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# *Off the Record*

THE TECHNOLOGY AND CULTURE  
OF SOUND RECORDING IN AMERICA



DAVID MORTON



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Manufactured in the United States of America

*To my mother and the memory of my father*

# Introduction



## Invention

During the busy summer and fall of 1877, Thomas Edison and his team of tinkers worked on dozens of projects, moving from one to another as new ideas struck them. Edison speculated that one of his gadgets, a device to record telegraph dots and dashes as they came over the line, might also be useful for recording the electrical messages of the telephone. For the first time, he realized, it might be possible to record and reproduce the human voice. In July, the telegraph recorder was modified so that it would respond to the voice, and Edison recorded the words, "Mary had a little lamb." After some more tinkering, Edison transmitted the news of this invention to the press, and *Scientific American* announced that the subscribers to Alexander Graham Bell's exciting new communication service would soon be to employ their telephones for serious business matters rather than just idle chat, since there could now be an exact record of their conversations.<sup>1</sup> He projected a confluence of these radically new inventions to accomplish a long-time goal of inventors; a system of instant, long-distance communication in which the voice could also be captured for later use. Further investigation showed that telephone recording was more difficult than anticipated, so Edison worked on a purely acoustic device, the "phonograph," in which a needle incised a groove on a wax-coated strip of paper. Scientific devices for tracing sound waves had been in existence for many years, but Edison aimed for something more; a machine that would not only record sound waves but reproduce them. In early December, Edison had one of his machinists construct a new model of the phonograph that used a sheet of tinfoil, wrapped around a metal cylinder, as the recording medium. The inventor bent over and shouted a few words into it, and to everyone's surprise

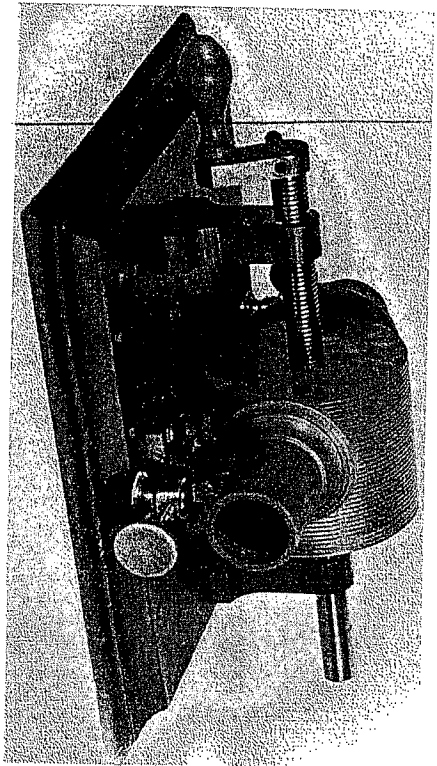


Figure 1. Edison's first tinfoil phonograph, 1877. U.S. Department of the Interior, National Park Service, Edison National Historic Site.

the phonograph worked the first time. Then, on December 7, 1877, at the offices of *Scientific American* magazine, he demonstrated a phonograph recording to the editors which "inquired as to our health, asked how we liked the phonograph, informed us that it was very well, and bid us a cordial good night."<sup>2</sup>

If in retrospect it seems like Edison had failed to rise to a momentous occasion in this choice of words, perhaps it is because the distance of a hundred years obscures the novelty of a machine that could talk. His words were not as impressive as the mighty "What hath God wrought?" used by Morse to demonstrate his telegraph years earlier, nor even as pragmatic as Bell's calling out to his assistant Mr. Watson. In any event, some inventors in the field of communication who followed Edison did even worse: Marconi's first transatlantic radio transmission would be simply the letter "s."

Americans greeted the phonograph as if it were a major scientific discovery, and the subsequent round of publicity for the phonograph made Edison a national hero. It was this invention that solidified Edison's "Wizard of Menlo Park" mystique, and the public's enthusiastic reception convinced him that the talking machine would amount to something big. Although he had created many inventions by 1878, Edison told a reporter that "this is my baby, and I expect it to grow up and be a big feller and support me in my old age."<sup>3</sup> But what would Americans do with the phonograph, especially since Edison himself was unable to build a practical telephone recorder? The specific commercial applications were still unknown. That same year

he outlined his vision for the phonograph's future. What he initially conceived as a way to record telephone messages would now become a mechanical stenographer for businessmen, a talking book for the blind, an elocution instructor, a music box, a family album, a speaking toy, an announcing clock, an historical chronicler, a student's note-taker, and, perhaps with a little more work, a telephone recorder, too.<sup>4</sup> In other words, what Edison had first conceived narrowly as a telephone recorder for business he now predicted would become a more general-purpose enhancement or even replacement for many kinds of oral and written communication for business and personal purposes.

Edison's phonograph was soon joined by another fundamental invention that, while less successful initially, would come to assume great importance later. Just a few years after the introduction of the phonograph, an inventor named Oberlin Smith, who, like Edison, was working in New Jersey, conceived of a technology to record sound magnetically. His recorder captured the telephone's electrical output on the surface of a steel wire or tape, just as motion picture film captures the effects of light. Instead of light, Smith's recorder responded to magnetism, since steel will retain an "image" of any nearby magnetic field. The source of the magnetic field was the flow of electricity in a telephone wire, for every electrical flow emanates an invisible magnetic field. Smith disclosed his ideas in 1888, and they were picked up by the Danish inventor Valdemar Poulsen. He demonstrated his "telegraphone," recording on steel wire, tape, or disc to an enthusiastic audience at the 1900 exposition in Paris, and announced his intention to sell it as a telephone recorder, a dictating machine, a telephone-based broadcaster, and a "relay," or amplifier.<sup>5</sup>

Almost all of these applications would eventually play important roles in American history, becoming the basis of systems of entertainment, record-keeping, communication and surveillance. Like the technology of writing, sound recording proved to be remarkably versatile, with many different uses in business and industry, in the home, in schools, churches, and almost everywhere else. Sound recording was destined to become more important, commercially and socially, than even Edison imagined. The basic phonograph would soon be joined by other forms of sound recording, allowing even more technical variation and expanding the possibilities for this new technological system.

Users of sound recording gradually wove the technology into the social fabric, and in so doing transformed both. Edison's original phonograph was merely a clever parrot, or better yet, an aural mirror. The phonograph's lackluster sales soon made it clear that few Americans would be satisfied with

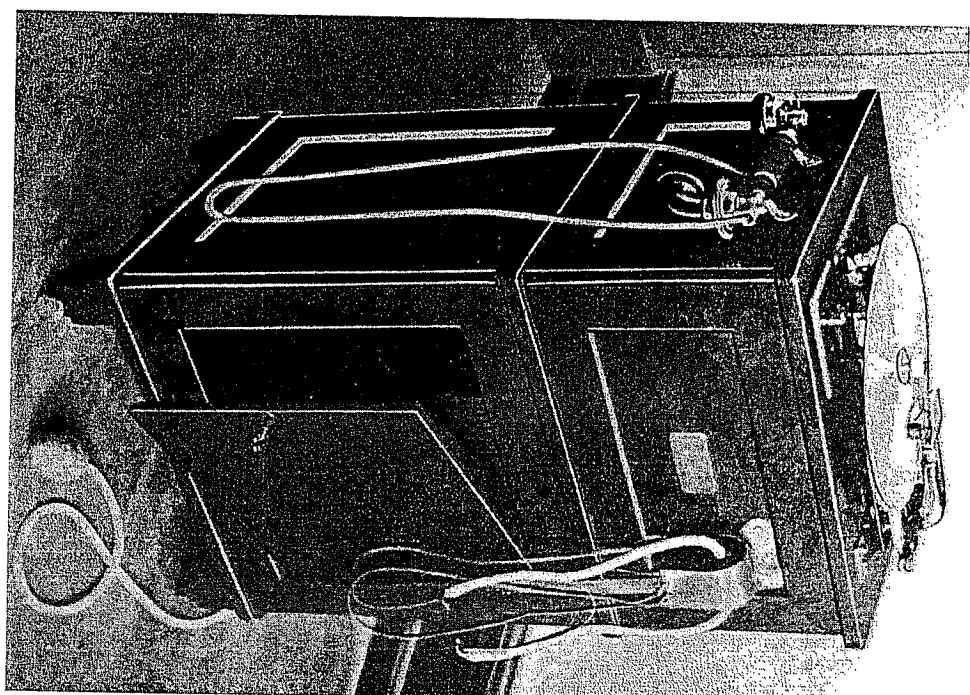


FIGURE 2. An early form of magnetic recording device, called the telegraphone, came in versions that could record on tape, wire, or disk. American Technical Publishers, Inc.

simply recording themselves. Instead, buyers rewarded those who used the phonograph to create a system for mass-produced entertainment, purchasing millions of records (or later tapes or compact discs) for their personal enjoyment.

While the word “record” has become virtually synonymous with music recordings, these represent only a single facet of sound recording’s complex history. The title of this book suggests that it is possible to appreciate sound recording’s long history as something much more than simply the story of mass-produced entertainment. It is time to reevaluate the history of recorded sound, to explore more of its history, and to include with the story of music on “records” the much wider history of sound recording in general.

On the heels of recorded musical entertainment came many other applications for recording, which neither Edison nor Poulson could have predicted, such as its use in radio broadcasting, telephone service, and for various purposes in the home. With each new application came fundamentally new ideas about the meanings and purposes of recorded culture, reflected in the technology, the practices associated with making recordings, and the recordings themselves. For example, some of the inventors of new recording technologies strove to make recordings that preserved the desirable aesthetic qualities of the original sound, and hence render the recording process invisible to listeners, while others struggled to make recordings of sounds that could not otherwise be heard, and hence make the recording process obvious to listeners. The aesthetic aspects of the recording were almost irrelevant in other circumstances, where sound recording became a tool for interpersonal, two-way communication, combining the spontaneous, personal qualities of the voice with the time-storage capacity of ordinary writing. That such an astonishing variety of technologies with such different uses could emerge from one simple, original machine is indicative of the adaptability of recording, and also suggests that its importance in American society can only be appreciated by examining it from several different perspectives.

The aims of this book are to evaluate the history of sound recording technology, the business of making recordings and recorders, the relationship of technology to “practice,” or the act of recording, and the significance of sound recording in American history. Understanding the history of both the hardware and the ways people used it is essential for understanding why any particular technology succeeded or failed in the marketplace, became a fixture in everyday life, or faded into obscurity. “Recording culture” encompasses the motivations for and outcomes of the act of recording; the relationships between the creators, promoters, and users of recording technology; and the

interactions between people, recording machines, and recordings themselves. Recording culture in America emerged not through the dictates of the technology itself but in complex ways that were contingent upon the actions of people. Every successful or persistent use of sound recording was the result of a two-way process of negotiation between the designers and users of a technology, which sometimes favored one or the other's intentions or desires more heavily. Ultimately, though, the persistence of practice is determined by users or consumers, whose purchasing decisions spell commercial success or failure, and whose individual actions shape the form and function and new technologies, if sometimes only indirectly. Yet the definitions of the terms "users" and "consumers" vary under different circumstances. The "consumer" can not always be equated with some hypothesized, typical member of "the public." In reality, consumers or users of a technology operate at different levels in the economy and in society, and exercise different levels of input into the technological development process. The purchasing decision of a manager acting on behalf of a company, for example, may have systemic effects throughout a firm or group of firms, with much greater social and economic significance than a decision by an individual to purchase a particular item for the home. Any analysis of the role of users in technological history has to account for these different types of consumers.

Starting with the basic technology of sound recording, a variety of inventors, companies, and consumers modified and reshaped the phonograph and its successors to create an equally complex mix of new technologies. Each of the case studies in this book emphasizes one aspect of the culture of recording and its relationship to new technology, at the same time telling the broader story of sound recording history in America. At the most general level, sound recording was an elaboration or outgrowth of existing forms of culture, absorbing and reshaping existing culture to create the new practices of recording. The recording of music, for example, incorporated but reshaped the aims, conventions, economy, and social hierarchy that had already developed around musical performance. Recording as a form of communication also enveloped and modified existing social structures. When recordings were used as a form of mass communication, for example, sound recording technology often became a medium within a medium that both facilitated existing communications and offered something radically new. Another form of social practice that sound recording affected was labor, and this is particularly evident where the recorder was a production tool in business. As such, sound recording involved issues of skill, managerial imperative and gender relations. Only by defining culture broadly to include not only the traditional

"high culture" but also other practices, beliefs, habits, and institutions of American society is it possible to analyze fully sound recording's rich history.

### **Recordings, Culture, and the Culture of Recording**

One of the misconceptions that this book hopes to dispel is that the only important category of sound recording involves music. However, music is important, so to illustrate what I mean by "culture of recording" in familiar terms, I begin this study with a brief history of sound recording in the American record industry. Here it is possible to see quite clearly some of the relationships between musical culture, the act of recording as a distinct form of culture, recording technology and the record as a cultural artifact. The histories of music, listening, and the record are familiar territory for many historians. For scholars as diverse as Theodor Adorno, Walter Benjamin, Jacques Barzun, Marshall McLuhan, and Daniel Boorstin, to discuss a sound recording was to discuss commercially recorded music. The modern "culture industry" that Adorno criticized commodified and "preserved" culture in the form of music recordings. Barzun's understanding of recorded sound was similarly limited to music and the music record's alleged "effects" on experience. He perceived an America saturated with the music delivered by "the machine" and believed that Americans were in the midst of a cultural revolution rooted in music. Boorstin, on the other hand, saw recording technology's importance as making possible the "freezing" of performance, annihilating time and making the musical experience repeatable. These are all useful concepts, but none adequately captures the scope of recording's role in American history.<sup>6</sup>

There is more to the history of sound recording than just music, of course, but for the moment consider the relationships between musical culture and the technology of sound recording. Music making in the nineteenth century had its own traditions, practices, and technologies independent of recording. Not all of the musical performance was compatible with the phonograph. Specifically, it was unclear whether the whole of any musical performance could ever be captured on the phonograph. If the phonograph required modification to suit music, what kind of music should be the model? Further, in the nineteenth century performance was already established as a form of business enterprise; the newly formed record companies now sought to combine performance with the technology of the phonograph in a new form of business. What, then, was the relationship between music, performance, business, and technology?

From the perspective of the finished product, the record, many have

argued that sound recordings have a cultural influence, but the reverse is also true; culture has an influence on the making of sound recordings.<sup>7</sup> One particularly important, recurring cultural influence has been "highbrow" ("serious" or "classical") music, owing to the high social status of symphonic and operatic music in American society. The repertoire, styles of performance, and the traditional relationship between audience and the music all found their way into the evolving culture of recording. At the same time, recording brought high culture music into the capitalist system of production. Despite considerable technological changes in recording technology over the last century, one of the most consistent features of the U.S. record industry has been its devotion to providing high culture music, despite the small economic rewards gained from recording and marketing it. Sales of popular music, not classical music, have been the major source of growth in the industry, so economic logic would dictate that recording technology should evolve somehow to suit popular music. However, during the formative years of the record industry, it was classical and other forms of highbrow music which proved surprisingly influential in fomenting technical change and shaping the practices associated with music recording studios. Only in the last thirty years have other forms of music come to influence the making of recordings in as profound a manner. In fact, one could argue that the capabilities of new recording technologies now have a stronger influence on popular music than ever before, but even so, highbrow culture is still a ponderous legacy.<sup>8</sup>

### **Sound Recording and Mass Communication**

Business, culture, and recording technology also interact in commercial radio studios, where the act of recording is a step in the process of broadcasting. Recording and the use of recordings in American network radio from the 1920s to the 1950s was an activity dominated by a few powerful corporations.<sup>9</sup> The leaders of the powerful networks that dominated American radio during its first three decades perceived sound recording as a direct threat to their commercial viability. Network managers, aided by government policy makers, enforced rules that prevented most recording activity in radio, and convinced the public that "canned" programs were a second-rate form of entertainment. Today, however, much of every radio station's programming comes from recordings; even the parts that seem to be "live." The crumbling of the networks after 1948 stimulated the greater use of recording technology, but radio stations bought recorders and invented ways to use them that could preserve the live sound of radio. Because recordings on the radio con-

tinued to carry a stigma, both within the radio business and among the public, inventors, engineers, and radio station technicians labored to hide the use of recording technology from the audience. Thus the desire to broadcast live (or at least simulate a live broadcast) continued to influence radio practice long after network restrictions on recording were relaxed. Sound recording use in radio today is simultaneously the dominant source of radio content and one of the least apparent of radio's techniques. Through innovations in recording, most evidence of the process of radio has been neatly removed from the product.

### **Sound Recording and Labor**

The commercial, cultural, and technological history of sound recording must also be interpreted in the context of labor history. Like any production process, the making of a recording involves technology plus work. In the context of business, the human side of this equation necessarily entails issues of labor and management. One of these labor contexts was the use of office dictation machines. Between the time of World War I and end of World War II, dictation equipment companies sold tens of thousands of dictation recorders to American companies, and managers in these companies successfully imposed the practice of office dictation on women and many lower-level male employees.<sup>10</sup> Equipment makers were much less successful in attracting higher-level managers and their secretaries to the device, despite considerable technical innovation and an intense marketing effort. Where corporate employees had the power to choose for themselves, as often as not they rejected machine dictation, because it was an unpleasant technology that threatened their skills and office social relations. Efforts to support the practices associated with machine dictation and stimulate voluntary adoption reveal how gender, power relations, and sound recording intersected in the office.

Even after a hundred years of promotion and technical change, office recording practice is not a part of normal business operations. Because it never truly displaced writing, the cultural aspects of machine dictation and their relationship to business imperatives, labor issues, and consumer desires are particularly visible. Dictation records themselves are not particularly important in this part of the story. They were the temporary and often pedestrian intermediate products in the process of correspondence production. This fact makes it easier to focus on the production process rather than the content of the records themselves, and makes the dictation recorder the ideal lens through which to examine the labor aspects of recording technology.

### Sound Recording as Interpersonal Communication

The history of the dictation machine also crosses the middle ground between the "industrial" forms of sound recording, those in which the recorder acts as a gateway between culture bearers and a mass audience, and forms of recording more readily available to the average American consumer. While dictation equipment was used by a minority of office workers during the twentieth century, it was nonetheless the form of recording technology most widely known to Americans before 1945. Up to that time, the vast majority of Americans experienced recording technology only as consumers of records. The history of the telephone answering machine, on the other hand, demonstrates the way recording developed into an activity in which ordinary Americans participated. The answering machine is also an outstanding example of the way an invention takes twists and turns on a long path from conception to widespread diffusion. Although the answering machine dates to the nineteenth century, it has entered daily life for most Americans only since the 1980s. The lengthy delay between the answering machine's invention and its ubiquity is partly attributable to the resistance of the nearly monopolistic American telephone service provider, American Telephone & Telegraph, or AT&T. The company recognized demand for telephone answering devices but tried for many years to satisfy customers with live answering services. However, AT&T underestimated the appeal of telephone answering technology, and demand for the machines grew. The company responded by narrowly defining the functions of the recording machines it provided, with important long-term results for the machines and the ways we use them. With the removal of legal restrictions to their use and the blossoming of microelectronics technology, sales skyrocketed in the late 1970s. As millions of consumers bought or used these machines, several things happened. One is that, for the first time, most Americans could have the experience of making sound recordings themselves. Once they overcame their initial shyness or hostility, and became accustomed to the peculiarities of telephone recording "Ma Bell" style, they embraced the practices of making and leaving answering machine messages and even began to find new ways to use the machines. Between the late 1970s and the mid-1980s, consumers transformed the use of the answering machine from a rather utilitarian business machine to an important enhancement of the telephone system.<sup>11</sup> Answering machines in use today embody the legacy of AT&T's resistance (in the form of features built into the machines and generally unquestioned by users), while consumers have invented many of the most widespread practices associated

with telephone recording. By transgressing the boundaries of functionality and proper use laid out for them by telephone companies and equipment manufacturers, ordinary consumers developed new ways to communicate via telephone, and in the process extended the utility of the answering machine. The history of the answering machine demonstrates several of the most important aspects of sound recording in the last fifty years; its diffusion to an ever-wider number of Americans, the ability of users to invent new uses for the machine, and the transition of sound recording from a tightly held communications monopoly to a more democratic form of interpersonal communication.

### Sound Recording at Home

One pressing issue in the history of the answering machine is why ordinary people decided they wanted to make recordings of themselves or of others. Why, in other words, did the culture of telephone message recording emerge at all? This is also a central issue in the history of home tape recording since World War II. Edison's original phonograph was both a recorder and a reproducer, yet its capacity for recording soon atrophied and finally disappeared by the early 1900s, reflecting the lack of demand for machines with the ability to record at home. Home recording machines were available in the United States during every subsequent year, as one manufacturer after another tried to interest the public in making their own sound records in addition to simply consuming mass-produced ones. Americans disliked standing before the recording machine and hated the sounds of their own recorded voices even more. If they would not record themselves at the turn of the century, manufacturers speculated by the 1920s and '30s that perhaps they would record the radio or duplicate phonograph records. They did not. Even an exciting new technology like the tape recorder, introduced in the late 1940s, did not stimulate more than a small fraction of the American public to begin making recordings. Many who did buy tape recorders abandoned their use when the novelty of the experience wore off. Even though the technologies of home recording changed over the years, changes in practice and not merely technical changes were the true stimulus to the revival of home recording. A sustained culture of home recording emerged only after new technologies and cultural changes converged in the 1960s, establishing the tape recorder as a portable entertainment device and tape recording as a low-cost, personalized alternative to commercial records and radio. As the size and price of recorders diminished, as young Americans began listening to rock and roll, and as the



suburbs and the automobile stimulated patterns of mobile music listening, greater numbers of people became home rerecordists of music albums and singles. The practice of home rerecording was growing rapidly in the late 1960s when the Philips Company introduced its "cassette," which proved to be a huge commercial success as a medium for both commercial records and those of the homemade sort. As record and electronics companies consider the next generation of home entertainment technology, the widespread and seemingly irrepressible practice of home recording looms like a dark cloud above their plans.

The case studies in this book illustrate the development of recording technology, the different meanings of the culture of sound recording, and the variety of contexts in which sound recording played a role in American history. The making of sound recordings is relevant to many areas of business, economic, cultural, gender, and labor history. The ways of—and motivations for—making sound recordings have played into events in American history as varied as the broadcast of the crash of the *Hindenburg*, the success of "The Chipmunks" musical group, and the outcome of the Watergate scandal. In an age when aural experience is increasingly mediated by recording technologies, it is important to understand what recordings are, why people make them, and how the technology for making them came to exist. For many reasons, recording technologies and the culture of recording are subjects worthy of study and long overdue for historical consideration.

## CHAPTER 1

# *High Culture, High Fidelity, and the Making of Recordings in the American Record Industry*



John Philip Sousa, in his 1906 essay on the "menace of mechanical music," predicted a dire outcome for American culture, a deterioration of talent and taste caused by the diffusion of music on records. Scholars have debated the cultural implications of recordings ever since, but few have looked at the culture of recording itself. The recording of music is an activity that combines a very old form of culture, the performance of music, with a variety of technological processes to create a new form of culture. Further, in the United States recording is part of an industry, so commercial concerns also form a part of recording practice. What we are concerned with here is not only music captured on record as an example of mass-produced culture but also recording as a cultural process; not only the meaning of the content of a record but the meaning of the practices which developed around the act of recording. Those practices, applied in the studio, resulted in the cultural artifacts we call records, which are snapshots of their times, which have various meanings to their audiences, and whose meanings change over time and are difficult to predict. The culture of recording is also a product of its time. It too is influenced by musical styles, but also by the needs of the music business and the practice of engineering. It has as much significance for mass-produced music as the music itself.

The field of sound recording is much broader than just the recording of music, but nowhere are the technologies and practices of sound recording as impressively elaborated as in the studios of the companies that record music. Since the invention of recording in the 1870s, American record companies have gradually transformed the act of recording from a simple shout

down a horn into a complex and capital-intensive ritual of musicians and machines, solemnly overseen by a priesthood of specialized technicians. The details of the machines and practices of operating them reflect far more than just the cumulation of improvements prompted by purely technical concerns, but are the result of decades of negotiation between musicians, sound engineers, production engineers, and businessmen. Despite the glaring imbalance between the economic power of record companies and the artistic aims of performers, technological development has not been overwhelmingly oriented toward business ends. Instead, engineers and musicians have participated in the development of technologies serving their own interests as much as managers and business owners during the course of sound recording's hundred-year history. Consumers, too, have acted as agents of change through their purchases of recorded music, for ultimately the success or failure of new recording technologies or practices depend heavily on the purchasing decisions of millions of record buyers.

The basis of today's huge record industry is, of course, the making of music recordings for sale, but this particular form of business was not the natural outcome of the introduction of the phonograph. At first, phonograph manufacturers were only interested in selling the machine itself and expected their customers to make their own recordings. Their initial interest in making recordings was merely to demonstrate the device effectively to customers. The limited success of this approach prompted them to cultivate their own sources of "content," to develop practices and techniques of sound recording, and to find ways to duplicate those recordings in large quantities. Later, the rising popularity of the entertainment phonograph spurred more systematic recording activity, and the practice of sound recording became the core of a new business by the turn of the twentieth century, one concerned primarily in making sound recordings rather than making sound recorders.

The record industry in the United States is one of the most thoroughly studied of all businesses, and its products, music records, are the subject of countless books, theses, and articles. Music recordings are the only form of sound recording that has its own secondary industry, which publishes hundreds of fan magazines, catalogs, and discographies, and justifies the careers of the academics who study recordings for a living. However, few historians of technology have contributed to this effort. Instead, this is a field that has drawn scholars of communications, popular culture, music history, business history, and other specialties. Music historians have explored how recording has affected music, or have written the biographies of particular artists or bands partly through the exegesis of their records.<sup>1</sup> Business his-

torians have written about the exploitation of artists or the monopolistic tendencies of the record companies. Communications scholars have described sound recordings as a form of mass communication. These scholars rightly believe that the products of a relatively small number of recording studios have a wide-ranging economic, social, and cultural significance. Few, however, have looked closely at the process of recording and the relationships between recording technology and recording practice.<sup>2</sup>

It is important to distinguish between the culture of recording, which refers to the practices surrounding sound recording technology, and music as culture. The sound recorder plays an important role in transmitting musical culture. Its limitations (and possibilities) have shaped musical expression in various ways. The mass production and broad distribution of musical records is also an agent of cultural change. Music historians have noted the extent to which the phonograph broke down social barriers and disseminated culture in a stratified society, bringing black music to white audiences, for example. They have been less successful in showing how culture, including musical culture, influenced technological change in recording, or how the making of phonograph records itself constituted a new form of culture. Another major stumbling block has been the concept of "high fidelity," or truth to the original source of the sound. Steven Jones and others have demonstrated how little real meaning the concept of fidelity holds in terms of today's popular music, which is largely electronically generated. They have also pointed out that "fidelity," or accuracy remains central in the technical vocabulary of music recording and reproduction, though practice has strayed ever further from the ideal. One important question that remains is how this situation came to be, and where it is likely to lead.

The problem of high fidelity is further confused by the assumptions that engineers, equipment manufacturers, and marketers make about fidelity, making the concept dependent on references to the performance of "highbrow" forms of music.<sup>3</sup> In its original form, the cult of high-fidelity recording and listening in America was completely devoted to classical, orchestral, or operatic forms of music, pieces that could be performed live in a concert hall and which were generally agreed to represent the best possible sound. Much of the scientific understanding of recording also depended upon these same high culture references. Further, to this fertile mix of musical traditions, engineering knowledge, and consumerism we must add corporate culture. Technical changes in recording technology sponsored by the record industry often made little business sense, unless one factors in the unique corporate attachment to high culture in the United States. Although the American

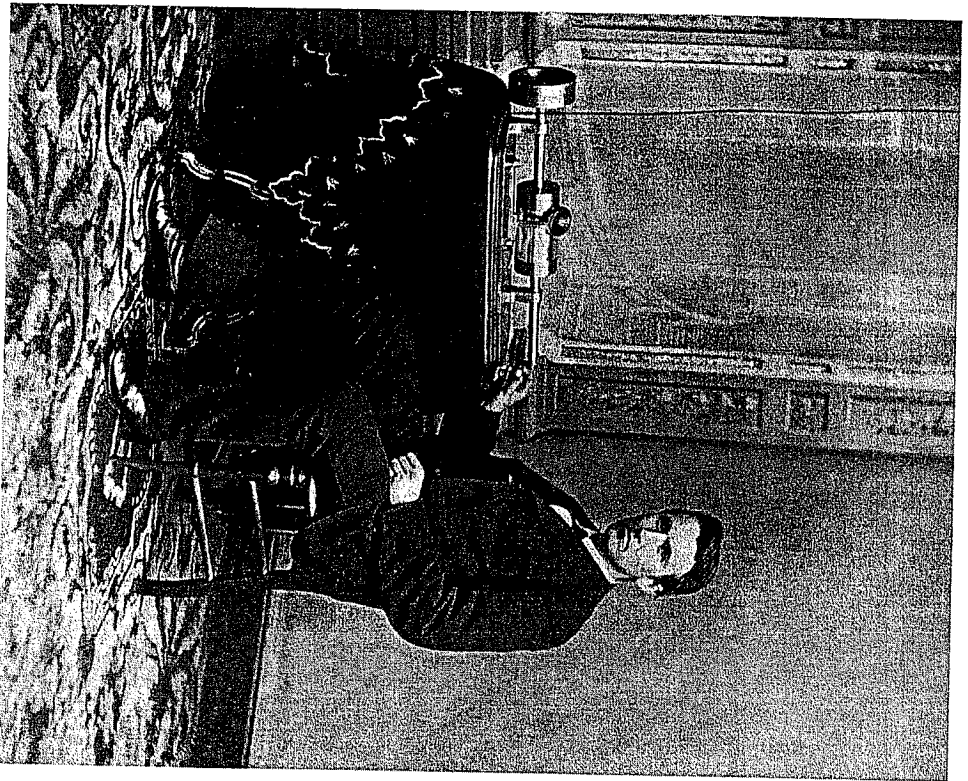


Figure 3. Edison poses with the phonograph, 1878. U.S. Department of the Interior, National Park Service, Edison National Historic Site.

public gave its money to the manufacturers of low culture music, even the musically "unsophisticated" often admitted the cultural superiority of the high-brow. Recording company executives sometimes revealed that their catalog of classical recordings was mainly for prestige, not money. The influence of high culture music in the development of recording technology greatly exceeded the economic importance of classical record sales or the size of the

audience for such music. Indeed, high fidelity and high culture played the most important roles in establishing the engineering basis of sound recording, and continue to exercise an influence today.

### **Records and Early Record Production**

The tinfoil recording process that Thomas Edison invented in 1877-78 was crude indeed. Many critics charged that a voice recorded on the machine sounded more like a squawking bird or shrill screech, so Edison and other inventors sought ways to improve the playback quality. The "improved phonograph" of the 1880s and its competitor, the graphophone, abandoned tinfoil in favor of a more reliable medium, the wax cylinder, and included an electric or clockwork motor and various controls. The purchasers of the patent rights to these inventions then set out to find agents to market the phonograph as a business dictation machine, and by 1890 over a dozen companies across the country were doing just that. The business phonograph had some commercial success, but later the local sales companies discovered an important new market after experimentally installing coin-operated phonographs for public amusement. The number of these proto-jukeboxes in use in the mid-1890s was still smaller than the number of dictation machines, but the revenues they generated were sometimes staggering. Hoping to interest individuals in the phonograph, Edison also designed a less expensive type for use at home, and he simultaneously went into the business of selling recorded cylinders.<sup>4</sup>

In retrospect, Edison might have been better off promoting the phonograph for entertainment right from the start. Business dictation required clear, intelligible records that the early phonograph simply was not capable of producing, at least not without careful attention from the machine's operator. Music, ironically, was in some ways well-suited to the phonograph's limited sonic range and high levels of noise and distortion. Listeners often knew the words to popular songs already, or could recognize the melody of even a badly recorded song. Then as now, it was not usually necessary for the recording of a song to be perfectly free of scratches, hissing, or distortion for it to be thoroughly enjoyable. Further, the recordings that Edison's experts made under ideal conditions were more likely to be satisfactory than the home made kind, and hence consumers might be willing to pay for a good recording rather than struggle to make their own. Belatedly, Edison and his competitors shifted their attention to the entertainment market, and by the turn of the century, office recorders and the entertainment phonograph had diverged technically and commercially.

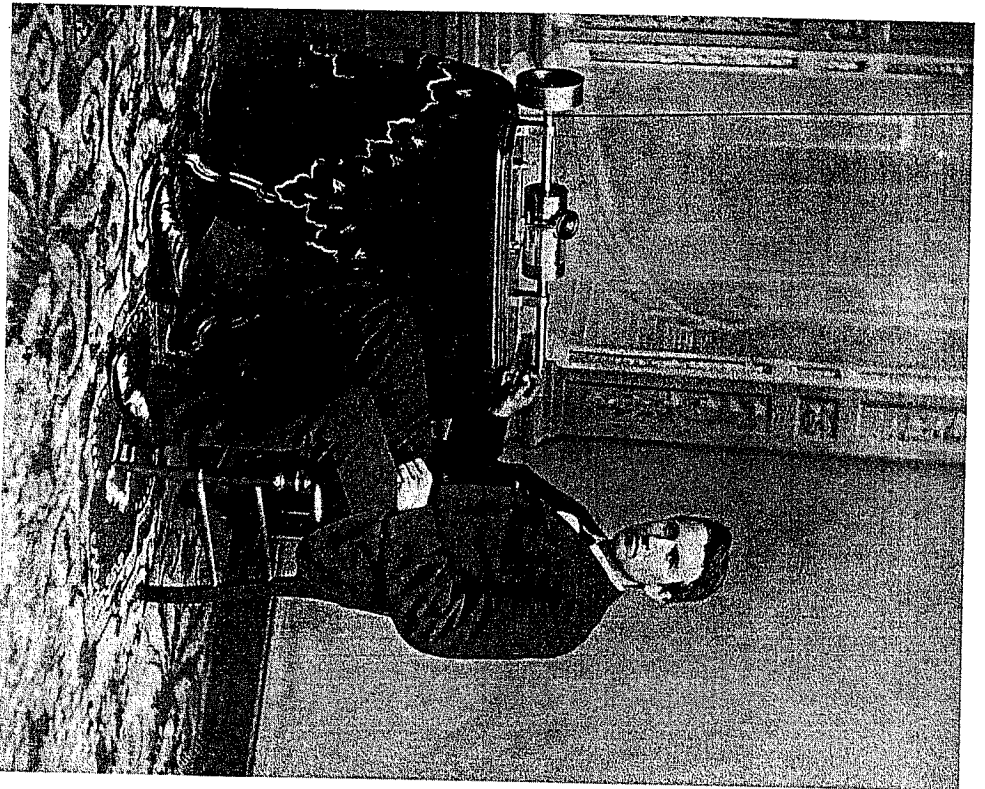


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audience for such music. Indeed, high fidelity and high culture played the most important roles in establishing the engineering basis of sound recording, and continue to exercise an influence today.

### Records and Early Record Production

The tinfoil recording process that Thomas Edison invented in 1877–78 was crude indeed. Many critics charged that a voice recorded on the machine sounded more like a squawking bird or shrill screech, so Edison and other inventors sought ways to improve the playback quality. The “improved phonograph” of the 1880s and its competitor, the graphophone, abandoned tinfoil in favor of a more reliable medium, the wax cylinder, and included an electric or clockwork motor and various controls. The purchasers of the patent rights to these inventions then set out to find agents to market the phonograph as a business dictation machine, and by 1890 over a dozen companies across the country were doing just that. The business phonograph had some commercial success, but later the local sales companies discovered an important new market after experimentally installing coin-operated phonographs for public amusement. The number of these proto-jukeboxes in use in the mid-1890s was still smaller than the number of dictation machines, but the revenues they generated were sometimes staggering. Hoping to interest individuals in the phonograph, Edison also designed a less expensive type for use at home, and he simultaneously went into the business of selling recorded cylinders.<sup>4</sup>

In retrospect, Edison might have been better off promoting the phonograph for entertainment right from the start. Business dictation required clear, intelligible records that the early phonograph simply was not capable of producing, at least not without careful attention from the machine’s operator. Music, ironically, was in some ways well-suited to the phonograph’s limited sonic range and high levels of noise and distortion. Listeners often knew the words to popular songs already, or could recognize the melody of even a badly recorded song. Then as now, it was not usually necessary for the recording of a song to be perfectly free of scratches, hissing, or distortion for it to be thoroughly enjoyable. Further, the recordings that Edison’s experts made under ideal conditions were more likely to be satisfactory than the home made kind, and hence consumers might be willing to pay for a good recording rather than struggle to make their own. Belatedly, Edison and his competitors shifted their attention to the entertainment market, and by the turn of the century, office recorders and the entertainment phonograph had diverged technically and commercially.

After the introduction of coin-operated phonographs, and particularly after the home phonograph began to garner sales, the phonograph companies began to ponder the problems of the high-volume production of records. The making and duplication of records for sale posed a new set of technical problems to which the original phonograph technology was poorly suited. Recordings for the business phonograph were unique, ephemeral products to be consumed within offices, not a commodity for sale to the public. Making permanent records for duplication and sale would require technologies that Edison had yet invented.<sup>5</sup>

Edison's work on the cylinder recording process in the 1870s and 1880s focused on producing a record that would duplicate the timbre and volume of the original sound. The life span of wax-cylinder records was short, and many inventors experimented with recording media that would harden after the record was made. One of Edison's approaches was to reproduce the cylinders in a mold, but others gained key patents for this technology. For the next ten years, Edison's workers had to rely on reproducing cylinders by a pantograph process, which mechanically coupled a reproducing stylus traveling in the groove of a recorded cylinder to a recording stylus cutting a new groove in a blank cylinder made of a soap-like compound (stearate of soda). Columbia, Edison's first major competitor, also used the pantograph method. This mechanical method made acceptable records, but sound volume was always lost in the process and distortion added.<sup>6</sup>

Within a few years, Edison found a patentable way to make a mold of a cylinder, which could then be the basis of numerous exact copies. This "gold molding" process involved electroplating the original cylinder and using the resulting negative copy to make a metal mold. Formed in celluloid, a plastic material, molded copies lasted longer and could be turned out in rapid succession. However, some of the sound information in the grooves was lost during the molding process, affecting the volume, and Edison struggled to overcome this problem. By 1912, Edison had a commercially viable cylinder molding process in hand, which became the basis of his "Blue Amberol" celluloid cylinders.<sup>7</sup>

The success of the phonograph, the expiration of some of Edison's patents, and other factors encouraged new phonograph manufacturers to become active in the United States in making records and players, sometimes using new technologies. The most important of these was the gramophone of Emile Berliner, a disc recording system developed in the late 1880s and 1890s. Berliner's disc recording technology differed from the Edison system in a number of ways. The disc used a lateral recording method, in which the

stylus moved from side to side in a groove of constant depth, rather than the Edison "hill and dale" method. Although many thought that the hill-and-dale recordings resulted in a better sound, Berliner chose lateral recording to avoid infringing on the Edison patents. The method that Berliner had worked out for reproducing the records was the primary reason for employing a disc rather than a cylinder. By a multi-stage electroplating process not unlike the one Edison used, an original recording in soft wax could be transformed into a metal stamper, which could press copies more rapidly and efficiently than was possible with cylinders. Perhaps more important was the fact the discs could be stamped out of a harder material than Edison's cylinders, allowing the stylus of a gramophone player to press harder into the groove to produce more volume. As Edison worked to perfect his cylinder molding process, Berliner's inexpensive gramophone took a growing share of the marketplace, and he foresaw what he imagined to be an immense untapped market for factory-produced records for home entertainment.<sup>8</sup>

### The First Studios

Berliner opened his first music recording studio in 1897 in Philadelphia, and began selling recorded discs and players. The playback machine was simple, relatively inexpensive, and marketed to consumers only as a form of home entertainment—it did not appear in the form of a business machine. Because of the disc manufacturing process, the gramophone was only suitable for playback and did not include a recording attachment.<sup>9</sup> Other companies appreciated the Berliner system's advantages for the entertainment market and began producing imitations. The American Graphophone Company, the prominent maker of cylinder machines, by 1899 already had a competing disc player out on the market. Eldridge Johnson, a former contractor to Berliner, also began producing discs and players in the 1890s. He formed several new ventures before establishing the famous Victor Talking Machine Company in 1901.<sup>10</sup>

The adaptation of the phonograph dictating machine to the recording of groups of musicians or performers posed daunting technical problems.<sup>11</sup> Edison, Victor, and Columbia all made early attempts to record large orchestras, but there was simply no way to crowd even a small fraction of the musicians in an orchestra close enough to the recording horn to pick up all the instruments. Further, the dynamic range, meaning the difference between the loudest and softest sounds, of many performances was simply too great for the phonograph to bear. A recorder equipped with a sensitive diaphragm could



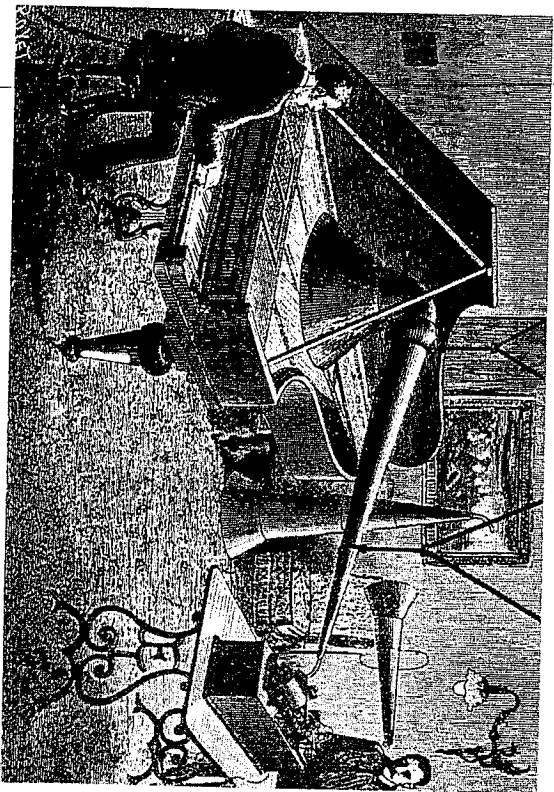


Figure 4. An early recording session with the Edison phonograph. U.S. Department of the Interior, National Park Service, Edison National Historic Site.

catch even a whisper, but the same diaphragm would break into unintelligible distortion when it was confronted by louder sounds. The compromise design could handle neither very loud nor very soft passages. The use of larger recording horns was a second tactic for trapping more of the sound in a room, but there were physical and practical limits to this technique. Edison, ever the experimenter, built a 200-foot long recording horn for orchestral recording, but it failed to work well.<sup>12</sup>

The most successful recordings of the “acoustic” recording era were of individuals or small groups of singers and musicians. In the early years, studios made multiple recordings simultaneously by clustering recording horns in groups of up to twenty. This meant that all the performers had to be crowded close to the horns, so studios had platforms to raise those at the back of the group up. Early recordings were made outdoors, in tents, or in Edison’s laboratory, but soon record companies built special rooms for this purpose. Even in the early days, the recording companies sometimes had contradictory ideas about how to build a studio to suit phonograph recording. Edison’s studio had thick, soundproof walls insulated with seaweed or cow hair, but Victor’s recorders preferred a “livelier” room with more reverberation, which gave Victor records a distinctive sound. In general, however, reverberation

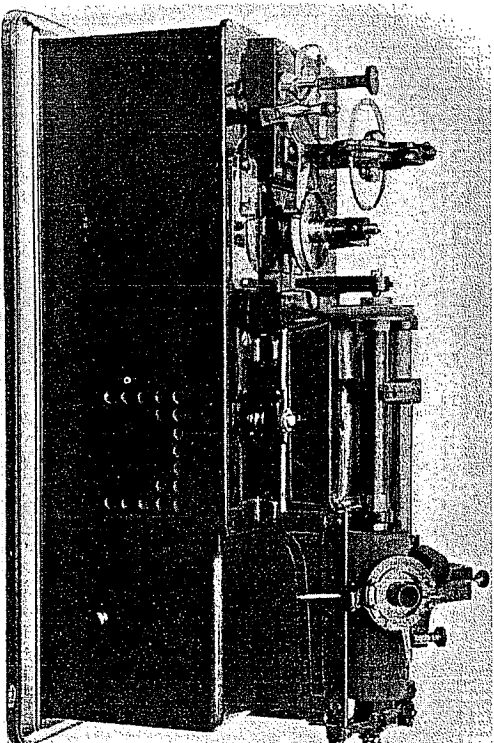


Figure 5. Edison’s “perfected” phonograph of 1888, shown here without its speaking tube or amplifying horn. U.S. Department of the Interior, National Park Service, Edison National Historic Site.

was the bane of early recording sessions, and most studio surfaces were well-padded.<sup>13</sup>

The recording process itself reflected the severe limitations of phonograph technology. During a recording session, a recording director (who might also be a conductor or serve other functions) physically arranged the musicians and managed the details of the session. During the session, the director motioned to vocalists to indicate when to lean in close and when to duck or step away from the horn during instrumental solos, allowing the musicians to come forward. More than a few stage performers, used to gestulating or moving about on stage, found singing for the phonograph constraining. Further, inexperienced phonograph singers who had not yet learned how to control their voices or step back during loud passages had to be physically jerked to and fro during recording sessions to ensure a good product.<sup>14</sup>

The phonograph’s limited capabilities also encouraged the culling of repertoire, the careful arrangement of songs, and the selection of musicians based on their recorded sound. Since the process could not capture the highest or lowest musical registers, record companies chose musicians who could make the most of what the phonograph could do. Enrico Caruso and many others owed much of their success to the limitations of the acoustic

recording process and the way it made them sound better than performers with different singing styles. Record companies eliminated many instruments, although at least one new one appeared, the Stroh violin, designed especially for the phonograph. Additionally, the fact that a cylinder or disc could only hold a couple of minutes of music (later increased to about four) meant that songs had to be abridged to fit the medium.

The inconsistency of recording diaphragms and cylinders or discs meant that multiple recordings had to be made simultaneously at a session, from which a few would be selected to become masters.<sup>15</sup> A recording session at Berliner's studio was not much different than one for Edison, except that the finished master could not be played back immediately but had to be chemically etched first. In the early years, Berliner's technicians etched the discs in the studio immediately following a recording session, a process that never failed to amaze the artists. However, the record companies did not stay with this direct method of etching metal master discs for long, and instead replaced the etching with an electroplating process more like the one Edison used, resulting in a "matrix" that could be employed to make a metal stamper. The delicate, soft wax of the recording disc, on the other hand, remained an excellent way to capture sound, and it soon became the industry standard.

Both cylinder and disc methods produced acceptable records, but the disc's eventual triumph had much to do with the shifting market for records and phonographs. By the early 1920s, the Thomas A. Edison Company was virtually alone in supplying cylinders. Many other companies had sprung up, and almost all chosen to use the disc. The price of Edison cylinders, mass produced by the molding process, actually dropped below the price of competing discs from Columbia and Victor, but it came too late to save the format.

As acoustic recording and disc production technologies gradually improved in the first decade of the twentieth century, the aural characteristics of records began to overcome the phonograph's earlier reputation for tinny, screechy reproduction. It was Thomas Edison, the pioneer in the field, who first articulated the notion that phonograph reproduction should sound exactly like the source in terms of timbre and volume. When the Edison Company finally bowed to pressure and introduced its own disc record, which it called the "Diamond Disc," the firm embarked on a series of public demonstrations called tone tests. These tests challenged the audience to detect the difference between the sound of new Diamond Disc records and the sound of the performers who made them. According to one account, millions of Americans took the test between 1915 and 1925.<sup>16</sup>

The claims that Edison made for the Diamond Disc revealed how the company had both technical and social goals for home recording and reproduction. In the first place, Edison wanted consumers to think of the phonograph as a new form of musical instrument, capable of reproducing not just popular tunes but also "serious" music. To do so, he claimed that the phonograph, unlike a real instrument, had no "tone." Instead, it faithfully reproduced the original sound without adding or subtracting anything. As one phonograph customer (or perhaps the magazine's staff) wrote to the *Phonogram*, "The phonograph never imitates, it reproduces the actual music as played by the performer." This was the root of a powerful idea that has persisted throughout the history of the record: that a sound recording should not simply sound pleasing, but should sound just like the original.<sup>17</sup>

The tone tests invariably proved the validity of Edison's claims. However, Edison carefully chose singers, usually women, who could imitate the sound of their recordings, and only allowed musicians to use the limited group of instruments that recorded best for demonstrations, such as strings or the flute. Nonetheless, it was also true that the Edison recording technology, using hill-and-dale acoustic recording, could provide remarkably realistic sounding records. The accounts of "reporters, reviewers, and music critics show that they took the challenge seriously, listened critically, and usually concluded that the Diamond Disc did indeed at least come very close to 're-creating' live music."<sup>18</sup>

### **Recordings, the Consumer, and the Status of Music**

The tone tests, Thomas Edison's own musical tastes, and the numerous published histories and reminiscences of the early years of the phonograph share a striking feature: the special status of classical, opera, and related types of "highbrow" music. These sources give the impression that high culture records were the most significant of the pre-1945 period, and that the desire to reproduce high culture music faithfully has driven technological change in the record and record player industries. Against this is the reality of the record market in the United States, which seems to indicate the overwhelming economic importance of popular music, presumably not artistic in nature and therefore not necessarily as demanding of technical excellence. These two very different types of music must have favored different technologies of recording, mass production, and home reproduction, and yet the evidence suggests that popular music and its makers had only a minor influence. How could this be?

Fred Gaisberg, a pioneering "artist and repertoire" man who located and recorded talent for Berliner's company around the turn of the century, admitted that in the early years "the main record sales were from such popular titles as 'Down Went McGinty to the Bottom of the Sea,' and 'Daddy Won't Buy Me a Bow Wow.'"<sup>19</sup> Yet he devotes most of the rest of his autobiography to descriptions of recording activities in connection with high culture singers and musicians, suggesting that these were the most important and fulfilling activities of his career. Similarly, Roland Gellatt, whose 1955 *The Fabulous Phonograph* became one of the standard histories of recorded sound, focused almost exclusively on high culture recordings, decrying the lack of "serious" music in the early catalogs of record companies and making broad claims about the "rebirth" of interest in good music after the introduction of the LP record. His subsequent description of technological development presents most of it as if it were explicitly linked to the desire to make better-sounding recordings of highbrow music. The task, then, is to reconcile the limited economic importance of high culture music during most of the history of recorded sound against its apparent influence in driving technological change in the industry.<sup>20</sup>

High culture music has had an influence in the record industry that exceeds its economic importance. The reason for this reversal of economic logic is related to the fluctuations of the popular music market, the prejudices of engineers and musicians, and the social agenda of the record companies. Within record company studios, engineers and musicians constantly sought ways to improve the recording process (although sometimes for different reasons), and considered orchestral and operatic recordings the highest form of their art. The bad times the industry periodically suffered convinced some in the record companies that their only faithful customers were buyers of classical music, and these companies repeatedly fell back on the consistent buying habits of these "cultured" consumers by introducing technical improvements intended to appeal to them. The special status of highbrow culture within the record industry even today rather dramatically bucks expectations based on economics. One record producer for Columbia noted that as recently as the 1980s, the company's classical releases accounted for 20 percent of the catalog but only 5 percent of its sales. Even more surprising is the fact that despite minuscule sales, classical recordings were often very expensive to produce; \$6,000 for a soloist, \$8,000 for a chamber group, \$50,000 for an orchestra, and \$100,000 for a full-length opera at 1970 prices. The costs had doubled by the late 1980s.<sup>21</sup>

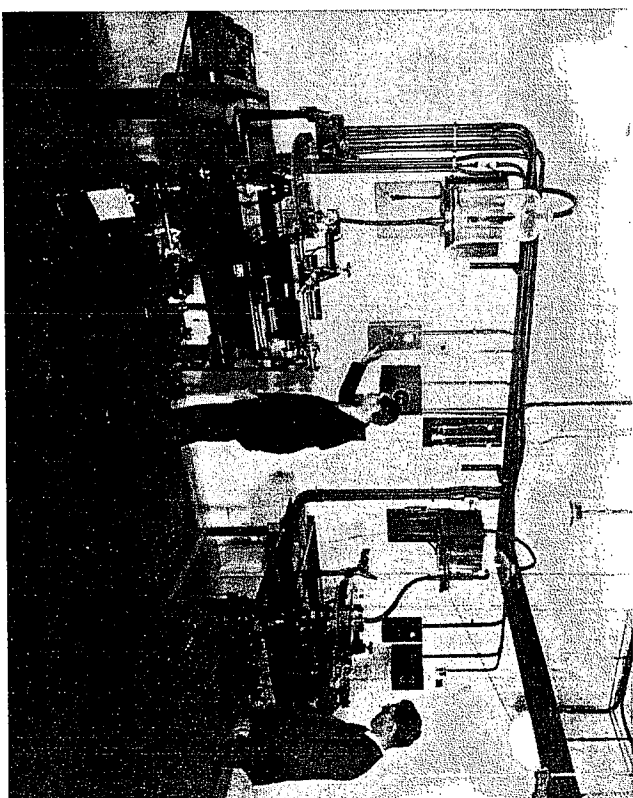


FIGURE 6. Early disk recorders in use at Western Electric, circa mid-1920s. Property of AT&T Archives. Reprinted with permission of AT&T.

### Electrical Recording

Music, and particularly classical music, attained a special status as an artistic endeavor before the introduction of the phonograph, and this fact had important implications in the record industry. When musicians and engineers considered the problems of the recording and mass production of high culture, they looked for ways to shape the development of the technology in ways that sometimes ran counter to the demands of capitalist production. The recording of music gave rise to a unique culture of production in the record industry and spurred a particular brand of technological change. Technology has steadily grown more complex in the recording studio, but unlike so many other twentieth-century production processes, the development of recording technology has not moved consistently toward greater mechanization or automation. Instead, musicians and engineers worked together to develop new technologies without particular concern for the costs of production, and sometimes without much concern for the other steps necessary to transform a master recording into the final consumer product.



One of the most important shifts in studio recording after 1920 was the adoption of electrical technology. The record industry after the turn of the century fell under the sway of this new and exciting technology as engineers discovered ways to electrify a previously mechanical process. Most of the new technologies came from the large research and development laboratories at General Electric and AT&T, which also gave rise to new systems of wireless communication and motion pictures. With these developments, the relatively new profession of electrical engineering was immediately thrust into the unfamiliar, unscientific realm of aesthetics, as engineers faced the task of improving the "quality" of the crude audio and visual media they had invented. Already steeped in the methods of science, electrical engineers responded by creating instruments to measure audio "signals," and borrowed heavily from the methods and vocabulary of acoustics. From the entry of Western Electric into investigations of the nature of sound until well after World War II, the electrical engineer was virtually unrivaled as master of sound recording in the radio and motion picture industries. Yet at the time radio broadcasting took off in the mid-1920s, the phonograph industry was still engaged only in acoustic recording, employing no microphones or amplifiers. Other than the electric motors that drove some home phonographs, there was little electrical engineering in the phonograph at all.<sup>22</sup>

Record companies welcomed the subsequent transfer of electrical technology from radio and motion pictures to the phonograph industry, but hated the effect these two new forms of entertainment had on the record business. Radio was the biggest threat. On the eve of broadcasting's debut, between 1914 and 1921, record sales had doubled, largely because of sales of popular music. With the inauguration of network radio in the middle 1920s, the market for popular recordings collapsed, resulting in a number of companies leaving the field or changing ownership. Classical music fans, however, continued to buy recordings, and record companies recognized their importance in bad times as loyal customers. In an effort to build up sales from the base of their remaining customers, record companies turned to technical innovations that would, they hoped, appeal to classical music lovers.<sup>23</sup>

Edison in 1877 had first proposed to use the electrical output of the telephone, driving an electromagnetic recording stylus, to make phonograph records, but he could not make this technology work as well as the acoustic recording process. By 1924, engineers at Western Electric took up this line of development, combining it with the new technology of electronic amplification to produce the "electrical" recording technique. AT&T's leaders at first thought to use the new technology within the Bell System, but later decided

to market it to outsiders such as the motion picture, radio, and phonograph industries.

What Western Electric engineers proposed was a new disk for home reproduction compatible with the existing phonographs and disk manufacturing technology. The recording process would replace virtually every aspect of the previous acoustic technology. Instead of having performers shout into a recording horn and using sound energy to record directly, the electrical recording process converted sound into electricity in a microphone. The signal from the microphone was amplified electronically and then fed to an electromagnetic record "cutter" to produce a recording on a wax-coated disk. The disks could be manufactured in the usual way, and even played on existing equipment (though with reduced effectiveness). Western Electric's engineers believed that electronics was still too expensive and balky for the home, so they designed a new acoustic phonograph to reproduce the disks. This acoustic, but scientifically designed record player did represent a noticeable improvement over earlier models. It was apparently easy to sell the American record companies on the new technology, with its distinct and more detailed sound. Some consumers also seemed to see them as an improvement, and in fact, the new disks and players sounded a great deal like the radios that were by then taking so much business away from the record companies. However, the shift to electrical recording had little effect on sales outside the field of good music. Some consumers, used to the more mellow sound of acoustic recordings, rejected the bright-sounding disks as too shrill.<sup>24</sup>

The transition to electrical recording offered few benefits to artists, who had to work harder than ever. Although they could now put a little space between themselves, they were no more free to move or turn their heads than they were in the days of the recording horn. The sensitivity of the new microphones was such that the rustling of sheet music, the shuffling of feet, and even noisy breathing had to be curtailed. "[The musician] can't move six inches from where he is standing for fear of upsetting the tonal balance; if he hums while he plays, he must stop it; and if he breathes through his nose, he must open his mouth a little so that he may avoid what can sound like a consumptive intrusion on the finished product."<sup>25</sup>

The introduction of the radio initially cut deeply into the sales of home phonographs. Soon, the cost-cutting measure of sharing one electronic amplifier between a radio and a phonograph cemented the link between the two devices. Although the original Victor Orthophonic reproducer was acoustic, manufacturers soon offered electromagnetic pickups suitable for use

with electronic amplifiers. With such a pickup, a very inexpensive record player could be easily wired into a radio, and the sound reproduced through the radio's amplifier and loudspeaker. Radio-phonograph combinations and inexpensive, add-on phonograph players probably contributed more to a revival of record sales between 1926 and 1929 than the introduction of the electrically recorded disks.

However, the onset of the Great Depression immediately halted growing record sales. Edison dropped out of the business completely in 1929, before the stock market crash. The situation was so dire that Columbia and Victor both went into receivership and were sold to new owners. Sales that had hovered between \$70 and \$75 million from 1926 to 1929 fell almost 39 percent the next year, then plummeted to only \$6 million in 1933.<sup>25</sup>

The record's comeback in the late 1930s (which continued until the musicians' strikes of 1942) was stimulated by price cuts, increased advertising, and jukebox sales. Decca,<sup>27</sup> Columbia, and a number of newer companies began to offer disks for as little as \$0.35, which was about half the normal price, and Columbia in 1940 spent \$1 million advertising them.<sup>28</sup> The nation's hundreds of thousands of jukeboxes were the outlet for as much as half of record sales in the late 1930s. Popular music, alternately known as "light," "swing," or sometimes "jazz," accounted for 85 percent of record sales by 1941. Ironically, music historians look to this period as one of the most important eras in jazz history, partly because of the spate of "field" recordings undertaken by the record companies in these years. While those recordings have had a persistent influence on musicians, at the time they reached a relatively small audience. In fact, much of the "jazz" that reached America's ears was jazz-influenced popular music of the watered-down, cleaned-up variety, performed by white, mainstream musicians.<sup>29</sup>

Despite the evidence against it, scholars, journalists, and musicians alike have also repeatedly emphasized the role of "good" music in the periodic revivals of the record industry. The essential thrust of this argument is that the increased availability of serious music and better technology with which to record and reproduce it meant that it was having a significant influence on the general public. "Although the biggest business is still in jazz," an author for the *New York Times* wrote, "the most important, manufacturers agree, is in the classics."<sup>30</sup> This way of describing the record market undoubtedly grew out of the chauvinism of music critics and journalists, many working in the urban cultural centers of the nation, who acted as cultural gatekeepers during these years, trying to encourage the "development" of musical taste.<sup>31</sup>

Market downturns of the late 1920s and 1930s encouraged the record

companies to emphasize their classical offerings and offer innovative new technologies suited to classical music, but neither the number of classical titles nor the appearance of new technology can be counted as a true indication of the significance of these developments. The radio networks, under constant scrutiny from government regulators, became self-styled social reformers and educators, pushing their highbrow predilections on the American public at the same time they promulgated popular culture. Thus while serious music was well represented in the programming of American radio, there was little indication that it was universally appreciated by listeners. What corporations, writers, and critics said must be balanced by an appreciation of just how tiny the classical music market was in these years. Further, this economic data regarding classical music sales has to be couched in disclaimers. The higher price of classical music meant that it accounted for a larger proportion of record company income than its sales would otherwise have suggested—15 percent of sales in 1940 but 30 percent of income. At \$0.35 per disk in the late 1930s, a top selling record could have less economic impact than, for instance, the recording of Leopold Stokowski conducting the Philadelphia Symphony in the *Blue Danube Waltz*, which brought in about \$500,000 for Victor between 1926 and 1939 but sold only 225,000 copies.<sup>32</sup>

Nevertheless, there is strong causal link between high culture and changes in recording technology. Within the record companies, influential people involved in sound recording often had highbrow tastes, and developed or encouraged technologies and practices that favored these types of recordings. Further, record companies and equipment manufacturers shaped many of the new consumer phonograph technologies to suit classical music customers.<sup>33</sup> The overall depression of the record industry in the 1920s and 1930s slowed consumer sales of new technologies, but not their adoption in the studio.

Diminished record sales persisted through most of the 1930s, yet this was a decade of great technical change in audio technology. While the record industry languished, most innovations in sound recording came out of the fattening movie and radio industries. These industries were already interwoven through corporate ownership or, indirectly, through their common connections with electrical equipment manufacturers such as Western Electric. The links that record companies made to radio and the movies when they adopted electrical recording in 1925 were only the beginning, and after that time motion picture and radio practices began to have a more noticeable influence on record making. Western Electric, in fact, sold many of its electrical disk recorders to motion picture producers in the 1920s, and provided considerable technical assistance to movie studios. Electrical Research Products,

Inc., the Western Electric subsidiary which handled sales, installation, and maintenance of electrical recording equipment, provided trained personnel to run the equipment, or trained technicians for clients. In radio, where less actual recording took place, engineers contributed to the development of new techniques using microphones and electronics, many of which were directly applicable in the record industry. Sometimes the link between movies or radio networks and the record industry was even more direct, as when the radio networks and motion picture producers worked in conjunction with record companies to make recordings or operated recording companies themselves. Often during the 1930s record companies released recordings made at the studios of NBC, CBS, or the larger radio stations.<sup>34</sup>

These associations tended to counteract the technical stagnation that might have set in due to the record industry's hardships and stimulated rapid development in sound recording technology. The 1930s and early 1940s, for example, saw significant changes in the design of recorders and related technologies, including microphones, amplifiers, and sound studios, all reflecting the scientific findings of electrical engineers at Bell Laboratories, RCA, and other companies, and the increased use of sound measuring instruments and procedures in the design process. The science of acoustics was already quite old by the 1930s, but never before had record companies had such a variety of instruments available to measure sound. The numerous technical articles on sound measurement, many written by scientifically trained engineers, gave the strong impression that what was measurable in sound was what was most important. Sound recording personnel in the record studios took on the mantle of science and engineering by adopting its terminology, instruments, and values. As sound recording activities became more professionalized, and as the position of "recording engineer" of the 1920s gave way to the "recording engineer" of the 1930s, the role of formal knowledge grew in importance, and the recording of sound took on a new, measurement-based aesthetic.<sup>35</sup>

What mattered most to engineers of the 1930s was not the subjective quality of sound but its measurement. Consumers, on the other hand, had little recourse but to evaluate a recording subjectively, "by ear." This disparity may account for the fact that many early reviewers admitted the technical superiority of electrically produced commercial recordings, yet they still objected to the way they sounded. But the growing divide between engineer and listener did not necessarily imply different values, since the electrical sound recorder and its corresponding home phonograph player were intended to reproduce, as closely as possible, the original sound.

The growing engineering orientation of recording in the studio did not

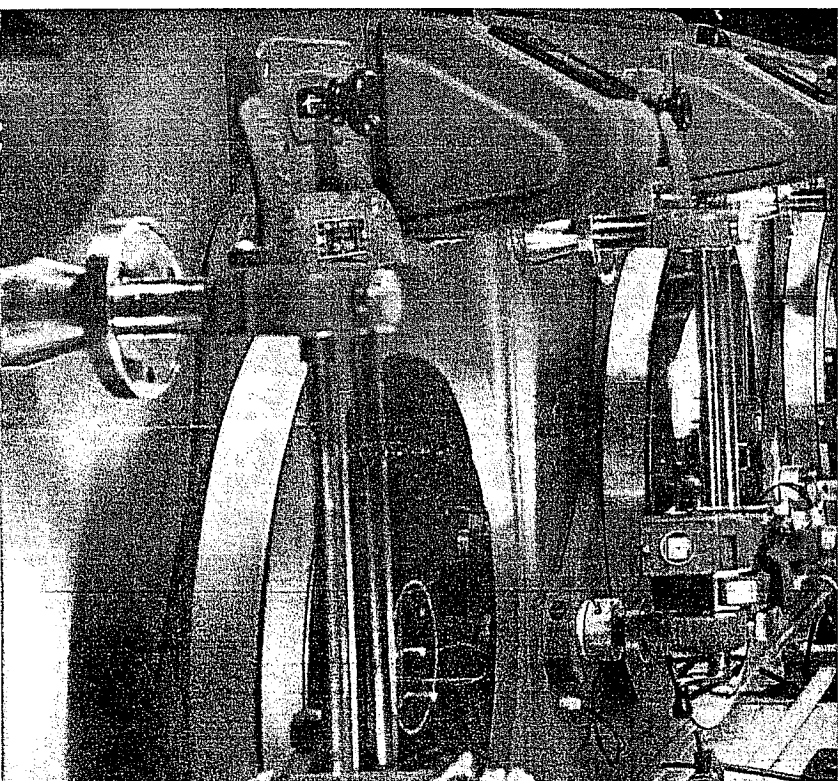


Figure 7. A bank of disk record cutters in use in 1949. *Audio Engineering*, June 1949. Reprinted by permission.

always suit artists or music critics. Too heavy a reliance on instruments and measurements could ruin a recording for listeners. Having the equipment work "right" did not always result in a record that was pleasing to hear. The problem, some critics charged, was that the technically proficient but musically inept engineer had taken control of the recording process. "He is all technician when he should be part technician and part artist," one author wrote in reference to the making of motion picture sound tracks in the early 1930s. "He is interested largely in microamperes and the response curves of audio-frequency transformers when esthetic effects and realism should be uppermost in his mind."<sup>36</sup>

Yet the recording engineers themselves were not all of a mind when it came to the question of how to preserve the original sound. Some of them took advantage of the enormous potential of the new electronic equipment to "enhance" the sound rather than be satisfied with preserving the original. The technology of sound manipulation was part of an electrical recording process that ideally was to be used only to bring degraded signals back to their original state or compensate for the differences between the way the human ear and the microphone responded to sound.

One example from the late 1930s, which originated in the motion picture industry, was the replacement of a single microphone with several, which fed into a common recording channel. A new sound craftsman, the balance engineer, took on the task of listening to the rehearsal to determine just where the microphones should be placed. He also operated the mixing board to raise or lower the output level of each microphone channel before all the music was mixed together and recorded. In theory, multiple microphones overcame the fact that a single microphone could not "hear" sound just like the ear. Particularly when recording large ensembles, placing several microphones in and around the group allowed the engineer to record all the instruments more faithfully.

A related technology was equalization. An electronic equalizer emphasized or de-emphasized certain bands of frequencies in a fashion analogous to the "tone" controls on a home audio system. Recording engineers equalized recordings in order to compensate for the uneven response of microphones, recorders, and the disks themselves. Boosting certain frequencies during recording would be counteracted by their partial suppression upon playback due to the deficiencies of the medium, with the end result being sound more like the original.<sup>37</sup>

All these devices had in them the potential to reshape sound, creating something new. Yet through the middle 1940s, most recording engineers adhered to the ideals of accuracy in recording, even if consumers and critics questioned their success in doing so. Changes in electrical recording technologies and practices all moved toward improving the "realism" of the master recording. Improvements in the record manufacturing process or the final product, however, were not forthcoming.<sup>38</sup>

### **The Birth of Consumer High Fidelity**

By the early 1930s, with both the radio receiver and home phonograph markets hitting rock bottom, the influence of high culture music in techno-

logical design was becoming especially apparent in the offerings of desperate equipment manufacturers and record manufacturers. In the midst of depressed sales, manufacturers introduced new lines of improved home equipment designed to reproduce a wider range of frequencies. One of the new consumer products from Victor during the 1930s was a twelve-inch, fine groove, extended play, 33 $\frac{1}{3}$  disk. Victor's claims for better sound were specifically targeted to classical listeners, as was the disk's ability to hold more than the usual four minutes of music. Unfortunately, the experiment was a commercial failure. The grooves were too fine for the home phonograph pickups then available, and the disk manufacturing process could not accommodate the higher-quality recordings.<sup>39</sup>

Radio receivers and improved radio-phonograph combinations designed to play ordinary disks but reproducing a wider frequency range were more successful, and electronics manufacturers in 1934 gave these new products a name: high fidelity.<sup>40</sup> The phrase captured perfectly what Edison had tried to achieve in sound recording and reproducing, and what studio engineers were striving to perfect in the recording of classical music. High fidelity was a powerful and lasting marketing concept, though access to high-fidelity equipment remained very limited in the 1930s and 1940s. High-fidelity music did not emanate from the paper cones of the loudspeakers in the cheap radio sets and phonographs that utterly dominated the market; nor did it reach the ears of many movie patrons, since few movie houses invested in top-quality sound systems. The enhanced sound of the new FM radio system available in New York and some other cities after 1939 reached almost no one because so few people bought the necessary receivers. In sum, high fidelity's time had not yet come.

The high-fidelity hobby of the 1930s was the province of an elite group of relatively wealthy record buyers. These consumers invariably used high culture as a point of reference, ensuring the continued association of high-fidelity technology with high culture music. Classical music, opera, and other forms of highbrow entertainment had temporarily risen in commercial importance relative to popular music, but would soon fall back to their normal place. The high-fidelity concept as a selling tool for consumer equipment was destined to persist and even expand, to be transferred out of the context of high culture when the market for popular music returned.

When the later 1930s saw the gradual resuscitation of the U.S. phonograph record industry, music aficionados once again credited it to the growth of interest in high culture. "With the reappearance of Toscanini before Victor recording microphones in 1936," one historian has written, "the evidence

became unmistakable that the phonograph was on its way back."<sup>41</sup> In fact, the real reason for the industry's rebound was the growth in jukebox sales, a new outlet for popular records that sustained the industry through the end of World War II. Only the major record labels, such as RCA-Victor and Columbia, engaged in much highbrow recording at all during these years; other labels re-pressed imported matrices or simply served the more lucrative popular music markets. Victor's sales of expensive, high-quality "Red Seal" records, the brand reserved for high culture music, were but a quarter of total sales. This, combined with the fact that each popular music record that went into jukeboxes was broadcast to a wider audience, argues strongly against the cultural centrality of "serious" music, at least outside the musicians' journals, New York highbrow magazines, and record studios themselves.<sup>42</sup> The 225,000 jukeboxes in operation in the United States in 1930 consumed 13 million disks, each of which reached perhaps hundreds of individuals. Classical records played at home rarely reached beyond the ears of their buyers, who numbered not in the millions but in the hundreds of thousands.<sup>43</sup>

Even so, many of the important technical innovations in the studio were oriented toward these classical music buyers. Edward Wallerstein, in charge of rebuilding Columbia's catalog after CBS bought the ailing record company in 1938, recognized that they were the backbone of the industry and made sure they were well provided for. As part of the ongoing drive to improve studio recording, most of the record companies around 1938 adopted a new disk for making master recordings. This acetate-coated aluminum disk offered less surface noise than its wax predecessor, resulting in low-noise stampers. But technical change in the studio had little effect on the final product. Audiophile engineers in the studio ran up against the same wall with the acetate master that they had encountered with the 33 $\frac{1}{3}$  disk years earlier, in that an improvement in the studio meant nothing without improvements all the way down the line from master record to final product.<sup>44</sup> Although consumers did not know it, Columbia in the early 1940s was preparing to offer a new long-playing disk, especially suited to classical music, and began using acetate masters in anticipation of the changeover. However, the expansion of the record industry was once again making sales of individual classical titles less significant than popular record sales; one top-selling symphonic staple of the Victor catalog sold a mere 62,000 copies in 1946, compared to Victor's total sales of over 55 million disks.

In the midst of these changes, the record industry's consumer offerings were artificially restricted in the early 1940s, first by a major musicians' strike,

and then by wartime restrictions. With the resolution of these problems in 1945, record companies prepared to dazzle consumers with exciting new technologies for the reproduction of music.

### **Tape Recording and Other New Studio Techniques**

The postwar period saw the erosion of the ideals of high fidelity in the recording studio, ironically just as it was taking hold as part of a new consumer movement. The single most important factor in decline of the high-fidelity ideal in the studio was the use of the tape recorder. The studio tape recorder was a German invention that American companies copied and improved upon after 1945. Tape recorders could not always outperform the disk recorders that record companies used in their studios, but they could do several things that disk recorders could not. One was to go "on location" with great ease. A tape recorder needed little set-up. It could be operated in a wide range of temperatures and humidity levels, and didn't require a separate recording room or even a level surface to sit on.<sup>45</sup>

Tape recorders were less prone to mechanical failures than a disk recorder. A tiny bit of the "thread" that a record cutter carved out of the groove during recording could fall under the cutter and ruin an otherwise perfect recording. The reliability of the studio tape recorder convinced engineers to insert it into the process of disk record-making. By recording onto tape and then copying to disk, if a master recording on disk failed, a new disk could be cut immediately at little additional cost. A tape could break, but record companies learned not to depend on reused or spliced tapes for master recordings. While disk masters had to be stored in a temperature-controlled environment and required surgically clean conditions, tape was robust and virtually immune to dust, cigarette ashes, or anything else that might be floating around a studio. A disk recorder was often isolated in a separate recording room, but the tape recorder could be placed in the control room, allowing an engineer to operate both the mixing board and the recorder.

Tape posed no serious threat to the disk recorder, but rather enhanced its value. After all, the making of a disk recording was still the final step before making a master for conversion into a stamper. The first hint that the tape recorder might change anything in the studio was the importation of editing techniques in the early 1950s. Motion picture sound men had used editing since the early 1930s, when film sound recorders came into widespread use. These devices recorded sound optically on motion picture film (though not



the same film used to record the video portion of the movie). Once processed, editors could easily cut and paste bits of the sound track to fit the action on the screen, which was also heavily edited. Then the audio and video portions would be rerecorded together on the final master copy. Sound-on-film, as it was called, was a powerful technology for making edits, since an engineer could look at the film to see exactly where to make a cut.<sup>46</sup>

A magnetic recording on tape was, unfortunately, invisible, yet it offered many of the other advantages as sound-on-film editing. Engineers almost immediately discovered that with practice they could edit tape as accurately as they could edit a motion picture film. Until the introduction of tape, editing was very rare in the record industry, but not for any lack of desire to edit. A disk recording dubbed from an existing disk in order to edit was sometimes noisy and muddled, and it took great skill to blend seamlessly two segments of the recording.<sup>47</sup> By contrast, engineers could create a high-quality disk master recording even from a heavily edited tape. Engineers began using their tape recorders to improve imperfect recordings, replacing missed notes or other flaws by cutting out the offending portion and replacing it with what they wanted.<sup>48</sup>

When music critics discovered this practice, many of them were horrified. "I discovered to my astonishment recently that many a popular song-with-accompaniment is recorded in two separate pieces," wrote Edward Tatnall Canby in 1950. "First, the instrumentalists record their parts on tape. Then, perhaps weeks later, the vocalist comes along, listens to the recorded accompaniment (via earphones, I suppose) and records a separate vocal sound track. Finally the engineers re-record both into a blend. . . . there is never an 'original.' . . . How far ought we to go?"<sup>49</sup> Musicians saw it differently, since it was their flaws and imperfections that a "one take" recording session captured for public inspection. In the past, some musicians had insisted on rerecording an imperfect performance until they were satisfied that they had done their best, but this was a luxury available only to well-established performers. With tape, it was easier to construct something better than any single performance from portions of several performances, and it was usually less expensive than rerecording.

The use of technology for manipulating sound and creating new effects, rather than maintaining high fidelity, drew similar criticism. Recording engineers in the 1950s more regularly employed the practice of using multiple microphones and more obvious sound "enhancements," including techniques such as artificial reverberation. Acerbic music critic B. H. Haggin decried the "possibility [magnetic tape] had offered of altering the original sound, and

the most notorious examples of such electronic manipulation—RCA's notoriously falsifying 'enhancements' of Toscanini's recordings."<sup>50</sup> After the LP record made it easier for consumers to hear the details of a recording, some began to notice that high-fidelity recording techniques seemed themselves to be a source of distortion. "Listen to some recent opera recordings and ask yourself whether in any seat in any known opera house you ever heard comparable tonal balances between soloists and orchestra," E. T. Canby charged in 1954.<sup>51</sup> The practices of using multiple microphones and synthetic reverberation, (which had taken hold in the record industry only after World War II) was by 1954 already creating a backlash among purists, who reverted to using a single microphone and the reverberation provided by the concert hall itself. John Hammond of Vanguard Records sought a "natural sound," using a single microphone, and he denounced popular record producer Mitch Miller's use of artificial reverberation as "horrible" and "phony." "What's the good of having every instrument in a band sound as if it were being played in the Holland Tunnel?" The use of tape-based special effects became completely obvious to the public in 1958 and 1959 with the release of a series of popular songs by "The Chipmunks," allegedly a group of singing rodents (all the voices were composer Ross Bagdasarian) created through the machination of tape recordings.<sup>52</sup>

E. T. Canby assured his readers that these practices would find a permanent place only in the popular music foisted on the enormous but "esthetically infantile" general public. He was wrong. More significantly, it was not the creators of popular music recordings who were solely to blame for this turning away from high fidelity. Rather, musicians themselves, and especially prominent composers and conductors, would begin to enter the control room to manage the details of the recording process. Even in the 1930s, more privileged conductors like Leopold Stokowski were taking a more active role in the recording process, placing microphones, setting the balance, equalization, and mixing, and specifying the details of editing.<sup>53</sup> Some later insisted on creating an annotated score, marked with instructions which the engineer was to follow. By the early 1950s, the recording engineer's technical control was often challenged by the recording director (or later the record producer), who did not replace the work of the engineer so much as supply an additional layer of creative input. Postwar recording directors often emerged from the ranks of artist and repertoire men, the agents of record companies who put together new talent and songs. Mitch Miller, a former oboist for the NBC Orchestra, was by 1950 an A&R man for Columbia. Pop musicians auditioning for Miller always made a test record, which he then played back on an inexpensive

phonograph that he kept on his desk. If the artist sounded good on a cheap phonograph, he or she passed the audition.<sup>54</sup> Miller, like many other recording directors, was not as committed to the old style of high fidelity, with its emphasis on capturing and reproducing a real performance, as he was to creating a perfect recording or simply a pleasing sound.

By the early 1960s, some of the most successful record producers were using the possibilities of electronic sound manipulation and tape recording to create their own unique sound or sonic "stamp."<sup>55</sup> The engineer's role in the 1950s retained most of the old principles of high fidelity, for as one wrote, "when an engineer takes part in a recording session he almost never tries to improve on the resulting music, except for routine splicing of takes."<sup>56</sup>

### **The Consumer High-Fidelity Movement in the 1950s**

As the goals and ideals of high fidelity were being subsumed under the new techniques in recording studios of the late 1940s and early 1950s, consumers were discovering hi-fi in greater numbers. The hi-fi hobby was underway as soon as the war ended, with customers creating a demand for the audio components manufactured mainly by a group of smaller, specialized companies. Victor tried to appeal to them by offering some of its classical recordings on 78-rpm disks made of a new, low-noise material called vinylite. Decca records in Britain similarly began selling its new hi-fi disks in the summer of 1946, calling them Full Frequency Range Recordings.<sup>57</sup> The high-fidelity movement and the vinyl disk passed a landmark a few years later in 1948–49 with the introduction of the 45-rpm and long-playing microgroove records.<sup>58</sup> Peter Goldmark and Edward Wallerstein, the CBS employees who publicly promoted the LP, were models of the record industry's high-fidelity culture. Well-educated, musically talented or at least good-music enthusiasts, and in positions of great power within a leading record manufacturing firm, the two envisioned the LP with classical music in mind. Even after the microgroove recording process and low-noise medium were available, Wallerstein sent engineers back to the drawing board to increase the playing time from its original duration of just over twelve minutes. "I timed I don't know how many works in the classical repertory and came up with a figure of seventeen minutes to a side. This would enable about 90 percent of all classical music to be put on two sides of a record. The engineers went back to their laboratories."<sup>59</sup> The final form of the LP, which held up to about twenty minutes of sound per side, made sense only in the context of the long pas-

sages typical in classical music. It was also considerably more expensive than a single disk, although it was less expensive than the "albums" of 78-rpm disks on which classical music had previously been offered. Columbia did not plan to replace the 78-rpm single, which was the mainstay of its business, but hoped to expand its market for classical music and certain other niche products such as Broadway-musical recordings.<sup>60</sup>

The very next year, RCA introduced a product that incorporated significant technical improvements in a package suited for the mass market: the seven-inch 45-rpm single. The 45-rpm disk combined many of the technical improvements of the LP with the inexpensive package of the 78-rpm single. For the tiny classical market, RCA proposed albums of several disks, to be used on the new RCA fast-drop record changer. At first, the RCA approach seemed to be on the mark. The LP was not the instant success that Goldmark had hoped. It did not begin to outstrip the combined sales of 78- and 45-rpm singles until the late 1950s.<sup>61</sup>

Sales of phonographs and high-fidelity equipment gained momentum in the early 1950s, particularly in the traditionally strong urban markets for music, such as New York and Chicago. There, high-fidelity promoters staged elaborate audio equipment "fairs" beginning in 1949. The focus of numerous magazine and television features on audio, high fidelity became a mass-market phenomenon after 1952. The essence of high fidelity, the notion of "realism" and the uncolored reproduction of music, dominated almost every discussion of home audio equipment. However, commercial recordings themselves betrayed the growing divide between the ideals of high fidelity and the reality of what happened in the recording studio.<sup>62</sup>

### **Multitrack Recording: Beyond Hi-Fi**

One common characteristic of the constantly changing technologies of home music listening is that manufacturers and record companies have sold every new innovation as an improvement in fidelity. Even today, companies seem unable to invent a new vocabulary to describe their products, and instead revert to the obsolete notion of high fidelity, usually accompanied by references to high culture music. A particularly important example of this was the introduction of the multitrack tape recorder.

The tape recorder diluted the pure version of high-fidelity culture through practices such as editing, but an even more important technique came later, beginning with the development of stereophonic recording. Stereo-

phonic sound has been in existence since 1881, when Alexander Graham Bell demonstrated a stereo telephone transmission in Paris.<sup>63</sup> The Columbia Phonograph Company as early as 1899 offered for sale its "Multiplex Graphophone Grand," a three-horned cylinder phonograph employing three separate sound tracks interleaved on a single cylinder. The machine's \$1,000 price tag undoubtedly discouraged sales. Western Electric engineers made multichannel disk recordings in the 1930s, though they were not available for sale until decades later. The public's only exposure to stereo, if they were lucky enough to have access to one of the handful of theaters equipped to reproduce multichannel recordings, was in 1930s films such as Walt Disney's *Fantasia*. Demonstrations of two- or three-channel magnetic tape systems for the studio began in the late 1940s, but these did not become commercially available for a few more years.<sup>64</sup>

In the early 1950s, however, manufacturers offered more affordable "binaural" reproducing equipment. The early binaural recordings were for headphones only, so that each ear received the sound of separate channel. This way, the listener could use the mind's eye to "see" the spot where a sound originated. With recordings of Ping-Pong games, a listener could follow the ball. With musical recordings, the listener could place each performer on an imaginary stage. One important but short-lived binaural medium was the Cook disk system of 1952, an ordinary phonograph disk with two separate, concentric grooves, each containing a distinct recording. The Cook phonograph required a dual tonearm with two separate pickups.

Stereophonic recording was a distinctly different approach intended to be heard through ordinary loudspeakers, not through earphones. Since each ear heard the output of both channels, recording engineers had to mix the recording just so to achieve the desired "sound stage" effect. Stereo tape recordings appeared around 1952, the products of home tape recorder manufacturers or independent record companies. Consumers could modify their existing tape recorders to play stereo tapes, adding a second playback head and an external amplifier. Radio stations also helped to popularize the technique, broadcasting the two programs simultaneously on two separate channels. Listeners had to tune in both stations on two different radios, and often one channel was on AM and the other on FM.

By 1953, the recorder manufacturers devised a way to squeeze two playback heads into one, rendering obsolete the earlier form of stereo tape. Finally, in 1958, RCA introduced a new stereo tape recording system for the home and a stereo LP record. It was the disc technology that found widespread

acceptance in the marketplace. Manufacturers promised consumers that stereophonic recordings offered high-fidelity reproduction never before possible. However, many engineers and acousticians recognized that stereo reproduction, while pleasing, was not necessarily more accurate than monophonic reproduction. The stereo illusion was just that. As one 1967 recording manual put it, "In stereophonic recording, duplication of reality is only one of the objectives."<sup>65</sup> Achieving a subjectively pleasing final product was more important. Further, the introduction of stereo recording came just a few years after rock and roll music became popular, and rock producers would soon take advantage of stereo's possibilities. Many rock and roll recordings continued to be monophonic well into the 1960s, but when rock record producers took up stereo, they rarely claimed to use it to preserve the original instrument placement. Instead they used it to achieve psychedelic effects or simply to create a powerful and satisfying "sound."

Multiple track recorders also played a major part in the ongoing development of editing techniques in the 1960s, pushing the practice of recording farther from the ideals of high fidelity. Multitrack recording for motion pictures was familiar to studio engineers by the time the first two-channel tape recorders appeared. RCA's Camden, New Jersey studios had been recording movie sound tracks this way since the early 1930s. By making separate recordings of groups of instruments, or perhaps putting vocals and instruments on different tracks, studio staff could have greater flexibility in creating the final recording. If the mixing process or the final record did not sound right, the source material was there to allow another try.<sup>66</sup>

While early stereo recordings were a break with the high-fidelity ideal, making them did not fundamentally alter the recording or editing process. Recording engineers still faced the problem of setting the recording levels of a multitude of microphones and mixing a number of inputs, although now there were two output channels instead of just one. In fact, since it was impossible to edit just one track of a two-channel tape by the old cut-and-paste method, making a stereo record could be a challenge. "[I]n the days of two-track stereo recording . . . it was essential to get the right sound on the sessions; there was no possibility of subsequently fiddling with the balance . . . you can never really correct faulty balance of either performance or recording—you can only alter it to make it sound less objectionable."<sup>67</sup>

The commercial success of stereophonic recordings on LP records came late, but was impressive; sales rose on average about 25 percent per year between 1959 and 1961. Yet even though "the cry no longer was for hi-fi but



stereo," stereophonic sound remained linked to notions of "realism" in musical reproduction. All the while, practices in the studio continued to carry sound recordings further from realism in the quest of a more pleasing stereo illusion.<sup>66</sup> With the advent of three-, four-, and eight-track studio recorders in the 1950s, record producers and recording engineers found it easier to record instruments or vocalists (or portions of songs) separately for combination later. Once again, the pioneers experimented with the recording of symphonic music, where the large number of musicians multiplied the opportunities for bad balances or flubbed notes. Where in the early 1950s recording engineers had started to mix the output of several microphones together into a single channel, after 1966 and the introduction of three-track recorders, they began to use more microphones. The ratio of microphones to tape tracks tended to converge after 1968, when four- and then eight-track tape recorders appeared. The practice in symphonic recordings by the early 1970s was to use two dozen or more microphones for a full orchestra, some of which were mixed to get the full recording on an eight-track recorder. More affluent studios used tape recorders with twenty-four or thirty-two tracks, a feature that carried over into the digital recorders of the 1980s.<sup>69</sup>

The establishment of tape recording in the studio clearly owed a great deal to three somewhat contradictory factors: the drive to improve fidelity, the desire to record perfect performances, and the effort by engineers to enhance their control over the recording process. What linked these together was the recording of high culture music. However, in more recent years the recording of popular music has taken a role in relation to technical change that is more consistent with its economic importance. The use of recorders with multiple channels, for example, contributed significantly to the recording of rock and roll music, but not until the late 1960s. Rock and roll as a recorded product was not pioneered by the large, established record companies with the latest equipment but by independents, and the lesser financial stature of these firms was reflected in their studio equipment. Tape recording did not penetrate all of these studios in the 1950s, and when it did it was rarely the best grade of equipment. These studios did not have the facilities or equipment to make strides in high-fidelity recording, but they could use what they had to achieve something more important for rock and roll: a new sound. The way most Americans experienced the new music was through recordings rather than live performance, so recording techniques were essential, even if high fidelity was not. The use of electric guitars, amplification, and an emphasis on percussion in rock and roll, while well-suited to live performance and large venues, also provided new opportunities for the creative manipulation of sound

in the studio. Musicians and engineers found that rock could often be successfully captured and canned in the crudest of studios.

Some of the same features that made the new recording technologies appealing to high-fidelity enthusiasts were also suited to the production of rock music. The relationship between rock music and the recording medium is extremely important. While "records" (either the original recordings made in the studio or the mass-produced kind heard by the audience) had in past years been "byproducts of performances," with the advent of rock music, records themselves became the performance for the majority of the audience. Through rock music, recording devices and specifically editing and overdubbing techniques became part of the performance rather than simply an intermediate stage intended to be inaudible. Clearly, though, these artistic techniques were developed before rock emerged.<sup>70</sup>

Just how this came about is not well-documented. At this time, it is clear that the role of the engineer was changing, and musicians were taking a greater role in the recording process. Just as conductors, arrangers, A&R men, or sometimes musicians (if they had considerable clout) had sometimes appropriated an active role in classical music recording, so too did rock producers and musicians become more prominent in studios by the 1960s. This trend was magnified in the smaller, independent studios that sprang up in the post-1945 period, where recording engineers were less often unionized, making it easier for other to appropriate the use of recording equipment. The first expressions of this came from producers such as Phil Spector. Working with engineers or sound mixers, Spector set out to use the capabilities of tape, equalization, compression, and other electronic technologies to invent sonic "signatures" that identified the recordings he produced. By the later 1960s, rock artists also discovered more inventive ways to use studio equipment to record music in ways that sounded good to them but might bear little resemblance to the original performance. The perfect example of this is the Beatles' use of multitrack recording and special effects ideas borrowed from avant-garde music to create the *Sergeant Pepper* album in 1967.<sup>71</sup>

Copying and recopying of bits and pieces of recordings in the studio before finally committing them to a two-track stereo tape and then a stereo master disk required other incremental but significant improvements in studio tape recorders. Part of the reason that the Beatles and other groups were able to do so much manipulation was that low-noise tapes, Dolby noise reduction and other ancillary technologies had arrived in the mid-1960s. These allowed the record producer or engineer to rerecord several generations before the inherent signal degradation became noticeable.<sup>72</sup>

## The 1970s: The Triumph and Failure of High Fidelity

By the 1970s, technological innovations put home high fidelity within reach of many more Americans. The transistorization of tape recorders, radio tuners, and preamplifiers began in the late 1950s; along with car radios, home audio products were among the first consumer products to use transistors. The high power requirements of amplifiers, however, remained out of reach for several years. Long after vacuum tubes were replaced in computers and military electronics, they remained the standard for most consumer audio amplifiers. Only in the mid-1960s did high-current bipolar transistors appear that could handle more than a few watts of power. By the mid-1970s, transistors themselves were being replaced in many applications by integrated circuits. The overall effect of the use of semiconductors was to reduce significantly the price of hi-fi home equipment.

Yet it would be many more years before equipment manufacturers acknowledged the fact that the technical capabilities of high-fidelity equipment were also well suited for the sound of rock music, and that their continued efforts to market hi-fi as a medium of high culture were misplaced. Though the approach has diminished in the last two decades, it is still not unusual to encounter advertisements promising to recreate the concert hall in the living room. Yet the continued changes in audio technology have not increased the sales of serious music relative to the popular kinds. Further, even today the vocabulary of high fidelity is still infused with the language of science and quantitative measurement. Only recently have manufacturers acknowledged that the same technologies that allow an amplifier or a set of stereo loudspeakers to handle the crescendo of a full symphony orchestra can also handle the sustained loudness of a "cranked up" rock and roll recording. Consumers, even those who recite the technical specifications of their equipment, are understandably concerned more with the subjective experience of listening.

Studio recording, on the other hand, reflects popular taste more and more. The digital recording and synthesis technologies that began to proliferate in the 1980s make it easier than ever to create and manipulate new sounds and have little relevance to the concept of high fidelity. Much of the popular music available today is composed on a keyboard instrument and is generated electronically by synthesizers or digitally sampled from existing recordings. These techniques make the concept of fidelity irrelevant, and even where the source is actually sung or performed with traditional acoustic instru-

ments in the studio, the ultimate criteria for judging the resulting recording is whether it sounds good, not whether it mirrors the truth.

## Conclusions

Technological change in the making of records for the recording industry has followed a unique path. For example, where many industries de-skilled, mechanized, or automated, the record industry continuously elaborated the recording process, demanding of its "production workers" greater and greater responsibility and skill. The motivations for technical changes in recording also run counter to the accepted wisdom about the way production evolves. Between the 1880s and the 1920s, recording directors, inventors, and record company engineers strove simply to produce cylinders or disks that were audible and intelligible. Yet once the technology of recording reached a certain level of refinement, other factors became more important as agents of change. One of them was the desire to duplicate an original performance. Edison, though fighting a rearguard action to save the defeated acoustic recording process, did succeed in popularizing the concept of faithfulness or fidelity to the original performance. The concept would have real meaning only as long as he kept alive the acoustic process and his "tone tests." A second driving force was the desire to promote high culture music, which critics, inventors, and record companies hoped would change the tastes of the public.

It is not too surprising that the leaders of the record industry presented themselves as the bearers of positive cultural influence through the release and promotion of highbrow music. High culture music represented an unassailable social good that record companies could hold up to counter accusations that their products undermined good taste. There was a significant market for serious music which during some years grew in importance. In fact, sales of highbrow music were, during the dark years of the interwar period, the core of the record business. The influence of high culture in the record companies also had important implications for recording technology. Many in the record companies were high culture aficionados who used their positions to further the cause of technological development geared toward "good" music listening and sincerely hoped that the public would respond. Similarly, when inventors and engineers proposed changes to recording technology and practice, they explained the potential benefits not only in terms of greater sales but in terms of the good they would be doing for highbrow music listening. The enthusiasm for high fidelity that drove technical change

was also an enthusiasm for high culture that record companies nurtured quite independently of their commercial aims.

Many of the technologies that grew out of the high-fidelity movement in engineering contributed to unexpected outcomes in the recording of music. The introduction of electronics and electrically recorded disks simultaneously promoted the concept of fidelity and made it less meaningful. In terms of measurable sound, electrical recordings bested the acoustic record. Yet the possibility of remaining faithful to a live performance as heard by a real person was gone forever. What remained constant in this radical transition was the high culture orientation of the most important agents of change in the 1920s; the engineers who invented electrical recording, the record producers who used it, and the consumers who were still willing to buy it.

The improved technologies of studio disk recording that came in the 1930s, the new technology of tape recording that arrived in the studio in 1947, and the introduction of the LP in 1948 all demonstrated how high culture remained important in pushing forward technological change, even though the new technologies reflected the interests of only a minority of consumers. In the postwar period, as high fidelity was finally becoming a popular fashion, the recording studio was also becoming a contested terrain. Performers, composers, managers, and engineers all had their own ideas about how to make a good recording, and increasingly these ideas strayed from the notion of high fidelity.

The decline of the engineer's dominion in the studio can be linked, albeit imperfectly, to some of the very technologies that engineers championed. Where electrical recording briefly gave technical personnel control over the process, the coming of the tape recorder after 1945 undid all that. Tape destroyed the already tenuous concept of an "original" performance and made the performance a source of content to be refined rather than something to be preserved. Some of the same technical features that made the tape recorder so desirable for high-fidelity recording contributed to the movement toward recordings that bore almost no resemblance to the studio "performances" from which they were derived.

"As popular music has evolved from the early twentieth century and Tin Pan Alley days to rock music," writes Steve Jones, "it has become sound—and not music—that is of prime importance in popular music production and consumption."<sup>73</sup> The search for better sound has indeed been a factor driving technological change in the recording studio, but until recently it was the sound of highbrow and not popular music that set the standard. However, highbrow culture and the cult of high fidelity seem to have a permanent

place in the recording studio. Today, the technologies originally developed to serve high culture are embedded in more recent inventions used to produce popular culture, and seem destined to stay there. It is difficult, for example, to imagine a new recording system that would restrict recording to a more limited range of frequencies, or inject a higher level of noise or distortion. Such changes would be seen as degradation, not improvement. A new form of recording that would not provide stereophonic sound also seems out of the question. The developers of new technologies consider these features the basis upon which new innovations can be added. The machines and practices that comprise recording culture in the studio have absorbed the older values and moved on. This redefinition of aesthetic quality and authenticity occurred within the contexts of science, business, and elite and popular culture. The outcome demonstrates the interactions between different kinds of culture in the history of recording technology. The ideal of authenticity also intersected with business needs, mass-produced entertainment, and recording technology in the history of radio broadcasting, the subject of the following chapter.