

Chapter 12

KEY WORDS

gong ageng
indie
synthesizer
overdubbing
soundscape
cassette culture
sampler

Learning Objectives

After successfully completing this unit, the student will understand that:

1. Technology extends human capabilities. Musical technologies include instrument making, sound amplification, sound reproduction, and electronic manipulations of sound.
2. Technological applications in music have important cultural significance. These may include the spiritual importance of instruments, the affective power of amplification, the cultural ramifications of recording distribution, and the creative and expressive opportunities afforded by various media.
3. Technological progress is not to be equated with cultural progress. Music does not necessarily get "better," it just changes to suit changing cultural situations.

Television Program

Music and Technology

Audio Selections

63. "Little Cabbage"

Music and Technology

*"I know engineers. How they love
to change things."*

LEONARD MCCOY,
CHIEF MEDICAL OFFICER,
FROM 1979 FEATURE FILM,
STAR TREK, THE MOTION PICTURE

In 1980 the feature film "Fame" flickered onto thousands of motion picture screens around the world. Auditioning for the NYC High School of Performing Arts, a teenage composer/musician used an electric piano, an electric organ, and MiniMoog and ARP synthesizers to create the impression of a one hundred piece orchestra. Blown away by the overwhelming power of the performance, the senior music teacher could only respond, "Mr. Martelli!!! Thank you. One instrument at a time will be quite sufficient." At that moment, millions of musicians, composers, and youngsters around the world knew that the future of music had changed forever.

In this chapter we explore the interconnections between music and technology. We examine the evolution of musical instruments, musical composition, musical performance, sound amplification, recording, reproduction, and playback. In conclusion, we bring the readers face to face with the momentous changes to music, music culture and the music industry that the digital age has wrought.

Music and technology have always been closely intertwined. Music from a radio or stereo system comes to our ears through twentieth-century technology. Earlier technologies, such as those of instrument building, also shape our experience of music. Musical technologies develop along with music itself, the one constantly suggesting new ideas to the other.

Technology involves extending human capacities beyond those of the unaided body and mind. Some percussion instruments, like Australian Aboriginal clapping sticks, enhance the abilities of clapping hands, producing a louder, sharper sound and alleviating the pain of constantly striking the palms. Instruments like the flute and violin expand the capacity of the voice to produce melody, providing attractive sonorities and extended range and volume, and requiring less stamina than continuous singing.

More recent technologies offer an augmentation of the ears through electronic amplification, and of the memory through sound recording and storage. Sound reproduction technologies even extend our physical location in time and space, enabling us to hear music produced on the other side of the earth, perhaps before we were born.

Until the mid-twentieth century, most people believed that only humans could conceive of and produce extensions of the body. Now we know that some animals, such as chimpanzees, are capable of making and using certain kinds of tools. Still, technology—like music—is an essential part of being human, and an investigation of the relationships between these two subjects reveals the ways in which we bring our ingenuity to our expressive capacities, connecting our rational and emotional worlds. We will begin with our most fundamental use of technology in music, extending our bodies by manipulating other objects to produce sound.

MUSICAL INSTRUMENTS

Clapping or singing, rhythm or melody—no one knows which came first in human history. Both activities require only the human body. But as soon as something beyond the body was used, the idea of a musical instrument was born, and musical technology came into being. It is a fair guess

that the first instruments were idiophones, since any hard objects can be struck together to make a sound. Melody-producing instruments involve more sophisticated technological developments.

We do not know when this kind of development first occurred, but a new discovery may push the date farther back than anyone previously thought. In a recent archeological investigation of a Neanderthal campsite, a bone fragment was found which looks like a flute: holes had been carved in it that closely resemble the fingerholes of flutes. Researcher Robert Fink has shown that the holes of this bone fragment would, if it indeed was a flute, produce a close approximation of a musical scale based on the overtone series. If this artifact was a flute—and some researchers feel that its relationship to the overtone series scale proves this conclusively—it would be the oldest musical instrument known, somewhere between 43,000 and 82,000 years old.¹

A flute involves relatively simple technology: basically, it is a tube with holes cut into it. The fife, like the one played by African-American musicians like Othar Turner is just a piece of cane stalk, cut to the desired length and reamed out with a hot poker, with one hole for blowing and five or six for the fingers. Similarly, the Japanese shakuhachi is a selected piece of hollowed-out bamboo with carefully-spaced finger holes, though it also involves further developments: a thumb-hole on the back, a specifically-shaped mouthpiece that allows it to be end-blown, and a lacquered interior. In the 1500s, instrument makers began experimenting with placing a mouthpiece with a reed on the end of simple flutes, and an instrument known as the *chalmereau* became a new voice in many European ensembles. Around 1690, Johann Christopher Denner and his son, Jacob, added a series of keys to the *chalmereau*, one of which, a “register” key, allows the instrument to be played in much higher octaves. This new instrument they named the *clarinetto*, (from *clarino* + *etto*, or little trumpet), and with further refinements became our present day *clarinet*. By the time it became a favorite of Mozart, it had 5 keys, and was becoming a standard part of the orchestra.

The modern Western orchestral flute is a metal instrument with holes which are covered by padded keys rather than bare fingers. This type of pad was the invention of Ivan Mueller, a Russian-born inventor and musician, who developed it for the clarinet in 1812. These pads allowed for larger tone holes in woodwind instruments, which gave them greater



▲ Modern flute making

speaking power, and led directly to the invention of larger instruments, such as the saxophone, which have tone holes much too large to be covered by the fingers alone. Some of these pads were made from leather, and some from fish bladder. The modern flute also has a myriad of extra keys, a system called the *Boehm fingering system* for trills and accidentals and is the product of some of the latest developments in industrial technology. The Boehm system was adapted to most of the woodwind instruments during the nineteenth century, as it greatly simplifies playing in different keys.

A basic idiophone is also technologically simple. Many everyday objects already make a satisfying sound when struck, and others can be modified in uncomplicated ways—by hollowing out or shaping—to produce a more desirable percussive sound.

Other instruments involve comparatively complex technology even in their simplest forms. A skin-headed drum requires at least three different materials: one for the resonator, one for the head, and one to attach the resonator to the head. The idea of one or more stretched strings is similarly complex, involving ways to adjust and maintain string tensions, provide a resonating structure, and—in the case of fiddle-like instruments—to design and construct an effective bow, which starts and keeps the string vibrating.

The modern piano involves an even more complicated combination of technological developments. A stretched string can be set in vibrating motion, producing a tone. Stretched strings of varying lengths, weight, or materials can produce higher and lower tones. Such strings can be attached to a frame, like a harp, so one person can play them melodically, rhythmically, and chordally. This frame can be mounted on a resonator, like a zither, increasing the strings' volume and enhancing their timbre. The strings can be struck, making a more vibrant sound than plucking. They can also be dampened, or muted, so intricate playing does not become jumbled as the strings resonate over each other. The piano keyboard mechanism can operate one striker and damper per string, enabling the player to strike several strings at a time with an automatic damping system which can be overridden by a foot pedal. And finally, this mechanical apparatus can be carefully adjusted to provide a wide range of dynamic subtlety. While we may not realize it when we enjoy the sound of piano music, we are listening to the operation of a complex technological marvel.

But musical instrument technology can involve more than just tool-making, just as musical instruments themselves can be more than mere sound-producing equipment. Some instruments are imbued with cultural

meaning, and the processes of creating them can be similarly significant. For example, Mantle Hood documented a process of drum making in Ghana which included offerings, libations, and formal speeches made to a selected tree before it was felled to provide the drum's hollowed-out resonator.² Another example of the intersection of technology and culture is the traditional process of making a *gong ageng*, the lowest and most important gong in a Central Javanese gamelan.

Gong Smithing in Central Java

Primary among the instruments of any gamelan is its largest gong, the gong ageng, which sounds at the beginning and end of a composition, and accentuates other significant musical events, sometimes separated in performance by several minutes. Only the most skilled of musicians play the gong ageng; its deep reverberations and meaning can be fully savored only when it is struck precisely at the right moment and with precisely the right feeling. A gong ageng can inspire such deep respect that it is often given a formal, poetic name, such as "The Venerable Tempted to Smile," "The Venerable Aromatic Rain," or "The Venerable Honeyed Thunder." And it is by this name that its gamelan is known. Elaborate arrangements of food and incense are regularly laid out as offerings next to the gong stand and some even feel that it is through the gong ageng that one is able to hear the voice of the Almighty.³

An instrument of surpassing spiritual power, the going ageng is not to be rolled off an assembly line at a factory. Central Javanese gong-smiths practice their art in much the same way it was done a hundred years ago. The process of making one gong ageng can easily occupy thirteen men, alternating to avoid exhaustion, for three full days or more.

Over a blazing fire fed with forced air by a goatskin bellows, copper is melted and tin is mixed in, carefully observing the required proportions, to make bronze. When the alloy is ready, it is poured into a preheated mold. Now the great energy of the workers must flow; bellows are pumped as the disk is heated in the fire until it is glowing red, and as soon as it is taken out and laid on an anvil the hammering begins. Up to five smiths, standing closely together around the fiery disk, must supply a torrential burst of pounding with their nine-kilogram hammers as it is slowly turned. This process is repeated again and again, and the disk slowly takes the necessary shape for the beautiful-sounding instrument. Finally, it is ready to be cooled by sudden immersions in a pool of water. The completion of the instrument will involve meticulous fine-tuning.

This process, involving such vigorous and sustained activity and resulting in an instrument of such cultural import, is considered to require great spiritual power. Traditionally, gong smiths approached their work only on auspicious days, after purification through meditation and fasting. To protect themselves from the spiritual dangers of presuming to control the elemental forces of wind, fire, and water, they assumed mythological personas when inside the forge. With the head smith ritually transformed into the great Javanese hero Panji, and the other workers changed into Panji's family and servants, extraordinary spiritual strength was summoned for the momentous task of producing an instrument of transcendent power.

While other instruments makers are seldom equated with mythic heroes, they are often highly respected as masters of their craft. All musical instruments extend the body, but they also extend people's ability to communicate their abstract, heartfelt inner world. An instrumentalist becomes a kind of superhuman, with enhanced powers of expression, and recent developments in electronic technology have broadened such possibilities even further.

ELECTRONIC MUSICAL TECHNOLOGY

Electronic applications have extended musical technologies in several ways. Sound amplification and recording have transformed both the ways music is made and its potential for access by audiences. Electronic sound-producing and processing devices have widened the range of possibilities for performers and composers. Developments in electronic musical technologies are rapid and complex, and their impact is felt all over the world. We now turn to an investigation of some of these developments and their cultural implications.

Sound Amplification

Starting in the 1860s physicists and inventors tried hundreds of combinations of materials in various ways in order to create what we know today as the microphone. Early sound recordings had been made by having performers stand in front of a large horn-shaped tube, with a diaphragm and needle at the other end which actually "cut" a groove into a spinning cylinder or platter, thus the term "cutting a record." However, the 1920s saw the development of vacuum tube electronic technology which allowed for the use of *electronic microphones*. This naturally led to the development of an entire new industry, sound reinforcement through sound

amplification—a microphone, an amplifier, and a loudspeaker. Electronic amplification made it possible for music to be heard at greater distances, over ambient sounds such as conversations, or at a more stimulating volume for dancing. It also enabled softer instruments to play with louder ones without being drowned out. Further, previously incongruous performance styles could be mixed; for example, a singer like Bing Crosby could croon gently into a microphone and still be audible over a piano, drums, and even horns.

This capacity for increased volume has had widespread cultural impact. The potential for mixing indigenous acoustical instruments with amplified ones has spawned a prodigious growth of new popular music genres throughout the world. For example, Christopher Waterman has shown how the ability to combine electric guitars and amplified voices with traditional Yoruba “talking drums” led to the development of modern *jùjú* in Nigeria. With this fusion of old and new technologies *jùjú* became a music which combines traditional Yoruba musical and social values with an infectious contemporary sound.⁴

Loud music both embodies and enacts power. Nineteenth-century European composers demonstrated this fact by increasing the size of their orchestras, just as instrumentalists and vocalists of that era developed increased capacities for resonance and dynamics. This connection between musical volume and its affective power is also evident in the aesthetics of today’s popular music.

Amplification in Performance: Rock and Heavy Metal

As we have seen, the earliest usages of amplification in music facilitated the inclusion of softer instruments with louder ones, and made it possible for a singer to be heard over a fuller accompaniment. However, it was the invention of the electric guitar that has been responsible for much of what popular music is today. In 1931, Adolph Rickenbacher and George Beauchamp hired craftsman Harry Watson to build an acoustic guitar with a tungsten pickup. A pickup is the device which senses the vibration of a metal string and turns it into a minute electrical current. They began manufacture in 1932 using the name “Rickenbackers,” and very quickly guitar players saw the advantage of being able to compete at last with a large group of musicians. Pickup technology improved rapidly, and by the mid-1930s inventors were experimenting with using a pickup on a solid-body guitar. In the early 1940s, Les Paul, a guitarist and inventor who played with the Fred Waring Orchestra, had created what he

called his "log guitar," virtually a piece of wood with a guitar neck and a pickup. In 1943 he presented a much fancier prototype electric guitar to the Gibson Guitar Company who declined to market it, thinking that it would not be a successful product.

Three years later, in 1946, Clarence Leonidas Fender (professionally known as Leo), an inventor and radio repairman, designed and brought to market the solid-body guitar which would change popular music forever. In the one-pickup design it was called the "Esquire," and in the two-pickup design the name was the "Telecaster." (When first introduced, it had been called the "Broadcaster," but due to a trademark dispute, the name was changed almost immediately). In 1954 Fender introduced the "Stratocaster," a three-pickup design which has become one of the most popular (and oft-copied) musical instruments of all time. Jimi Hendrix played one, as did Eric Clapton and hundreds of other popular guitarists. It is interesting to note that by 1949 the Gibson company was manufacturing the Les Paul design guitar to compete with the Fender solid-body instruments.

Soon amplification came to be used for an entire group, enabling performance in larger spaces. But in today's popular music, volume is also an affective choice. Combined with other kinds of electronic sound processing, volume enhances the power of the music's emotional expression, addressing the listener not only through the ears, but through the whole body. In his study of heavy metal music, Robert Walser notes that:

Heavy metal relies heavily on technology for its effects, not least for this sheer volume of sound, impossible until recent decades. But reverb and echo units, as well as sophisticated overdubbing techniques, have also become important to metal performance and recording. Such processing can expand aural space, making the music's power seem to extend infinitely. . . . Loudness mediates between the power enacted by the music and the listener's experience of power. Intense volume abolishes the boundaries between oneself and such representations; the music is felt within as much as without, and the body is seemingly hailed directly, subjectivity responding to the empowerment of the body rather than the other way around.⁵

A significant component of this affective use of amplification is controlled distortion. In most cases, distortion—the noisy buzzing caused when a loudspeaker or amplifier is driven with more volume than it was built to handle—is considered undesirable in sound amplification and

reproduction. But in the late 1950s rock musicians such as Link Wray (whose first record, "Rumble" had a name with a serious double meaning!) began experimenting with using distortion deliberately, as a timbre which symbolized power. Walser points out how this timbral change functions symbolically:

Not only electronic circuitry, but also the human body produces aural distortion through excessive power. Human screams and shouts are usually accompanied by vocal distortion, as the capacities of the vocal chords are exceeded. Thus, distortion functions as a sign of extreme power and intense expression by overflowing its channels and materializing the exceptional effort that produces it.⁶

Indeed, the most characteristic use of distortion in rock and heavy metal is in the sound of the "lead" guitar, which provides melodic lines recalling—and sometimes purposely imitating—the human voice.

Unlike the late-1950s electric guitarists who slashed loudspeaker cones and overdrove their amplifiers for a distorted sound, rock musicians since then have relied on electronic processing devices which produce distortion without endangering their equipment. Other processing devices produce other sonic effects, like the "wah-wah" pedal used by Jimi Hendrix and other musicians starting in the 1960s.

While some musicians revel in the range of such possibilities for electronic processing, others feel that they can go too far. A rock musician interviewed by Leslie Gay criticized a guitarist for having "too many knobs between the guitar and the amp's speaker," later explaining that "every electronic thing adds some muck to the sound and deteriorates the fidelity, hindering the directness of the 'feel' of the guitar."⁷ Commenting on this perception, Gay noted that musical expression which is "obstructed by the technology, rather than controlled by the musician, not only obscures communication between musician and audience but also disconnects the musical instrument from the musician."⁸

Whether it works for or against expression and communication, electronic amplification and processing are involved in many musical performances today. But amplified sound is not only heard in performance settings. It is also part of what R. Murray Schafer termed our "soundscape," the audible environment in which we live.⁹ Amplified music can be found in Western soundscapes in the form of barely-noticed music playback in retail environments, or as a neighbor's too-loud radio, but Western soundscapes include much less amplified music than some Eastern ones, such as those of Indonesia.

Amplification in the Soundscape: Indonesia

Western visitors to Java—and other parts of Indonesia—are likely to notice within hours of their arrival how different the soundscape is from their own . . . The new arrival will inevitably be startled out of slumber at 4:30 or 5:00 in the morning with sounds of the call to morning prayer blasting from large and powerful speakers in the mosques . . . Traffic movement in daylight hours is heavily punctuated with honking horns. . . . Small trucks advertising films, concerts or even herbal medicines are equipped with loud speakers and screech out a combination of recorded popular *dang-dut* music and “live” announcements at ear-splitting levels of amplification.¹⁰

Java is one of the most densely populated places on earth, and in its urban soundscapes a chaos of loud sounds in commonplace. This daily cacophony is exacerbated by layers of amplified music, issuing not only from advertising trucks, but also from shops and cafes.

But in some cases the Javanese actively cultivate this kind of multi-musical soundscape. “The large public celebrations occasioned by important holidays in Java are characterized by a kaleidoscopic variety of overlapping sounds,” R. Anderson Sutton pointed out. Strolling slowly through such an event with his tape recorder running, Sutton captured “an overlapping of sound streams that, without any editing on my part, gives the impression of a tape collage. For example, I passed by a shadow puppet performance—with full, live gamelan accompaniment, amplified voices of female singer and puppeteer—and with these one hears a host of ‘other’ sounds from the fair, including recorded popular music.”¹¹

Sutton noted that comparable Western events are carefully scheduled and physically laid out so that “musical sounds do not intrude upon one another, even at a festive event where undivided attention toward the musical sounds is not expected.” To explain the difference, he referred to the Javanese word *ramé* which “translates as busy, noisy, congested, tangled—but in a positive sense.”¹² The word derives from a Sanskrit word meaning “beautiful,” and one can appreciate the beauty of *ramé* in the complex patterns of a Javanese *batik* textile print, or in the intricate polyphonic textures of gamelan music. Multiple amplified sound systems at a public celebration enable a boisterous enactment of this indigenous concept, which is considered appropriate for a festive atmosphere.

Amplified music in the soundscape can also involve social power. Edward Herbst describes an event in Bali in which certain visiting dignitaries had come to a temple courtyard to witness a rare performance of a dance-drama accompanied by the gentle sound of long bamboo flutes. This

performance was suddenly rendered inaudible by "a blaring noise, so it seemed to all around, coming from a loudspeaker somewhere." The many other courtyards of the temple were searched to find the loudspeaker, and its cable was traced to "a little old man in the *jeroan pura*, inner courtyard of the temple, intoning the *kawi* verses, as he had no doubt done countless times before, in that same place, but then only heard by a few nearby friends and passerby bringing their offerings":

We learned that some kind of power play was being enacted and that whoever was in control of the microphone was not willing to delimit his newly acquired technology. The visiting dignitaries could not convince the possessors of the amplifier to turn down the volume. Now, it turns out that the intravillage rivalries had been going on since colonial times, in which performance forms were already being incorporated into the struggle for power and social order. The amp and speaker happened to be a new instrument of power and dominance in this dynamic between kinship groups and political persuasions.¹³

Although Indonesia is officially Muslim (excepting Bali, which is Hindu) older animistic beliefs are often just below the surface, and they can interact with the superhuman quality of amplified music in various ways. "Once when I felt unusually tired at my gamelan teacher's house," Sutton recalls, "he suggested I lie down and sleep for a little while. His wife ushered me into one of the bedrooms and turned on the radio at near full volume—not to keep me awake, but to make me feel secure. With loud sounds around, I would not feel lonely or, worse, empty. Emptiness represents vulnerability to the spirit world, which is ever waiting to catch human beings unaware."¹⁴

One Javanese musician described to Sutton the exhilaration of amplifying his own voice: "a kind of modern magic (*gaib*), as he put it."¹⁵ But such "magic" is not necessarily perceived as benign. In the sacred shadow puppet theater forms of Java and Bali, the *dalang* puppeteer is considered far more than an entertainer. A *dalang* embodies and expresses great spiritual power, both through manipulation of the puppets and through an extraordinary range of vocal subtleties in heightened speech and song. The now-common practice of amplifying the *dalang*'s voice raises spiritual concerns among some, like those interviewed by Herbst in Bali:

While several *dalangs* have expressed to me their feelings of a need to keep the interest of their less-focused contemporary audience, many recognize a difficult trade-off with the sound blaring from a loudspeaker, rather than the body of the *dalang*, changing the

corporeal and spiritual nature of performance. In my recent discussions with *dalangs* several have pondered whether the *dalang* is losing his real voice, and whether *kawi suara* (the transcendent, spiritual voice of the *dalang*) can exist in such a disembodied, detached form. In a discussion I had in 1992 with two prominent *dalangs*, one even went so far as to say that loudspeakers would be the death of *kawi suara*.¹⁶

This example raises the issue of cultural pollution, in which use of Western technology clashes with deep indigenous aesthetic and spiritual values. Like Westerners, some people in other cultures are eager to embrace technological developments, while others worry that essential human qualities are lost in the process—like electric guitars with “too many knobs.” But as our other Indonesian examples have shown, sound amplification can also present opportunities for reinforcing cultural values, uniting the old and new in ways which affirm indigenous principles. The same kinds of possibilities are afforded by another important technological development: sound recording, the ability to store and reproduce musical performances.

Sound Recording

While the development of music writing and the printing press had widespread effects on the transmission and storage of music, musical notation could, at least until the early twenty-first century, only be used by specialists. And such notations did not really present a musical experience, except to skilled and imaginative music readers. They were more like sets of instructions for recreating music, rather than actual, “pictures” of sound. Before the end of the nineteenth century music existed only

in live performance: it vanished into the air the instant it was produced, never to be heard again.

This situation has changed dramatically with the advent of sound recording. Not only can we hear a piece more than once, we often can choose from several different performances of it, selecting out favorite and listening to it whenever we wish. With lightweight, portable playback machines and headphones, we can also listen to it in any location. We can even record music ourselves, and send it wherever we please. And digital

▼ A Recording Studio



recording technology enables us—in theory, at least—to produce sonic archives which will never deteriorate.

Of course, sound recording has not always been so sophisticated and accessible. The first sound recording device, called the phonograph, was developed in 1877 by the American inventor Thomas Edison. This hand-cranked machine directed sound through a mouthpiece and vibrating diaphragm to a needle which etched grooves into tinfoil wrapped around a turning cylinder. The recording was played back by a similar mechanism working in reverse, with a paper cone amplifying the vibrating diaphragm. One could only play these recordings a few times before the tinfoil became useless, and their scratchy sound was hardly something one would listen to for aesthetic pleasure.

Still, some scholars were immediately drawn to the invention's potential for documenting and storing musical performances—if not for aesthetic pleasure, at least for study. Wax cylinder recordings of Native American and other oral-tradition musics were made as early as 1889, by people who would later be considered among the founders of the field of ethnomusicology. Not least among these was the visionary Hungarian composer Béla Bartók, who traveled around eastern Europe making hundreds of wax cylinder recordings of folk musicians. Back home at his writing desk, Bartók meticulously transcribed these recorded performances, producing some of the most detailed notations the world had ever seen. Despite the care he lavished on these transcriptions, he declared that the only true “notations” of these performances were the grooves etched on the cylinder itself!

In 1887, the German inventor Emile Berliner patented the first device which recorded sound on a disc rather than a cylinder. Originally marketed as a toy for children, it began to generate wider interest. Unlike cylinders, which could not easily be duplicated, a metal plate could be made from the original disc, and this plate could be used to stamp out reproductions. Commercial enterprises arose, and sound recordings became consumer goods. At first the playback apparatus was a novelty item for the rich; a phonograph cost almost \$200 in the American currency of the 1890s. But by the turn of the century the price had come down to \$25, and more people could enjoy this new form of entertainment. Recordings of humorous and dramatic monologues and scenes could be purchased, as well as popular tunes and songs. Soon American record companies were also targeting ethnic immigrant groups and African Americans with songs in their own languages or dialects.

By the early 1900s, the quality of sound reproduction had become sufficient to interest lovers of classical music, and records of opera arias and short chamber works appeared. Advertising for these products stressed the fidelity of the sound, with images like the Victor dog listening intently to "his master's voice" issuing from the playback horn of the phonograph.

The advertisements worked. Half a million phonographs were sold in the United States in 1914, two million in 1919. Packaged in a handsome cabinet, the phonograph became a desirable piece of parlor furniture, often providing more entertainment than the piano. Less elaborate models could be purchased by less affluent people, and some record companies started recording rural blues and country music, expanding the audience for sound recordings to poorer but more numerous customers.

Remember that these early recordings were made by aiming instruments and voices toward a large horn which directed the sounds to the diaphragm and needle recording apparatus. Softer instruments were placed closest to the horn, and sometimes small amplifying horns were affixed to instruments like the violin, in an attempt to balance the overall sound. To record a full orchestra, certain players sometimes had to run up to the horn for their solo passages, then return to their seats to rejoin the ensemble sound. Despite these difficulties, the resulting recordings were immensely popular, and sound recording and reproduction flourished.

Notwithstanding the many economic, political, and social upheavals of the ensuing years, sales of sound recordings and playback equipment have continued to grow. As technology drove the music industry worldwide, the phonograph became the home reel-to-reel tape player of the 1950's, which in turn became the cassette recorder/player of the 1960s. The compact cassette, invented by the Philips Corporation in Europe in 1963, has had a fairly long life due to the invention of an effective noise reduction system by electronics engineer and inventor Ray Dolby. (Dolby was also a co-inventor of video tape recording while working for the Ampex Corporation.) The audio cassette is inherently noisy, and a new cassette played back in a player without noise reduction will exhibit a sound similar to a radio between stations. However, Dolby was able to devise an electronic noise reduction system which, simply stated, boosts high frequency signals during recording and then turns them back down by the same amount during playback, thus reducing the high-frequency noise. As noted in the next section of this chapter, the cassette is still a popular medium for music in many countries.

The cassette has been supplanted in much of the industrialized world by digital methods of recording and playback, the CD and MP3, and

for good reason. It became possible in the first part of the twenty-first century to store literally hundreds of songs on a device not much bigger than a small stack of credit cards. These songs can be downloaded from the internet, "ripped" from a CD, or created from music already existing on the hard drive of a computer. The need for the "Major Record Label" is fast disappearing as independent recording companies (and individuals!) called "indies" make their music available to anyone with a computer.

As Peter Manuel has noted, the burgeoning indie scene in the United States "illustrates that in a society sufficiently affluent that minorities can own independent recording companies, the music industry may come to offer a relatively satisfying balance and coexistence between dominating, homogenizing majors, and smaller, marginal indies."¹⁷ But what about less affluent societies, where indies cannot even begin to compete with majors on the same playing field?

Cassette (and Digital) Culture

In a groundbreaking study, Manuel coined the term "cassette culture" to describe independent sound recording "in the context of a new world order with new potentialities for decentralization, diversification, autonomy, dissent, and freedom."¹⁸ Small cassette indies have arisen throughout the world, finding niches in which they can prosper. Cassettes are relatively inexpensive to produce in mass quantity, so they can be sold more cheaply than records or CD's. Cassette playback systems are also comparatively inexpensive, and many are both durable and portable.

A cassette-producing indie can be established almost anywhere. Some third-world cassette-based indies involve little more than a technician, one or two microphones, and a bank of tape-copying machines. As late as 2008, new cassette manufacturing plants were opening regularly in India and the middle east. Local musical styles can be featured, tailored to local populations, without the headaches of operating a centralized recording company and targeting a wide audience with expensive advertising. Manuel discusses how these grassroots companies can ignore broad cultural demographics and distribute exactly what their specialized audience want to hear, directly to them:

In Israel, *rock misrahi* associated with Oriental Jews, although scorned by Ashkenazis and the state radio stations, has enjoyed ample dissemination by cassettes. Similarly, while air play on the Egyptian state radio was once a prerequisite to any sort of musical renown, singers like Ahmad 'Aduwe have become stars via cassettes, in spite of being shunned by radio gate-keepers. . . . The Turkish state mu-

sic bureaucracy, although contemptuous of the Arab-influence pop genre *arabesk*, has been unable to curb its popularity, as cassettes of it abound. Sri Lankan pop *baila* has similarly flourished almost exclusively on cassettes, with taxi drivers playing essential roles as disseminators via their car stereos. Even in the United States, cassettes have established niches as vehicles for regional syncretic genres; one example is "Jawaiian" a Hawaii-based fusion of reggae and Hawaiian pop music."¹⁹

As late as the early 2000s, automobiles were still being sold in many areas of the world with playback systems which included both CD and cassette players.

These are but a few examples of popular musics which thrive in the world of cassette culture, despite their neglect by major recording companies and radio stations. Small cassette companies play an increasing role in religious music as well. In India, playing a cassette of devotional music can become a part of religious rituals, and the availability of cassette recordings of songs relating to particular deities and sects can help to cement a minority community which is otherwise threatened by the more homogeneous devotional music of the mass media.

Cassette culture can also nurture local folk musics, in some cases even contributing to a revival; of endangered musics. Manuel quotes the founder of a small cassette company in northern India:

My friend, an agriculturist, points out that a different fertilizer may be needed for every hundred yards of land, because here there is a potassium shortage, there a nitrate shortage. But the big fertilizer companies just make a general product, and the crops suffer. It's the same with folk music. [A famous popular singer]'s songs will sell, because they're melodious, well-produced, and extensively promoted, but the special heart and soul of a region—only a local can convey that. Especially for the little guy, who's illiterate, who only knows his own little dialect—if he hears his own little dialect sung on the media, by a local who knows the soul of a region, he is so happy. With regional music, even people who sing out of tune can make hits, because they have soul.²⁰

Such a featuring of regional style can have an opposite effect, one of homogenization, when it is the product of a larger enterprise: the widespread dissemination of one local style can prompt neglect of others, even by their practitioners. As Jerry O'Sullivan explains, in Ireland "prior to the radio and the phonograph, learning music was done very, very locally. Keep in mind that going back only a hundred years ago or so . . . most people

never got beyond their little village and you could tell where somebody was from just by listening to them play—you wouldn't even have to hear them speak."²¹ In the 1920s a number of Irish musicians made recordings in the United States including Michael Coleman, a masterful fiddler who played in the style of Killarney, a small town in County Kerry.

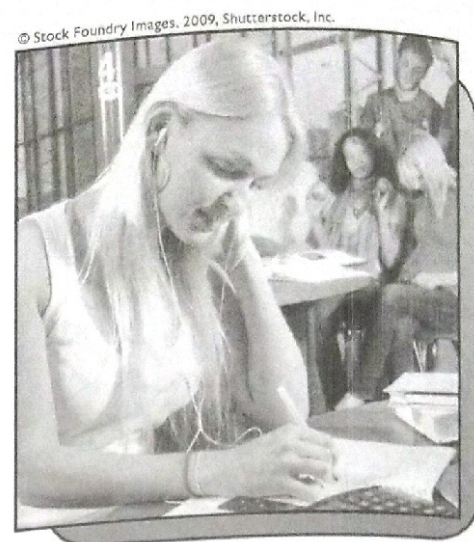
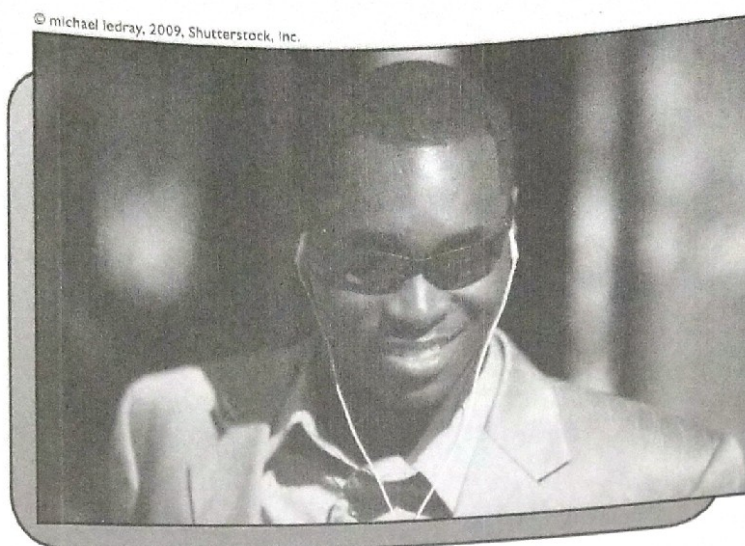
O'Sullivan notes that Coleman's impressive recordings "traveled back to Ireland and they changed fiddle playing style. People tried to imitate Coleman whether they were from Sligo or whether they were from Cork or Donegal. It was no longer the case that you could tell where somebody was from by listening to them. That was the beginning, that this was starting to be homogenized."²²

The smaller technology and audience of the cassette-producing indies are less apt to cause a situation where recording one local style causes the neglect of others. Indeed, these indies tend to encourage regional styles, both rewarding local musicians and reinforcing the identity of their audiences.

Some cultural critics envisioned a grim future of cultural "gray-out" in which the wonderfully varied regional musics of every corner of the earth would be abandoned one by one until the major record labels ruled the musical taste of the world. Too be sure, recordings and performances by some pop music stars are and will be in demand almost everywhere. But thanks in part to cassette culture and the *democratization* of music, discussed later in this chapter, grassroots music-making has not been overwhelmed, and in some cases both local tradition and hybrid innovation are flourishing more than ever before. As the cost of the new versions of playback equipment falls, (remember that in 1969, a good quality cassette recorder/player cost almost \$1,000!), the term *cassette culture* will likely expand to become *cassette*, *CD*, *MP3*, and *internet culture*. Like much technology, sound recording and dissemination is neither good nor bad in itself; it is a versatile tool which can be used for many purposes.

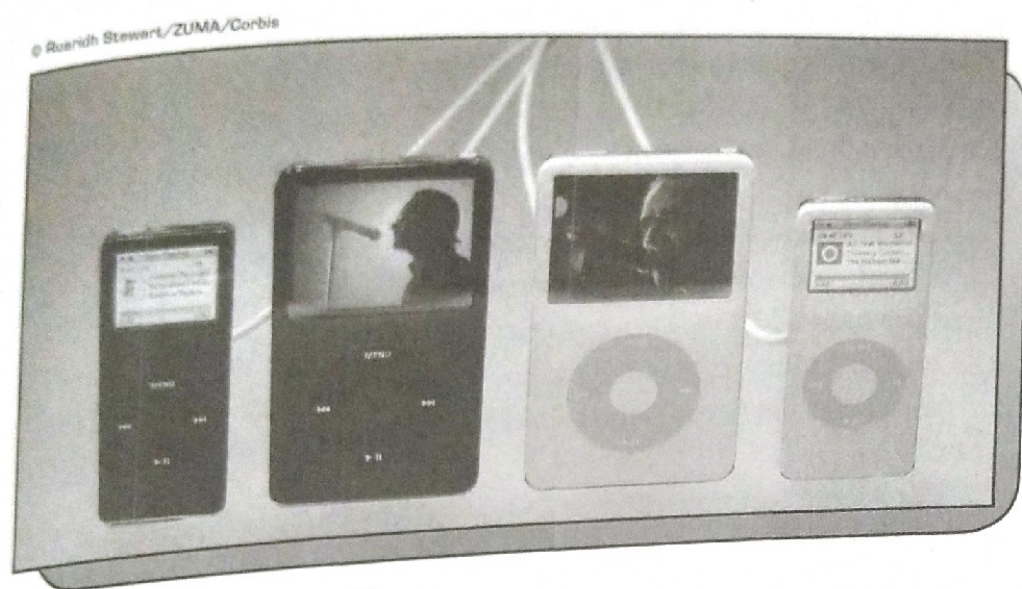
MP3 and the Internet Dissemination of Music

Although the invention and subsequent success of the CD brought digital storage and playback of music to the masses, the digital files were much too large to be stored on small hard drives or quickly and easily transferred over the internet. The idea for a compression algorithm for audio had been proposed in the late 1970s, and the AT&T-Bell Labs, along with physicists from around the world, began to experiment with reducing the size of digital audio files. The result of this experimentation is what is known today as the MP3. Similar to the JPEG compression tech-



nology for images and video files, the MPEG-1 Audio Layer 3, (or MP3) compression algorithm involves the discarding of musical material which the majority of people would not miss. It takes advantage of the fact that there is a perceptual limitation in human hearing which is called *auditory masking*. In other words, there are some frequencies in music which are hidden to the human ear by other frequencies. The ones which are hidden are eliminated in an MP3. Engineers from all over the world helped develop the MP3, which is an audio-specific format approved in 1991 by the ISO (International Organization of Standards), and named for its designers, the Motion Picture Experts Group. The end result of this compression system is that the digital file of a song in MP3 format is approximately 1/10 the size of the original. This makes it far less difficult to transmit songs over the internet, and much easier to store large numbers of songs on computer hard drives and in personal playback devices. The first real-time software MP3 player was released in the fall of 1995, and allowed PC owners to store large numbers of songs in very little hard drive space. (The average home computer in 1995 had hard drive space of less than one-half gigabyte, much of it consumed by software). It should be noted that audiophiles do not consider the MP3 to be a high-fidelity format, because all of the information in the original digital file is not available after compression.

Once this software became universally available, the opportunity presented itself to, in effect, share a compressed version of a song, usually an MP3 but sometimes a full-frequency digital copy, with anyone who could



▲ iPod Portable Digital Media Player

gain access to files on another computer, via the internet. The leading conduit of this “file sharing” was *Napster*, which became the scapegoat for all the file sharing websites due to a federal (U.S.) lawsuit based on copyright infringement laws. Since the creator of an artistic endeavor legally owns the right to copy his or her work (copyright), technically the website was promoting violations of the copyright laws. Since the resolution of that lawsuit, legal song download sites, such as iTunes, have become the choice of the music-buying public. In 2008, iTunes became the second biggest retailer of music, surpassed only by the “hard copy” sales of CDs at WalMart stores.

As with every new development in technology, there are good and bad consequences. The bad is, of course, the billions of dollars of royalty income lost by the composers of music which is “shared” over the internet. On the other hand, the worldwide web has created a wonderful new way for musicians and composers to introduce millions of new listeners to their music without the need to have the aid of a traditional record company. There are now websites which allow, for a small fee, musical performers to place their music on the popular music download sites, and receive a royalty each time a song is downloaded. Yet another potential use of electronic musical technology involves the creation of music itself.

Electronic Technology and Creative Musicians

Until the twentieth century, the palette of sounds available to the composer of music consisted of the instruments which had been available, in

various forms, for hundreds of years. The late nineteenth century brought several new instruments (such as the saxophones) and many improvements to the old, but most composers continued to work with different combinations of instruments in order to create new tonal variations in their music.

That all changed in the 20th century as technology, especially electronics, allowed inventions only dreamed of in the past, and greatly altered the musical soundscape. An early example, which can still occasionally be heard today, is generally known as the “theremin” after its Russian inventor Leon Theremin, who called it the “etherophone” when he created it in 1920.

The theremin makes a memorable visual impression: standing before something which looks like a radio receiver with two antennae, the performer’s hands move gently through the air, controlling pitch and volume by the special relationship of hands to antennae. Writing in the *New York Times* in 1967, Harold C. Schoenberg described its sound as “not unlike an eerie, throbbing voice,” or like “a cello lost in a dense fog and crying because it does not know how to get home.” The instrument may be recalled as a swooping sound heard on some 1960s popular recordings, or carrying the melody in the original “Star Trek” theme music.

Bell Labs, well known for their work in digital technology, was able to program an IBM mainframe computer to “play” music in 1957. This started a rush of composers looking into the opportunities available in programming computer music. But this was not the first time a computer had been programmed to play music. That honor goes to a Ferranti Mark I (the first commercially available computer) at the University of Manchester in England—in 1951. A BBC recording team had gone to the university for another project, and overheard talk of a program that could play music. They took their recorder into the room, and the programmer coaxed the computer to play “Baa Baa Black Sheep,” “God Save The King,” and a short piece of the popular song “In The Mood.” The recording still exists today, and at the end, the announcer, who had noticed that the computer could not complete the song “In The Mood,” quipped “the machine’s obviously not in the mood.”

Most early electronic instruments were used either to play conventional music or to produce special effects. Like mechanical instruments, they were seldom viewed as devices which could significantly expand the scope of musical creativity. Still, a few composers started to explore the potential of electronic applications in their work, including a young American named John Cage.

Composers and Electronic Music

"Every film studio has a library of 'sound effects' recorded on film," Cage wrote in 1937. "With a film phonograph it is now possible to control the amplitude and frequency of any one of these sounds and to give it rhythms within or beyond the reach of the imagination. Given four film phonographs we can compose and perform a quartet for explosive motor, wind, heartbeat, and landslide."²³

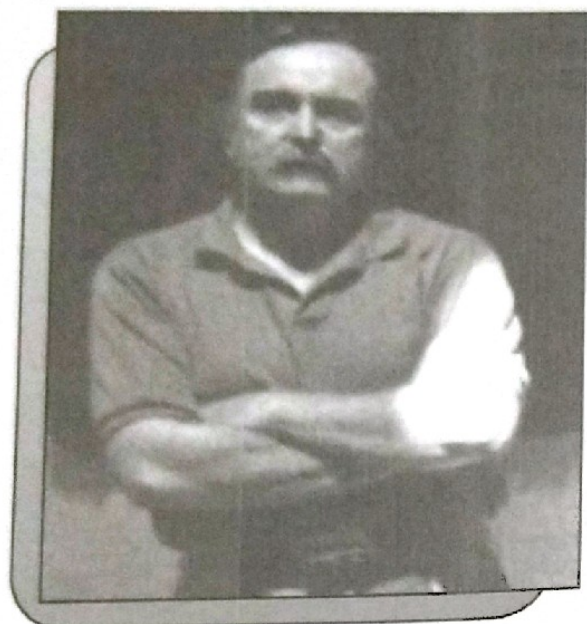
While such ideas were largely considered little more than amusing novelties at the time, and still are by some people, other statements in the same essay now sound visionary:

The special function of electrical instruments will be to provide complete control of the overtone structure of tones (as opposed to noises) and to make these tones available in any frequency, amplitude, and duration . . . The composer (organizer of sound) will be faced not only with the entire field of sound but also with the entire field of time. . . . No rhythm will be beyond the composer's reach . . . Before this happens, centers of experimental music must be established. In these centers, the new materials, oscillators, turntables, generators, means for amplifying small sounds, film phonographs, etc., available for use [sic].²⁴

Such centers were indeed established, one of the most notable being IRCAM, a research and educational institute in Paris. Initially headed by composer Pierre Boulez, the institute was the idea of Georges Pompidou, president of France from 1969–1974. It is housed in the Pompidou Centre which opened in 1977. Today the centre offers musical software development, acoustics research, instruction for composers in computer technology, and a large collection of sheet music. Many important composers have written innovative music while studying or teaching at IRCAM.

While Cage was among the pioneers of composing with recording technology, he was interested in working with the broadest range of sonic possibilities, including doing unconventional things with conventional instruments. His early experiments with "prepared piano" involved placing items like bolts and leather strips between the strings of a grand piano, resulting in an increased timbral palette for the pianist: a new technological development for a nineteenth century instrument. Cage also made use of electronics as instruments in live performance: for example, one of his pieces from the early 1950s is a composition for twelve radios.²⁵

Composer Alvin Lucier's *Music on a Long Thin Wire* involves a very simple electronic setup: a thin wire stretched across a room between poles of a large magnet, vibrated by a single oscillator, and amplified through loud-



▲ Alvin Lucier

speakers. The whole system becomes a delicate, ever-changing feedback loop which can be “played” by manipulating the oscillator and amplifier. “A short length of wire would look like a laboratory experiment,” he said in an interview, “but if you thought of it as a sound sculpture, your imagination could take that wire down the length of a room. I had to be prepared for not knowing what it was going to sound like, although in my imagination I knew I had an intuition that it would sound amazing.”²⁶ Lucier’s aesthetic approach is clear in his description of fellow composer David Rosenbloom “playing” the wire:

I was struck by the sensitivity with which he tuned the system. It seemed that the more he reduced the power, the more effectively it vibrated. It was paradoxical. I guess there’s a natural plateau above which the wire refuses to handle more power; below that point, it accepts what comes into it and interesting things start to happen. At one point, David achieved a state in which the wire would start and stop vibrating of its own accord; it would go through long cycles of marvelously complex harmonic changes.²⁷

Lucier’s long thin wire is a kind of electronic musical instrument, notable for its structural simplicity. Other composers worked laboriously splicing tiny bits of recorded tape together to create new types of compositions, but the multi-track tape recorder brought a whole new wave of capabilities to creative musicians and composers.

Guitarist Lester Polsfuss, known by the professional name Les Paul, was given an Ampex tape recorder in the late 1940s by his friend, singer Bing Crosby. Paul had been making sound-on-sound recordings for some time by recording one part on a shellac disc, then playing another part along with the original while recording both onto a second disc cutter. With his wife, Mary Ford, he had several hits with songs recorded in this way, with Paul playing all the guitar parts and Mary singing all of the lead vocal and harmonies. When he received the tape recorder, he soon envisioned opportunities for doing sound-on-sound with a more elaborate design, and convinced the Ampex Corporation to build 2- and 3-track versions of the machine. These machines became the standard for use in recording facilities and radio stations for decades. In 1954, he ordered an 8-track version of the machine (and recording tape wide enough to accommodate that number of tracks) from Ampex. The idea was so revolutionary that it took Ampex three years to perfect and build the machine, but

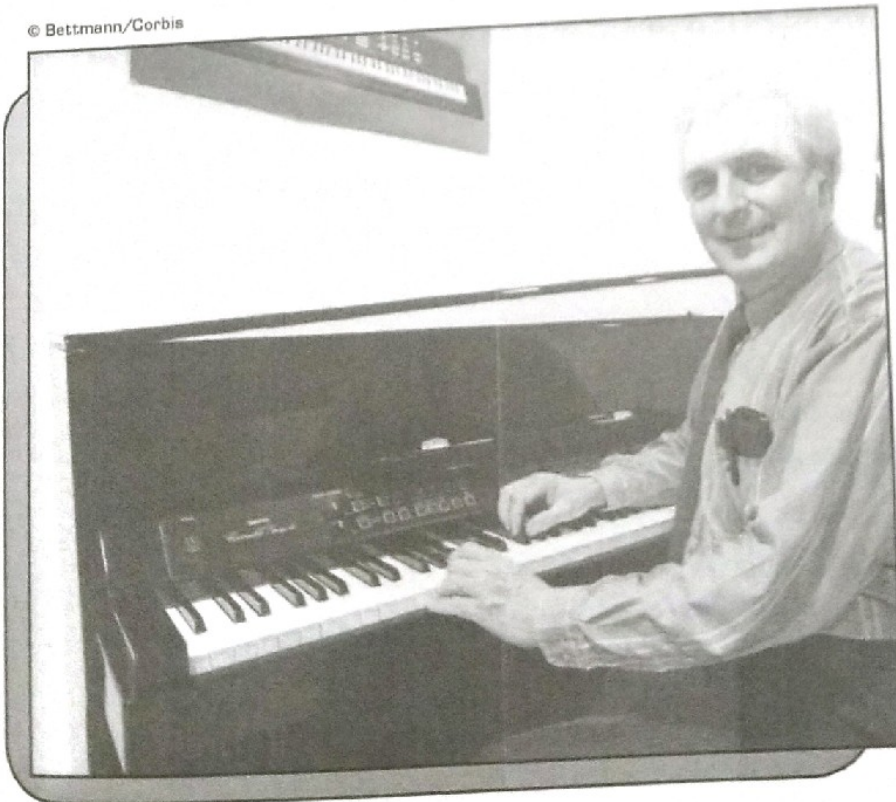
the idea of large numbers of individual tracks on one recorder would dramatically alter the music business. Over the next 30 years, the tape widths for studio recording grew to 2 inches, and the number of tracks went to as high as 32. Since these machines allowed the performer to listen back to some previously recorded tracks while adding new ones, it was no longer necessary for the entire ensemble to be in the studio at the same time. This process is called *overdubbing*, and it allows creative composers and musicians even more capabilities to work with sound.

In 1957, composer Edgar Varese was chosen to create music for the Philips Pavilion at the 1958 Brussels World Fair. Philips is the company which developed the ubiquitous cassette tape, and was one of the major players in the development of digital audio, including the CD. Varese combined vocal, organ, percussion, orchestral and piano music with sounds from nature and the industrial soundscape on a multi-track tape recorder, all altered sonically to fit his compositional ideas. He produced an 8-minute composition which was played over a sound system with more than 400 speakers, a true "composition for tape recorder," *Poème Electronique*. Barely ten years later, in 1968, Walter Carlos (now known

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◀ Robert Moog With Synthesizer

as Wendy Carlos) would create the first classical music album to go platinum (over 1 million sales) with "Switched On Bach," an album of classical music recorded on a multi-track tape recorder using only synthesizers as sound source, mainly the instruments of Moog Music, an early designer of synthesizers.

And it was these mass-produced instruments, in the 1960s and 1970s, mainly the products of Korg, ARP, and Robert Moog's Moog Music, that completely changed the composer's abilities to forge new paths in sound. These new instruments combined tone generators and processors, in one interlinked system, along with "sequencers," devices which enabled the placing of sonic events in time. Using a bank of knobs and a keyboard, composers and musicians could now perform electronic music in real time, rather than relying on tape recorders. Synthesizers proved extremely versatile. While they could be used to streamline the work of electronic composers, they could also be played as keyboard instruments, and some jazz and popular musicians started to use them in this way.

More recently, digital technology has made it possible to integrate non-electronic sounds through "sampling," the converting of musical and other sounds into digital codes which can be electronically processed and played back from a keyboard or computer. Now both electronic and natural sounds—from voices and acoustical instruments to "explosive motor, wind, heartbeat, and landslide"—can be produced from a single keyboard instrument, putting any sound literally at the musician's fingertips. Samplers and synthesizers can also be programmed through connection to a computer, enabling performances well beyond the capacity of a human keyboard player. An agreement among the manufacturers of these instruments in the early 1980s made working with these keyboards and computers even easier.

The Musical Instrument Digital Interface (MIDI) allowed synthesizers, samplers, sound modules, and computers to "talk to" each other through a single cable. Such basic information as note-on and note-off is supplemented with information about volume, various effects, and much more. A number of different virtual "tracks," corresponding to MIDI channels, allows the composer or performer to use these tracks to play different keyboards, synthesizers, or samplers from one computer. Upon listening to the music during a presentation of "The Lion King" at the Lyceum Theater in London in 2001, one of the authors of this text went to the orchestra "pit" to view what sounded like a large symphonic orchestra.

"To my surprise, I saw one violin, one viola, one cello, one bass (acoustic and electric), one each of the brass instruments, one each of the woodwinds, with some players playing more than one, several percussion players—and six or seven Kurzweil Digital Sampling keyboards! The level of realism for these sampled orchestral sounds, when combined with just a few of the real instruments, was breathtaking."

With the availability of electronic samplers, synthesizers, and computer applications, many composers no longer work at a piano with manuscript paper and pencil. This new way of composing heightens awareness of the ways that available technology can influence musical creativity. Composer Gerald Shapiro has grappled with the ways technology can affect his work:



▲ Gerald Shapiro

One way of making a piece is to make the piece on a synthesizer and record as you go on the computer. No notation: playing, playing, I don't like this, I don't like that, try it again, record again on the computer as a sequence. Little by little I began to realize that the music I wrote was very shaped by the technology I was using to write it. The process became sort of passive: way more listening, and way less writing, it was slowed down and I was losing track of the shaping of it. So I switched over to paper and pencil again. And then after awhile I switched back again. And after awhile it began to seem that I could work either way interchangeably.²⁸

Synthesizers and samplers have expanded the idea of what a musical instrument can be, and even of what a creative process can be. In the 1980s a new type of pickup was invented for the guitar, the hexaphonic pickup, which allowed each vibrating string to send MIDI information to a synthesizer. This meant that a guitarist could play a synthesizer or sampler from his guitar, opening great new capabilities for the guitarist who was not fluent in keyboard technique. A further expansion of these concepts involves using the recording studio as an instrument in itself: a single interlinked system which allows composers and musicians to create new music, score it, scan it, download MIDI files, play a melody on a brass or woodwind instrument directly into the score, print all the parts and publish it on the internet, using a sophisticated computer software program like *FINALE*, rather than simply to document a performance.

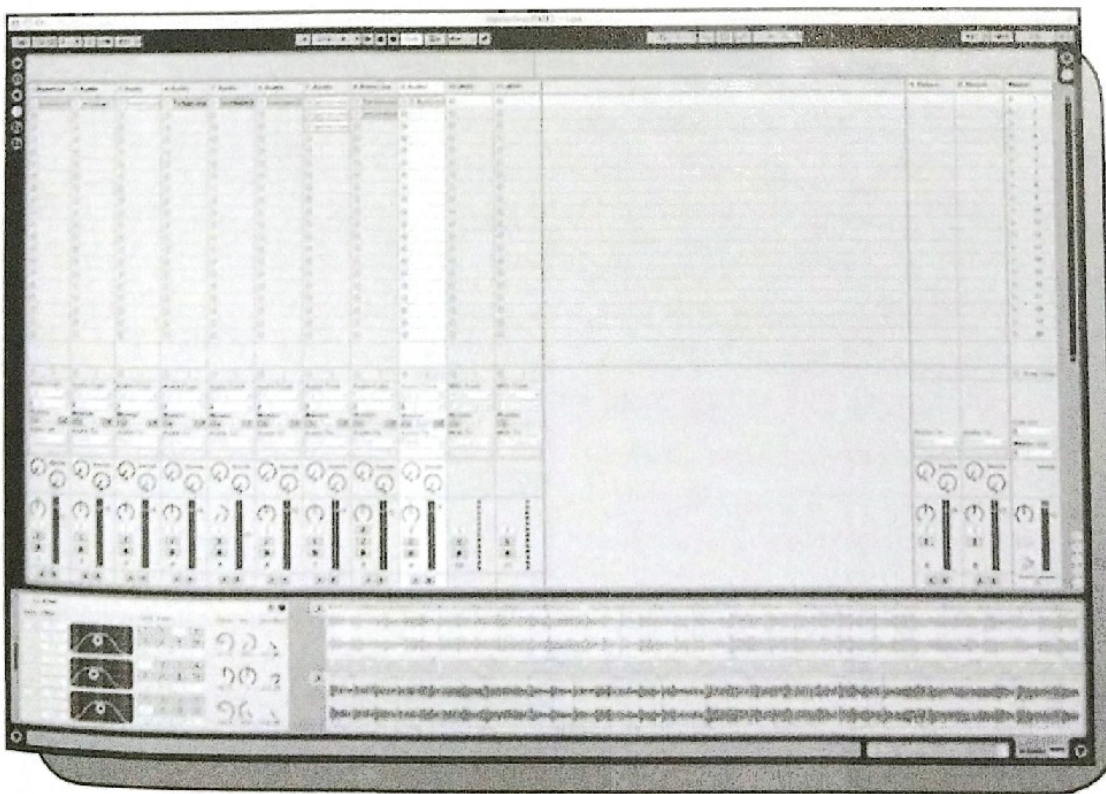
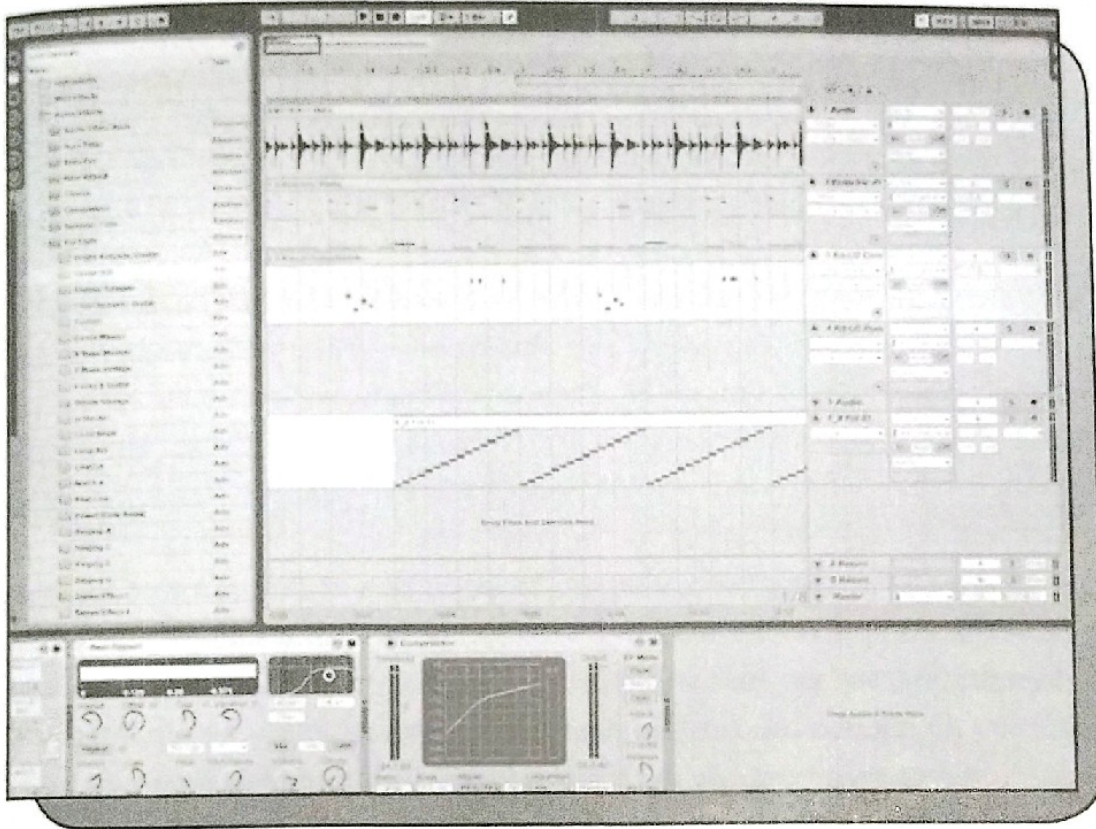
Twenty-First Century Studio Production and the Democratization of Music

As the word indicated, a sound "recording" was first conceived as a record—as accurate as possible—of a sonic event, comparable to a film record of a visual event. But just as film can now be edited and manipulated for myriad "special effects," sound recording studios can produce music which goes well beyond the possibilities of a live performance, and many of these studios are now found in "personal" spaces. A spare room, a desk in a bedroom, or even a portable laptop computer, the studio of the twenty-first century has moved from the multi-track tape recorders described in the last section to computer software-based recording.

Combined with electronic sound processing, such as adding echo, reverb and other effects, *overdubbing* in a computer-based system has moved sound recording from mere documentation of a performance into a new realm of creative potential. In the late 1960s, popular music albums started to present sonic experiences which seldom merely replicated the sound of live performances. Imaginary sonic worlds could be constructed, and recording became an expressive form in its own right, no longer a simple reproduction of a musical event. The technological realm of the electronic music composer was merging with that of the popular entertainer, but the performers were still tied to the professional recording studio, an expense which kept many performers and composers from being able to profit from their work.

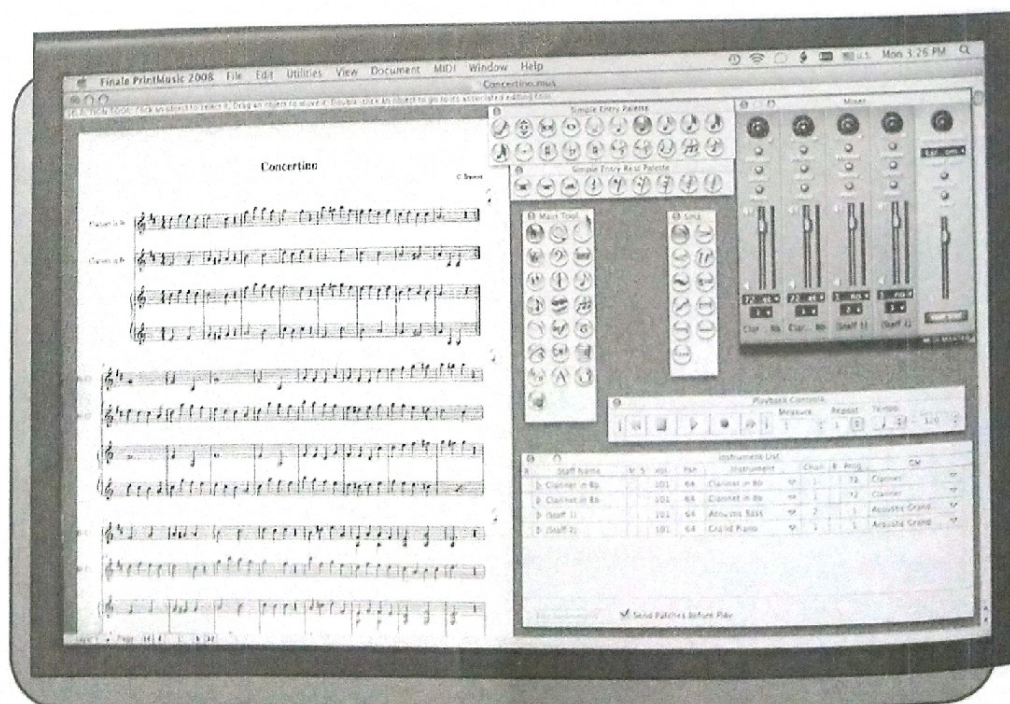
In 1991, the Alesis Corporation in California introduced the ADAT 8-track digital tape recorder. It was capable of recording 8 individual tracks, either one at a time or in multiples. The noise-free digital sound was recorded on a Super VHS tape, and the machine could be synchronized with other ADATs to provide 16, 24, or even more individual tracks. This machine—followed closely by TASCAM's DA-88, which used the much smaller 8mm video cassette and offered twice the recording time—started a revolution in recording, the *home studio*. With a small mixer (for monitoring while recording and eventually mixing the tracks down to stereo) and a microphone or two, noiseless digital sound recording became available to almost everyone. However, also in 1991, the Digidesign company introduced ProTools, a computer-based program for multi-track recording directly onto the hard drive of a computer. This technology, called the *digital audio workstation*, or DAW, was invented by and first demonstrated on a commercial basis by MicroTechnology Unlimited, a Raleigh, North Carolina-based company which had been working with digitizing complex music since the early 1970s. The first professional quality

direct-to-disk Digital Audio Workstation with CD-quality sound on a microcomputer was shown by MTU at the West Coast Computer Fair in Los Angeles in 1979. It would be a number of years, however, until hard drives in the average computer would be large enough to work with the huge files encountered in digital audio.



The huge advantage of this type of recording is that the sounds can be edited and manipulated in almost any conceivable way with a few clicks of a mouse. In the 1990s other companies began to release their own versions of recording and editing software, and laptop computers became powerful enough to use not only ProTools, but Nuendo, Garage Band, Sound Forge, Cubase, Cakewalk, Cool Edit Pro, and Ableton Live, all of them powerful programs for recording and editing music, used by such Twenty-First Century bands as *Cold Play*. Most of these programs possess a virtual mixer on the computer screen which looks like a hardware mixer used with a tape-based digital multi-track, but claims much more power. Built into the virtual mixer are effects such as reverb, echo, distortion, compression (so that sounds do not get too loud) and *equalization*, a technical term for elaborate controls similar to the *bass, middle, and treble* controls on a stereo system. Now removed from the expense of the professional studio, and without need of a major label record company to finance the recording process, the *democratization* of the music business has begun. With these tools, anyone with talent and recording software can record, manipulate, mix and release—on CD or the internet—his or her own music.

Some of the composers who are creating new styles of music in these powerful computers are working with combinations of sounds which have been taken from pre-existing recordings. In rap music, for example, often the studio itself is the “instrument” which accompanies the rapping. Production crews (often made up of a producer, a computer operator, and a re-





coding engineer who works with such things as microphone placement) like Public Enemy's "Bomb Squad" assemble carefully-crafted polyrhythmic accompaniments. Robert Walser describes the creative process of the Bomb Squad's Hank Shocklee:

Shocklee's compositional method is to combine pre-recorded sounds, drawing on his collection of over nineteen thousand recordings. Like other producers, he must find just the right sounds for each piece, which sometimes requires layering, for example, four different bass drum sounds from different records to make one new sound. The samples must be delicately balanced, and the sequences are carefully fine-tuned to simulate the nuances of live performance. All of this means that it is often more work to build tracks out of samples than it would be to compose and arrange for live musicians.²⁹

This procedure almost seems to subvert the technological ease promised by synthesizers and samplers. Indeed, Shocklee's creative process recalls that of the early electronic composers like John Cage, as does his musical philosophy: he explained to Mark Dery that "We believed that music is nothing but organized noise. You can take anything—street sounds, us talking, whatever you want—and make music by organizing it."³⁰

As hard drives became large enough to hold thousands of these musical and sound segments (often called *loops* because they are looped together to form a musical track) the DJ culture began using computers instead of records to create long dance sessions. Ableton Live is one of these tremendously powerful software programs which allow automatic tempo-matching of loops on a hard drive, so the live DJ can audition (on his headphones) segments, at the chosen tempo, as he is stringing them together. These programs also feature real-time effects which the operator can use to make the segments into a more cohesive blend. In reality, they offer the DJ the opportunity to join the players of traditional instruments in the world of *improvisation*, as they can now model and create new music as their immediate feelings dictate. This program and others like it has helped composers create a new genre of music called *mashups*, where the vocal track from one song will be laid over the instrumental track from another. Since the programs can change the length of a track, thereby slowing it down or speeding it up, it has become relatively easy for mashup artists to experiment with various combinations. Several mashups have become top 10 hits. The Sugababies "Freak Like Me" started out as a clever digital combination of Tubeway Army's "Are Friends Electric?" and a vocal track by Adina Howard. Originally melded by a mashup artist who goes by the name Richard X, this underground hit on the internet created such interest that the Sugababies copied the work of Richard X, rerecorded the vocals, released it on CD, and watched it climb to the top of the charts in Great Britain. Building on such developments in rap and DJ production, composers in other popular music genres like new age and techno are constructing virtual musical worlds. As digital technology becomes less expensive, more and more people have access to a range of creative possibilities which were once only available to composers in a handful of electronic music centers. Sophisticated music production can even be done in one's home.

In the (not too distant!) past, the major record companies were the "filter" for what the consumer was able to listen too and purchase. The executives of these companies chose the music and artists which they hoped to be the most profitable, and very seldom dedicated production budgets to anything else. It is, of course, the business of any company to make a profit, but many very deserving composers and musicians were denied a large audience because their appeal in the marketplace—real or imagined—was too limited. In the last half of the 20th century, there were record labels (called *vanity labels*) which would, for a fee, release the music of a composer or musician on LP records or CD, but it was expensive, and

the opportunities for promotion and distribution were limited. Digital technology doomed these companies, because the artists (now with the aid of the internet) have a potential audience in the billions, rather than attempting to gain listeners by having a few thousand CDs sent to radio stations (and usually never listened to, much less played on the air). But now we begin to see a problem. We no longer have the filter which the record companies offered. To quote Sturgeon's Law, "90% of everything is crap."³¹

So it is necessary to remember that for every thousand demo tapes sent to record companies in the past, it is likely that only one or two might be seen as being profitable for the company. Some of the others, though worthy in the artistic or musical sense, were viewed as having too limited an appeal. In today's music business, it is up to the artist to find and exploit his market. The democratization of music has forced many composers and musicians to become as good at marketing as they are at their musical craft.

SUMMARY

Some people assume that as technology improves, music gets better. To them the piano, with its wider pitch and dynamic range, is an improvement of the harpsichord, just as the more versatile keyboard sampler is an improvement of the piano. But this is a simplistic view of culture. Expressive culture does not merely get better or worse: it changes with its overall cultural context, mirroring every development. Today, use of recent technology may be a matter of taste: a musician may choose a wooden flute, for example, out of a preference for its sound, even if it is harder to find than a modern metal one. As a composer who works with both electronic and conventional media, Gerald Shapiro expresses a long-range view of music and technology:

All instruments have developed technologically, and it slowly, slowly changes. The important thing to remember is it doesn't get better. Technology gets better, but the music of the Middle Ages is as compelling, is as good, as the music of the twentieth century—and I know some would say better. There's no progress in music or any of the arts, but there is change, and that change is certainly driven as much as anything by changes in technology.³²

POINTS TO REMEMBER

1. Music and technology have always been intertwined. Technology involves extending human capacities.
2. Musical instrument technology augments our physical musical capabilities. Instrument-building technologies range from simple to complex, and are imbued with cultural significance.
3. Sound amplification extends our ears, and it too has cultural meaning. Amplified sound is part of our soundscape.
4. Sound recording enhances our abilities of musical transmission and storage. The dissemination of sound recordings has myriad cultural ramifications.
5. Electronic instruments and studio techniques open a wide range of possibilities for creative musicians.

POINTS FOR DISCUSSION

1. What are some of the ways that music and technology have always been intertwined?
2. How does musical instrument technology augment our physical musical capabilities? How is instrument building imbued with cultural significance?
3. What roles have independent recording companies—known as “indies”—played among local music cultures all over the world?
4. Why is technological progress not always to be equated with cultural progress in terms of music?
5. How do electronic instruments and studio techniques open a wide range of possibilities for creative musicians?

STUDY QUESTIONS

1. What are examples of musical technologies?
2. What are examples of technologically simple instruments? What are some more complex ones?
3. How does instrument technology articulate cultural values?
4. What is the cultural significance of amplification in popular music?
5. What is a soundscape? How does the idea relate to the concept of *ramé* in Java?
6. What is cassette culture? How does it relate to the overall music industry?
7. How has the ability of the DJ to improvise been influenced with the advent of new tools?
8. What is the meaning of "democratization of music?"

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25. Ibid.: 9.
26. Lucier and Simon, 1980: 164.
27. Ibid.: 167.
28. Shapiro interview, 1997.
29. Walser, 1995: 196.
30. In Dery, 1990: 83.
31. 1972 Interview of Theodore Sturgeon by David G. Hartwell (published in *The New York Review of Science Fiction* #7 and #8, March and April 1989).
32. Shapiro interview, 1997.