twist comes from writer Ann Beattie. She frequently played music as she was writing, and often the music ended up in her stories. Beattie commented once, “At times, I think the story grows out of the song” (Eisenberg, 1987, p. 80).

The past's view of the future

In 1887 Edward Bellamy wrote a futuristic book called Looking Backward which imagined what life would be like in the year 2000. He imagined that homes would have different acoustically correct chambers that would be filled with piped in music. The music would be programmed to flow from one selection to the next and appropriately chosen to augment what the listener might be doing. Someone in a position to make such things happen, Edward J Hall, new vice president of the fledgling American Telephone and Telegraph Company described in 1890

a scheme to have a fine band perform the choicest music, and distribute them to any number of subscribers who could listen to their favourite operas while enjoying the evening meal, and the effect will be as real and enjoyable as though the performers were actually present in the apartment. (Marvin, 1988, p. 80)

The 1920s was a decade of wired music. The whole concept captivated writers who mused about the application of background music in the future. Erik Satie, in 1920, wrote about “furniture music” which was designed to complement urban life, possessing melody but produced in some fashion that was emotionally neutral. In 1929 Elmar Rice wrote a novel about life on a distant planet where “melody is as much a condition of life as are light and air”. The planet’s inhabitants slept, woke, and lived with “an omnipresent harmony; now pathetic, now gay, now ominous, now martial, now tender, but always awakening familiar memories, always swelling, mellifluous.” (Lanza, 1994, p. 28). With so many writers fantasizing about the application of music as a background of the 20th century, it is no wonder that those with the ability to implement the concept would do so.

The film industry may have been one of the first to recognize the importance of music as an unheard background to events. The music in film, as it is in life, provides a continuity of events. The film score connects times and places that are not cinematographically contiguous. Background music in real life does much the same thing. The 1932 MGM movie Grand Hotel was one of the first films to have music that was played by musicians In the picture, as well as a score that was outside the picture. Music came out of speakers in the halls of the hotel and went up and down in volume as doors were opened and closed. The score to Grand Hotel may well have “inspired Muzak’s arrangement of the scores of our lives” (Lanza, 1994, p. 56). As movie music developed, composers began to attach themes to moods, places, characters, and so on.

It was obvious to any film producer that music was a requirement for any film, but low budget “B” films were often unable to afford specially produced scores. By 1930 this need was satisfied by flourishing libraries of music. Music was provided on a per minute fee basis. These same libraries were used by news reel makers, radio commercial makers, and so on. The libraries made up of music that was not identifiable as anything that had been previously popular, but their frequent use caused some of the pieces to become identified with certain people, products or programs. The library producers were some of the first to identify music selections by the mood they were supposed to set or portray: “rush hour”, “the wee hours”, “dawn”, etc.

The start of Muzak

At the beginning of the 1920s, Brigadier General George Squier, the inventor of Muzak, took his idea to the North American Company, a Cleveland utility company. In 1922, North American started a subsidiary, Wired Radio, that was expected to compete with the emerging radio industry. For several years they experimented with methods of delivering music programming direct to homes via telephone lines and did trials in a few suburbs. In 1930, North American, through
the delivery system of Cleveland Electric Illumination Company, attempted to use the power lines to send three channels of music into homes in a suburb of Cleveland. The service cost $1.50 a month. By 1933 the company had concluded that its market was not the private home, but restaurants, hotels, and other types of public locations. It also abandoned the use of electric wiring for transmission because the interference was too high. It started leased telephone lines for music distribution.

We will return to the history of Muzak later in this chapter, but first a description of some of the theories behind music's relationship to work, and as a background for other types of experiences.

Research into background music

Work songs have been around forever: songs to sow, to hoe, to pick, to plough, but these songs were all initiated by and came from the workers. They reinforced and reflected a natural rhythm of the work day, its peaks and valleys. Background music, on the other hand, was born with the Industrial revolution and initiated by the employer. The use of piped-in music as background for industry, education and sports has been used and studied since the 1930s, but began to have wide spread usage in the mid 1940s. Its first purpose was to fill the industrial shop floor with music that would stimulate workers to work at a regular pace, so that they neither got ahead of, or behind, the machinery. Controlled studies in industry also identified other benefits. In the 1930s, the Stevens Institute of Technology found that "functional music" reduced absenteeism in the workplace by 88%, with a 53% reduction in early departures. Studies by Lever Brothers, Fairfield University Language Laboratory, and the U.S. Army Engineering Labs showed that background music programmed in a "stimulus progression" increased office output, reduced stress, lessened costs, enhanced worker concentration, and improved personnel morale (Lanza, 1994, p. 162-165). Other reports followed and all of them substantiated the favourable impact that background music had, first in the workplace, and later as a wash for most other activities. Later research would find that the music was not so much the reason for the favourable results, but its ability to provide a diversion from boring and monotonous working conditions. The addition of the outside stimulus of background music created a positive effect on workers and those passing through public spaces. Background music provides a familiar surrounding in those areas we might otherwise find disturbing or uncomfortable sounds, such as the cables and chains clanking on the elevator roof, or passing conversations coming through hotel room doors.

At times there has been some strong objection to the existence of background music on grounds it was an invasion of privacy. In 1951 a case went all the way to the U.S. Supreme Court regarding background music in Washington D.C. trains. The court concluded that the presence of background music was not an invasion of privacy and that it was not "inconsistent with public convenience, comfort and safety and tended to improve the conditions under which the public ride". Justice Burton also quoted a 1949 public opinion poll that indicated that 93.4% of the public had no objection to the music and 76.3% approved of it outright (cited in Lanza, 1994, p. 51-52). In the 1990s, there is an increasing awareness that background music, rather than intruding on the silence, actually provides a sonic mask, covering up the cacophony of our society. True silence is a rare commodity that is only found in the quietest sound studios, acoustic labs, or far from civilisation. A majority of the public is not comfortable in such silence. Background music provides a continuity amidst all the disassociated noise. Harold Burris-Meyer was one of the people who implemented in the late 1940s Muzak's most elaborate program "Stimulus Progression". In a 1946 Reader's Digest article, he wrote,

If people who claim they require absolute silence were placed in a vacuum, they would probably go nuts. We are conditioned to sound, but our present need is for more that soothes us and less that frays the nerves. (Lanza, 1994, p. 54)

Background to the foreground

The background music industry has also become a foreground product. Most markets, shopping malls, department stores, food stores (and so on) have their own prepared music tapes which include store specific promotional and sales announcements. Such locations include youth oriented clothing and specialty stores, amusement parks and other leisure locations, etc. These oriented formats now include music with lyrics and commonly include material sung by the original artists, sometimes which early background music formats specifically avoided. Every amusement park theme area has its own blaring environment, and shopping malls have "contemporary" shop now has its own blaring sonic environment, and shopping malls have amusingly playing in each area of the garage. The motorist may not remember the floor, or the wall, or the letter on the pillar, but they quickly recall that when they parked, a certain song was playing. Even if there isn't an attendant to tell them the floor where that song is playing,
motorists can stick their heads out of the elevator and quickly recognize the song for the right floor. As Brian Eno commented in a 1986 article, "We can use recordings to insert a sense of place in the various locations that we end up in" (Jones, 1992, p. 182).

The latest in the story of background music distribution is the emergence of cable radio. General Squier's original plan to provide music to every home has finally come to fruition via the same distribution system that provides dozens of channels of cable TV. The largest provider of this service is Digital Cable Radio. This company has a central control room in Hatboro, Pennsylvania. From there the company transmits several programs digitally to a satellite which downlinks the signal to satellite dishes at nearly every cable TV operation in the U.S. There is a sister facility in Europe. In Japan, a similar service was begun in 1961. Osaka Yuseki Broadcasting goes into over a million homes and businesses. The Japanese service includes channels with Japanese zithers and koto music, bells, insects, animals, babbling brooks, and even street sounds to help the illusion when someone wakes up late and calls into work to say they're stuck in traffic.

The commercial success of background music producers

There have been many occasions when a composition started out as background music and later became foreground music. That is to say that a background instrumental became a hit record. In 1956 Hugo Winterhalter's "Canadian Sunset" went to #2 on the national charts, and Horst Jankowski had an international top ten hit in 1965 with "A Walk In The Black Forest". But the most successful performer would be Roger Williams who arpeggiated his first hit in 1955 with "Autumn Leaves" which was #1 for four weeks. From 1955 to 1969, he had 22 Billboard hits including the classic "Born Free." from the movie of the same name.

Over the years, successful mood music and Muzak composers and producers have also done well in other areas of record production. Such mainstream composers/ conductors as Frank Chacksfield, Lawrence Welk, Arthur Lyman, Peter Nero, and many more have had parallel careers in background music, movie scoring and record production. Most record labels have also marketed background and mood music albums. As earlier discussed, in the 1950s, some of these albums were the first to use stereo positioning, and were an ideal sonic showcase. As Lanza (1994) put it, "Their acoustical forays into advanced sound technology allowed the record producers and engineers to accrue stardom along with the musicians". (p. 70). In 1950, the 101 Strings billed themselves as the "World's First Stereo Scored Orchestra", and prominently featured on their albums a colourful spectrum representing what the human ear could hear and claimed that they were using the latest in binaural technology. According to Lanza (1994):

..they modernised the classics by exposing them to a new acoustic technology, by experimenting with the 'stereo depth' of microphones, and by practising the art of layering to generate sounds rarely heard at live concerts. (p. 137)

The technology was key to creating the right mood that the producers were attempting to portray. Mantovani was enormously successful with a sound that used a reverb process that Decca had developed. Arthur Lilley, Mantovani's engineer, would make the studio as live as possible and use many mikes at different distances on the strings to get as much reverb as possible. Mantovani's records also used Decca's "FRRR" (Full Frequency Range Recordings) process which was developed partially through W.W. II research. Some of that research came from Berlin's Jesus Christus-Kirche cathedral, whose acoustics were used extensively by Deutsche Grammophon in the early 40s. When the U.S. established RIAS (Radio In The American Sector) during German reconstruction, one of its engineers came across the church and started using it for modern recordings. Andre Kostelanetz also had a high regard for what modern engineering techniques could add to the sound of his records. Many special microphones and reflecting panels were used in his radio performances as well as recording sessions.

Ethel Gabriel, one of the first female record producers, was responsible for Melachrino, Moods in Music, and countless "Living" series albums (Living Strings, Living Brass, Living Voices, etc.). She had a certain feel for mood records, and was one of the most successful producers of this type of music. She often used a church on New York's 19th street that had been turned into a studio, but when it wasn't available for the required ambience, reverb alternatives were improvised. Gabriel (cited in Lanza, 1994) describes one such technique:

Echo was important back then. Before we got the German echo chambers in the early sixties, we found that the best echo was through the men's room at RCA's studio on 24th street. When Toscanini recorded at places like Manhattan Centre, they would channel his music through it and pipe the sound into the studio. (p. 90)
In the creation of music there are many that see a converging of background music with other forms of mainstream music. Environmental, mood, and meditative music can easily fit into what was, in the past, background music. Some of the music which most relies on technology, techno-pop, also has a close association with background music. Considine (cited in Lanza, 1994) comments:

In an odd way, techno, the intensely robotic dance music that's all the rage in Europe these days, has much more in common with new age music's fondness for soft textures and quiet melodies, but both styles do tend to work better as a sort of functional background music. (p. 212)

Background music's influence on the musician

At the beginning of this chapter is a reference to writer Ann Beattie's description of how she listened to music as she wrote, and that sometimes the music made its way into her stories. But what happens when music makers are unwittingly influenced by the background music that surrounds them? Even if they don't like background music, can they avoid it? Where can they go to not hear it for even a day? In 1992 John Sbarra filed a copyright infringement suit in the Federal Court in Newark, New Jersey against John Addison, one of the top composers for film and television. In particular, Addison wrote the theme for the TV series, Murder She Wrote, which it was claimed in the suit sounded very much like "Basket Full Of Wishes", a tune written by Sbarra and Joseph DiBuono in the early 50s. There's nothing particularly new in one composer claiming that another has plagiarised. What made this case unusual is that Muzak was named as a catalyst since the Sbarra tune could only be heard on Muzak as a background melody. The song had been exclusively licensed to Muzak since 1981, and used regularly since that time. Addison said he never listened to Muzak, but is it possible to avoid it? It surrounds us like air and invades our unconscious consciousness. While Addison could claim to never listen to Muzak, he couldn't avoid hearing it. But can he be held responsible for unwittingly assimilating it? Lanza (1994) observes:

Sbarra's case may ignite an explosion of similar legal battles as background music's influence tangles the notion that songs are aesthetically distinct units with names, owners and homes. (p. 215-216)

The case is still working its way through the U.S. legal system.

A closer look at Muzak

With the emergence of background music came the birth and growth of the Muzak company. It is virtually impossible to go a day in modern society without being exposed to it. Muzak is such a part of our culture, it bears a closer look. The Muzak Corp. wants its product to be heard but never listened to, to be omnipresent, but never draw attention to itself. It was developed to smooth dips and peaks in worker productivity. In the beginning "Music by Muzak" was a collection of classical, semi-classical, pop vocal, quasi-Pacific and Gypsy tunes. A more standardised format was developed in 1936 that included specific sequencing, timing and pacing of the material, the avoidance of slow music, and no Waltzes and tangos after 12:30AM. This format also evaluated vocal impact and completely avoided vocals between 9PM and 12:30AM. Traditional Muzak is programmed in 15 minute segments, with five selections per segment. Each of the five selections is more stimulating in terms of tempo, rhythm, and orchestration compared to the previous selection to give a sense of time that is dynamically and significantly moving forward. As the Muzak brochure puts it, "Each fifteen minute segment contains a rising stimulus which provides a logical sense of forward movement. This affects boredom, monotony, and fatigue".

Since the introduction of this format, Muzak has continuously analysed its programming strategy for various target audiences. By the late 30s, Muzak had four networks and also acted as a redistribution service for interference free transmission of New York radio stations WABC, WOR, and WEAF. In 1948, "Traveling Muzak" was introduced with songs such as "I Want My Mamma" and "I'll Be Seeing You" on trains, planes, ships, etc. Muzak also responded to certain types of requests. Its most popular was a wedding sequence. Over the years, Muzak has developed different programs depending on the application, e.g. offices, light manufacturing, heavy manufacturing, elevators, lobbies, etc. Some years ago, Muzak expanded into non-workplace environments. It now distinguishes programs between those emphasizing efficiency, and those that are for "general well being", that create friendlier atmospheres for customers in shopping areas.

According to a Muzak in-house publication entitled Environments (1972), "Program specialists... assign values to the elements in the musical recording, i.e., tempo, (number of beats per minutes); rhythm (fox trot, waltz, march); instrumentation (brass, woodwind, strings); and orchestra size (five piece, symphony, etc.)." There are few soloists (vocal or otherwise), and only those...
selections that pass the “test” are added to the programs. The Muzak company prides itself on having a background music formula that it believes can assist its customers to meet specific needs. The fact that nearly everyone who has an opinion about Muzak is bored at best by the selections is ignored by the background music provider. Those even less kind regard Muzak as rigid, formalised and manipulative. Nonetheless, more than 100 million “non-listeners” a day pass through spaces referenced to Muzak time. Many more are exposed to generic and unofficial Muzak. With the invention of tape recorders, the installation of background music systems became substantially easier. By 1955, RCA and Capitol had established arrangements with Magnecord, an early tape recorder manufacturer, to provide music for restaurants, offices, factories, etc. All sorts of Muzak “wannabes” entered the background music business, all of them hoping to find a specific niche in the market. One of them recorded a selection of material at New York’s St Patrick’s Cathedral for a catalogue entitled “Music For Mortuaries”. The J.P. Seeburg Co, well known for its jukeboxes, also entered the background music market. It had some advantage going into the market since it already had a music catalogue of 7000 titles. Seeburg also entered the domestic market in an experiment that connected 570 new homes in a suburb of Detroit with Seeburg “Select-O-Matic” units that were connected to a central studio. The music went back to the home through telephone lines. In 1952, to meet this new competition, Muzak began delivering long play tape programs, and its first tape playback unit in 1953. These systems were ideal for smaller communities, or specific applications. Muzak also franchised its operations into smaller markets. By 1955 it had 150 franchises.

Muzak’s future
From its beginning, Muzak used telephone lines to deliver its programs from its studios to customers. By 1950, Muzak was the largest consumer of phone lines in America. In 1955 it had begun to use sub-carrier signals, available through broadcast FM stations, to carry its programs. This method of transmission quickly diminished the need for telephone lines and considerably improved the sound quality. It is worth restating that Muzak has been responsible for the development and improvement of many aspects of record manufacturing and was one of the first companies to release vinyl long play records.

Muzak now replaces 20% to 25% of its library every year. Its environmental channel that we have come to identify as elevator music, remains its most popular product. However, it now has several foreground services that include adult contemporary, current AM rock favourites, and classical. In 1992 it began to offer ZTV, a video clip service. Over the decades, Muzak has worked for 43 of the world’s 50 largest corporations, and it has branches in nearly every industrial country in the world. With 500 subscribers, Australia is the third largest Muzak franchise. In the 90s, Muzak revenues have exceeded $400 million dollars per year.

Lanza, (1994) believes that

Muzak has always been at the forefront in producing music that directly addresses our role in modern life. Its efforts to use tempo and timbre to reflect parts of the day and to adjust them to the human ‘fatigue cycle’ reveals how walls, corridors, lighting, and the contours of manmade enclosures alter our perception and bio-rhythms. (p. 150)

Sharing Lanza’s view, but changing the angle somewhat, Dr James Keenan (cited in Lanza, 1994), an industrial psychologist from Stanford, presented an address, The Eco-Logic of Muzak, in which he characterised Muzak as being‘synomophic’ with the modern world and interrelated with all matters of time and place: “Muzak helps human communities because it is a nonverbal symbolism for the common stuff of everyday living in the global village... Muzak promotes the sharing of meaning because it ‘magnifies symbolism in which not few, but all can participate. (p. 150),

Summary
Background music grew out of research into efficiency and quality control on the assembly line. It was found that with the correct programming, music helped factory workers do their job with less boredom and more accuracy. Over the years countless studies added to the body of literature on the subject of background music and with few exceptions continued to reaffirm its positive impact on people relaxing, passing time, or conducting any repetitious task. Muzak became the leader in background music, and continues to lead the field that is now filled with other companies delivering different background/foreground program products.

As the industry grew, it began to commission music that would be suitable for its purposes, and countless numbers of music producers were involved in this process. Some of these producers and the music they produced became commercially successful. Background music has had a
profound effect on all modern musicians who have grown up passing through its sonic wash. It is
difficult to evaluate the influence this music has had on the creative production process, but it is
undeniable that it has been a factor of some kind. Background music has not only been a com-
modity, but has affected the subconscious of those involved in every aspect of the production of
all other music.
Notes: Chapter eleven

1 Edward J. Hall, Extensions and Improvement Of The Telephone Service, Electrical World, Sept., 20, 1890


3 The EMT plate reverberators described in Appendix 1.
THE JUKEBOX'S ROLE IN POPULAR MUSIC

The early commodification of recorded music

Popular music first became a commodity through the entrepreneurial activities of carnival and penny arcade operators who made their own recordings and then played them for the price of admission. It was in response to requests by this group of users that the phonograph/gramophone manufacturers began to produce prerecorded product. Without a doubt, the lack of success of the phonograph as a dictating machine also played a significant role in redirecting the product towards an entertainment delivery system. Coin operated music delivery systems did not decline as gramophones proliferated into homes. The opposite was the case. Not until the late 1930s was the cost of reproduction systems and the records themselves so low that nearly anyone could afford them, however, the spread of recorded music within the upper middle class, and radio had the effect of creating a desire for recorded music throughout the entire population. Coin operated systems allowed anyone for the price of a few pennies to hear his/her favourite and/or the latest record.

Often these would include recordings of local acts that were prominent in that specific community. By the mid 1930s in every jukebox there was a smattering of local releases. By 1940, those who chronicled the U.S. record industry were recognizing the importance of the jukebox. Jack Nelson wrote in Billboard (June 1940) that "coin operated phonographs, through a tremendously wide distribution, appeal to millions of individuals everyday, thus ensuring for this industry an important part in the next phase of American music" (Pearce, 1988, p. 41). The jukebox had become a significant centre piece anywhere small-town America gathered, and record sales to the jukebox operators were becoming significant. As Pearce (1988) describes it,

> It was the jukebox into which the lonely trucker at the coffee shop dropped his nickel to inspire dreams of his baby back home, the jukebox that the kids made for in Chuck Berry's song when they wanted to hear something really hot, the jukebox that linked communities whose local operator stocked it with songs and dances from the old country. (p. 9)

Choosing what records would go in the jukebox was probably the origin of the "Hit Parade", due to the limited number of records that could go into a machine, and the practice of installing new records weekly based on which ones were and were not played. The jukebox brought the choice of what music would be played down to who wanted to hear a certain song badly enough to spend a nickel. Boehlert (1994) observed:

> The jukebox undeniably changed the landscape of the music business, but it also brought democracy - one nickel, one vote - to entertainment. It transformed popular music into a more public, shared experience, one that continues to shape generations along rhythmic lines. (p. 93)

Since a jukebox, by its nature, is associated with a certain establishment and clientele, the jukebox trade had to have music that satisfied local tastes. The local jukebox operator kept a critical ear towards which records were wanted by those who used their machines. Charles Altro, a New Haven jukebox operator in the early 40s, was typical when he explained,

> We are fortunate to sell many used records to students at our headquarters. We not only keep a careful check on their purchases but discuss records and music with them personally. We also urge them to write us to save certain records for them. By these means we have obtained straightforward information on their likes and dislikes. (Altro & Yale, 1940).
Until television forced radio to reinvent itself, it was the mass medium, and with few exceptions had generally ignored blues, country, and other regional or fringe music. The jukebox filled this void. In the fifties, it was the jukebox where teenagers would find the latest in rock and roll. They were doing what Teresa Brewer suggested “put another nickel in...” but they were selecting Chuck Berry whose advice was to go

up to the corner and round the bend, right to the juke joint you go in. Feeling the music from head to toe, round and round, and round you go. Hail, hail, rock and roll! Deliver us from the days of old!  

Teresa didn’t know it, but her days as a pop artist were numbered as was the style of recordings she made. As the jukebox industry grew, the major record companies saw the need to do more than produce records that were for the broadest appeal. They also saw an increasing number of independent labels meeting the need of this ethnic and regional market, and they (the majors) realised they would have to enter this market or be left behind.

This chapter chronicles the development of the jukebox, an icon for youthful rebellion, nostalgia and rock and roll.

The first nickelodeons

The Columbia company (in 1890) seemed headed for liquidation, but it was saved by a new field of activity which was created, almost without its knowledge, by showmen at fairs and resorts demanding records of songs and instrumental music. (Read and Welsh, 1976, p. 108-109)

Columbia, Victor and Edison all began to recognise that their market was not in dictating machines but in domestic entertainment delivery systems and in record players at carnivals. They also realised that in order to sell players, they had to produce and manufacture prerecorded product that the consumer wanted to hear. Initially the preferred programs for coin operated players were comic songs, bands, monologues, and whistling. The revenues from these “pay for play” machines was amazing in light of the fact that the quality was poor and the selection meagre. “Certain machines yielded up to fourteen dollars in daily earnings” (La Nature, 1891 cited in Attali, 1977, p93). Edison was perplexed by the coin operated carnival players. He feared they might create the impression that the phonograph was only a toy. His worries were unjustified, since the showman-operated players cultivated a consumer appetite for recorded music and desire for players in their homes.

As the turn of the century approached, the penny and nickel arcades were becoming an increasingly popular centre for entertainment. There were hundreds of different coin operated amusements. The most popular of these machines were those that played music. Into this market came the nickelodean followed by the first jukebox. The first jukebox appeared close on the heels of the introduction of the phonograph. Louis Glaz installed an Edison cylinder system at the San Francisco Royal Palace in 1889. In 1906 the Automatic Entertainer, which used Berliner style flat records, was introduced by the John Gabel Company. The system was entirely mechanical and required winding up. It was popular in spite of the poor quality. In Paris, at the Pathe Salon du Phonograph, patrons could choose a musical selection, which would be played for them from the floor below where there were a battery of players. As in San Francisco, they would hear their selection through listening tubes.

In France, Claude Debussy was perplexed by the emergence of such jukebox emporiums where, for a few coins, a selected recording would be played. In a broader context he was probably more worried about home phonographs and playing music at home. The following quote has two interesting points. While he was concerned that the low cost of the disk and its availability would have the effect of cheapening the music itself, he acknowledged that the discs preserved a certain magic. In 1913 he wrote (as cited in Eisenberg):

In a time like ours, when the genius of engineers has reached such undreamed proportions, one can hear famous pieces of music as easily as one can buy a glass of beer. Should we not fear this domestication of sound, this magic preserved in a disc that anyone can awaken at will? Will it not mean a diminution of the secret forces of the art, which until now have been considered indestructible? (p. 55)

Debussy, like so many other classically trained musicians had fears about how this new technology would impact on his beloved art, and probably his concert income.
The jukebox and nickelodeon changed the way people heard the popular music of the day “by placing the day’s hits within reach of the increasingly mobile masses” (Boehlert, 1994, p. 93). The coin operated record player of the turn of the century was exceedingly popular for a while and then people got bored with it. So many other coin operated musical machines were considerably more visual and enticing. The most elaborate player pianos had mechanical animals playing drums, cymbals, harps, horns, violins, etc. Most notable were the player pianos, or orchestra in a box systems such as the Wurlitzer Tonophone, Lyon and Healy’s “majestic, pneumatic, self playing pianos”, and the Rosenfield “coin slot illustrated song machines”.

The modern jukebox

With the introduction of the electric phonograph, motors and amplification, the modern jukebox became a reality. Somewhere in its early years, the coin operated record player acquired the name “Jukebox”. There are several theories about the origin. The most accepted is that the word “juke” is a corruption of the word “jook”, a black American slang term for dancing. The source of the music for this dancing would have been called a “jookbox”. A second version is that “jook” meant “sex” which may have made sense since brothels were some of the first establishments to install jukeboxes. A third source of the word may have been from the term “jeep”, or “jute joints” where the jute pickup workers relaxed, drank and danced. Whatever the source of its name, the jukebox of the 20s was generally associated with “speakeasies” and the “low-life” of prohibition since they were featured entertainment in such places.

In 1926, J.P. Seeberg, a Swedish immigrant to the U.S., invented an electric system that was coin operated and would play any of eight records. A year later Automated Musical Instruments introduced its electric jukebox. Unlike their mechanical predecessors, which could only be heard by fee paying patrons standing near the machine, these systems were capable of filling an entire room with sound. These innovations rekindled interest in the jukebox and so began the modern jukebox craze. The other two major manufacturers of jukeboxes appeared in 1933 and 1935. A long time manufacturer of pianos and player pianos, Wurlitzer was founded in 1856 by a German immigrant Rudolph Wurlitzer. The company had been one of the leaders in automated piano orchestras. It would become one of the major manufacturers of jukeboxes and large electronic pipe organs for churches and theatres. Rock-Ola had been building scales and coin operated games. The name Rock-Ola had nothing to do with rock and roll which didn’t come along for another 15 years. The machine was named after its founder David Rockola.

Over four decades, jukeboxes electronically and mechanically advanced by increasing the capacity of their changers, better amplifiers and speakers, selectors at each table, roll around selector, and so on. Of paramount importance was the “look” of the machine. The jukebox had to be visually exciting. The exterior design became a key to the jukebox’s success. Seeberg and Wurlitzer hired top industrial designers just when Modernism was coming into vogue. Translucent coloured plastic was starting to be widely used and was ideally suited for the illumination of the jukebox. Most of the manufacturers believed that the customer wanted to see the record changer work and a cabinet that lit up. Later versions would have coloured bubblers, lighting that responded to the music, and by the 60s some machines would play film clips.

When the great depression occurred in the 30s, the jukebox business became the one bright spot for the record industry. For the public, a nickel would pay for six plays and “like the movies of the day, provide a much needed escape during the country’s long economic struggle” (Boehlert, 1994, p. 94). There were two other historical events which catapulted the jukebox into greater prominence. The repeal in America of prohibition in 1933 meant that there were now tens of thousands of bars, clubs and other drinking establishments that were installing jukeboxes for entertainment. The second was the outbreak of W.W. II, and the relocation of millions of young soldiers to camps and far away locations. The armed services installed hundreds of jukeboxes in PX’s and service clubs in America and overseas. At home, these young people would have frequented jukeboxes that may have had only a couple of types of music in the 24 available selections and these were chosen to suit the area and the jukebox’s clientele. But the military jukeboxes were unique in that they were stocked with a range of music since they were used by those who had come from every part of the country and ethnic background. These jukebox “helped introduce GIs to all sorts of new music. American blues, gospel, country and pop records were all thrown together on Army Jukeboxes” (Boehlert, 1994, p. 94). After the war this would have a significant impact on the coalescing of those musical roots that would form rock and roll. Since many of these GIs were musicians, this cross pollination of styles undoubtedly changed the way many of them would write music when they were again civilians. “Almost overnight, the country’s regional sounds, never really brought together by radio, had a common home, and for the price of just a nickel anyone could explore them, absorb them, and learn from them” (Boehlert, E., 1994, p. 96).
More songs to choose from

During the early 1940s, AMI almost left the jukebox market to focus on its "Automatic Hostess" system. This ambitious project combined aspects of centralised background music, the jukebox and dedication radio. AMI had machines that resembled its jukebox, but without records and phonograph changer. When a selection was made it was played from a central studio via telephone lines. This system was designed to overcome the limited number of records available in the machines and it was believed would cut down on the cost of records since far fewer sets were needed. For an additional nickel a customer could get an "automatic hostess" in the studio to dedicate the record to whoever it was being played for. It was also possible for a selection and request of dedication at one location to come out of a machine at another location. In 1941 Rock-Ola started a similar service called "Mystic Muscle". With the start of W.W. II and the sudden shortage of hostesses who were now involved in the war effort, both AMI and Rock-Ola abandoned this service and went back to record playing jukeboxes. In 1947 AMI attempted a new "Automatic Hostess" system but it never caught on.

Wurlitzer dominated the post W.W. II market with its classic machine, the 1015, which featured coloured arcs and floating bubblers. But in 1948, Seeberg introduced the first jukebox to handle 100 selections, The Select-O-Matic 100. The number of records that could be played had gone from a couple of dozen records, to 50 records with both sides available for play. This new changer mechanism was introduced by Seeberg after years of development. Until its introduction, the industry believed that 24 titles were all that were necessary for a selection of "pop" songs. The other jukebox manufacturers quickly redveloped their mechanisms to accommodate more records when it became obvious that the customers wanted a wider selection. By 1956, 200 title machines were available. The expansion in capacity also meant that a wider variety of records could be available in the jukebox. Country and western could finally live in the same jukebox with Perry Como, Bing Crosby, Bill Haley and Elvis.

Stereo records arrived in 1958, and in 1959 Seeberg brought out the first stereo Jukebox. The problem for the jukebox was the operator and the location coping with the two separated speakers. The other problem for the stereo juke was that record labels in the late 50s were not making stereo singles. As previously described, stereo records were released almost exclusively for the adult market even though 70% of the records bought were by teenagers. The promotion of stereo by the jukebox was being missed by the record labels. An article in a 1959 issue of Cashbox discussed this issue.

"With an estimated 15 thousand to 20 thousand stereo (juke)boxes on location throughout the U.S., manufacturers are losing considerable plus business. Since only 28 of the Top 100 records are available in stereo, any new stereo hit placed in the hands of the distributors, and one-stops, where operators can get at them, will be gobbled up. At the same time record manufacturers seem to be losing sight of the tremendous promotional effect stereo singles can have on the public... every teenager is a stone's throw from becoming a young adult who will want a phonograph (probably stereo) for his own home or apartment. (Pearce, 1988, p. 109)

In time, labels would become more active in releasing stereo singles for the record buyer and the Jukebox trade. In 1962, Seeberg introduced a machine that could play an intermixed collection of 33 1/3 EPs (extended play) or 45s.

The Jukebox, the teenager, and the 45

During W.W. II, many fathers were at war and mothers were working. There was a growing juvenile delinquency problem with so many parents unable to pay attention to their teenagers. During the 40s, in many communities in America, youth centres were opened for after school and weekend activities. To bring in the teens, free jukeboxes were brought in, turned up, and rarely turned off. The program was successful. A few years later however, the Jukebox fell out of favour with the conservative establishment and was increasingly considered a corrupting influence. "One prominent critic wrote in the October/November 1948 issue of Musical Director that the Jukebox was responsible for "the musical taste of America's youth starting on a steady decline" (Boehlert, 1994, p. 96). That year Frank Sinatra was the most popular artist in the country. For such critics, matters would become far worse. For many Americans, in the early 50s, rock and roll was the devil's tool, and existed for no other purpose than to morally corrupt the youth. Since most radio stations were only playing the most sanitised rock and roll selections, the Jukebox became the source of the majority of rock music. Particularly those machines in racially mixed neighbourhoods. These machines had records of black artists who were singing rhythm and blues and early rock. For the first time teenagers had their own beat and it could be found blasting out of the malt shop jukebox. The public had heard from the pulpit and conservative press about the evil, passion firing sounds coming from those machines at the end of the bar or in the middle wall of the malt shop, but when Evan Hunter's 1954 book, The Black-
board Jungle, was made into a movie the following year, the conservatives were convinced. They hadn’t beaten Hitler to see their children lost to rock. The formula of its title song “Rock Around The Clock”, plus the images in the movie, established rock and roll as equalling teenage delinquency.

The step from Blackboard Jungle to “jukebox jungle” was a short one and from the second half of the 1950s, jukeboxes became an integral part of rock’n’roll imagery. (Pearce, 1988, p. 91)

The jukebox was a tangible object for conservatives to focus their concern. In many counties in America, the government did require a sticker stating that “Minors are forbidden by law to operate this machine”, but generally the jukes remained uncensored. Also, the Jukebox operators were frequently placed under suspicion of jukebox stacking as outlined in the chapter on radio. Those who operate Jukeboxes didn’t kick this image until the 70s (Pearce, 1988, p.12-13). “Like no other coin operated amusement machine, the jukebox shaped America’s culture” (Roehlert, 1994, p. 93). By 1956 there were somewhere around 750,000 jukeboxes swallowing dimes in America (inflation had struck).

Unquestionably the biggest change to hit the jukebox industry came in 1948, when RCA introduced the 45. Not only did they sound better than the 78s but they were lighter, smaller, and the centre hole was large and more suitable for automated operation. In short, it was the perfect record for a jukebox. The new models could accommodate over a hundred titles. The 45 in the jukebox of the 50s would become the focal point of the teenager and the first line source of rock and roll.

Post war second generation

There were several instances where a record became a hit almost exclusively through jukebox exposure. In the early 70s, Jimmy Buffet had a big hit song called “Why Don’t We Get Drunk”. Few radio stations played this song about drunken romance, but it was in an overwhelming number of jukeboxes. Jukeboxes have continued to be important in the country and western music market but have declined in popularity with the youth who had loved them so much in the 50s and 60s. The youth of the 70s onward could find their music on radio attuned to a more liberal society and they were generally more affluent, so they could buy the record themselves and play them at home, in their car stereo, or walkman. Since the 80s, they could find it on TV, along with the fashion statements that come with the images. The Jukeboxes themselves had also lost the style and visual attraction that their mid century predecessors exuded. They had become just another piece of electronic appliance. In the 90s, video arcades are having a significant impact on the young, but not as all encompassing as the jukebox in the 50s and 60s. CDs have given jukeboxes somewhat of a new niche holding 1000 titles and full length albums. Some of these machines, in the trapping of the classic 50s enclosures, are being sold for $10,000 (U.S.) to “baby boomers” who want both some nostalgia and a fully computerised and automatic CD library in their living room.

Summary

As has been pointed out, an unintended application of an invention becomes the dominant force in the further development of the product. Such was the case when the phonothrow/gramophone became an entertainment delivery system. This was primarily due to the vision of some coin operators to recognise that the public was interested in hearing recorded programs, and would pay to hear them. The commodification of recorded music became established in these penny arcades, international exhibition halls, and carnival side shows. Customers could listen until their coins ran out. Only after their interest was plucked by what they heard in these coin parlours would some of those who could afford it decide they should have a player in their living room and start acquiring records.

Those who could not afford their own systems remained loyal to the pay-for-pay machines which became the centre piece in local gathering spots. But as Pearce (1988) pointed out, it is easy to over-romanticise jukeboxes, to forget that whatever echoes of their era were embodied in their design (the coloured lights, the boppers, the flashing fins) the only motivation for producing them was to create a commercially desirable piece of equipment. If we look back at the jukebox, we can see that it flourished purely because the public wanted it. (pp. 123-124)

Pearce’s view is accurate, but jukes are more than that. These machines became more than music delivery systems. Their external designs were trend setters in the art deco movement and an important aspect of their popularity. They offered the latest music at a time when most of the public could not afford to buy a record, much less their own playback system. The jukebox was
key to the popular spread of country, hillbilly, rhythm and blues, and of course the development of rock and roll music. For a generation, the jukebox at the local hang-out was the only place that some of the “hippest” and latest rock and roll could be heard. Their significance has declined over the last two to three decades but in the 40s through the early 60s they were an important focus for the young. Rock and roll might have been beaten down by the establishment if it had not been for the existence of jukeboxes in every bar, bowling alley and malt shop in America.

For some of those who were there, Buddy Holly and Bill Haley will never sound better than when they were first heard blasting from a jukebox after inserting a nickel in a Wurlitzer. For those who weren’t, it’s hard to capture it all, since it wasn’t just the jukebox that held the sound, it was where it was happening in time and place when teenagers and rock and roll were being invented. As a 50s Wurlitzer ad stated “For millions, the jukebox was ‘America’s favourite nickel’s worth of fun’” (Pearce, 1988, p. 124).
Notes: Chapter twelve

1 Line from world wide hit "Music, Music, Music". London Records. 1950
2 Line from world wide hit "Rock and roll music". Chess Records. 1957
SECTION VI
CONCLUSIONS & THOUGHTS
FOR FURTHER INVESTIGATION
Popular music in the technological age

The continual advancement of labour saving inventions that started appearing in the last decades of the 19th century and throughout this century have provided the public with more free time. The turn of the century also marked a significant change in the length of the work week due to the efforts of labour unions. These factors gave people more time for entertainment and recreational pursuit and coincided with the introduction of the first of many technologically based personal entertainment machines. The phonograph/gramophone became the first consumer electronic product, and the record became the first consumer software. The record and now the CD are naturals for wide spread distribution being easily understood objects, hence highly promotable. For favourite recordings, if they are lost, they will be replaced. Regardless of how many records (or CDs) people own, they will at some point hear something new which they wish to add to their collections. They are the perfect product, every one of them is manufactured the same, but every one of them is artistically different.

Popular music had been around for centuries. However, it became a commodity with the development of the technologies of recording and reproduction, radio, sound movies, piped-in background music and so on. As a commodity it is ideal since new acquisitions are not determined by the obsolescence or wearing out of previous acquisitions. Popular music, and specific songs in particular, change as quickly as modern society, and much of society wants to participate in these changes, hence the desire to buy the latest music productions. While consumers may have less interest in a record after they buy it and repeatedly play it, they will not choose to dispose of it once they are momentarily satiated. Sometime later, they will return to it and recall their previous experience with it.

Pop songs have become for many, a contextual memory technique for episodic associations that trigger the recollection of personal histories. The inventions and development of a wide range of public and private delivery systems have made this experience a personal and not just a public one. The many outlets from which popular music may be heard allow a given song to be listened to over and over again during its popularity and thus become firmly attached to occurrences in the life and times of the listener. The conscious and unconscious use of pop songs as recollective triggers can easily form an entire dissertation. For the purposes of this paper, it is sufficient to say that without the technology which allows this music to be so readily available, this experience would not be a universally common experience of 20th century society.

The technological development of recording, record production and all the various delivery systems have provided access for each new generation, to all earlier generations of popular music artists. For the music producer this has also meant the opportunity to not only enjoy the music of the past, but to grow creatively from it. Recording also codified popular music by converting it from primarily an oral tradition into a fixed form that could be reviewed and compared by listeners far removed in place and time from the captured performance. The record industry became a billion dollar, multi-national industry by taking this music, turning it into product, and marketing it throughout the world.

Breen (1992) picks up this theme,

"The globalisation of the music industry has made it possible for vast numbers of people to experience the "aura" of popular music in some way, whether it is obscure blues from the Mississippi delta or the enthusiastic pulsations of Merseyside, Melbourne, or Memphis. One thing however is assured, the record industry has brought us ... an array of sounds that we would have been unlikely to hear without the phonograph invention. (p. 41)"

Records and radio brought not only entertainment but the sonic actuality of the world into the home. As Stockhausen (1989) put it, "In earlier times it was only possible to hear music from Africa by going there. Today, we can all listen to such sounds" (1989, p. 26).
MacKay (1981) concludes,

Because of the development of the mass communication media - records, radio, films and television - (modern) popular music has had an impact far exceeding that of any popular music of the pre-electronic age. (p. 85)

In carnivals and nickelodeons phonographs brought recorded music into the awareness of the public. Eventually recorded music became a consumer product, as most homes that could afford it purchased their own record players. Radio and then television, dramatically expanded the public's exposure to the personality and music of the pop music artists. Background music industrialised the delivery of popular music and completed the wash of sound that has become the sonic environment of the late 20th century. But it was the jukebox that, more than any other, first met the local needs of the popular music consumer. It was the jukebox that most often presented each new popular music trend, including the introduction of rock and roll. All of these presentation systems required a listening space which became a commodity in itself.

Sound has become a way of controlling one's surroundings. The technology has provided a wide array of reproduction possibilities, some of which provide isolation without invading the space of others, while some are designed for the very purpose of domination and intrusion.

The commodification of the pop musician

The forefathers of the record industry, it would seem, saw the musician and composer as necessary for the initial performance of a recording but with no role beyond that. Only the most popular artists were paid anything beyond the original session fee. Over the decades however, the record industry has increasingly turned to artists to assist in the promotion of their music, with the effect that the labels have assisted in making popular musicians influential figures in the 20th century.

For centuries, travelling minstrels and popular musicians have chronicled society, and throughout history have been presenters of topical commentary about their times, but the international distribution of records has allowed them to become globally significant to a world population. Modern pop musicians are often not only commentators of their surroundings, but their images, persona and life style have become a catalyst for emulation by entire generations of youthful followers. The record industry in its desire to sell product, has become the champion of free expression, globalised western culture, and has taken democratic beliefs throughout the world. While people in power (politicians, big business, the church, etc.), often fear, criticise and attempt to censor popular music and the musicians who create it, they also court it, and seek endorsement when it suits them because of the influence popular artists have. The commodification of artists and their personae by mass duplication, marketing and distribution of music products (records/CDs, clothing, posters, T-shirts, fan magazines, etc) has provided the essential exposure to turn them into authority figures.

The commodification of popular music has elevated what was a hand-to-mouth, travelling musician's existence into a profitable profession. For those who are successful, making records can bring wealth beyond imagination. While live performance is still an important part of many popular musicians' existence and income, record production and sales are seen as the most important aspect of a popular musician's career. In many respects, pop musicians live or die by the recordings they make. If the public buys them, most other elements in their careers can proceed, but without record/CD sales, there is little hope of success.

Technology's effect on access

Ivan Illich (1973, cited in Jones 1992), argues that technology should not be allowed to grow uncontrolled:

"Society can be destroyed when further growth of mass production renders the milieu hostile, when it extinguishes the free use of the natural abilities of society's members, when it isolates people from each other ... or when cancerous acceleration enforces social change at a rate that rules out legal, cultural, and political precedents as formal guidelines to present behaviour."

Probably James Petrillo, the 1940s Musician's Union President would have agreed with Illich. Agreement would also have come from certain publishers regarding the impact of radio and records on their sheet music sales. In fact record companies would have initially agreed, regarding radio when it first appeared. And of course, major recording studios in Hollywood must have agreed as they attempted to stifle the commercialisation of project/ home studios. Rapid technological evolution is often a threat to the status quo of those who never embrace what it has to offer. It also affects those who do embrace the prevailing technology of a certain time, but once
they develop a successful niche, are unwilling to move toward some new innovation or shift in the state of play, which is likely to change what they've successfully developed. It's fortunate that these technological combatants have not won the war. New technology it seems, can never be stopped by those protecting their position. It may be slowed down, but it will always advance. Only the consumer can decide to reject a new technology, and only new technology can bring about the rejection and replacement of an established technology.

Modern production technology has provided the means for the popular musician to have control over the creation of recorded product. The widespread availability of music technology, and its ease of use by those with lesser, traditional musical skills (ability to read music, perform live, advanced motor skills, etc.), has meant that a great many more people can make their own music. An enlightened view of this technological access comes from papers presented at the International Communication and Youth Consortium. It was suggested that modern music technology will provide “opportunities for the democratisation of popular music production” and a new era of music production “in which musical creativity would flourish” (Robinson, Buck, Cuthbert, 1991, p. 55). But access does not automatically imply that talent will emerge, nor that musical creativity will flourish. Flashes of greatness may emerge but mediocrity will flourish. A comparison can be made with the explosion in desktop publishing where there is now an ocean of publications, with many examples of bad taste and poor design. That being said, personal production equipment is the primary method that emerging artists will use to hone their craft and create product that will at least demonstrate their potential. In the best of cases, they may produce their own albums and manufacture CDs which they can sell at their personal appearances (gigs, flea markets, book stores, etc).

Without question, affordable and easy to use music production technology has also created the recreational music producer. Most people who play music are not successful in the music industry and go on to other careers. But modern technology has provided a way for those who played music in their youth, to continue their creative interest throughout their lives. There are countless numbers of amateur musicians who own home studios. Most have some aspiration to have successful careers in the music industry, but are happy to have the opportunity to recreationally produce music. The technology allows them to satisfy this desire without any need for other musicians, thus they can do it at their leisure and without affecting other areas of their lives. For these people, investing in a home studio is no different from any other recreational hardware such as a boat or sports car.

The record industry has a long history of change due to technological advancement, particularly through the development of new delivery systems. Unfortunately, the increasing amalgamating of labels and multi-nationalisation of ownership may well mean that the big five (BMG, Sony, EMI/Polygram, Warner, MCA) will be less open to the marketing of fringe product. On the other hand, the ease with which programs can be duplicated (and pirated) have provided a means to sidestep the influence of bureaucratic control, censorship or commercial domination. The availability of music technology has spawned a constant flow of independent labels, most of which will not succeed but some will become successful champions of emerging musical trends. Throughout the history of the record industry, innovations in popular music have consistently come from independent labels. Quite possibly, the accessibility of affordable high quality technology may give independents more tools to achieve success, lower their production and duplication costs, and expand their ability to cheaply distribute products, etc. Following the historical pattern of the record industry, those independents that are successful will eventually be acquired by one of the majors, the independent label owner recognising the benefits of the vast resources available to promote their artists.

Past Performance in present time

The record and the various subsequent delivery mechanisms made this musical performance into a backdrop for any type of personal experience. Record listeners could have a most intimate and singular experience when listening to music without a first person interaction with the musician(s). They no longer had to be members of an audience, nor did musicians need to be there when listeners experienced the music. The record listener could be an audience of one. The listener no longer held the image of the performer, and unlike a live performance, while the listener might have a powerful and immediate response to the performer, the performer, long finished with the recording, would be unaware of it. Video brought a new dimension to pop music but the images were just as frozen in time. The performer's life quickly moved on, and away from that particular recording and video. However, for the fan, the impression and recollection of that artist became fixed to the record and video. Only rare exceptions existed to the notion that once its vinyl its final.
The objectification of popular music made recorded music accessible to the "common" person. While opera and classical recordings were popular, it was pop songs and pop artists (some of whom were opera singers) who appealed to the broadest market. Some such as Walter Benjamin (1969) complained that mass produced objects "substitute a plurality of copies for a unique experience" (p. 215). But most shared the view of Andre Kostelanetz who praised the phonograph because it provided a means for anyone to be able to hear more music than the most professional composers of any previous time. Kostelanetz began making records in the 30s and sold 32 million albums during his career. He (1955) once said:

I don't know if you can compare this amazing discovery of music by millions of people over the past quarter of a century to the invention of the printing press, but perhaps a better analogy would be the also recent development of the colour offset press that enables millions to see, and own fine reproductions of paintings by Renoir and Degas. (p.10)

The tools of production

From the beginning of recorded music, producers have driven the development of new electric musical instruments and production equipment technology. The manufacturers have been more than willing to embrace the suggestions of technologically aware musicians. Nearly all music product manufacture has been started by technologists with musical backgrounds. And all major manufacturers have many top musicians on retainer to provide ongoing consultation. Product testing and review is a common practice.

We have seen how "The Sound" of a popular music production is a commodity and key to the success of any pop record. The ever growing list of musical instruments and production equipment, their seemingly infinite number of features, and the infinite number of creative applications provide the means by which the "The Sound" of modern production is constantly changing. Even though computer control is an essential part of most music production, the implementation of these tools in the creation of successful pop music is painstakingly hand crafted by technologically sophisticated music producers. Jones (1992) adds a final comment:

Popular music, a form of music that relies on concepts of spontaneity, inspiration and creativity, is in some sense directly opposed to control. Yet it is precise control over all the parameters of sound — volume, rhythm, spatial location, timbre — that now enable recordings to sound animated. A recording made over the course of several months, musicians recording their parts individually and never in personal contact with each other, can sound as if the musicians had been rehearsing together for weeks — thanks in some part to technology, but mostly because of the expert use of that technology. (p. 184)

A certain magic

But is there something lost in this fragmentary process of "cut and paste"? Possibly so, since the synergy between a group of players, or even a single performer playing a complete composition may no longer exist. With this isolation, and due to the technology's ability to incrementally every aspect of the creative process, there has been a tendency for music creators to sometimes forget that a total performance can generate a certain "magic". When several musicians play together, the existence (or lack of) a certain quintessence is much more apparent.

But the technology can enhance the synergy. For those more traditional productions that employ several performers, high speed digital communication can transcend time and space, almost eliminating delay and distance. Musicians who live in different cities need not leave their homes, nor is it necessary for a producer, with tapes in hand, to travel to different cities to record each part. High speed digital data links allow a control room in one city to be connected to one or more studios in other cities. The recording can be made in real time, with full, two way video for communication between the various locations. This technology causes musicians who are playing on the same song to be further separated from each other, and at the same time provides the opportunity for them to once again interact in real time musically as though sitting in the same studio. The synergy of musicians playing off one another is returning through high technology recording. In the U.S. there is already a network of studios that have fibre optic interlinks and long distance digital recording is common.

From where we stand today (looking back/looking forward)

The violin appeared sometime in the 16th century. Its full impact on the creation of popular music of the time wasn't felt for a hundred years. The electric guitar first appeared in the early 1920s and by the mid 1930s was having a significant impact on popular music in the hillbilly/country and blues idioms. Even big band guitarists were using electrified guitar to have their
instruments heard over the horn section. The speed of technological advances was due principally to advancement in communication between consumers as well as inventors and marketers. Since the 30s, invention and innovation in sound recording and delivery technology has been swept along by this accelerating technological wave. In the early 50s, music production and delivery technology moved into modern times and was the key reason for the success of many independent record labels and studios. The tape recorder in particular, facilitated the recording of ethnic music (country, rhythm & blues, hillbilly) and the emergence of rock and roll. Tape recorders and computer technology have rapidly changed the methods of popular music production and how we hear it. Hughes (1964) wrote, “It needs considerable imagination today to realise how difficult it was for anyone interested in music at the beginning of the (20th) century to follow up that interest” (p. 152). Today, such is not the case.

Changing roles of music producers have come about due to advancing technology. The move from technical to artistic status for sound engineers and producers has been growing since the early 70s and is a reflection of the impact of music production technology on the creation of music. While Les Paul started recording at home in the 50s, it was in the 70s that a significant number of pop artists began to co-produce with their engineers, and considerable production began to emerge from home studios (particularly those who were self contained or wrote their own songs, such as Steve Miller, Frank Zappa, Jeff Lynne [ELO], Tom Scholz [Boston] etc.).

It is now common for the solo musician/recordist/producer to create music by themselves in a quest to combine the unique essences of their various alter egos as captured on each overdub. For them, the passage of time is measured by the increments of musical additions to the production, not the tick of the clock. In many cases, their isolation from the outside world is complete when they are producing. In such an environment, Mickie Most sees the studio as “...a bit like being in a prison...[you] feel the oppression, this confined mental as well as physical inhibition” (Tobler, & Grundy, 1982, p. 140). Many contemporary recorded music producers have little need for fellow musicians and are significantly self contained. The interpersonal skills which are required to play with other musicians has become less essential to them, while the ability to understand technology has become paramount.

The ability to write music, or at least to convey musical ideas to other musicians, is less important today compared to early times. Nor is the ability to technically perform and expertly play a specific instrument a necessary requirement for successful music production. However, a general overview of all the instruments used in production is essential. For this new generation of music makers, learning to control sound modules through a computer is their equivalent to practising. Pop musicians will continue to find a certain amount of music theory useful, and they may need very basic keyboard skills, but few will have a need (or ability) to perform a musical composition in real time or to read a musical score.

As Goodwin (1992) describes:

We are now hearing the results of the first generation of “musicians” who have grown up thinking of drums as something that comes out of a machine...they have taught themselves MIDI programming instead of piano scales. These musicians rarely if ever go to ‘band rehearsals’ for there is no band to rehearse. Rather they sit down at a workstation. (p. 94)

Musicians of the future will possess a technological understanding of video with many able to put together video clips on the same equipment that they use to produce their music. Without question, popular music artists will be active in multi-media. There will be little distinction between sound and images. Artists will sign contracts that involve the creation of moving images to accompany the song. The next generation of music consumers and producers will be tapped into the information super highway. They will have access to large, on-line libraries of music which may eliminate the need for the object based music storage system that has existed through this century. In the age of the sound byte and sampler, reconstructions, reprocessing, and reissues have made everything that was old new again.

The homogeneity of technology

Through the history of recording, popular music has been influenced by the constantly advancing processes that new technology has to offer. As the technology has become more international in its development and manufacture, and more digital in design, its proliferation has made the sound of popular music more global. Regardless of where in the world musicians perform, they play the same electronic instruments, with the same preset sounds, manufactured by a few dozen multi-national manufacturers.
But has this created a synthesis where everything is internationalised and cultural and creative differences are lost? Does this corrupt? Are we headed toward some sort of homogeneity? The evidence seems to indicate that a more typical outcome is that indigenous musicians take what they want from outside (the music and the technology), and create something that suits their cultural value and concerns. Modern popular western music and the technology that creates it, is most appealing when any culture is first exposed to it. The sounds and themes in the music of one culture can quickly become influenced by this technology. With this assimilation, there may be justifiable concern that values, issues, and problems communicated in music from one culture may be quite out of place in another culture. Some themes of songs may raise conditions in one culture that are completely foreign to the other. However, in practice local musicians continue to develop their own styles regardless of the exposure they have with the outside. If anything, the 90s have brought third world sounds and themes into mainstream pop in what is broadly identified as “world music” (D. Mark & others cited in Lull, 1992, p17-19).

Stockhausen (1989) addressed the writing of music that takes from both the new and traditional:

The indigenous song writer] ...must invent extremely strong new music, endowing it with more time and space, in order to align it with ancient pre-formed phenomena. A balance must be reached between the new and the established. The idea isn’t to obliterate existing music but rather to diversify its effectiveness, thus creating a new experience (p. 27)

Predictions

Predictions of what popular music will be like in the future must be tempered by an understanding of the speed at which music technology is changing. Popular music is written for the instruments that are available. It is woven out of the new sounds which these devices deliver. If the past is any indication, the next century will have instruments far removed from those we have today. Keyboards may be replaced by direct mental projection, or at the least by vocal control. Specialised dedicated boxes will fade away, with all processes occurring within a real-time, multi-tasking computer of some variety. Companies that make music production equipment will no longer produce dedicated hardware, but market software for all of these processes. A certain number of controllers will still be available, but all of them will have universal application to any number of processors. Through high speed fibre optic links, which will be common place, it will be possible to have access to large data storage facilities for recording, so that such storage will be available to anyone working from a particular location, without the need to invest in such storage. Releasing product will be through internet distribution, and music stores will be facilities where music is downloaded into reusable storage media. Any number of other possibilities will be common. At the same time, history has shown that music producers recycle and reuse not only the sounds of the past, but also the technology. While digital processes may be king, analogue recording and processing will not die but will still be used for certain productions sound and styles. While solid state, high tech hardware will abound, vacuum tubes will undoubtedly continue to be used in certain types of devices.

The intoxication of technology

Technology is intoxicating, it can be an amulet for the capturing of magic, and it can be creatively stifling. In the late 80s, Timothy Leary (1987) quoted novelist Bruce Sterling whose words seem as appropriate in the 90s:

A new alliance is becoming evident; an integration of technology and the 80s counterculture... the counterculture of the 1960s... was rural, romanticised, anti-science, anti-tech. But there was always a lurking contradiction at its heart, symbolised by the electric guitar. Rock tech has grown even more accomplished, expanding into high tech recording, satellite video, and computer graphics. Slowly, it is turning rebel pop inside out, until the artists of pop’s cutting edge are special effects wizards, mixmasters, tape effects techs, graphics hackers, emerging through new media to dazzle society... And now that technology has reached a fever pitch, its influence has slipped control and reached street level. The hacker and the rocker are this decade’s pop culture idols. (p. 90)

It is hard for many music production people to come to terms with the idea that there are times when the technology may actually stand in the way of inspirational creativity. Access to the latest technology does not necessarily guarantee that a recording session will capture an artist’s soul, or create a production that will move listeners. The intense, eruptive soul of an artist like Bob Dylan could be effectively captured on a cheap ghetto blaster if need be. It is the fire in the music and what the artist is saying, not the sound technology, that makes the difference. We still listen to, and are moved by, the primitive recordings of Billie Holliday, Bessie Smith, B.B. King, B.B. King, B.B. King, B.B. King, Jimmie Rodgers, Robert Johnson and so many others who have come before.
There is hardly anyone in the music industry who cannot recount a story about producing a song only to find that the demo held more magic compared to the final version. Sometimes, the mesmerising possibilities of the latest technology cause the producer to strive for perfection and to lose the music's soul along the way. Many of the greatest vocal performances ever captured on record were "scratch vocals" or first time takes, which were recorded as a reference and intended to be replaced later on. The relaxed atmosphere of recording a demo, or the spontaneity of a scratch vocal or first take, freed the artist to deliver the performance of his/her life. Marathon sessions of segmentary recording can create more accurate vocals, but when they are heard in their entirety, will they have the essential emotional appeal?

Nor has "technically superior" equipment always led to success. Unlike all other forms of electronic media, the latest, greatest, biggest, fastest is not necessarily always the best sounding for a given production. Some old tube amplifiers, certain models of microphones, signal processors and other production equipment have unique, sought after qualities which contemporary technology does not hold. Music production is about moving people when they hear a song. The first of those who must be moved is the artist and music producer, and the elusive qualities in the sounds must be captured in their creation for this to happen. Such performances will hopefully move those who are listeners to the final production. What the technology does provide is the opportunity for new visions, but only in the hands of those who are truly visionary. A quote from MCA Music Entertainment Group Chairman Al Teller, in an address to the City of Hope Foundation, an organisation which the music industry supports, appropriately concludes this paper. He was comparing the technologies of medicine and those of music, and how such technologies are only useful in the hands of those with ability. Teller (1991) declared that the music industry appeared to be "locked in a technological arms race." He lamented:

The invasion of increasingly more sophisticated synthesizers, samplers, and computers in the recording process, [the result of which has been] a lot of one hit wonders in recent years...fabricated icons...visionless virtuosos, cut and pasted together with multitrack magic and pumped up by electronic steroids masquerading as musical muscle. While we may be dazzled by the technical wizardry, we should not be blinded to a simple truth... that it still takes the talents of a gifted artist to make these instruments really sing. (p. 15)

Summary

This paper has covered in an historical fashion, a wide range of technological developments that have affected music production and delivery in the 20th century. While no single innovation can be pointed at as the only reason for an event to occur, there have been four key pivotal developments.

The first would have to be the development of the phonograph followed by the gramophone. This innovation established a product the record, that began the commodification of recorded music.

The next milestone was the development and implementation of the vacuum tube amplifier. This innovation affected every aspect of communication technology from records to radio. The amplifier moved sound technology into the electronic age. By the improvements that followed in recording techniques, entire styles of recording were born, a new intimacy, and an entirely new type of artist became popular, the crooner. In the delivery systems, the amplifier allowed high quality record and radio reproduction that could fill a lounge room and provide a family with an evening of entertainment. Countless changes occurred with the development of the amplifier, but one is worth comment for its significance to the spirit of popular music. Were it not for the amplifier, the electric guitar would not have been possible.

The third period was right after W.W. II when several developments and events occurred in rapid succession to feed off one another. Within a very short time frame the tape recorder was commercialised, transistors were invented, television came along, radio became a medium for records and a proponent of youth music, the teenager was invented, and rock and roll music began to dominate contemporary music. Into this time was introduced the LP and 45 record formats, and a rising generation of baby boomers to buy them. The 50s were a time of extraordinary social change when taste and styles were starting to change. The pop charts were dominated by a new type of musician who was seen by the youth of the time as not only an entertainer but a style setter in dress, language and life style. In many cases the artist needed "a look" more than a talent. While good looking, no-talents declined over the following decades, looks became as important as musical talent when television and music videos became a significant factor in the success of a "musical" artist. The artist had become a commodity. In the 60s, social upheaval and change were everywhere. For the musical artist this trend to influence would extend to life style, social issues and even political systems. Artists would be spokespersons on
their own behalf, commenting on what was wrong with the world. The popular artist would create not just pop songs, but whole albums that carried a theme throughout. To deliver this message, FM radio became a key promoter cultivating an image as the primary voice beating the tribal drum.

The development of digital technology in music production was rather slow, but when it did happen its impact was significant. It came into its own with the development of samplers and the establishment of the MIDI specifications. In the early 80s, these two developments provided the means for a new style of music, techno-pop to become mainstream. Since then, digital technology has become increasingly more prominent in the production of music. Through deconstructions and reconstructions, the sampler has made it possible for all the sounds of previous generations of popular music recordings to be included in new productions. The use of previous recordings was dramatically assisted with the introduction of the CD and the subsequent reissuing of tens of thousands of long discontinued titles. For the first time, a single generation had widespread access to all previous generations of popular music.

Digital technology with MIDI implementation created an entirely new type of music producer and production facility. This technology did not rely on an ability to accurately play a musical instrument, rather, under computer control, performances could be constructed through methods of correction, edit, cut and paste. Nor did the music producer need the aid of other performers, an expensive studio, or advanced technical assistance. Music production technology capable of professional results is now easy to use and affordable, allowing anyone to have a private recording space. In the 80s and 90s, this has resulted in an increasing number of people who record for a recreational outlet. The power of affordable computer technology has also expanded the range of products which the popular musical artist might produce to include not only music and video but the interplay of these two in interactive media.

Finally, starting in the 50s, "The Sound" of popular records became an important aspect in a record's appeal. With the introduction of digital processing and the implementation of preset settings and commercially created sample files, the sounds themselves became commodities that anyone could buy and use. Starting some one hundred years ago, popular music production has become what some editorialists refer to as post modern pop. While this term may or may not be appropriate, there is no question that the commodification of popular recorded music now integrates all past times and allows all future generations to have access to the life and times of an important aspect of 20th century culture.
Notes: Chapter thirteen

1 The Grateful Dead were notorious for releasing an album and after several thousand were sold, they would decide to remix some of the cuts and remaster it. The result was that dedicated Deadheads have two and three versions of the same album. However, in the 60s, when stereo albums became the source for singles release it was common practice for a selected cut to be remixed, edited, and possibly some things added or rerecorded for a monophonic single release which would take into consideration the limitations of the broadcast media. A particularly interesting example of this was Simon and Garfunkel’s The Sound Of Silence. When first released in 1964 on their first album Wednesday Morning 3 a.m. it was strictly a folksy-acoustic sound. Producer Tom Wilson, unbeknown to S&G later added electric guitar, drums, and bass. The folk/rock version became #1 on the charts in December of 1965 and launched S&G into years of successful recording.

2 Mickie Most has been a successful producer since the mid 60s. He produced the Animals, Lulu, Donovan, Suzi Quatro, Hot Chocolate, and Kim Wilde to name a few.

Appendix 1 Glossary

AB MIKING: A stereo mixing technique using two identical microphones placed three to four feet apart (over drums for instance). This kind of separation gives an expanded stereo impression on the separated hi-fi speakers found in most living rooms and cars. See STEREO MIKING.

ACCESS PATCH POINTS: A position within the signal flow of a mixing board, most commonly located between the microphone preamp and the channel fader, where the audio signal may be accessed and sent to an effects box for signal processing. The larger the board the more likely that there will be additional access points at other points in the signal flow. It is also referred to as an Insert Point or Channel Send and Receive. Some variable gain amplifiers such as compressors or gates, also have access points for external control. Unlike Auxiliary Sends (see below), access point don't permit you to retain a portion of the unaffected signal, so the entire signal will be processed. Consequently, they are generally used with in-line effects such as equalization or compression, where it is desirable to process the entire signal. See SCHEMATIC DIAGRAM.

ACOUSTICS: A study of the generation, transmission, and perception of sound. See REVERB- ACOUSTIC.

ACOUSTIC COMPRESSION (MICROPHONES): A noncompliant microphone with relatively large mass tends to respond slowly to percussive transients. This can be used to advantage for a little bit of acoustic compression on drums for example. Using such a mike on the tom-toms or kick will compress the attack of the stick or beater thus bringing out the sustain and fitness. See MICROPHONES.

ACOUSTIC COMPRESSION (SPEAKERS): A natural phenomenon that occurs when the diaphragm found within larger speakers (like those found in bass guitar amplifiers) cannot vibrate fast enough to accurately reproduce the transients, or very beginnings, of certain sounds. As a result, the signal peaks are lower, the overall level of the amplified signal is averaged out, and the signal sounds as if it has been sent through a compressor.

ALGORITHM: A process or a set of steps which will produce a desired output as the results of a given input. Most commonly used to describe the programs that are used for the encoding and decoding and processing of digital recording systems, and digital signal processors.

ALIASING: To prevent frequencies in the audio signal that are too high from entering the digital converter and causing “aliasing”, the converter circuits incorporate a very steep “anti-aliasing” roll-off equaliser before the input to the A to D and another in the D to A. These filters cut the upper harmonics of the sound passing through them. A method for minimising some of the effect of the playback aliasing filter is to keep the data sample rate the same, but over sample the data. In other words, the sample rate might be 44.1kHz as used in CDs, but the same sample is taken and reproduced a multiple of times (2X, 4X, etc). By using over sampling the designers are able to raise the frequency where the playback aliasing filter begins to take effect. When CDs first came out, most of them had a very harsh top end caused primarily by the playback aliasing filter. While the CD sampling rate has not changed, the current generation of CD players sound considerably better because nearly all of them use over sampling techniques. Playback over-sampling, however, does not reduce the loss of high harmonics from the incoming sound due to the input aliasing filter. Only by having a higher sampling rate can higher frequencies enter the A to D converter. It is for this reason that most professional recording systems operate at a sampling rate of 48kHz (some much higher). See DIGITAL RECORDING.

AMPLITUDE: The loudness or volume of an audio signal. Also, the height of a waveform when viewed on an oscilloscope.

A&: ARTIST AND REPERTOIRE: The name given to the department within a record company that manages the signing and development of artists and recording product.
ATTACK: The first stage in a sound's overall amplitude envelope. The attack is the period between the onset of a sound and its initial peak point. See ENVELOPE. See VGA.

ATTACK TIME: The amount of time it takes for an audio signal to reach its highest amplitude or volume level. Also, in a compressor or limiter, the amount of time it takes between the point at which the amplitude of a sound crosses the threshold of the input level detector and the point at which the gain reduction begins to occur. In an expander or gate, it is the time it takes the variable gain amplifier to return from the reduced level to its normal operating level after the amplitude of the sound falls below the threshold of the input level detector. See VGA.

AUXILIARY RETURNS: A component of mixing boards with Auxiliary or Effects Sends where the signal is brought back from the effects processors and 'returned' to the signal flow within the mixer. Each Effects Send will have its own dedicated Effects Return. On many expensive mixing boards, the Effects Return sections will include their own level controls, panning and Eq for adjusting the processed signal, though most boards only offer a level control. The Aux Return is connected to the stereo mixdown system of the mixing console and can also be sent to the headphone system so the artist can hear reverb while recording without it being added to the recording. See SOUND MIXING CONSOLE.

AUXILIARY SEND: A component of a sound mixing console that permits a blended mix of signals from each channel to be sent to an external effects processing device, such as a reverb, delay or multi-effects processor. The level for each and hence the mix of the combined signal is normally controlled by a knob labelled Aux Send, or simply Aux. Many mixers offer a number Auxiliary Sends per channel, allowing the same signal to be sent at the same time to several different signal processors. Aux Sends are generally used with side chain devices such as reverbs or delays to allow the original unprocessed signal to be mixed with the affected signal produced by the processor. See SOUND MIXING CONSOLE.

AVERAGE or MEDIAN VOLTAGE: The level halfway between the positive and negative amplitude peaks of an audio signal. It is also referred to as the ground plane of an electronic circuit.

AVERAGE OPERATING LEVEL: see ZERO LEVEL.

BANDWIDTH: With parametric, or peak/dip equalisers, the range of frequencies, measured in Hertz, that will be affected (over a range of +/-3db) by the equalisation circuit. In true parametric equalisers, this range is adjustable; in pseudo-parametric EQ it is fixed. Bandwidth is also used as a specification that describes the range of frequencies which a particular piece of gear is capable of processing. For reference sake, the normal range, or bandwidth, of human hearing is 20Hz to 20,000Hz. See EQUALISER.

BAUD RATE: In computer usage, the speed of serial data flow through an interface, in bits per second.

BIAS TAPE
see TAPE BIAS

BIDIRECTIONAL MICROPHONE: A microphone designed to pick up sound that arrives from the front and back or on axis, and to reject sound that arrives from the sides. The microphone has a bidirectional or “figure eight” pickup pattern. See MICROPHONES.

BIT: The smallest unit of binary data, either a 0 or 1.

BOOST EQ: The process of altering a sound's tone colour by raising the amplitude level of certain frequency ranges. It is the opposite of Subtractive EQ, where a sound is altered by removing unwanted frequencies. See EQUALISER.

BYTE: The smallest measurable grouping of bits, usually 8. A half a byte is made of 4 bits and is called a nibble.

COMB FILTERING EXAMPLES
see DELAY. See MICROPHONES

COMPRESSORS
See VARIABLE GAIN AMPLIFIER

CANCELLATION: When two signals of equal amplitude and frequency are combined, the effect is normally additive, the sound gets louder or the sounds reinforce and thicken each other. However, if the two sounds start at slightly different times, and hence are out of phase, then in
the resulting waveform, certain frequency bands will disappear because portions of the original waves will mathematically cancel each other out. The sonic result is that the combined waveform will sound much thinner or more hollow than the original ones, and if the two are perfectly out of phase, the sound will actually disappear because the waveforms will completely cancel each other out. See DELAY.

CAPACITOR: A capacitor is a storage device for electrons. It usually consists of 2 closely spaced metal plates and a thin insulator or dielectric between them. If the relationships are fixed between the various parts the amount of storage or charge is also fixed. Large storage capacitors are often called condensers. See MICROPHONES. 

CAPACITOR MICROPHONE: see CONDENSER MICROPHONE

CAPSULE: The moving element in a microphone which responds to soundwaves. 

CARDIOID MICROPHONE: A directional microphone designed to pick up sound arriving from the front and reject sound arriving from the back. A cardioid mike has a heart-shaped pickup pattern. See MICROPHONE PATTERNS.

CEILING: The maximum operating level for an amplifier. If a signal attempts to go beyond this maximum level, clipping and distortion will occur. 

CENTRE FREQUENCY- In peak/dip type equalisers, the main frequency around which the equalisation will occur. In other words, equalisation will affect frequencies above and below this one central point. The range or band of frequencies that is affected is determined by the bandwidth or Q control. The Q is given a number rating and is a relationship between the bandwidth and the amount of boost or cut. A narrow notch filter that affects a narrow range of frequencies has a high Q=100, while a wide bandwidth would have a Q with a low number, for instance 2-8. See EQUALISERS.

CHORUSING: A delay based effect created by modulation, or changing, the delay time of a processor as a signal is being fed through it. The delay times used to create chorus effects are generally from about 30-60 milliseconds. As the sweep delay time increases, the pitch of the delayed signal gets slightly lower. The sonic result is a thickening of the sound, similar to the effect of hearing the same part being played (or sung, hence the name) by several different people at once. When the length of the wave is expanded or stretched, the pitch goes down, and when it is shortened or compressed, the pitch goes up. For example, the sweep rate is plus or minus one millisecond every ten milliseconds. If a sound goes into the delay when the delay time is at 40ms, in 40ms the delay time will have changed by 4ms. So, depending on the direction of the sweep, the signal will come out after 36ms or 44ms, which means the wavelengths of the sound of that original moment are all 4ms shorter or longer at the instant of their output. The actual amount of time delay stretch or compression depends on the prevailing amount of delay at the instant the signal enters the input, the sweep rate of time modulation, and the maximum delay setting.

CLIPPING: When the signal level of a sound goes beyond the maximum operating level of a circuit, particularly an amplifier, the peaks of the signal are flattened, or clipped. Clipping is nearly always accompanied by sonic distortion. The distortion is particularly harsh in digital systems when the signal exceeds the maximum allowable level. In the case of digital the distortion will be low right up to the point of clipping and then the distortion will be almost 100%. Analog amplifiers and recording tend to distort more gradually and are more forgiving to peak levels.

COMB FILTERING: A type of effect which occurs when certain frequency bands within a signal are cancelled out (see CANCELLATION above), leaving deep notches 'filtered' out of an otherwise flat response curve. A graphic representation shows the effect produces a shape that resembles a comb. Acoustic comb filtering occurs when sound combines after travelling different distances on its way to the microphone capsule thus causing dips in the response.

The most common acoustic example of "sweeping comb filtering"
frequency response because of phase cancellation. Cancellation of certain frequencies in a sound, can also occur when delay is introduced electronically. The frequencies that are cancelled are those which have half wavelengths (or multiples thereof: 1.5xw/l, 2.5xw/l, 3.5xw/l, etc.) equal to the delay time. This can also occur when two microphones pick up the same sound. Acoustic phasing can occur if the sound source is moving such as with cymbals. Phasing on drums becomes apparent when the overhead microphones on the drums are heard in mono (or AM radio).

COMPRESSION: A variable gain amplifier-based effect that decreases the peak levels of a given audio signal. A compressor works by adjusting the normal 1:1 input-to-output ratio of a signal so that as the input level of a signal level increases, the corresponding output level increases at a slower rate. The normal range for most compressors is ratios from 2:1 to 6:1; anything above that and the effect is generally referred to as limiting (see LIMITING below). The overall effect of compression is that the dynamic range of the processed signal is reduced or compressed, the average signal level is increased, and the sound appears to have more punch. See VGA

COMPLIANCE: A microphone's ability to respond to a transient (the initial attack of a sound) is determined by the mass of its diaphragm. Heavier diaphragms, or diaphragms attached to a heavy coil, are less able to respond to very quick atmospheric changes. The lighter and more compliant the mike, the better it's transient response. See MICROPHONE TYPES

CONDENSER MICROPHONE: The popular name for a capacitor microphone. In condenser microphones the diaphragm is one plate of a capacitor. Unlike magnet-based mikes, condensers need a power source and an internal preamp. The amplifier may be transistorised in which case it can be "Phantom Power". If a vacuum tube is used for amplification a separate external power supply is required. Phantom power should not be applied to dynamic or ribbon microphones since they can be damaged by its application. In general condenser microphones are the most compliant type of mike because their mass is so small. See PHANTOM POWER. See MICROPHONE TYPES

CYCLE: One occurrence of a waveform. Equal in length and time to one complete wavelength.

CYCLES PER SECOND: A unit of measurement that describes the frequency of a given sound. It is interchangeable with Hertz so that a sound with 1,000 cycles per second has a frequency of 1,000 Hertz (Hz) or 1 kilohertz (kHz).

DB: The abbreviation for decibel, a unit of measurement that describes the amplitude of a given sound. A decibel level determines the strength of a signal above or below a given standard level. For instance 0dB SPL is the threshold of human hearing, and 130dB is the threshold of pain and the roar of a jet taking off.

DECAY: The final stage in a sound's amplitude envelope. The decay is the period between a sound's sustain level and its return to silence. Also, with reverb, the amount of time it takes for a sound to reach a certain low level; or put another way, the amount of time a signal continues to reverberate. See ENVELOPE. See VGA. See REVERB.

DE-ESSER: A frequency-dependent variable gain amplifier-based device, also referred to as a sibilance controller, that attempts to eliminate the problems in vocals caused by speaking or singing the letters "s", "p", and "t". A de-esser works by compressing only the portions of the signal which contain the frequencies that the sound of these letters create. Some de-essers allow you to adjust the frequency bands that you wish to affect, so you can also use them for other applications where frequency-dependent compression is required for instance on hi-hats or cymbals. See VGA

DEFINITION: In digital reverbs, a condition in which the final reflections of a sound are more clearly audible as individual echoes.

DELAY: A type of audio effect, as well as the actual processor that performs the effect, which simulates the natural reflections and echoes that occur in nature. A delay works by holding an incoming signal in memory for a given amount of time and then playing it back out. Delay is most often used as a sidechain effect where the original signal is mixed in with the processed signal. By adjusting the delay time and modulation parameters on a given unit, you can create a
wide variety of effects ranging from slapback echo to discrete echoes, chaurusing, flanging and phasing. see CHORUS, FLANGING, PHASING, DOPPLER EFFECT

DELAY, TAPE
By recording on a three-head tape recorder (3 heads=erase, record, playback), while monitoring the playback head, there will be a delay between the input signal and the output. The delay time is how long it takes the tape to travel from the record head to the playback head, an inch or so away. While the distance between the heads on a tape recorder is fixed, the length of the delay can be altered by varying the capstan speed of the tape recorder.

DEPTH or WIDTH: A parameter on a delay device which controls the balance between the signal of the fixed delay and the swept delay for time modulation-based effects. As the depth parameter is increased, the swept delay signal is increased and the pitch modulation becomes much more dramatic. On digital reverbs, depth is a parameter that affects your position in the reverberant room.

DESTRUCTIVE INTERACTION: The process that occurs when audio signals which are out of phase combine together. Certain frequency ranges cancel each other out and the net result is that the sound becomes more thin and hollow. See also CANCELLATION, COMB FILTERING.

DIAPHRAGM: The moving membrane in a microphone or loudspeaker.

DIFFUSION: The density of the reflections or echoes in natural reverberated sounds, as well as a parameter on digital reverbs that electronically affects this density. A sound in which you cannot hear discrete reflections has high diffusion, whereas a sound which has very well defined echoes is said to have low diffusion.

DIGITAL SIGNAL PROCESSING: The process of generating effects in the digital domain through the use of microprocessors. In order to do this, all digital signal processors (which includes just about every reverb, delay, and multi-effects box being made today) must convert the incoming analog audio signals into digital "ones and zeros" through the use of a circuit called an analog-to-digital, or A/D, converter. The digitized audio signal is then processed according to the software within the machine, and then reconverted to an analog audio signal via a digital-to-analog, or D/A, converter.

DIGITAL RECORDING
To better understand the degree of complexity and the amount of computations required in order for digital to rival analog recording the sound must be sampled at a rate of at least 44,100 times a second. The sample converters that are doing this digitising must have adequate dynamic range and the jumps between sample points must be sonically imperceptible. These converters must use 16 bits (eg-1 or 0) or higher in order to be transparent to the ear dynamically and frequency wise. A 16 bit converter provides 65,536 dynamic steps.

At the instant the sample is taken, it is compared against a "truth table" with binary points representing exact voltage steps along the device's dynamic range.
The dynamics of the device and accuracy of the sample improve as the number of binary digits or bits increase in the converter circuitry. If, for instance, you have a four bit converter, then the entire peak to peak dynamic range can only be divided into sixteen points or two to the power of four (ie-2X2X2X2=16). An eight bit converter would have 256 points or two to the power of eight (ie-2X2X2X2X2X2X2=256) and so on.
Sixteen bit converters are com-

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<th>Example of 4 bit conversion with 5dB &quot;linear&quot; steps, ±35dB dynamic range.</th>
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<tbody>
<tr>
<td>±35dB=0000</td>
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<tr>
<td>0dB=0111</td>
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<td>24dB=1100</td>
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monly used with a dynamic range of 65,536 points peak to peak. Half of the points are assigned to the positive portion of the sound wave and the other half to the negative portion. High quality digital devices now use 20 and 24 bit conversion. At the output of the data storage there is a digital to analog device (D to A) which converts the digital numbers to an analog signal. For accurate reproduction it operates at the same frequency as the encoding A to D converter. It is equally important for the D to A "truth table" voltage steps to be identical to those in the A to D.

An extremely important point to realise is that there is an unavoidable inaccuracy between the digitally recreated signal and the original analog signal. At the moment the input voltage is sampled and held for comparison, the binary number that is created and stored will be the sample point closest to the level of the actual sampled instant. Most of the time the voltage represented by this digital "word" will not be the actual voltage that was sampled; it is close to it, but not identical. This is due to the slight discrepancy between the "truth table" points and the signal actually is at the moment of sampling. The difference between the digitally recreated output and the actual original analog input is called quantising error.

An equally important consideration to high quality digital transmission is the sampling rate, which determines the bandwidth of the device. If a 20KHz cycle sound wave is sampled at a rate of 20KHz times a second, the output would show that there was no change between the samples since a complete cycle could pass in the time interval between the samples. If this frequency were sampled as described, and the sample data was allowed to pass to the output, what would be generated would sound nothing like the incoming signal.

At a sample rate of 20KHz cycles, the audio above 10KHz would be sampled so infrequently that the converter would think the samples were of lower frequencies. This phenomenon is called "aliasing". For an illustration to better explain this aliasing phenomenon we will turn to a common scene in a western movie. Recall a scene with a runaway wagon, the spokes of the wheels are a spinning blur except for individual spokes which appear to be rotating at a slow speed or even backward. In a sense, the fixed speed of the camera shutter is sampling the spinning wagon wheel. The sampling is too low to capture the speed of the spinning spokes, so they appear to be turning at a lower speed of rotation. If the camera shutter rate was faster, this illusion wouldn't happen. To prevent this, digital devices must sample at least two and a half times the rate of the highest audio frequency to be sampled. Essentially, the higher the sampling rate, the better the frequency response. See aliasing. See error correction. See PCM.

(DI) DIRECT OUTPUT, OR DIRECT INSERT

A direct output means that the signal from the guitar goes directly into the mixing console and does not go through a guitar amp. It is usually done using a "direct box" that matches the electronic characteristics of the guitar with the input of the mixing console. This was common practice in Jimi Hendrix's day and is still used to eliminate the sound of the guitar amplifier from "leaking" into the drums that are played at the time of the basic rhythm section recording. Everyone in the rhythm section session will be able to hear the guitar through the headphones, but the sound does not have the distortion and color contributed by the amplifier. Such distortion was a key component to Hendrix's sound. In modern studios direct recording is often done, but with some form of speaker emulator in order to get the sound of the amplifier and speaker.
DISTORTION: Any change in the amplitude, frequency, phase or timbre of a signal as it passes through a system. Some distortion is desirable, such as that generated by guitar distortion pedals, but in most recording situations, distortion is to be avoided.

DOPPLER EFFECT: A naturally occurring phenomenon in which the pitch of a signal increases and decreases over a period of time as its sound waves are compressed and expanded. Delay processors can emulate the Doppler Effect by using long modulated delay times (above 60 milliseconds) to produce extreme changes in pitch. Shorter delay times and the corresponding less extreme pitch variations are referred to as chorusing. See REVERB.

DRIFT: The gradual and unintentional shifting of an oscillator away from a fixed value or setting. This may be due to temperature fluctuation or to instrument shortcomings.

DRY (SIGNAL or TRACK): An audio signal without any processing on it. The term is normally used with its opposite, “wet”, to differentiate between the two types of signals (unprocessed and processed) that are combined when using side chain effects such as reverb and delay. See SCHEMATIC DIAGRAM

DYNAMIC MICROPHONE: Technically, Dynamic microphones include Moving Coil microphones, Ribbon microphones and Regulated Phase microphones, since all three type operate on magnetic principles. In practice the term Dynamic Microphone is usually used to describe Dynamic Moving Coil microphones; Ribbon and Regulated Phase mikes are grouped separately. In Dynamic Moving Coil Microphones the vibrating diaphragm moves a coil in a magnetic field, creating a fluctuating voltage in the coil which shadows the acoustic sound. On the whole, Dynamic Moving Coil microphones are very durable but because of the relatively large mass of the diaphragms and coils they are not highly compliant. Therefore their transient response is not as good as that of a condenser regulated phase or ribbon microphone, for example. See MICROPHONES

DYNAMICS: The amplitude levels of a signal or a musical line.

DYNAMIC CONTROLLER: see VARIABLE GAIN AMPLIFIER

EARLY REFLECTIONS: The first echoes generated by a sound in a reverberant field or room. They generally occur within the first 30 milliseconds after a sound has been produced. The frequency and amplitude of the early reflections give your brain a great deal of information about the size and character of the room. See REVERB-ACOUSTIC

ECHO: A discrete repetition of a sound generated after a given amount of time. If there are multiple repetitions, they will all be equally spaced from each other and decay at an equal rate. Echo differs from reverb in that echoes are generally perceivable as individual events while reverb is a continuous wash of sound that actually consists of thousands of reflections with different decay times.

EFFECTS SEND AND RETURNS: Another name for AUXILIARY SEND AND AUXILIARY RETURN.

ELECTRET MICROPHONE: Electret microphones are similar to condenser mikes but have permanently charged capacitor/diaphragms that do not require external power for their capsule. However, they do require power for their internal pre-amplifier. Unfortunately, most electrets tend to lose their sensitivity as they get older.

ELECTROACOUSTICS: The name refers to topics where acoustical sound is transduced into electrical energy or electrical energy generates acoustic sound.

ENVELOPE: A graphic representation of a sound as it dynamically changes over time. All envelopes contain an Attack, a Sustain and a Release section, the length and size of which vary according to the type of sound. See VGA

EQUALISATION or EQ: An in-line effect that basically functions as a sophisticated tone control to shape a sound’s timbre. Equalisers all boost or cut select frequency bands within the audio spectrum, the only difference among the various kinds of EQ being the degree and type of control over this boosting and cutting process that each one offers. See EQUALISER TYPES.

EQ CURVE: Roll-off curve: At a specific frequency point in the audio band the roll-off filter will begin to reduce the sound at so many dB per octave, and

Roll-off curve
will continue to roll-off until it is out of human hearing range. The point at which roll-off begins is most often fixed, but in some designs the cut off point is adjustable.

Shelving curve: A shelving equaliser will stabilise or flatten out at a certain frequency point. It can function in a boost or cut operation and in conjunction with a roll-off filter. For instance, a boost of the high-frequency shelf at 10,000 cycles followed by a roll-off at 16,000 cycles. In this case the high frequencies are boosted but the very highs are diminished. They are generally found in simple, two band EQs or as the top and bottom ranges of a more elaborate design.

Pass Band: A peaking or dipping equaliser creates a bell shaped curve in the sound’s frequency response. The boost or cut is centred at a certain frequency, but will affect a range of frequencies to both sides of the centre frequency. A bell shaped EQ pattern is commonly called a pass band. It is generally found in the high-mid to low-mid range of a multi-band equaliser and as an alternative to shelving in the high and low range. A passband equaliser can have a variable band control. An extremely narrow band is called a “notch” filter because it takes out a very narrow range of audio frequencies. A notch filter is useful, for instance, when dipping 60 (or 50) cycle hum or any other well defined fixed frequency, such as film camera noise.

Slope: A slope is the angle of boost or cut an equaliser will deliver over a one octave range. A sharp slope will have a greater number of dB per octave than a gentle slope of a few dB per octave. Slope is usually not adjustable in board EQ, however it does change with variable bandwidths. In the case of speaker crossover networks, the correct slope would depend on the speakers, the number of speaker ranges, and the cabinets involved. Some crossovers give a choice of two or three different slopes. See FIXED FREQUENCY EQ.

EQUALISER- GROUP DELAY DISTORTION

Multi-band equalisers and speaker crossovers can generate another type of phase shift distortion. The design of the device may be such that in the dividing process of the full range signal, one range passes through the circuitry faster than another. This is called group delay distortion. It can affect the definition and clarity of a broadband sound coming from the combined output of the speaker system. Group delay on a drum track for instance, would have the kick drum (low range) passing through the EQ sooner than the cymbals and high hat (high range) and after the snare drum (mid range). The total sound at the equaliser's or crossover's output will lack time coherence, a consequence of group delay distortion. The sound will have less attack, because the single instant of total drum sound that entered the crossover will now be heard at three different frequency dependent times. Group delays are not obvious, and are measured in milliseconds. Nonetheless, the sound will lose some of its transients, percussiveness and sharpness. In a live application it is common for the time coherence to be adjusted using high quality delays PAs with time coherence have more clarity and are much less prone to feedback.

EQUALISER MUSICALITY

A cause of non-musicality in EQ circuits is phase shift to which the components and the circuit design contribute. All equalisers use frequency dependent phase cancellation to selectively boost or cut particular frequency ranges. Depending on how this phase shift is handled, it can seem as though the sound passing through the EQ is being “flanged”. As equalisation is boosted, this effect is accentuated and it can be most unpleasant with a poorly designed equaliser. For this reason, cut instead of boost EC is preferred by experienced mixers. Although cut EQ has phase shift, the effect is being diminished rather than enhanced. Another source of EQ coloration is the shape of the bends in the EQ curves. For example, a bell shaped curve that comes to a point will sound more harsh compared to a smooth topped curve. A pleasing musicality in an equaliser is often associated with outboard equalisers that use vacuum tube amplification. The phase shift problem is aggravated when the equaliser uses a combination of coils and capacitors. Both of these component types

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contribute phase shift, but in opposite directions. This makes the total effect considerably less pleasing.

EQUALISATION PRACTICE

A common mistake made by many is to boost high frequencies in an attempt to achieve more clarity. However, boosting the highs remove the reason why the sound is muddy. The low-end rumble must be removed. The solution is to reduce the low frequencies. When undesired frequencies are reduced, all the other frequencies become more prominent. A second benefit of this approach is that the quality of sound will be less electronically coloured because the amount of boost EQ will undoubtedly be less severe.

EQUALISER TYPES

Simple Program Equalisers: Many small mixers have simple two-band equalisers which may also include a few selectable frequencies for each boost/cut control. A bit more elaborate, but within the same group, are program equalisers such as those made by Pultec & Lang, Groove Tubes, Summit and others. These designs date back to the 50s but remain a popular outboard EQ because of their broad and gentle effect on the sound. The vacuum tube amplified versions are particularly prized because of their warmth (due to the nature of tube distortion).

Parametric (Sweepable) Equalisers:
Most console equalisers are of a parametric variety which describes their ability to continuously boost or cut a sweepable frequency band within a range (+10dB to -10dB). There will be two, three and up to six overlapping frequency ranges. For example, the low range might be tunable from 20Hz to 1kHz, the mid-range from 500Hz to 10kHz and the high range from 5kHz to 15kHz. Many equalisers use concentric controls for each range, with the knob that tunes the frequency setting on top of the one that controls the amount of boost or cut (or vice versa). A true parametric equaliser will also have adjustable bandwidth for each frequency range, which makes most sweepable equalisers "pseudo-parametric", because of the absence of variable bandwidth.

Graphic Equalisers: Graphic equalisers have the ability to boost or cut at specific frequencies. Most of them cover the full audio range, but some are designed for a specific frequency range. An example of this is the Cinema Graphic which has all of its control between 800Hz and 5kHz, and is used primarily in film post production on vocal recordings. Graphic equalisers have a certain number of bands or controls per octave. This means that the frequency intervals between controls is wider as the frequency goes up. Graphics tend to be the least usable type of equaliser for recording, but they are very useful for "room tuning" and feedback control of P.A. and stage monitors. Graphic equalisers give the impression that the settings of their front panel controls indicate the actual equalisation curve created. Unfortunately this is not the case. In order to achieve control over each of the narrow bands, the actual curve of the composite equalisation becomes a series of notches.

ERROR CORRECTION

There are many different methods of digital error correction. The recording system may provide redundancy which means the same data is recorded twice at slightly different points on the storage medium and on playback the processor will verify that both "packets" of data are identical. A variation of this process is called "interleaving", which has the data stored in a non continuous fashion and interspersed with other data which is also interleaved. As well as redundancy, there are additional bits in the digital word called parity checkers which verify that the data in each packet is correct. For instance, if the simple addition of the data bits of a packet give an even total, the parity number will be a "1" and if odd, it will be a "0". Or if there are several parity bits, the data information can be broken down into smaller amounts of correction
(the first four numbers, the second four numbers, etc). With clever redundancy, interleaving, and parity coding, a drop out can be corrected without ever affecting the audio output. On the other hand, digital decoding problems do tend to compound themselves and, as the number of subtle drop outs increase, it becomes less likely that the sound will remain unaffected. There may not be an audible drop out, but the amount of error correction might become so great that the sound begins to change. See DIGITAL RECORDING.

EXPANDER: A variable gain amplifier-based device that reduces a signal's level more quickly after the input signal drops below a specified threshold point. Quiet parts are made more quiet. An expander increases the dynamic range of a signal. Extreme ratios, such as 1:100, are generally referred to as gating. Expanders are often used to clean up and decrease the noise of a given signal. See VGA.

FEEDBACK: The process of returning a portion of the output signal of a device back to its input. With delays, feedback is a parameter used to create repeating echoes. When used improperly this parameter can create a squealing or howling type sound that's also called feedback. Feedback is also sometimes called regeneration.

FILTER: A device that prevents specific frequency components of a given audio signal from passing through it. By only allowing a select range of frequencies, a filter can be used to dramatically shape a sound's timbre. See EQ.

FIXED DELAY: A delay in which the delay time is set to a given time and does not change. All time modulation effects, such as chorus and flanging, combine two delayed signals: a fixed delay signal and the ever changing swept or time modulated delay signal. The fixed delay time also serves as the upper limit for the range of the swept delay. See DELAY.

FIXED FREQUENCY EQUALISER: Equalisation is also designed into the electronics of analog recorders to compensate for various anomalies in the magnetic medium and to reduce the effect of the tape's background noise (referred to as hiss). Another equaliser at the output compensates for this introduced "distortion" by applying a complementary equalisation. In addition, throughout the circuit path there are several EQ circuits that compensate for the non-linearity of the magnetic medium. Unlike CD, cassettes, records and film, the equalisation curves for reel to reel tape recorders vary depending on where in the world a recording is made and the tape speed employed. In the U.S., the standards established by the National Association of Broadcasters are used for all speeds (3 3/4 ips (9.525cm), 7 1/2 ips (19.05cm) or 15 ips (38.1cm)) except 30ips. As tape recording evolved, different nations established their own standards. In Germany, Switzerland and a few other countries they use the DIN Standard. England and most Commonwealth countries, use the CCIR Standard. In Japan there is the IEC Standard. The NAB standard is the oldest and therefore doesn't optimise the current technologies quite as well as some of those which followed. Because broadcasters had no need for 30ips (76.2cm) performance, the music production industry developed its own spec for this speed (machines that ran at 30ips were very rare, even in the early 70s). The world standard for 30ips is called the AES standard. A tape recorded with one standard will not sound accurate when played on a machine set for another standard. In most cases, the initials represent the various organisations that establish the standard. Cassettes have a world wide standard called the EIAJ, which stands for the Electronic Industry Association of Japan, and is different depending on whether the tape type requires a high or low bias setting.

Before the introduction of pre and post emphasis the signal on a Berliner disk was recorded "flat". The lateral movement of the grooves meant that loud bass notes required a significant amount of record surface because of their wide excursion. This reduced the amount of available time on the record. By reducing the bass when the record was cut the groove excursion was diminished, but not lost, providing the playback system introduced a bass boost of a comparable amount. At the other end of the audio spectrum the record surface noise tended to be primarily high frequency in nature, so the record companies would pre-emphasise the high frequencies before the record cut. The same playback equaliser that boosted the bass would diminish the high frequencies.
comparable amount. The result would be less surface noise in the playback. Such "complementary" equalisation made it possible to make longer records with more bass, and at the same time, reduce groove surface noise. In other words, the high frequencies were boosted, the bass diminished when the record was cut, and the opposite process occurred during playback. In the early days most record companies used such EQ but the consumer had to change playback EQ depending on the record label. The record industry developed a standard that it would use called the RIAA which was not officially approved by all participants until the middle of the century.

**FLANGING:** A delay-based effect that uses modulated delay times (of approximately 20-35 milliseconds) to create a series of changing phase cancellations within a signal. For flanging effects, the modulated delay time is swept from the point at which the initial signal occurs (eg. no delay), to a maximum delay as set by the fixed delay time. The overall sonic effect is a sweeping type of high frequency "wooshing" sound.

**FLANGING USING TAPE**

For the recordings cited ("Life in the Fast Lane", and "Itchi Coo Park") the entire final mixdown was flanged. Then, wherever the effect was wanted, the effected copy was edited into the original master. The effect was made by simultaneously recording the master onto two other tape decks. The playback outputs of these two machines were mixed during recording. Because the copying "effect" machines were identical, the distance between the record and playback head was the same for both. Their outputs were then equally combined through a mixer and recorded on a fourth machine. The record and playback levels on this machine were carefully adjusted to be the same as the "original" master on the first machine (making seamless editing possible). With all machines in play or record respectively, the engineer would gently rub the "flange" of the holdback reel of one of the two "effect" recorders. The tape speed of that machine would slow down and speed up as he ever so slightly varied the pressure on the "flange". The amount of time that it would take to go from the record to the playback head of the "flanged" machine would be constantly changing. When the fixed-speed tape and the slightly "flanged" tape were combined, swept frequency cancellation would occur because of the ever-changing delay time. For the example cited the entire mix was phased and then edited into the master similar to note.

**FLAT RESPONSE:** When a piece of equipment has a consistent output across all frequency it is designed to amplify, it is said to have a flat response. In other words, when output amplitude is plotted against the input frequency, the resulting graph will be a (relatively) straight line.

**FREQUENCY:** The fundamental pitch of a given audio signal, though in a complex form or generated by a musical instrument frequency and pitch are not the same. Also, the width of a waveform when viewed on an oscilloscope.

**FREQUENCY DEPENDENT DELAY:** A separately controllable decay time for different portions of the frequency spectrum of a given sound. See EQ-Group Delay Distortion.

**GAIN:** The level or amplitude of an audio signal.

**GATE:** A variable gain amplifier-based effect, as well as the device which creates it, that drastically reduces the level of a signal after it drops below a certain threshold. Similar to an expander, which has less severe input-to-output level ratios, a gate makes quiet sound quieter. When a gate is at normal gain and is letting sounds through, it is said to be 'open' and when it has reduced its gain it is said to be 'closed'. The complete name for the effect, noise gate, properly suggests its usual application: to clean up the noise, and specifically leakage from a given signal. See VCA applications.

**GATED REVERB:** A type of reverb effect in which the tail end of the reverb sound is abruptly cut off once the reverb drops below a certain specified level. Many digital reverbs offer already-made gated reverb setting, but the effect can be created by connecting a noise gate after any reverb. See VGA.

**GRAPHIC EQUALISER:** A type of fixed frequency equaliser which offers several different
bands spread in octaves or divisions of the octave across the frequency spectrum. There are individual boost/cut controls for each of several frequencies per octave, with usually an equal number of controls per octave. The number of bands available generally varies from 10 to 31, depending on how fine of an octave division there is. A 10-band graphic offers one band per octave, while a 31-band offers 3 bands per octave (sometimes also called a 1/3 octave EQ). See EQUALISER.

HAAS ZONE: Delays of up to 35 milliseconds (one millisecond equals one one-thousandth of a second) are difficult for the human ear to perceive as distinct repetitions because they are so short. This range of short delays is called the Haas Zone. Extremely short delays within the Haas Zone, up to 7 milliseconds or so, tend to cause comb filtering while longer delays within the Haas Zone usually reinforce or thicken the sound.

HEADROOM: The dynamic range between the average operating level and the point at which distortion occurs in a given piece of equipment. The more headroom a piece of gear has, the better able it is to properly handle high level transients. In tape-based systems, the trade off is always between signal to noise and headroom. The greater the headroom, the lower the average operating level, and the worse the signal to noise. When the average operating level is raised, the headroom is not as good, but the signal to noise is better.

HERTZ or Hz: A unit of measurement used to describe a signal's frequency. It is directly related to the number of cycles per second of a given waveform. One thousand Hertz are generally shortened to 1 kilo Hertz (kHz).

HYPERCARDIOID PICKUP PATTERN: A microphone pickup pattern that is longer and narrower than a cardioid pickup pattern and has a lobe of sensitivity centred 180 degrees off axis (at the rear of the mike). Hypercardioid microphones are often used for film and television sound when it is necessary to keep the microphone off camera.

INBOARD EFFECT: The processing that occurs to a signal within a mixing board. Most mixers only offer EQ, but the latest designs have variable gain amplifier effects as well as on-board digital signal processing. Inboard processing is in direct contrast to outboard processing. See SCHEMATIC DIAGRAM.

INSERT POINT see ACCESS PATCH POINT. See SCHEMATIC DIAGRAM.

INVERSE REVERB: An unnatural type of reverb effect in which the tail end of the reverb sound gets louder instead of decaying as do most reverbs.

KEY INPUT: An insert point on a noise gate that permits the opening and closing of the gate from an external signal. Two possible applications of this capability are triggering one sound with another and frequency dependent gating effects. The first one is achieved by putting a sound into the input of the gate and connecting the triggering sound into the key input. Whenever the amplitude of the trigger signal crosses the specified threshold, the gate will open and permit the sound connected to the input to be heard. The gate can be adjusted so that the signal is still heard when the gate is off, but at a reduced level. This is done by the range control. For instance a bass may be triggered by a kick drum so that the bass remains on all the time, but gets louder everytime the kick drum is struck. Frequency dependent gating works on a similar principle, but uses a heavily EQ'd version of the input source as the key input to determine which frequencies should be let through the gate. A Key Input is sometimes called an EXTERNAL INPUT. Many limiter/compressors also provide access to the threshold detector loop which makes it possible to make the device frequency dependent (like a deesser), or where one instrument can effect compression on another.

KNEE: The pivot point at which the input signal level reaches the threshold in a variable gain amplifier and gain reduction begins to occur. When represented on a graph, the input-to-output ratio at this point bends like a knee. On some devices, often called "overeasy" the knees is curved.

LIMITER: A variable gain amplifier-based device that severely restricts the dynamic range of an input signal. Most limiters prevent a sound from going above a certain output level, regardless of the strength of the input. Once the threshold level is exceeded, the input signal can go up with very little change to the output levels. See RATIO below. See VGA APPLICATIONS.

LIMITING RATIO: When the ratio between the input and output levels of a signal exceeds figures of about 8:1, it is termed a limiting ratio. Even higher ratios of up to 100:1 place severe restrictions on the dynamic range of a given signal, but they are often used in P.A. systems and radio transmitters. See VGA APPLICATIONS.
LP- LONG PLAY: Refers to long play records that were introduced in the late 50s. LP records are made of vinyl, have narrow grooves, and rotate at a slower speed (33-1/3RPM) compared to previous records.

MICROPHONE PAD: A resistive network inserted between the microphone or other line to lower the level by a specified number of decibels before the signal enters a high gain amplifier (i.e., mic pre-amp). It prevents the microphone’s output from overloading the consoles pre-amp. Capsule pads which are inside condenser microphones serve a similar function by reducing the effective output of the condenser capsule before the signal enters the microphone’s internal pre-amp.

MICROPHONE STEREO TECHNIQUES

The earliest stereo recordings occurred accidentally and long before anyone imagined a practical method for stereo delivery. In the very beginning of mechanical disk mastering, several mastering machines were set up in the studio to record the same session in order to create a number of masters at once. Years later, enthusiasts of those early recordings discovered that they might have two records that were obviously from the same session, but were slightly different in their perspective. Many such releases were found to have positional difference between disks. Using some clever engineering, the recordings were transferred and synced onto a stereo recorder. The result was a turn-of-the-century session with quite a dramatic stereo panorama.

Most popular records are mixed from monophonic sources (sound generators, recorder tracks, or microphones) which are blended and positioned into a stereo image using the mixing console’s pan controls. Reverb and other effects are used to enhance this manufactured stereo experience. To record in stereo, two microphones must be used to pick up two points in space, similar to how our ears are continuously picking up two points in space. Essentially, there must be a difference between two signals coming from the same sound.

To record an acoustic instrument in stereo, a pair of identical microphones are usually used. Several positioning techniques are common but the one most frequently used for non-pop music (i.e. classical, jazz, etc.), is to pick up a single point of stereo information. Two microphones are angled toward one another, nearly touching. Most of the time, directional microphones are used facing the sound at an angle somewhere between 90 and 140 degrees (stereo TV has settled on an angle of 130 degrees). This is called XY placement and it picks up the difference in intensity and phase between the signal entering the two microphones as they hear the same stereo moment. The advantage of the close placement of the two microphones is that there is very little delay between the two signals and so when they are combined to mono there is a minimum of comb filtering or phase cancellation.

This technique sounds very real on headphones because the distance between the two ears and the mikes is similarly close. However, when the playback distance is separated such as between two speakers, the distance between the mikes is not great enough to create a stereophonically dramatic image. The XY technique lacks that bigger than life sound that pop recorders strive for.

Most stereo pairs for rock and roll are placed some distance apart depending on what instruments are being recorded and the amount of panoramic separation that is desired in the stereo image. This kind of mic’ing is described as the AB technique.
MICROPHONE PATTERNS

MICROPHONE TYPES

There are three groups of microphone transducers. The most common is called a moving coil or dynamic. A moving coil microphone has a spool coil connected to its diaphragm (usually at the back). The diaphragm is positioned over a circularly channelled magnet. The coil at the rear of the diaphragm sits inside the channel. As the diaphragm moves, the coil breaks magnetic lines of force spanning the gap in the magnet, and an electron flow is generated in the windings. When the diaphragm changes direction, the magnetic lines of force are broken in the opposite direction and the flow of the electrons through the coil reverses direction. This oscillating electron flow shadowed the acoustic sound. However often the diaphragm changes direction reflects the frequency or pitch, and how far it travels in a given instant determines how great the output signal will be during that instant.

The second group are ribbon microphones. They too use magnetic principles. In their case the diaphragm is also the electrical conductor which breaks the lines of force in the magnetic field. The ribbon is held at its ends and positioned in a magnetic field. As it vibrates back and forth in the magnetic field, the voltage is generated in the ribbon diaphragm. The classic RCA 44s and 77s use long thin “ribbons” of corrugated metal. In order for the ribbon to have enough compliance, it must be thin. At the same time, it must be long enough so that its vibration will break sufficient magnetic flux lines to generate a high enough output voltage. Ribbon microphones tend to be more fragile compared to moving coil microphones. Some of the modern designs are able to handle high sound pressure levels.

The most common studio microphone would be the condenser. This design uses capacitive principles. The capsule’s electron capacitance changes in response to the sound waves that strike the diaphragm. The mike’s diaphragm is a condenser within the internal preamplifier circuit inside the condenser microphone. The internal amplifier senses this change and generates an output. The diaphragm of the condenser microphone consists of a fixed rear plate and a movable front plate (the diaphragm), with the result that as the diaphragm vibrates, the electron charge, or capacity, is constantly changing. The movable “plate” is usually a 3-10 micron thin piece of mylar that has been spattered with a microscopic spray of silver, gold, or nickel alloy so that it is conductive. Vacuum tube, as well as transistor amplifiers are used in these microphones.

Some dynamic microphones, do not have particularly good high frequency or transient response but these “weaknesses” make them ideal on drums. They reduce the transient attack of the stick while enhancing the body of the drum sound. At the same time the mikes that are above the drum kit need to respond quickly to the high frequencies of the cymbals but may not be the best choice for the toms, kick or snare because they will respond too quickly to the stick’s attack. Many factors determine the choice of a mike for a specific purpose. See microphone patterns. See vacuum tube. See VGA for more information about transients.

MIDSIDE OR MS MIKING: A stereo milking technique utilizing a cardioid mike facing the sound source, and a bidirectional mike at right angles to the sound source. In-phase Information from the bi-directional mike is combined with the signal from the cardioid mike to create one stereo channel, and similarly, out-of-phase information from the bidirectional mike is combined with the cardioid mike to create the other stereo channel - common classical recording technique.

MILLISKCOND: A unit of time equivalent to one thousandth of a second, used by delay devices to determine delay times.

MOVING COIL MICROPHONE: See DYNAMIC MICROPHONE, MICROPHONE TYPES
NOISE GATE: See GATE, VGA

NOISE REDUCTION, TAPE

Tape noise reduction is used in order to reduce the existence of tape hiss. There were several companies marketing noise reduction at the beginning of the 70s. The two that emerged to capture the market were Dolby and DBX. Dolby developed its "A" system in about 1965 and by the early 70s it was in wide use in professional studios. In 1970 a cheaper "B" version quickly gained acceptance in cassette recorders. Over the years Dolby has continued to develop new noise reduction systems to meet the needs of the changing market. For many years DBX found its niche as noise reduction for home and semi-pro multi-track recorders. The home recording market now also uses Dolby "C" which was introduced in 1981. These two companies remain active in noise reduction development with Dolby developing both television and film noise reduction systems that provide more channels (stereo, and surround), and digital formats on the traditional delivery systems used in film and video.

NORMALISED PATCH BAY: A type of patch bay in which the signal flow between two points is not broken until the input point is connected. Consequently, the output point can be used to connect to an external device and adjust the levels of that device appropriately without stopping the flow of the audio signal. See SCHEMATIC DIAGRAM

NOTCH FILTER: A device which can create a very steep drop in the frequency response of a signal at a very specific, narrow frequency band. With extremely high Q, or bandwidth settings, parametric equalisers can function as notch filters to remove specific frequency bands from a signal without adversely affecting the rest of the sound. Notch filters are often used to remove 50Hz hum from a sound.

OMNIDIRECTIONAL MICROPHONE: A microphone designed to pick up sound from all directions. An omnidirectional mike has a spherical pickup pattern. See MICROPHONE PATTERNS

ON AXIS: Directly in front (of a microphone, for example).

ORGANIC REVERB: Naturally occurring reverb which occurs in real acoustic spaces. See REVERB

OSCILLOSCOPE: A device which is capable of displaying in graphic form the changing waveform of an audio signal in real time.

OUTBOARD EFFECTS: Signal processing equipment which is physically outside of a mixing board and whose signals are patched into the insert points and effects sends and returns of the mixing console. Most outboard gear is rack mounted though some guitar foot pedals or stomp boxes would also be considered outboard effects. See SCHEMATIC DIAGRAM

OUTPUT: The audio signal that comes from any device which creates or alters an audio signal. Also, the level at which a signal appears from a sound generating or processing device.

OVEREASY: A type of operation used by certain variable gain amplifier-based devices in which the input-to-output level ratio gradually increases automatically as the input signal level goes further above the specific threshold setting. As a result, the same setting on a single device can perform both compression and limiting or, more commonly, operate at several different compression ratios.

PARAMETRIC EQUALISER: A peak/dip type of equaliser that permits the adjustment of the centre frequency, bandwidth (or Q), and level of from 2 to 6 overlapping frequency bands. Equalisers that are described as pseudo-parametric do not provide variable Q of a band, but the frequency selection is sweepable. Parametric EQ offers the most flexible and most precise type of frequency control among all types of equalisers. See EQUALISER.

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PASS BAND: The range of frequencies determined by the bandwidth control of a parametric equaliser. See EQUALISER.

PEAK: The highest level of an audio signal.

PEAK/DIP EQ: A kind of equalisation that provides the adjustment of a range and level of frequencies. Parametric and pseudo-parametric equalisers are peak/dip type EQs. See EQUALISER

PHANTOM POWER: A circuit that supplies d.c powering to condenser microphones, using the same conductors as the audio signal.

PHASE CANCELLATION: The attenuation that occurs when two waveforms of equal frequency and opposite polarity are combined.

PHASING: A time modulated delay-based effect using short delay times in which the swept delay signal occurs both before and after the unprocessed signal. It is physically impossible to create true phasing with an electronic device because you cannot make the delayed signal occur before the undelayed signal, so true phasing effects can only be achieved with tape recorders using two tapes of the same material. Phasing is similar to, but slightly different from flanging, in which the delayed signal only occurs after the unprocessed signal.

PHASING WITH TAPE

For phasing, instead of holding back the reel of one of the machines, the sound recordist uses the variable speed control on one of the machines to change the tape speed, thus varying the delay time. For the phasing to occur the recordist constantly varies the speed on the recorder from slightly slower to slightly faster than the normal fixed speed of the other effect machine. The motor speed variation must be smooth in order to create a smooth phasing sound that sweeps across the full frequency range.

PHASE SHIFT: The phenomenon which occurs when one audio signal is combined with another similar signal that has been delayed by an extremely short period of time and the two become out of phase. The delay time is dependent on the frequency of the wave, but it is equal to or less than the time it takes a waveform to complete one half of a cycle - generally under 5 milliseconds. If the two waveforms are only slightly out of phase they constructively combine, but if they become completely out of phase they will destructively interact.

PICKUP PATTERN OR POLAR PATTERN: Describes the directional characteristic of a microphone (usually determined by the microphone's housing design). Most mikes have only one pattern but some are selectable or interchangeable.

PINK NOISE: An audio signal that contains random amounts of all audible frequencies. Unlike white noise, which has no emphasis whatsoever, pink noise is modified to have an equal amount of energy in each octave. This is achieved by reducing the voltage level of the higher frequency components by 6db per octave. It is commonly used as a standard to test audio equipment.

PITCH SHIFTER: An effects device which mathematically processes a digitized audio signal and instantly produces the same sound at a different pitch.

POLARITY: Polarity refers to the positive or negative direction of an electrical, acoustical or magnetic force. Normally, a positive going acoustical event should generate a positive electrical pulse. This is called correct polarity.

PREDELAY : The amount of time that passes between the direct sound and the point at which the first reflections of a sound within a reverberant field hit your ears. In other words, the amount of time it takes until you begin to hear the reverb. The amount of predelay has a great impact on how your brain determines how large the room is: the longer the predelay, the bigger the room.
PRESETS: The various programs stored within the memory of a microprocessor-based device such as a digital signal processor. Most signal processors allow you to adjust the parameters of the various programs and store them as your own presets, but some devices only offer unalterable presets that were created at the factory.

PULSE CODE MODULATION
The method of PCM is to generate pulses at a fixed rate. The interval which the pulse occupies and its duration is accurately fixed. If there is a constant and continuous pulsetrain the numbers generated are all “on” or “1”. If a pulse is not created in a given pulse interval that instant is read as an “off” or “0”. See digital recording.

PSYCHOACOUSTICS: Deals with the effects of sounds on humans.

PZM MICROPHONE: Pressure Zone Microphone. PZM microphones are designed to be placed on the surface of a wall or other barrier. This eliminates the comb filtering that occurs when a microphone simultaneously picks up direct and reflected sound.

QUADRAPHONIC SOUND
Quadrphonic sound attempts to create for the listener the experience of hearing a live performance, within the inclusion of the concert hall as part of the experience. When we attend a live concert at an entertainment centre we are within an enclosed acoustic space. The source of the sound can be located in all three dimensions and we have a sense of our surrounding which gives us some indication of the volume and acoustic characteristics of the venue. The space itself enhances our experience as does seeing the musicians play their instruments. The spatial information we hear helps our brain separate the musical lines, the position of the players, our location in the venue, where the sound re-enforcement speakers are located, and so on. Depending on where we are sitting, we will also have a lesser or greater awareness of our fellow audience. The experience we have at an outdoor concert is quite different. Outdoors, there is no ambience within the audience area unless there are some geographic boundaries such as a cliff face or a steep hill. The position of the PA becomes the dominant source of the sound, with little reflection from the surrounding space.

In popular music production, quad was less about extending the “bigger than life” experience. Sonic elements were positioned to come from all corners of the room, and, using quadraphonic pan pots, sounds travelled around the room.

QUANTISING
See DIGITAL RECORDING

RADIUS DISTORTION
The rotation of the record is a fixed speed, hence the stylus travels over a given radius of the record in a fixed amount of time regardless of where it is playing on the records surface. Since the radius of the grooves are ever diminishing as they move inward, the groove length representing a certain amount of time gets shorter as the radius gets smaller. This means that the groove modulation or “excursions” must be closer together as the groove moves inward. In particular, this compressing of the groove length for a given amount of time, makes it more difficult to cut and reproduce high frequencies.

RANGE: On variable gain amplifier-based devices, a parameter which determines the final level beyond which a signal will not be affected by gain reduction or expansion. On expanders and noise gates in particular, the level below which a signal will not be reduced.

RATIO: The relationship between the input level and the output level on a device that uses variable gain amplifiers. A normal 1:1 ratio, or unity gain, has no effect on the sound; ratios above that are achieved via compression and ratios below that are achieved via expansion or gating. In other words, it takes 20dB of signal above the threshold for the output to go up by 1db. Input-to-output level ratios of 8:1 or higher are generally considered to be limiting; anything below that (2:1, 4:1, 6:1) is termed compression. Expanders have ratios of 1:2, 1:4, 1:6. In other words in the case of an expander, when the signal drops below the threshold by one dB the output will go down by 2dB. Gates have a ratio of 1:50 or greater. When the input signal drops 1dB below the threshold the output will go down by 50dB or 100dB.
REGENERATION: Another name for the feedback parameter on delay devices. It is used to create repeating delays or echo.

REGULATED PHASE MICROPHONE: A mike which combines the principles of dynamic and ribbon microphones. A spiral coil is attached or "printed" on the diaphragm's flat, circular surface which is held between two magnets that are perforated so the sound can influence the diaphragm. It's output is generated like a ribbon mike but it is as durable as a moving coil mike.

RELEASE POINT: The point within a sound's envelope at which the decay begins. See ENVELOPE.

RELEASE TIME: A parameter that determines how quickly a VGA amplifier will return to normal levels. In compressors and limiters, the amount of time it takes to return to unity gain, or a 1:1 ratio, when the level has fallen below the threshold; in expanders and gates, the time it takes to reach the reduced levels of expanded or gated operation (i.e., the amount of time it takes an amplifier to turn off).

RESPONSE CURVE: A graph of frequency input vs. amplitude output that is used to describe a device's response to different frequencies.

REVERB: In nature, the reflection of sound in a confined space. Also, an effect, and a device that produces reverb. A reverb device produces a series of sonic reflections, or ambience, when an audio signal is electronically placed into a virtual "room" of a particular size, shape and construction. Reverb gives life and body to a sound.

REVERB, ACOUSTIC & NATURAL: Unfortunately, when the sound of an acoustically dead instrument is electronically introduced into a reverb device, the reverb is only interacting with a small portion of the "natural" potential sound. On the other hand, if that instrument is played and recorded in a room that reverberant, the total sound of the instrument in the reverberant space is picked up by the mikes and sounds more natural. In a dead studio (one with little reverberation), aware engineers will take large sheets of plywood and lay them on the floor. The players sit in the middle of the wooden floor so that early reflections off the floor will enhance the sound of the acoustic instruments. Many times a plywood floor will also be used under the vocalist.

Reverb in a venue is dependent on the volume of the space, the position of all the reflective surfaces (the walls) and the materials used in the room's construction. The experience of the reverb is dependent on the listener's location and the placement of the sound source. Reverb time is identified as RT60. This is the amount of time it takes for a sound to decay from its loudest point to 60dB below that point. Reverb time is a full bandwidth figure, but most acoustic reverb and the reverb that is used in music production have different decay times depending on the frequency. Reverb in a natural space will generally have a short high frequency decay compared to the low frequency, but the reverb that is most suitable for recording has a long high frequency decay and a short low frequency decay.

The "Too Cool" agent and his girl friend sit at the back of the theatre. They hear from the edge of the space and after the direct sound has been affected by the reflections in the room. An adoring fan sits as close as possible and hears every note. The reverberation from the space will come to them later.
REVERB CHAMBERS: A reverb chamber is an extremely reflective room that has a microphone or two in it, and a speaker. The microphones are mixed back into the console through a reverb return on the console, and the speaker is connected to a power amp and EQ which is fed from a row of "reverb-send" controls, also on the console. One reverb "send" control is associated with each of the input channels so that any of the signals coming into the console can have reverb added to them. The combined reverb-"send" signal goes to the speaker in the chamber where the sound bounces around. The microphones in the chamber pick up that reverberating sound and return it to the recording console where it can be panned and blended with the rest of the mix.

The reverb chamber has walls that are extremely hard and rigid. Often pool cement is used as a plaster, but other materials can be used including very hard mirrors and concrete. The chamber has to be built so that no sound or vibration from outside can leak into it. The volume of the best sounding reverb chambers is between 43 cubic meters (1500 cu/ft) and 85 cubic meters (3000 cu/ft). The walls are non-parallel in order to prevent flutter echo, where the reflections coincide upon themselves (like those you might hear when you clap your hands in a subway passage). Also, in order to have an even decay, and an absence of "standing waves", the walls need to not only be of different lengths, but built in non-recurring mathematical proportions (e.g. a 3:5:7 progression, or the Pythagorean "Golden Mean"). To design and build one "that special way" is difficult and nearly borders on having to be right with the spirits.

REVERB, DIGITAL: Digital reverbs use mathematical algorithms to compute what would occur if a sound is generated in a certain reflective space. They approximate the boundaries of the space and the acoustical characteristics of that space. The programs are grouped into banks of environments (for instance, there might be a bank of "halls", one of "rooms", another of "plates", etc. Within the "hall" bank there might be a "bright hall", "dark hall", "auditorium", etc.). These programs are created by "fourier analysis" of real environments (fourier analysis analyses the reflection characteristics and decay times of different sounds in specific environments and takes into consideration the changes in frequency response over the course of time).

In order for music producers to get the best out of a digital reverb they need to have a concept of time and position (or place) in a given environment. In a sense, the various controls on the device move the walls and change the angles and surfaces of the "room", the position and character of the sound source and listener, and where the reverb is being picked up in the device's imaginary space. To stretch the possibilities offered by digital processors requires an understanding of the concept behind the controls, how they interact and interrelate, and a certain idea of what the space needs to be. All digital processors have presets which are usable in themselves, but are best seen as starting points upon which to build unique environments.

REVERB PLATE: The original EMT plates came from certain East European steel mills. They would intentionally mill the plates toward the end of the roller's life when they were very polished so that the plates would be as smooth as possible. Off slightly from the centre of the plate was a voice coil wrapped around a small cone which was attached to the plate. Surrounding, but not touching the coil was a magnet similar to those used in speakers. The pickup at one end of the plate generates a voltage that corresponded to the rippling reverberations passing by them. The original EMT plate was about 1 by 1.3 metres, with screwbolt mechanism at the corners for tightening the plate within a tubular steel frame. Much like a drum head, the key to getting the best out of the reverb required tightening the steel to just the right tension. Engineers would tap the corners to hear changes while adjusting the tightness of the tension. The reverb time was controlled by moving an absorbent acoustic panel closer or further away from the rear of the metal plate (without ever actually touching it). As the panel got closer, it atmospherically damped the vibration of the plate.

Plate reverberators were very expensive until EMT's patent ran out and others began to build them. Several small companies built low-cost plate reverbs, but all of them withered away when digital reverbs became available. Plate reverbs were built
in a variety of different sizes using a number of different metals (such as gold foil). Like so many other things in professional audio, there continues to be a good business in refurbishing, buying and selling second hand plate reverbs.

REVERB, SPRING: A spring reverb has an electromagnetic movement which causes one end of the spring to vibrate in sympathy with the sound that is fed to the windings. At the opposite end of the spring movement are two extremely small magnets attached to the spring which rotate within a magnetic pick-up winding. A voltage is generated within these windings from which the reverb derives an output. The oscillating rotations start a chain reaction of twisting vibrations through the spring all the way to the other end, where it bounces off the retaining block and then returns back through the spring until the energy is dissipated. Multiple and complex reverberations occur when the vibrations come upon opposing rotational movements and the mechanical variations in the springs. Generally, the more springs, the more unique reflections and the smoother the reverb. In a two-spring reverb, it's likely to sound like a racquetball court if a percussive sound is fed into it because such sounds quickly pin the driver and pick-up movements. The more springs employed, the less likely an exaggerated, coincident vibration at a certain frequency. Multiple springs tend to even out this problem. The cheapest spring reverb uses two springs. Better ones would use three or six, and the very expensive ones would have dozens. The most complex designs have springs that are different diameters and lengths, with noncontinuous, irregular spirals. The spring wire spirals for a while and then curls back on itself, then spirals in the opposite direction for another length then curls back again and so on. Spring reverb can be very small, but the more expensive ones often had springs that were two to three feet long. Leslie built an organ choral cabinet that included a spring reverb. To change the reverb decay time, a pan of oil at the base of the springs could be moved up and down. Another design of spring reverb connected all the springs to a speaker cone type of movement, and instead of rotating, the springs contracted and expanded ever so slightly, undulating up and down. This design greatly reduced the racquetball effect on transients because there was no pinning of a rotating driver movement.

The springs in Fender amps are Acuronic springs, circa 1955. The Fender reverb mechanism is attached to the inside bottom of the speaker cabinet. The guitar signal is sent to the springs to generate reverb, and at the same time the amp cabinet shakes the box and generates additional sympathetic reverb by the mechanical vibration of the springs. Even today, if a guitar player wants to hear a twin reverb sound, what the amp has to offer using the spring reverb cannot be recreated by more expensive digital technology. Guitar amp spring reverb is a unique sound and has played a major role in the sound of rock and roll.

REVERBERANT FIELD: The area in which the audio signal reflects off various surfaces to produce reverb (i.e., that which surrounds the sound). Also, the virtual "room" created by the parameters of a reverb.

R&B: RHYTHM AND BLUES: The blues style of music took on a heavier beat when electric instruments appeared, and drums were added. The new style of music was called Rhythm and Blues.

RIBBON MICROPHONE: A form of dynamic microphone in which the diaphragm is a thin ribbon of metal suspended in a magnetic field.

ROLL OFF EQ: A type of equaliser in which all frequencies beyond a certain point are gradually removed from the audio signal. All frequencies prior to that point pass through unaffected.

RPM - REVOLUTIONS PER MINUTE: The speed that a record rotates. For instance LP records rotate at 33-1/3 RPM.

RUNNING REVERB: Some reverb devices allow you to set two different decay times: one for when a signal is always present and one for when the input signal has ceased. Running reverb refers to the time when a signal is present and the reverberation continues to 'run.'

SAMPLING: See DIGITAL RECORDING
SCHEMATIC DIAGRAM, BLOCK DIAGRAM: A block diagram shows the "flow" of the audio signal through a mixing console. To the left are all the input "patch points", and to the right are the output "patch points". The block diagram also indicates where the signal can be rerouted through the patch bay to outboard devices such as signal processors. In-line device such as VGAs and equalisers are usually connected between the mic pre-amp and the mixing desk's equaliser. Side chain effects such as delays and reverbs are connected to the auxiliary sends and receives. Input patch points are normally "normalised" to the microphone lines in the studio and the output of the multi-track recorder. The output patch points are normally "normalised" to the inputs of the monitor amplifiers, the reverb devices, the multi-track inputs, and the stereo mixdown recorder. "Normalised" means the patch point are available for rerouting, but devices that are normally connected are done so through the patch bay. The "normal" is broken when a patch lead is plugged into the input of a device. This also disconnects the signal that would otherwise have gone into that device. On most "normalised" patch bays all of the output connections can be accessed and connected to other inputs without disconnecting the signal to the "normalised" input. Only when a patch lead is inserted into an input is the "normal" broken.

SEND/RECEIVE: see ACCESS PATCH POINT. See SCHEMATIC DIAGRAM

SHELF EQ: A type of equalisation where all frequencies above or below a given point are increased or decreased in level by a certain degree. This equalisation curve when represented on a graph resembles a shelf, hence the name. Like rolloff EQ, shelving EQ is commonly used for the highest and lowest ranges of an EQ.

SHOCK MOUNT: A suspension system which mechanically isolates a microphone from its stand or boom, thus protecting the microphone against mechanical vibrations.

SHOTGUN: A highly directional cardioid microphone, called this because of its characteristic appearance.

SIDE CHAIN: Describes the signal path in which an audio signal is routed to an external effects box and the output of the effect is mixed together with the original, unprocessed signal. Reverbs and delays are most commonly used in side chain signal routing. See SCHEMATIC DIAGRAM

SIGNAL PATH: The routing of an audio signal as it passes through a system such as a mixing board and effects processors.

SINE WAVE: The most basic of all waveforms. A sound with a fundamental frequency and no overtones.
SLAP ECHO: A delay effect created with a single short delay. The delay times for slap echo are just above the Haas Zone and into the range where individual echoes are distinctly audible. Slap Tape, or Tape Delay, is an echo effect created with a three head tape recorder in which an audio signal is recorded onto a tape track and monitored by the playback head at the same time it is being recorded. The distance between the record and playback heads generates a delay between the input and output signal whose time can be controlled by the pitch or varispeed control of the tape recorder.

SLOPE: In a EQ or filter, the severity of the boost or cut, that is, the speed at which the amplitude of frequencies beyond the cutoff point will decrease, is determined by the slope, or rate of change, of the filter. Slope is commonly measured in the number of decibels that a given audio signal will decrease per octave. For example, 12db per octave. See EQUALISER.

SOUND MODULE: See SYNTHESIZER

SPECTRUM ANALYSER: A measurement device that displays the level of different frequencies in an audio signal and how they change over time. Unlike an oscilloscope, which displays what a waveform looks like, a spectrum analyser displays what frequencies a waveforms consists of.

STEREOSONIC MICROPHONE: A stereo mixing technique using two bidirectional microphones whose axes are at ninety degrees to each other. The microphones are usually aimed at the extreme right and left edges of the sound source to be recorded.

STOMP BOX: A signal processing device housed in a small foot pedal. (i.e., a guitar pedal).

STOP REVERB: In reverb devices which allow you to set two different decay times (see RUNNING REVERB), the stop reverberate is the signal which is generated when the input signal temporarily stops. For instance in a musical break in the music.

SUBTRACTIVE EQ: The process of altering a sound's tone colour by lowering the amplitude level of certain frequency ranges. It is the opposite of Boost EQ, where a sound is altered by emphasising desired frequencies.

SUPERCARDIOID: A uni-directional polar pattern, slightly narrower than a regular cardioid pattern, with a lobe in the rear that is somewhat wider than the lobe on a hypercardioid pattern.

SUSTAIN: The second stage in a sound's overall amplitude envelope. The sustain is the period after the sound's peak and before the release during which most of the sound's main body occurs. See ENVELOPE.

SWEPT DELAY: When the delay time on a delay unit is modulated, or changed, at a specific rate over a period of time, the result is termed a swept delay. Most time modulation effects, such as chorusing and flanging, are created by combining the output of the swept delay with a fixed delay.

SYNCHRONISERS: Time code is recorded on each audio or video tape that is used. One of the recorders (usually a video deck) is chosen as the Master, and all the other decks are described as Slaves. Each of the slaves is connected to its own synchroniser. The synchroniser compares the time code being played from the two decks (Master and Slave) and controls the transport functions and play speed of the slave so that the tape synchronises (or is in sync with the Master. If for some reason the code is not completely consecutive in its count, most time code synchronisers will take the jump in stride as long as the numbers count up during the playback of the tape and the jump is identical for all the tapes. In chase, which is to say rewind and fast forward, the synchroniser will compare a tach pulse generated by an electronic counter in the tape path. The Slave deck(s) follows whatever the master does.

The time code provides for a series of user definable numbers, but in audio production these are seldom used. The original SMPTE code uses an 80 bit word (80 ones or zero) and is now referred to as longitudinal time code (LTC) since it is recorded on a continuous track of the audio or video tape. There are now other types of SMPTE code, most
commonly VITC (Vertical Interval Time Code) which uses a 90 bit word that is recorded as part of the picture portion of a video signal on one or more of the several video "lines" that form the blanking interval between picture frames (the black bar that is seen when the picture goes into vertical roll). The advantage of VITC is that the code can be read even when the picture frame is paused. LTC code cannot be read below a certain playback speed. It can however be read either forward or backward due to the nature of its fixed dual bi-phase pulse width character. In every 2ms. segment, if the pulse does not change direction the number is a zero. If it changes between the pulse width the number is a one. See PCM.

SYNTHESIZER VOICE: A synthesizer "voice" is a single sound that can be played polyphonically, a three note chord requires three "voices". A keyboard or sound module will have the ability to play as many voices or parts at once. When a request is made to play more voices then are available, the device will drop one of the voice sounds currently being reproduced, or ignore the request for the most recently requested. A sound module would be best described as another keyboard, but without the keyboard. One master keyboard is used to program the sequencer which controls several sound modules via MIDI. See MIDI.

TAPE BIAS: Tape bias is a very high frequency that is added to the audio signal right before it enters the record head. Bias breaks down the natural tendency of the magnetic "domains" to remain static until they are exposed to a loud signal. This magnetic characteristic is called hysteresis and a diagram which represents this is called a hysteresis loop. The bias is so great that the domains are alternated at the bias frequency. Because the audio is also a part of this signal, the much lower level audio is recorded along with the bias. The bias has the effect of linearizing the magnetic transfer curve. As the bias frequency is increased the hysteresis loop becomes more linear, and the audio is more accurately recorded. The bias amplifier is also used by the erase head to provide a signal for erasing the signal on the tape before the tape travels to the record head. The amount of record bias must be great enough to overcome the hysteresis characteristics, but not so great as to cause the signal to be erased before the tape can move away from the record head (this is called self-erasure). The amount of bias is dependent on the tape formula, and the bias of a recorder must be readjusted when the tape type is changed.

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A typical (non linear) response of magnetic tape when an audio signal is recorded without the assistance of AC bias.
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A linear magnetic curve as the result of adding high frequency bias to the signal going to the record head.
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TAPE RECORDER HEAD: A typical tape recorder record head is illustrated. The recording occurs on the trailing edge of the gap. If the bias is too great self-erasure will cause the signal, in particular the high frequencies to be erased before they are able to exit the influence of the head's magnetic field. The playback head is physically the same as the record head.

The playback head is connected to an amplifier that amplifies the difference in magnetic phase between the two pole pieces as the tape travels past them. The head's output is greatest when the physical width of the gap equals the physical length on tape of a half cycle wave. This is when the gap experiences the greatest difference in magnetic phase. When the physical distance on tape of one wave length equals the distance between the two pole pieces the head's output is zero because the two pole pieces are "seeing" the same point on two different waves.
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and the relative phase difference between them is identical. This is not unlike what occurs with digital sampling. The narrower the gap the better the high frequency playback, but the wider the gap the better the low frequency. A low frequency wave recorded on tape is physically very long, and the pole pieces are only able to see a small segment of it, hence there is little difference in the phase between the two poles. For this reason the output of a head rises as the frequency goes up until a point when the gap distance equals one half wave length of a wave recorded on tape. Equalisation is added to the playback circuit to compensate for the non-linear characteristic. The reason the bias frequency is not heard is because its frequency is so high that the playback head is unable to reproduce it. See DIGITAL.

**TIME CODE:** See SYNCHRONISER

**THRESHOLD:** In a variable gain amplifier, this is the amplitude level beyond which gain reduction will occur. In other words, when the input signal drops below the sensitivity level of a gate or expander, the VCA will begin to reduce its gain. Or when the input signal exceeds the sensitivity level of a limiter or compressor, the VCA will begin to reduce its gain.

**THRESHOLD DETECTOR:** A circuit within a variable gain amplifier that determines when the input signal has crossed the point beyond which gain reduction should occur. The design of the detector is an important factor in why different devices have unique characteristics. See VCA

**TIMBRE:** The specific tonal quality of a sound. Different sound timbres can be understood as combinations of different frequencies at different amplitude levels.

**TIME MODULATION:** The process of continually changing the delay time on a delay device in both a positive and negative direction so as to create effects such as chorusing, flanging, phasing, and the doppler effect.

For maximum effect with any of the time-modulated processes, including phasing and flanging, it is important that the loudness of the swept delay's signal be equal to that of the undelayed signal, and that the depth control is set to 100% sweep delay. The depth control (sometimes called width) varies the balance between the continuously sweeping delay and a stationary delay that is fixed at the maximum time the delay is set to sweep. In other words, the fixed delay setting will be the maximum delay time boundary for the swept delay. To create a prominent flange effect or any other strong time-modulated effect, the width control should be turned to full modulation. The speed or rate control regulates how fast the delay time is swept from a short delay to a long delay and back again. It controls how quickly a delay change will occur. If it is slow, there will be a more gradual sweeping of the delay. If it is very fast, it will sound “fluttery” and seem to warble. With a long delay setting and fast modulation, the result will sound almost as though it is being chopped, a very erratic sort of noise (enter Darth Vader). A very fast rate with a very low depth will create a loud, constant delay with a much lower level random fluttered pitch variation (a setting frequently used on delay that is going to a reverb).

Slow time modulation, which is set very deep, is used to create the effect of phasing, flanging, chorusing, etc. Both flanging and phasing are created with a maximum swept delay time of around 35 to 50 milliseconds, however, flanging always has the swept delay after the undelayed
signal, while phasing will sweep the delayed signal in front as well as behind the undelayed signal.

TRANSUDER: Any device which converts energy from one system to another. A loudspeaker is an electro-acoustical transducer as is a microphone. Record and playback heads are electromagnetic.

TRANSIENT: The leading edge, or very beginning of a sound. Transients usually have very sudden jumps in amplitude level; they provide the ears and brain with a great deal of information on the type of sound which is heard. They are characterised by a rapid attack and decay. The hit of a snare drum or other percussive instrument will generally produce a well defined transient. See VGA

TRANSIENT RESPONSE: The measure of an audio system's ability to accurately reproduce transients.

TRANSPARENCY: Nearly all sounds have a very large range of frequencies which, by themselves sound fine, but when mixed together with other sounds often get lost or muddled. To correct this, you often need to equalise a sound in such a way that its most important and most identifiable frequency characteristics (i.e., its most important overtones) remain, while the frequencies which overlap with other sounds are reduced. This process gives a sound transparency.

UNNATURAL REVERB: A type of reverb effect, such as inverse or gated reverb, which does not occur in nature but can be created with a digital reverb. See REVERB

VACUUM TUBE: A key invention of the 20th century

VARIABLE GAIN AMPLIFIER or VGA: A device which can quickly and automatically adjust the amplitude of a signal that passes through it over a wide range of levels. Compressors, limiters, expanders and gates are all based around the concept of variable gain amplifiers, which are also called Dynamic Controllers. Interestingly, the actual circuit which varies the amplitude level is called a Voltage Controlled Amplifier, or VGA

VARIABLE GAIN APPLICATIONS: If a signal has too loud an attack, a limiter or compressor will solve the problem. For example, the pluck of an electric bass string is significantly louder than the sustain, release or decay of the bass note. The bass player, and for that matter everyone else, will say, "Can you put a compressor on this so I can get a fatter sound with more sustain?" What they are actually asking is: "Can you put a compressor on this so that the pluck will be less loud?" Then we'll be able to turn up the overall average level and hear more sustain in relationship to the pluck" (Although no engineer has ever heard a bass player say it that way). By being able to raise the average level, the relationship between the now quieter pluck and the rest of the bass's envelope is more even, and therefore the bass sound has more sustain. A limiter is used when the overall level of a signal cannot exceed a certain output. It is essentially a severe form of compression. It is seldom used in music but is often found on the output stages of radio transmitters.

The application of a limiter or compressor is a matter of deciding how much dynamic range a recording should have. The more overall compression, the narrower the dynamic range between the quietest part of the recording and the loudest. Keeping in mind that something only sounds

![Without compression: The pluck is significantly louder than the sustain. With compression: The peak of the pluck is dynamically closer to the sustain.](image)

Comparison of envelope of a bass with & without compression
loud when compared to something that sounds soft, a record with a great deal of compression has no peaks of comparison and doesn’t seem very loud when it’s turned down.

Most engineer/producers use noise gates on snare, tom and kick drums. If the snare, tom, or kick drum mikes have too much leakage from the cymbals, high hat, or the rest of the kit (or other nearby instruments) for instance, a gate can be used to reduce or eliminate the lower level leakage between every snare, tom or kick drum beat. The gate can be set to turn off the track immediately after each drum hit. When the snare drum is struck, the gate instantaneously turns on and the sound of the snare drum passes through. As the snare rattles away into leakage, the decay goes below the threshold and the amplifier once again turns off. The result is the elimination of the leakage between every beat of the snare drum. An expander will do much the same thing, but its amplifier turns off more gradually. See VGA parameters.

VARIABLE GAIN PARAMETERS

Even though all the front panel variable controls might have essentially the same settings, the type of threshold detector, the input/output circuitry and the design of the actual variable gain amplifier in the VGA give each design a unique sound. For instance, a tube compressor will have a warmer sound and generally act more slowly than a transistor amp with an FET threshold detector.

No matter how fast a circuit is, the attack of many sounds is faster, thus a certain amount of transient response is lost from the sound. How quickly a VGA can respond to these transients depends on the type of detector, the input/output circuitry and the design of the actual variable gain amplifier. Compressor/limiters of an earlier vintage are particularly prone to this problem. Usually, this is less of a problem with a compressor/limiter since it is most often used to reduce transients, but it can be a problem in the case of expanders and gates which have to open on the leading edge of the transient. For this reason the expander/gate are often connected after an equaliser which is used in an effort to offset the coloration that the gate introduces. “The more pipe you have, the dirtier the water” analogy applies here.

VARIABLE PITCH

The variable pitch system uses a computer to control the motorised lead screw which pushes the cutting head across the disc being mastered. The computer is able to know how loud the upcoming signal is going to be through a “preview” playback head that is attached to the analog tape playback machine. This mastering machine has several alternate tape paths between the preview head and the primary playback head. The tape paths are measured to represent in time exactly one revolution of the disk at either 45 or 33 1/3. The master tape playback machine also has alternate paths to allow for differences in the speed of the master tape which could be 15 or 30 inches per second. In the 80s when digital masters became common, but records were still being made, the variable pitch signal was played from the master recording, and then the signal was digitally delayed (for the exact amount of time) and then played out to the cutter head.

VIBRATO: Slight vibrations of pitch above and below a particular note. Vibrato is employed by traditional instruments and voices to add a quality of “warmth.” The electronic analogy is frequency modulation.

VARIABLE Q: A parameter that provides adjustment of the bandwidth of a particular equalisation band on a true parametric equalizer. On pseudo-parametric EQ, the bandwidth is fixed and cannot be adjusted. See EQ.

WAVELENGTH: The physical space taken up by one cycle of a given waveform.
WET (SIGNAL or TRACK): A processed audio signal. The term is normally used with its opposite, "dry", to differentiate between the two types of signals (unprocessed and processed) that are combined when using side chain effects such as reverb and delay. Effects like compression are frequently used during the recording process, but reverb and delay may not be added until the mixdown.

WHITE NOISE: A signal that contains a continually random sampling of all frequencies and amplitudes within the audio range.

WIDTH: see DEPTH

WINDSCREEN: An acoustically transparent filter, placed over a microphone to shield it from wind induced vibration.

XY MIKING: A stereo miking technique using two cardioid microphones located in the same vertical plane, with their axes about 90 to 130 degrees to each other. See Stereo miking techniques.

ZERO LEVEL: The average maximum operating level of a given piece of equipment, normally set by the instrument’s or system’s designers. Additional room, or headroom to be exact, is made available for short peaks of even higher levels.
Appendix 2 Biographical statement

Tom Lubin was born in Hollywood and grew up in L.A. He was given his first recorder when he was nine (a wire recorder) and had an old record cutter at age eleven. As soon as he was old enough he was spending time in sound studios. Tom has worked in sound production since the early 60s. Throughout his career he has been involved in engineering and/or producing every type of sound recording for film & TV, radio drama, radio commercials, theatre, and of course records. Through most of the 70s he was a staff engineer at CBS studios in San Francisco. Before and after that he worked as a staff engineer (or assistant) at many prominent studios throughout America and Australia. He moved to Australia permanently in 1986.


He is a voting member of the National Academy of Recording Arts and Sciences (the Grammy people). Since 1976 he has developed and delivered adult training for a long list of education providers. His educational "Shaping your sound" videos on music production are used throughout the world. He is currently working on a PhD and is teaching at the JMC Academy in Surry Hills, NSW, Australia.
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