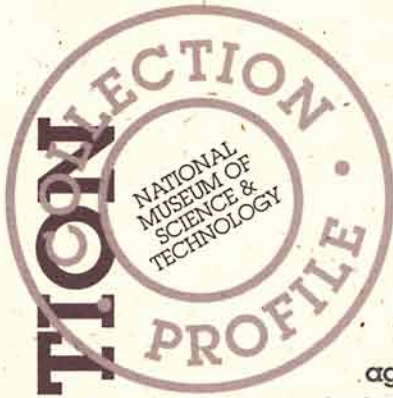


SOUND

RECORDING & REPRODUCTION



THE NATIONAL MUSEUM OF SCIENCE AND TECHNOLOGY is a place where visitors may take pleasure from observing and learning about the impact of technology and science on everyday life. The Museum has a mandate to reflect both the history and recent advances in the fields of communications, space, transportation, energy, agriculture and renewable resources, industrial technology and pure sciences, and the links between technology and society. It pursues this mandate through collecting, recording, researching, and preserving a wide range of artifacts and information. This guide has been published in order to heighten the reader's appreciation of the Museum's collection of sound recording and reproduction technology, as well as to provide information on the Museum's purpose in collecting such material.

To Capture a Sound

Sound is invisible, bodiless, and largely elusive to all but one of the human senses. However, it could not elude all those inventors who grappled with the tantalizing mystery of recording, and replaying sound, since the mid-1800s. They experimented with many different methods that followed the same general idea: sound is recorded by transcribing its vibrations onto a storage medium such as a record or a magnetic tape. It is reproduced in reverse, by converting sounds stored on the medium back into sound waves. The main systems for doing this are mechanical, electro-mechanical and magnetic.

The Museum's collection of sound recording and reproduction artifacts consists of approximately 470 items, 320 of them complete machines, spanning the industry's history from the beginning to the present. The collection traces

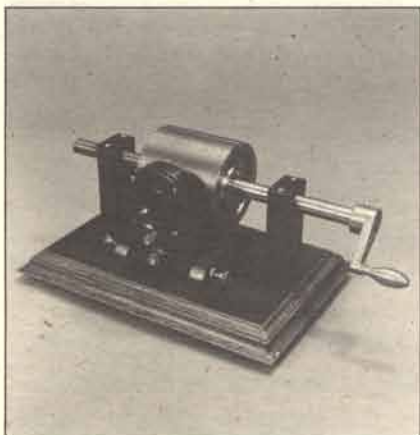
the major stages in the development of mechanical, electronic, magnetic and modern digital systems, with an emphasis on technologies that eventually achieved commercial success.

Mechanical Systems: In the Groove

Mechanical systems store sound waves as undulations in a groove carved into a rotating surface. In reverse, the vibrating diaphragm and stylus that inscribe the groove are often used to reproduce the sounds when they are replayed.

The first machine that could both record and reproduce sound was developed by Thomas Edison in 1877. Edison's machine produced recordings by creating indentations—hills and dales—on a delicate sheet of tin foil. The tin foil was wrapped around a grooved cylinder that was rotated under a stylus as the sounds were being recorded. To reproduce the sound, the indented foil was again run under the stylus, the tin foil now moving the stylus and diaphragm.

The early years of development are featured in the collection



Tinfoil phonograph (810681) built at the Museum in 1979, from 1878 instructions.

by replicas and well-preserved machines of the period. For example, Thomas Edison's tin foil cylinder phonograph (810681),* patented in 1877, is represented by a working replica built from specifications published in an 1878 issue of *Scientific American*. The remainder of the nineteenth century is represented by subsequent Edison models, ca 1888-98, and by other cylinder machines produced by North American Phonograph, Columbia Graphophone, American Graphophone, and others.

Edison remained a force in the phonograph industry throughout the first part of the twentieth century. The Edison Standard, ca 1901-8 (760125); Opera, ca 1910-12 (760129); Amberola, ca 1912 (860816); and Diamond Disc, ca 1912 (690174) models—all included in the collection—became household names.

Advances came quickly in recording technology. In 1885, Chichester Bell (cousin of Alexander Graham Bell) and Charles Tainter of the United States patented a machine that produced better sound than Edison's by cutting, or engraving, a groove into the surface of a wax cylinder.

* NOTE TO READERS: the numbers in brackets are the accession numbers of artifacts held by the Museum.

These developments led to a cylinder record industry that dominated the early sound-recording market.

The First Disc

Fifteen years later in 1900, German-born Emile Berliner patented a device that marked the first radical departure in sound recording. Berliner's machine recorded sound by tracing a spiral on a flat disc; the sound information was contained in minute lateral (side to side) variations in the spiral groove. His master disc was made of zinc, which was coated with a thin layer of a waxy substance that was removed by the stylus as it passed over the disc. When the recording had been completed, the disc was immersed in an acid bath, which left a groove of uniform depth in the zinc where the wax had been removed. Berliner's disc could then be played back on a machine he called the Gram-o-phone.

Berliner took his process one important step further, toward the notion of mass-production. He used the master disc to create a negative mould. This allowed many discs to be moulded from a single master, while in the Edison and Bell-Tainter methods, each cylinder had to be cut individually.

The Berliner Gram-o-phone is particularly well represented both because of its original approach to sound recording and reproduction, and because of Berliner's early pre-eminence in the Canadian industry. The earliest Berliner artifact in the collection is a hand-cranked experimental model, ca 1890 (770123). More than 20 additional models span the Berliner Gramophone Company's 20 year history in Canada.

In the early decades of the 1900s, many technical innovations improved the quality of sound reproduction. For instance, wax was replaced by harder materials such as celluloid (as in Edison's famous

"Amberol") in the manufacture of cylinder recordings. Such materials permitted grooves to be spaced 200 or more to the inch, more than doubling each cylinder's playing time. The cylinder itself all but disappeared by 1915, replaced by the 78-rpm record.

The Museum has a collection of record cylinders and discs. They include wax, Amberol and Blue Amberol cylinders of various sizes; and zinc, shellac and plastic discs. Accessories such as needles, pick-up arms, horns, carrying cases, lubricating oil and repair tools are also included.

Getting Past the Hand-Crank

The first record players were hand-cranked machines. Within a few years, spring-driven motors became the industry standard and remained so until the 1920s, when they were largely replaced by electric motors.



Record player (770132), Berliner Gramophone Company of Canada, type GT, 78 rpm, ca 1910.

Record players were entirely dependent on mechanical methods of recording and reproducing sound, until electronic methods of sound amplification were introduced in the late 1920s. Early performers had to shout into recording horns, and playback volume was severely limited.

Many attempts were made to increase the quality of phonograph horns. At first, most horns were conical in shape. To improve their recording and playback qualities, the horns were enlarged and a flared bell was added to the end. The tapered tone arm was a major improvement because it showed recognition that the arm was part of the complete horn reproduction system—every element affected sound quality. In 1906, the Victor Talking Machine Company introduced a horn contained entirely within the phonograph cabinet, an arrangement that produced a more acceptable appearance, but which actually had a detrimental effect on sound quality.

The Victor Talking Machine Company, which grew out of Berliner technology, is well represented in the collection from the time of its



creation in 1901. Notable among these machines are the "trademark model" introduced in 1908 (770118); the Victrola VV-IX (700192), introduced in 1914; and the famous Orthophonic Victrola (680294) of 1925—perhaps the best record player of the pre-electronic era. It incorporated the first true exponential horn and delivered superior sound quality.

Also represented is the Columbia Phonograph Company, which produced popular acoustic models such as the Graphophone, ca 1900; Leader, ca 1906 (760137); Twentieth Century, ca 1908 (760148); and Prince, ca 1912 (760154).

In addition to the "big four"—Edison, Berliner, Victor and Columbia—numerous smaller manufacturers of disc and cylinder machines are represented. Among them are: the Canadian Vitaphone Company (the Vitaphone, ca 1913) (770246), Mignon (the Mignonphone, ca 1913) (790027), Curtiss Aeroplanes (the Aeronola, ca 1915) (750041), Phonola (the Duke, ca 1918) (770398), and Brunswick-Balke-Collender (ca 1920) (740724).

At later stages in the development of acoustic phonographs they became elaborate "home entertainment centres," housed in ornate wooden cabinets. The collection includes several excellent examples of these machines.

Electronic Amplification

Electronic sound amplification was the elusive goal, and it was eventually attained in the early 1920s, following the invention of the Audion vacuum-tube amplifier. Microphones were used to collect sound, which was then amplified electrically to a level suitable for recording. Microphones and electronic speakers quickly replaced the acoustic horn for recording and

playback—producing vastly improved sound.

Following this breakthrough, other refinements were added to vie with the popularity of radio in the early 1920s. Manufacturers developed record players that could be plugged into a radio's electrical system, and new accessories such as record changers enabled listeners to play several records in sequence.

Stand-alone and combination units—which consisted of a radio and phonograph machine housed in the same cabinet and sharing some components—are well represented in the collection. In addition, there is a small sampling of the jukeboxes of the era, notably the Wurlitzer model 412, ca 1935 (710577). Of particular interest are examples of professional-portable disc recording devices, such as the Presto recording turntable, ca 1940 (740689), of a type used during World War II by radio news correspondents to bring an unprecedented degree of realism to their reports.



Jukebox (710577), Wurlitzer Simplex, Multi-selector, model 412, ca 1935.

Several phonograph manufacturers also produced dictating machines for the business market. The

Museum's collection includes more than a dozen such machines covering the period 1900 to 1955, from manufacturers such as Edison, Dictaphone, the Brush Development Company, Northern Electric, Philips, Sonograph, Soundscriber and Sud-Atlas-Werke. It includes machines that employed reusable cylinders and one-use-only discs. An important accessory also featured in the collection is the shaver—the device used to remove the grooves from the surface of wax cylinders so that they could be reused.

The Modern Era

The modern era in sound reproduction began in 1948, when Columbia introduced the long-playing (LP) record. Approximately 12 inches in diameter, the LP used "microgroove" technology and a 33 1/3 rpm playback speed to deliver 30 minutes of playing time per side. Shortly after, the RCA Victor Company introduced the 45-rpm disc. Together, these new records soon replaced the old 78-rpm discs.

Phonograph systems continued to improve as stereo and binaural sound was introduced in the 1950s and 1960s. Stereophonic records—incorporating two separate channels of information in a single groove—made it possible to reproduce sound with spatial perspective. The Museum's collection includes stereo systems produced by companies such as Philips, RCA Victor and Marconi, dating from the early 1950s. Novelty items include the binaural player arm manufactured by Livingston Corporation, which consisted of two needles spaced approximately three inches apart, and the special Cook records with two sets of grooves made specifically to suit it. The system was connected to two independent speakers to produce "wrap-around" sound.

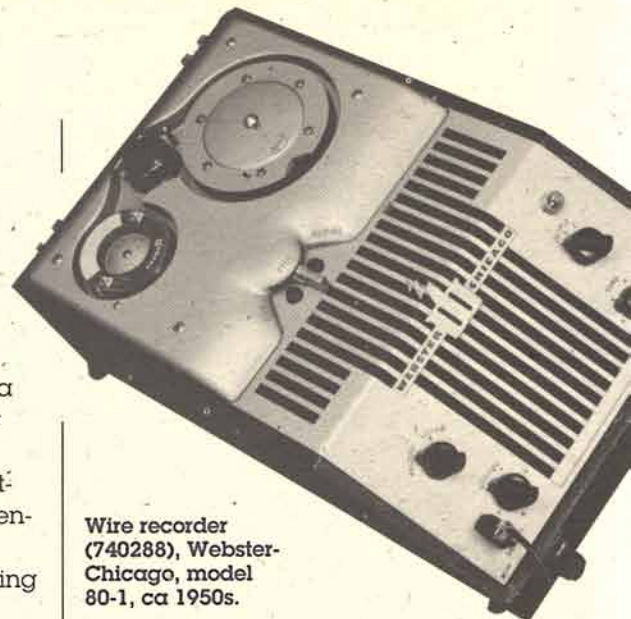
Magnetic Systems

Not all pioneers in the field trapped their early sounds in tiny, parallel grooves. Magnetic systems recorded, and detected for playback, sound waves as magnetic patterns on a moving, magnetized surface (for example, wire, tape).

The first such device was patented in 1898 by the Danish inventor Valdemar Poulsen, who recorded sound waves by converting them to electrical information which was stored on a fine, magnetized steel wire. He called his device the Telegraphon. Eventually, the Telegraphon was able to record continuously for 30 minutes. It never became a successful commercial product, however, as many of the related technologies that were needed to improve the quality of magnetic sound recording would not be available until the 1920s.

The required breakthrough in recording technology was finally achieved by a German engineer, Dr. Kurt Stille. His device, which incorporated vacuum-tube electronics to amplify the recording and playback signals, used a narrow ribbon of special-alloy steel as the recording medium. Stille's technology led to the development of the "Blattnerphone" by the Ludwig Blattner Picture Corporation, Ltd., of London, England, in 1929. The Blattnerphone—or the Marconi-Stille Recorder—was first used as an alternative to the phonograph disc for recording sound to accompany motion pictures. But it soon found its most useful application in the radio industry, where it was used to record material for rebroadcast.

The Blattnerphone (690727), a highlight of the collection, used reels several feet in diameter loaded with thousands of feet of



Wire recorder (740288), Webster-Chicago, model 80-1, ca 1950s.

narrow steel tape. It was the only recording medium of the 1930s and 1940s that could record more than a half hour of sound without interruption.

While commercially successful, the Blattnerphone was cumbersome and dangerous to operate: the rapidly spinning tape could injure a bystander if it broke. So, the search continued for alternative recording media and for more satisfactory ways of using magnetism for recording sound. A new generation of wire recorders that used very fine steel wire as the recording medium became available in the late 1940s.

The Plastic Tape Breakthrough

In the meantime, an alternative to steel bands and wire emerged in 1927, when a U.S. patent was issued for a magnetic tape made by drying a liquid containing magnetic particles on the surface of a strip of paper. Then, in 1936, the Magnetophon Company of Germany demonstrated a recorder that used a plastic-base magnetic tape—the beginning of modern plastic-base tape recording.

But wire continued to be used as a recording medium. Good examples are the Magnatone wire recorder, ca 1948 (690726) used by

the CBC in the brief period between the disc recorder and the modern tape machine, the Pierce wire recorder, ca 1948-49 (760359), which featured replaceable cassettes, and the Protona Miniphon P-55, ca 1955 (730193), a miniature German-made recorder. The collection also includes several examples of the popular Webster-Chicago wire recorder used by North Americans for home recording in the 1950s.

In the years following World War II, magnetic sound recording became a serious rival of the record industry. A number of American companies—Ampex foremost among them—began to manufacture and market magnetic recorders for the commercial and home entertainment markets. Other prominent companies such as Minnesota Mining and Manufacturing (3M) developed a new generation of iron-oxide-on-plastic tapes that delivered much better sound quality than wire or steel ribbons.

The transition to tape machines is represented by the Brush Sound Mirror, ca 1946 (730201), one of the earliest widely available machines to use a plastic-based tape as its recording medium; the Magnacorder tape machine, ca 1949

(700102), typical of the machines used for good-quality sound recording in the early 1950s; and several Ampex studio tape recorders, ca 1952-60 (840005), used for professional studio recording.

The rapidly improving tape machines that became available in the 1960s and 1970s are represented by items such as: the Stellavox tape recorder, ca 1962 (720213), a good example of the portable, battery-operated tape recorders used by reporters; the Kudelski Nagra II-C professional-quality field recorder, ca 1964 (691031); and the Philips EL-3581-978, ca 1965 (730526), one of the first tape machines to feature interchangeable, fully-enclosed tape cassettes.

The First Cassettes

At first, tape was stored on open reels. Then, in the mid-1960s, Philips of the Netherlands introduced tape cassettes for use with its dictation machines. In the 1970s and 1980s, cassettes and micro-cassettes became commonplace.

The collection also features many examples of tape machines used for business dictation—and traces the introduction of personal stereos such as the Sony Walkman, ca 1980 (820114) and portable “boom boxes” (870072).

Digital “Sound”

In the 1970s, digital audio made its appearance in the form of digitally-mastered recordings

converted into conventional tapes. By 1983, fully digital discs and players were available as consumer products. The “Compact Disc” (CD), which holds approximately 60 minutes of digitally encoded music on one side of a 12-centimetre diameter disc, is the finest source of recorded sound yet to be introduced into the home market. Upon the introduction of Digital Audio Tape (DAT) recorders, the concerns raised by recording artists and record producers about the DAT’s ability to produce “perfect” copies, prevented the technology from immediately becoming widely available in North America.

The modern era in recording is represented by the Compact Disc (CD) (830340) machine and by the Digital Audio Tape (DAT) machine (870241).

The Canadian Industry

Canadians have been avid buyers of these products since the earliest days of their manufacture. But the Canadian sound recording and reproduction industry has been dominated by technologies developed outside the country, and by foreign-owned manufacturers.

Canada’s first manufacturing facility for phonographs and discs, the Berliner Gramophone Company Ltd., was established in Montreal in 1899 by Emile Berliner. At that time, competition was fierce in the international “talking machine” market. In 1901 Berliner sold

Digital Audio Tape recorder (870241), Luxman, model KD-117, 1987.



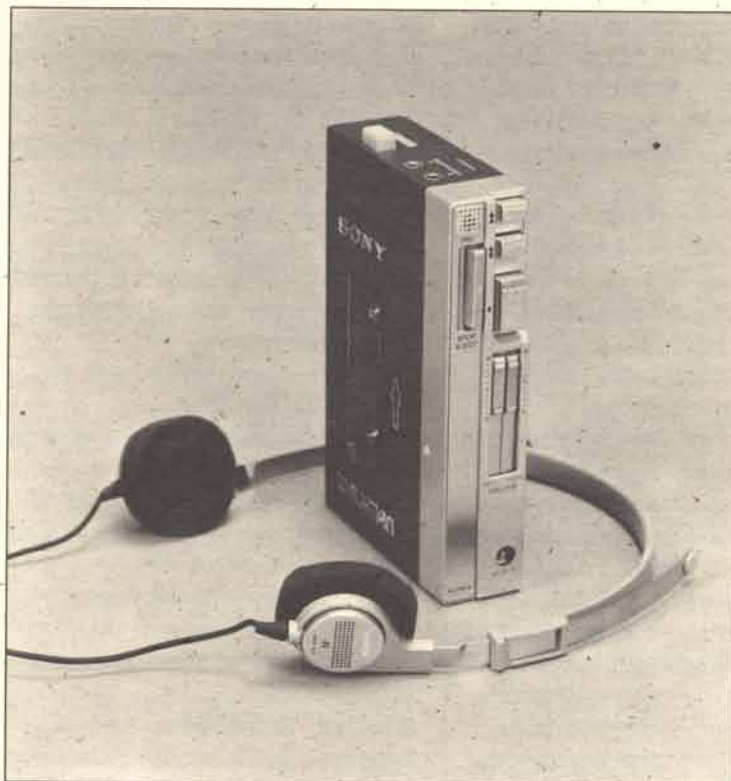
his U.S. patent rights to the Victor Talking Machine Company, but retained exclusive rights to the Gram-o-phone in Canada. In its first year of operation, Berliner's company acquired the now famous logo depicting a fox terrier looking intently into a gramophone horn, with the caption "His Master's Voice."

During the following decade, many American companies established branch plants in Canada to take advantage of the strong demand for their products. Concentrated in southern Ontario and in the Montreal area—with a sprinkling of manufacturers in other cities—these companies marketed disc- and cylinder-playing machines under brand names such as Vitaphone (770246), Sonora, Aeronola (750041), Manophone, Brunswick (740724), Concertophone, Symphonola, Concertola, Peerless, Crescent Silver Tone, Brant-Ola, Musicphone, Melotone, Prattephone, Disc-O-Phone, Melodia and Cremonaphone.

However, the Berliner Gramophone reigned supreme in Canada until 1921, when Emile's brother Herbert resigned from the company. The Victor Talking Machine Company quickly acquired a controlling interest in the company.

The Jukebox Appears

The recording industry experienced a temporary decline when radio emerged as a popular mass medium in the 1920s. However, it revived in the late 1930s with the



Personal stereo tape player, Sony Walkman, model TPS-12 (820114), 1980.

emergence of the jukebox—a coin-operated phonograph—as a favourite form of public entertainment.

Sound recording technology has since become a pervasive part of daily life for Canadians. In the 1980s, Canadians spent more than \$500 million each year on recorded music, making them the highest per-capita consumers of recorded music, records and tapes in the world.

Library Support Materials

The Museum library at 2380 Lancaster Road in Ottawa contains a collection of several hundred items covering the era of sound recording and reproduction. Library resources focus on histories, textbooks, and special-interest magazines such as *Audio*, *Audio Scene*, *Electrical Review*, *The Bell System Technical Journal*, *Scientific American* and a selection of music-box periodicals.

Other items include technical manuals, convention proceedings, restoration manuals, record and cylinder catalogues, and owner's manuals for Edison, Victor, Berliner, Presto and other early machines. The library has a small collection of manufacturers' catalogues, service manuals, electrical supply catalogues and collector's magazines.

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