1

Recording History

Before approaching the voice and all the tools that will capture, process, modify, mix and even embellish it, before putting it on a medium that everyone will be able to listen to, I think it is necessary that you discover the eventful history of sound recording from its beginnings until today.

1.1. In the beginning was the phonautograph

In 1857, the Frenchman Edouard Léon Scott de Martinville[1], a typographer, invented the "*phonautograph*", a device that records the voice. His machine consists of a membrane with a stylus, placed at the end of an acoustic horn. The stylus records the vibrations received by the membrane on a cylinder coated with black smoke.

Sound was recorded but the question of how to read the recordings still remained; half of the work was thus carried out. E. de Martinville nevertheless filed a patent for this invention on March 25, 1857. He improved his invention the following year by associating with the manufacturer Rudolf Koenig.

The phonautograph received the support of many scientists, but unfortunately not of the financiers with whose money he could have used to market his device. Ruined by his research, which he continued, he died in 1879 forgotten by all.

1 Édouard-Léon Scott de Martinville, 1817–1879, French typographer and inventor who worked in the world of sound.

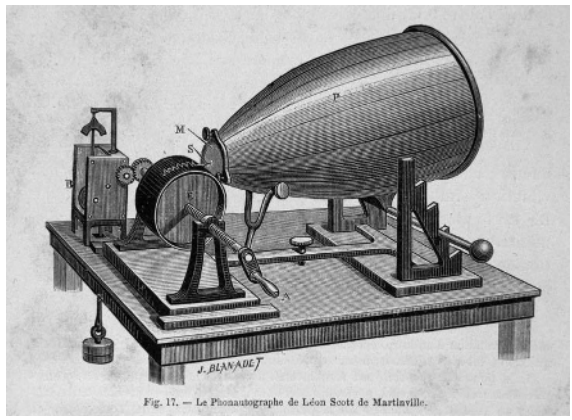

Figure 1.1. *The phonautograph. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

1.2. When it really started

On April 18, 1877, the Frenchman Charles Cros[2] deposited, in a sealed envelope, at the *Académie de Sciences*, a process allowing for a voice to be recorded on a cylinder and on a disk that he named the "*paleophone*". The device was named the "*phonograph*" by the abbot Le Blanc (his real surname was Lenoir), who described it in a "*La semaine du Clergé*" article in October of the same year.

Figure 1.2. *Charles Cros' "paleophone"*

2 Charles Cros, 1842–1888, French poet, scientist and inventor who worked in the field of sound reproduction and color photography.

On December 3, the *Académie des Sciences* opened Charles Cros's envelope, which placed Cros as the first inventor of the phonograph, ahead of Thomas Alva Edison[3] by a few days. Indeed, Edison filed his patent on December 24 for a recording device with tin foil lying on a cylinder.

Figure 1.3. *Edison's phonograph*

On March 11, Edison presented his phonograph to the *Académie des Sciences* and on April 22 to the press. On April 24, 1878, the Edison Speaking Phonograph Company was founded with the purpose of promoting, improving and selling this new invention. Edison envisioned new possibilities such as the "sound letter", and even the premise of the speaking clock, etc. He was never short of ideas and, ever the good businessman, he wanted the phonograph to be present everywhere, in homes and companies.

In 1886, Alexander Graham Bell[4] and Charles Tainter[5] filed a patent for a vertical recording device, the *graphophone*, whose medium was a cardboard cylinder covered with wax and natural kerosene (ozocerite or fossil wax). Together, they created the American Graphophone Company and the Volta Graphophone Company.

3 Thomas Alva Edison, 1847–1931, American inventor and scientist, founder of General Electric. Prolific, he filed more than 1,000 patents.

4 Alexander Graham Bell, 1847–1947, Scottish Canadian scientist, inventor and engineer, naturalized American. Winner of the Hughes Medal in 1913.

5 Charles Sumner Tainter, 1854–1940, American engineer and inventor.

The term vertical engraving deserves an explanation, because this technique, as well as its competitor, lateral engraving, remained at the center of discussions about the different types of phonographs for several decades.

Vertical recording was the first to be used for cylinders. The tip of the stylus engraves the disk deeply, while the depth of the groove is modulated by the sound. The grooves are perfectly equidistant.

The disks with lateral engraving have a furrow of constant depth, whose position varies on the right and on the left of the unmodulated furrow. The spacing between the grooves is, therefore, not constant. These disks are read with a very sharp needle that wears out quickly; it is thus necessary to change it regularly under penalty of irremediably destroying the disk.

It was quickly realized that lateral engraving gave much better results in terms of sound quality; however, the Pathé company used vertical engraving until the end of the 1920s. The reading was done with a stylus provided with a spherical sapphire; the advantage, compared to the needles used in the lateral system, was that there is very little wear.

Figure 1.4. *A Pathé sapphire pick-up for a vertically engraved disk. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

The reading styli are not compatible with each other; a needle cannot read a vertically engraved disk, as it would destroy the groove, and a sapphire would slide on a laterally engraved disk, scratching its surface.

The year 1887 was important; the Edison phonograph was going to be perfected, the tin foil cylinder was abandoned in favor of a cardboard medium on which fossil wax was deposited (invented by Bell the year before). Many inventors like

A.G. Bell, G. Bettini[6] and E. Berliner[7] saw the possibility of abandoning the cylinders, which remained too fragile and of a very limited conservation in time, to replace them by a disk.

On September 26, 1887, E. Berliner filed a patent concerning the recording on disk and invented a process of duplicating the disks by galvanoplasty[8]. Edison created the Edison Phonograph Company.

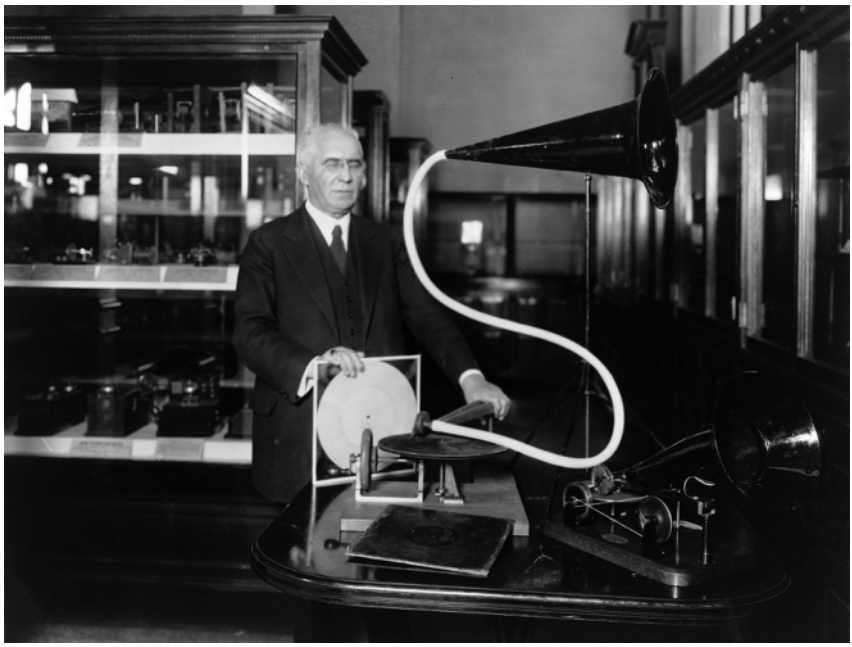

Figure 1.5. *Emile Berliner and his first phonograph (source: Wikipedia)*

In 1888, Edison presented a phonograph equipped with an electric motor. He also turned to the solution of the wax-coated cylinder (Bell and Tainter's graphophone), abandoning the tin foil which had a much lower performance in terms of sound quality.

That same year, Berliner founded the Gramophone Company.

6 Gianni Bettini, 1860–1938, Italian inventor who worked in the fields of sound and cinema.

7 Emile Berliner, 1861–1929, German-American engineer and inventor.

8 A technique for applying a metallic deposit dissolved in a liquid to the surface of a metal object.

The Americans Louis T. Glas and William S. Arnold presented the first public phonograph (juke-box[9]), the "*multiphone*", on November 22, 1889, in San Francisco. It was a multi-cylinder phonograph with a coin-operated machine.

Between 1890 and 1892, the idea of archiving sound content was born, whether it was music or narrative content. It was also the beginning of the first duplication devices that could engrave new rolls from a mother cylinder. The process used *pantographs*; the most efficient ones could copy up to 50 rolls simultaneously. The engraving speed was much slower (about eight times slower) than the reading speed, in order to obtain a duplicate of the best possible quality. The master cylinder needed to be re-recorded, on average, for every hundred copies.

In 1893, the French watchmaker Henri Lioret developed a new type of cylinder. It was made of celluloid and was considered unbreakable.

Figure 1.6. *The Columbia Graphophone Grand. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

9 The term juke-box emerged in the 1930s in the USA.

The year 1896 marked the birth of the Pathé Frères, the company of brothers Charles and Emile Pathé. They imported and marketed American phonographs in France. Two years later, the French researcher François Dussaud perfected the electric reading and recording of cylinders.

The format of the cylinders evolved, with their diameters increasing from 5.5 cm to 12.5 cm, which required the manufacture of a suitable machine. Columbia, which was at the origin of this new format, designed the "Graphophone Grand", capable of reading these new cylinders.

In order to keep up with the competition, Edison also had to create a machine compatible with large cylinders. Following in Columbia's footsteps, he marketed the "Edison Concert" phonograph model, which worked with cylinders 11 cm in diameter.

Figure 1.7. *The "Edison Concert" phonograph. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

It should be noted that during the following years, many different cylinder formats were created; not only did their dimensions vary (length: 106, 108, 110, 125 mm; diameter: 55, 88, 110 mm), but also the speed of rotation was necessary to their reading (100, 125, 144 and 160 rpm). The average duration of listening was two minutes and four minutes for the Edison Amberol Four cylinder (1908). There were also re-recordable rolls like those of the *Distaphone* (1903). Among the general public, there was a lot of confusion about which format and material to choose.

1.3. Magnetic recording

On December 1, 1898, Valdemar Poulsen[10], taking up the work of Oberlin Smith who had published, a few years earlier, an article entitled "Some possible forms of the phonograph" in the journal Electric World, filed a patent for a device called the *Telegraphone*, which used magnetic recording. In fact, this device was the ancestor of the telephone answering machine, broadcasting a message of a few seconds to the caller and making it possible for them to record and leave a message themselves. This invention was presented at the Universal Exhibition in Paris in 1900.

The medium of the sound message was a steel wire wound on a cylinder and the reading–writing head was a small electromagnet.

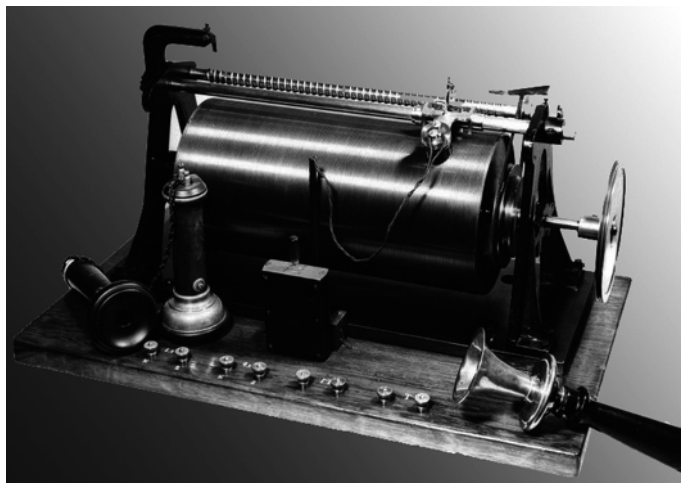

Figure 1.8. *Poulsen's "telegraphone"*

Although in principle the telegraphone was revolutionary for its time, few people showed interest in magnetic recording.

At the beginning of the 20th century, five large companies shared the market: Edison, Victor Recording Company, which was later bought by RCA[11], Columbia, Pathé and Gramophone. They manufactured and marketed the machines, engraved the cylinders, duplicated them and took care of their distribution.

10 Valdemar Poulsen, 1869–1942, Danish engineer and inventor.

11 In 1929, the RCA (Radio Corporation of America) bought the Victor Recording Company, which was, at the time, the world's largest manufacturer of phonographs.

At the 1900 Paris Exposition, we could see films, of short duration, sounded with the help of cylinders, and synchronized manually. Numerous improvements appeared, such as models of phonographs with multiple reading heads and horns to enable greater sound volume ("Multiplex" phonograph, from Columbia), the telegraph, the telephone answering machine, the luxurious "Céleste" phonograph from Pathé, etc.

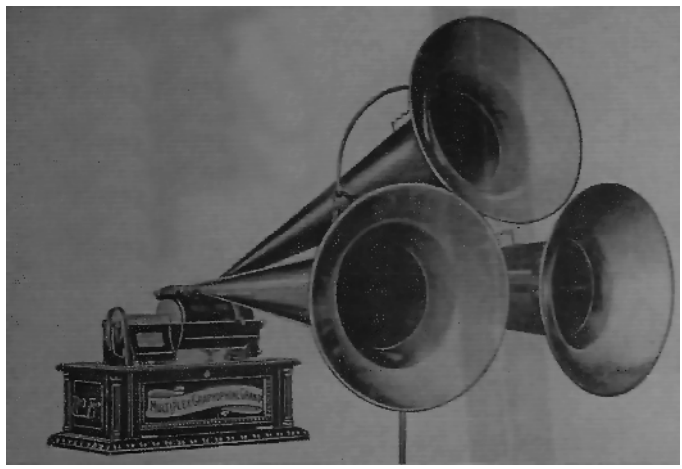

Figure 1.9. *The Columbia Multiplex, with its three pavilions*

In 1902, the sound was automatically synchronized with the image of the projector, the "*Chronophone*", a machine developed by Gaumont and Decaux.

1.4. The advent of 78 rpm

Between 1902 and 1906, professionals mobilized themselves and understood that cylinders were not the best choice. They were cumbersome and fragile for some; they instead turned to the disks. Columbia abandoned cylinders in 1912 and Edison in 1929.

In 1906, Pathé, who understood that having a large catalog of various works was important to achieve commercial success, invented a device to transfer the contents of its cylinders to flat disks. This device was named the "Poisson" pantograph. With this process, the disks obtained started towards the center and had a speed of rotation of approximately 95 rpm.

Figure 1.10. *Pathé's "Poisson" Pantograph. At the left end is the engraving stylus and at the right end, the reproducing sapphire. At the bottom is the weight compensation and at the top, the rotation and holding axis*

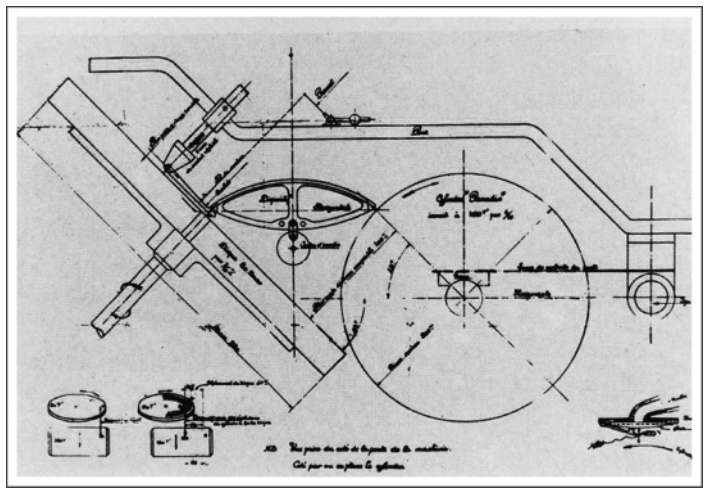

Figure 1.11. *Pathé's "Poisson" principle (source: La nouvelle revue du son, no. 286)*

In 1908, Columbia began to produce double-sided disks, which doubled the recording time. This was the decisive point that generated a shift from the cylinder to the disk.

Figure 1.12. *A Columbia double-sided 78 with its cover. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

From 1912 onwards, the cylinders and disks were duplicated by electroplating, a process that made it possible to produce copies of excellent quality in large quantities.

NOTE.– It is necessary to note an important point: it is the reading stylus that required needles. These were made out of steel most of the time, but other materials were also used (ivory, glass, bamboo, etc.). The classic needles wore out quickly and had to be changed often (practically after each reading) to keep the record in good condition and to have a good quality listening. The advent of tungsten steel, around 1905, enabled a longer life (about 50 readings), but it was the sapphire stylus, very widespread after 1910, which predominated by offering minimal wear, better sound quality and low degradation of the groove. The steel stylus eroded the record.

Faced with the multitude of dimensions and speeds for the cylinders, the same phenomenon appeared for flat disks; however, the speed of 78 turns was going to predominate as the reference, with a diameter between 20 and 50 cm included, generally readable by all the apparatuses.

Why 78 rpm? This was due to the technology in the USA – the synchronous motors that equipped most *gramophones*[12]; this was the name retained for the flat

12 Over time, the terms phonographs and gramophones have become confused, and today, both are used.

disk phonographs which were supplied with 110 V 60 Hz and turned at 3,600 rpm. They are connected to a speed reduction system of ratio 46, which leads to a speed of 3,600/46 rpm, that is, 78.26 rpm exactly.

At the beginning of this century, many artists were being recorded and questions of ethics were beginning to arise. Would these recordings harm their career, their image and their prestige? It is true that the quality of the recordings gave the voice a very nasal, parasitic and not very faithful sound.

In 1925, electrical recording developed rapidly with the appearance of the microphone and the quality of the recordings became much better.

The Columbia Company bought the Gramophone Company from Pathé brothers in 1928. Three years later, it became the Electrical and Musical Industries Ltd. (EMI).

From 1927, we started to find devices with an electronic amplification[13] that finally gave a significant sound volume and a good reproduction quality. In general, the apparatus is associated with a radio that shares the amplifier and the loudspeaker, with the whole apparatus being assembled in a commode-type piece of furniture. Pavilion gramophones started to disappear. The diaphragm reading head was replaced by the electric pick-up.

Figure 1.13. *The electric pick-up (top) and the membrane read head (bottom)*

13 The invention of the electronic tube, in 1906, and of the triode, by the American engineer Lee De Forest made the technologies progress very quickly, particularly those related to sound and image, with the possibility of amplifying the current modulated by a microphone or a reading head.

At the end of the 1920s, the broadcasting and military industries were finally interested in magnetic recording.

In 1931, RCA released the recordable cellulose acetate disk, which was widely used by radio stations before the advent of magnetic recording.

Figure 1.14. *Examples of electric pick-up phono cabinets (wireless telegraphy). For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

The first phonograph cases that made the gramophone transportable also made their debut. They were mechanical and became electric in the mid-1930s.

Figure 1.15. *A mechanical phonograph case. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

In 1934, the German physicist Curt Stille[14], who studied magnetic recording in detail and was associated with the English company Marconi, presented one of the first magnetic recorder-players. In 1933 he created the *Blattnerphone*. The medium used is a steel ribbon that is 3 mm wide, running at a speed of 1.5 m/s, which can record a sound message of 30 minutes. The device uses three heads, one for reading, one for recording and one for erasing. It is enormous and weighs several hundred kilos. It must be said that the electronics of the time were very rudimentary and many technical problems had to be solved (constant speed, amplification of the signal from the microphone, bandwidth, etc.).

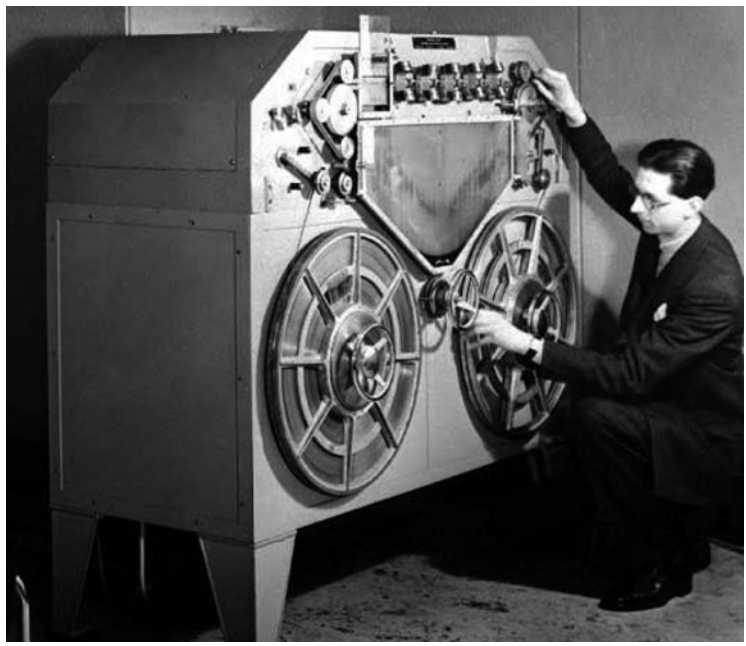

Figure 1.16. *Curt Stille's magnetic reader-recorder (source: www.EMTEC.co.uk)*

At the same time, a German engineer, Fritz Pfleumer[15], taking up the work of Oberlin Smith, coated a paper tape with iron particles to create the first recording tape and built a device capable of reading and recording it. Unfortunately, the sound quality was poor. Pfleumer registered the patent in 1930, but was unable to promote and market his machine.

14 Curt Stille, 1873–1957, German physicist and chemist, one of the fathers of magnetic recording and the first steel wire dictation machines (Dailygraph and Textophon).

15 Fritz Pfleumer, 1881–1945, German-Austrian engineer.

Figure 1.17. *Fritz Pfleumer with his magnetic tape machine*

1.5. The magnetic tape and the LP

It was not until 1932 that the president of the German company AEG (Allgemeine Elektricitäts-Gesellschaft) bought the rights to Pfleumer's patent and devoted part of his research to magnetic recording. Its position as a manufacturer of electrical and electronic equipment was not sufficient to ensure total control of the processes necessary for magnetic recording. Therefore, AEG called on the IG Farben company, which specialized in chemistry, to finalize what would become the magnetic tape.

It was 6.5 mm wide and made of acetate. It was coated with *carbonyl iron* powder, a pure iron of more than 97%. The scrolling speed was 77 cm/s.

In 1934, AEG presented to the public, its first *tape recorder*[16], the K1, a self-contained, fully integrated device with its own amplifier and loudspeaker.

As early as 1939, AEG worked on a magnetic head with two air gaps that made it possible for two tracks to be recorded on the same tape, but it was not until 1942 that the first stereophonic tape recorders appeared.

16 The name *Magnetophon* was originally a trademark of AEG and IG Farben for a magnetic tape recorder.

Figure 1.18. *The AEG K1 tape recorder (the letter K stands for "Koffer", the suitcase). For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

From 1946 onwards, magnetic recording on tape became widespread and began to attract the general public in 1950.

The first 78 rpm records were made of *shellac*, a naturally occurring plastic material discovered by Fred Gaisberg[17]. It is a substance obtained from the secretion of an Asian insect to which slate powder and wax are added. The first disks made from this material appeared in 1898 and production stopped in 1948. During World War II, the importation of shellac was interrupted and records were produced in polyvinyl chloride, which was less resistant to the action of gramophone needles.

In 1946, Peter Goldmark[18] took up the idea for Columbia, in a different form, and the company patented an entirely new, lighter *polyvinyl chloride* record. One of the advantages of this material, which is a thermoformable plastic, is that reproduction costs are reduced.

For this new support, the size of the groove is reduced and the speed of rotation has been lowered to 33 1/3 revolutions per minute, which offers a longer reading time for each side, up to 23 minutes. The diameter[19] is set at 12 inches or 30 cm. The

17 Fred Gaisberg, 1873–1951, musician and one of the first sound engineers and producers.

18 Peter Carl Goldmark, 1906–1977, German-Hungarian engineer, naturalized American.

19 The diameter of 30 cm is the most common; however, microgrooves of 25 cm also exist.

reduction of the speed is possible because the vinyl lets the stylus slide with much less friction than the shellac, thus having the effect of drastically reducing the background noise and increasing the range of transmitted frequencies.

Columbia marketed its product under the name of *microgroove* and *long play* (LP).

It should be noted that the support force that was 100 g for the 78 rpm, played on a non-amplified gramophone with needles, passed between 10 and 30 g for a reading on a pick-up with an electronic amplifier to reach less than 2 g with the microgroove disk with a reading point of 15 µm.

The *single* or 45 rpm record (17.5 cm in diameter with a large hole in its center) arrived in 1946 and sounded the death knell for the 78 rpm records, which were still around for a few years.

NOTE.– The larger hole was intended to facilitate its use in jukeboxes that developed considerably since the 1920s. There are, however, 45 rpm with a small hole, identical to the 33 rpm.

Figure 1.19. *A 4 (rpm) disk and its cover. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

At the end of the 1940s, Deutsche Grammophon introduced the variable pitch, which tightens the grooves during low-intensity passages in the recording process. This process makes it possible for the duration per side of a record to be substantially extended.

At the beginning of the 1950s, several companies marketed record players for the general public, also known as *electrophones*. They were presented in the form of a case whose lid almost always contained the loudspeaker. The base of the apparatus supported the turntable, of reduced dimension, approximately 20 cm in diameter, and its articulated reading arm carrying a cell that was generally piezoelectric. Most of them had several playback speeds (33, 45, 78, and sometimes 16 rpm), which were mechanically selectable. In the base, there was also a pre-amplification device (with tubes and then with transistors a few years later), which offered the user a volume control and sometimes a bass-treble correction.

Figure 1.20. *An electrophone from the 1950s. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

The LP gave birth to the term *Hi-fi* (High Fidelity), which spread among the general public. It is supposed to indicate that equipment with this qualification is of a superior quality, bringing a sound reproduction very close to the original. Contrary to what one might think, there is no Hi-fi standard.

In 1958, the LP improved with the appearance of stereophonic records developed in 1931 on 78s by the engineer Alan Blumlein[20], who had called the process *binaural sound*. The stereophonic recording condenses the two sound channels into a single groove. It is a compromise between vertical and lateral recording.

20 Alan Blumlein, 1903–1942, English engineer who specialized in electronics related to telecommunications and sound recording. He filed more than 128 patents during his career.

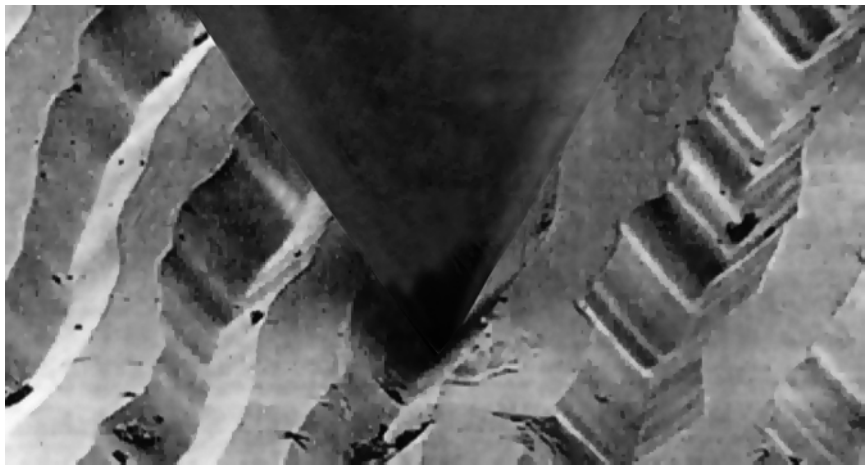

Figure 1.21. *Pick-up and groove of a stereophonic LP*

In 1951, the first miniature 1/4 inch magnetic tape recorder, the Nagra I, appeared. It was designed by the Polish engineer Stefan Kudelski[21], who did not stop improving it. He built the subsequent models II, III, IV and IV-S (stereo) between 1953 and 1971.

Figure 1.22. *The Nagra I news reel-to-reel tape recorder with miniature lamps. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

21 Stefan Kudelski, 1929–2013, engineer and designer of the high-quality Nagra recorders, dedicated to cinema and radio. Founder of the Kudelski company.

1.6. 8-track cartridges, mini-cassette and Trimicron

The *cart machine* introduced by Collins Radio arrived in 1959 in the USA. It was used by the radio to broadcast jingles or commercials.

Figure 1.23. *An 8-track tape and its internal structure. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

A few years later, in 1962, it turned into a 4-track version, then in 1964, an 8-track version. It became the *8-track cartridge* or 8-track tape or *stereo 8*, which was very popular from the end of the 1960s to the beginning of the 1980s, especially in car radios, although players, and even player-recorders, exist as equipment of a high-fidelity system.

Figure 1.24. *The Akai GXR-82D 8-track tape player/recorder*

This cartridge is an endless tape that was invented by Bernard Cousino in 1952 that embeds a 1/4 inch magnetic tape that runs at 9.5 cm/s. The 8-track version was designed by Richard Krauss who also modified and simplified its mechanics. Its duration was 80 minutes in stereophony.

The 8-track tape disappeared in 1990, although very limited editions were still produced until 2011.

Figure 1.25. *A limited edition 8-track released in 2009 – Cheap Trick – "The Latest". For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

At the beginning of the 1960s, tape recorders had made enormous progress and were very widespread. The reels had diameters of 8, 13, 15, 18 and 27.5 cm. The average recording time of a 13 cm reel is one hour, but can vary according to the speed and thickness of the tape.

Figure 1.26. *The Telefunken 76 (Tube) tape recorder, 4 tracks (stereo 2 X 2 tracks), speed: 4.75–9.5 cm/s, reel to 15 cm diameter, dating back to 1960. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

They can be mono, with 2 times 1 track, stereo with 1 times 2 tracks, stereo with 2 times 2 tracks. Tube electronics were progressively replaced by transistors, which made the manufacturing of more compact devices possible.

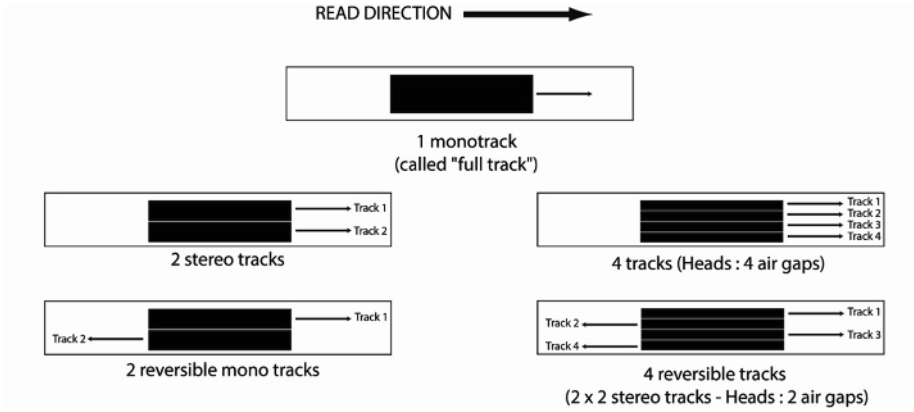

Figure 1.27. *The different formats of magnetic tape recording*

In 1963, the audio cassette or *mini-cassette*, abbreviated *K7*, was launched by Philips. It was used with a specially adapted tape recorder, the *mini-cassette recorder* or cassette recorder, which could be integrated into a more complex device such as a radio cassette or a high-fidelity system.

Figure 1.28. *One of the first mini-cassette player-recorders with its microphone, the Philips Model EL3302*

The K7 had 4 tracks, 2 stereophonic tracks for each side, since it can be turned over. Its reduced dimensions (100 x 83 x 12 mm), as well as its use in car radios and Walkmans made it an essential piece of equipment everywhere in the world until the appearance of the CD and even long after.

Figure 1.29. *A type I – C90 (2 X 45 min) mini-cassette from TDK. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

NOTE.– The mini-cassette has found variants in other dimensions such as the microcassette, of smaller dimensions, reserved for dictaphones (57 x 38 x 11 mm).

It was an element present in most of the consumer hi-fi systems and in the studios for 25 years. Its decline only came at the dawn of the 2000s, with the rise of digital players.

Figure 1.30. *The Tascam 122 MKII professional cassette deck. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

In parallel with cassette decks, manufacturers tried to combine a cassette player-recorder and a multitrack mixer in the same unit. This gave birth to small portable studios, the first of which was the Portastudio 144 from Tascam. Over the years, and still today, the term *portastudio* is used to describe a stand-alone multitrack recorder.

Figure 1.31. *The Portastudio 144 stand-alone multitrack from Tascam (1979). For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

Four types of K7 existed:

– type I: normal (30 Hz to 15 kHz) – 1963;

– type II: chrome (30 Hz to 16 kHz) – 1970;

– type III: ferrichrome (30 Hz to 16 kHz) – 1975;

– type IV: metal (30 Hz to 18 kHz) – 1980.

Their duration at a scroll speed of 4.75 cm/s is 30 (C60), 45 (C90), 60 (C120) and 90 (C180)[22] minutes per side. The K7 used by the music publishers, known as "musicassettes", were of variable length according to the lengths related to the recorded works.

22 These K7 produced by TDK were known to be very fragile, with the thickness of the tape being very low.

Figure 1.32. *A musicassette – Metallica – "Master of Puppets". For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

In the USA, mainly, the 4- or 8-track tape developed in parallel.

The year 1964 brought a novelty that spread in the small world of the LP, also called *stereo-mono* or *synchro-stereo*. It made it possible to indifferently read the record in mono or in stereophony. Technically, it is a stereophonic recording for which the vertical modulation amplitudes are limited to a certain threshold. The vertical component thus decreased ensured the good functioning of the monophonic reading head for a reading of the horizontal engraving (only existing in the case of a monophonic recording).

In 1971, the *tetraphony* or *quadraphony*, *quadrophony*, *quadrasonic* emerged on the market; the objective was to record the atmosphere of the place of recording to restore it to the listener. This innovative technique was, however, a commercial failure because of many technical problems, including the fact that the user had to have a material that could restore the four channels, which was very expensive.

In the middle of the 1970s, the *Trimicron* developed by MDR (Magnetic Disk Recording) and invented by a French researcher, E. Rabe, tripled the possible duration of an LP, thus ensuring one hour of music per side. These 33 turns had a certain success; unfortunately, the advent of the CD (Compact Disk) made it disappear quickly.

Figure 1.33. *A trimicron disk from MDR. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

Figure 1.34. *A 24-track 2-inch multitrack (Studer A800 – MKII), a standard of excellence in the studios of the 1970s and 1980s. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

Tape recorders also saw their performance increase. While individuals still confined themselves to 4-track stereophonic tape recorders, working at speeds between 2.38, 4.75, 9.5 and 19 cm/s, in recording studios, it was not uncommon to find multi-track equipment working on magnetic tapes, whose widths were ¼, ½, 1 and 2 inches. They were capable of recording 2, 4, 8, 16, 24, or even 32 tracks in parallel, whose tape ran at 19, 38, 76 cm/s, or even 114 cm/s, with the sound quality increasing with the speed.

1.7. The compact disk and the advent of digital technology

At the beginning of the 1980s, the digital era made its entrance, relegating analog processes to the background, even though it took several years for this new technology to become established.

In 1979, Philips and Sony Corporation decided to work together to produce a new digital medium for music to replace LPs. The specifications imposed significant improvements, including:

– an increase in listening time;

– a reduction in background noise;

– an improvement in sound quality;

– a medium less fragile than the LP (scratches, dust, etc.);

– a smaller, lighter and less cumbersome medium;

– an extended frequency range of 20 Hz to 22 kHz;

– frictionless reading, no stylus tips;

– indexing of the ranges to move quickly from one to the other;

– an accelerated reading option for tracking;

– a time display for each track.

All of these technical characteristics were listed in the *Red Book*.

Philips designed the medium and the playback system, while Sony defined the digital format and the related software devices. The final medium was the CD (Compact Disk), with a diameter of 120 mm and a thickness of 1.2 mm, covered with a thin layer of aluminum, offering a maximum duration of 74 minutes with a 16-bit coding and a sampling frequency of 44.1 kHz.

Figure 1.35. *The first CD released by Sony, Billy Joel – "52nd Street". It came with the purchase of a Sony CD player. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

On August 11, 1982, Philips and Sony announced the release of their new product and the production started quickly. The first commercialized players were the CD100 from Philips (August 17, 1982) and the CDP-101 from Sony (October 1, 1982).

Figure 1.36. *The first two commercial CD players, the Philips CD100 (left) and the Sony CDP-101 (right)*

The first portable player was released in November 1984; it was the Sony D50 (Discman). The era of the Walkman[23] was starting.

23 Walkman is a trademark of Sony that has become an antonomasia over time.

Figure 1.37. *The first portable CD Player, Sony D50 "Discman"*

1.8. Digital technology is essential

While the CD was the new medium of the 1980s, in the recording studios, digital technology was also making its entrance. New machines emerged to make digital recordings. The DASH (Digital Audio Stationary Head) standard, presented by Sony, brought a new digital audio tape format in 1982. Other manufacturers like Studer, Teac and Matsushita also took this option.

NOTE.– To be accurate, it should be noted that at the same time, another standard, named *ProDigi*, also exists. It was designed by Mitsubishi. Its popularity remained much less than the DASH system. However, it was quite popular in Nashville, and was employed in the studios dedicated to country music. ProDigi fell into disuse in the mid-1990s with the advent of the first DAWs (Digital Audio Workstations) and direct-to-disk on hard disk.

Figure 1.38. *Studer D827 Mk II (DASH 48 tracks) with its remote control console. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

With DASH, you can record two tracks on a ¼ inch tape and up to 24 or 48 tracks on a ½ inch tape. The PCM (Pulse Code Modulation) encoded data is stored linearly and parallel on the tape; this makes it possible for you to work as with analog magnetic tape, by cutting it with a razor blade to make edits. The sampling frequencies supported by DASH are 44.1 and 48 kHz, with a resolution of 16 bits.

Figure 1.39. *Sony PCM 3324 S digital multitrack (DASH 24 Tracks). For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

At the end of the 1980s, the transition to digital technology shook up everything related to sound at a frantic pace, both for the general public who abandoned their LPs and vinyl turntables in favor of CD players, and for professionals who sent their analog machines to the scrap heap.

Innovations are multiplying and new standards are appearing all the time; the audio industry is looking for itself. While for the average listener, the compact disk became the reference, for recording studios and radios, there was no stability. In this boiling environment, the DAT (Digital Audio Tape) cassette made its entry in 1987, with the objective of replacing the audio cassette (mini-cassette) by offering a duration of three hours in a digital format 16 bits, 48 kHz (superior to the CD). However, it did not win the patronage of individuals, as the readers-recorders were very expensive. On the other hand, the DAT system made it possible to produce

perfect digital clones by duplication, which forced manufacturers to introduce limitations on certain models of consumer DAT decks.

It is, therefore, limited to professionals who are satisfied to find a compact solution (73 x 54 10.5 mm) with high audio quality to save their recordings in a digital format without compression.

NOTE.– Be careful not to confuse the DAT audio cassette with the DDS (*Digital Data Storage*) cassette, which has the same format but is intended for digital data storage. Even if a DSS cassette is accepted without any problem in a DAT player-recorder, you should know that DSS tapes are not compatible and there is a risk that the playback heads may permanently deteriorate.

Figure 1.40. *A studio DAT player-recorder – Sony PCM 2800*

The DAT player-recorder has a rotating playback head and a helical scan of the tape, similar to a VCR, and the magnetic tape is 3.81 mm (0.15 inch) wide. The tapes can have durations of 15–180 minutes[24] and are not reversible.

The history of the DAT tape ended in December 2005, but many professionals still use it today.

As previously mentioned, the DAT equipment is very expensive; to compete with Sony, Philips and Matsushita invented a new medium in 1992, the digital compact cassette or DCC, for the general public with less expensive devices. It was to supplant the mini-cassette in this period oriented towards digital. It is not reversible; only an auto-reverse device reads the opposite side, but it keeps a compatibility with the mini-cassette that made it possible for the DCC player to read a mini-cassette as a DCC cassette as well.

24 The 180 minute tapes, because of their thickness, were very fragile. A 120-minute tape is 60 m long.

Figure 1.41. *A DAT cassette (73 x 54 10.5 mm), on the left, compared to a mini-cassette (100 x 83 x 12 mm), on the right. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

Figure 1.42. *A DCC cassette*

The DCC recorder uses a fixed magnetic head and linear recording. The cassettes have a maximum duration of 105 minutes. One of the fundamental differences between DAT and DCC is that for the latter, the audio data is compressed[25] to ensure a greater recording capacity. For this reason, the DCC cassette was often decried as the poor man's DAT cassette by purists.

25 Compression is ensured by a coding called PASC (Precision Adaptive Subband Coding).

Figure 1.43. *The Matsushita RS-DC8 technics DCC player-recorder*

It is necessary to recognize that like the DAT, the DCC did not meet the success expected by the users, although Walkman were even manufactured.

This beginning of the 1990s still reserves many other digital surprises, after the DAT cassette and the DCC cassette, a new product, the ADAT digital audio tape was announced in 1991 at the NAMM convention[26] in Anaheim.

The American company Alesis designed this new system. The ADAT devices, which were also called *Blackface,* had 8 tracks and could be synchronized between them, offering the possibility of managing 128 tracks simultaneously (with 16 machines in parallel). The first models worked at 44.1 kHz on 16 bits, the later models accessing 48 kHz on 20 bits. Backward compatibility was assured.

Figure 1.44. *The first-generation ADAT Blackface player from Alesis. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

26 National Association of Music Merchants, the music industry's largest trade show.

The medium used was a Super VHS (S-VHS) cassette identical to that used in consumer VCRs.

Figure 1.45. *An S-VHS tape for use with an ADAT recorder. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

To compete with Alesis, Tascam, one of the divisions of the Teac Corporation also released its own machine, the DA-88, a digital multitrack recorder, in 1993. This machine uses Hi-8 video cassettes as a recording medium and is capable of recording eight tracks or more by combining several devices. The resolution is 16 bits; later, it will be increased to 24 bits (DA-78HR and DA-98HR) for a sampling frequency of 44.1 or 48 kHz. The recording format is called DTRS (*Digital Tape Recording System*).

Figure 1.46. *The Tascam DA-88 digital player-recorder. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

A 120-minute Hi-8 cassette provides 108 minutes of audio recording.

The DA-88 was replaced by several models with different characteristics, DA-38 and DA-98, and a model edited by Sony, the PCM 800.

Figure 1.47. *A 90 minute Hi-8 cassette (95 x 62 x 15 mm). For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

In 2012, the DTRS format was definitively abandoned and even while some afficionados still use it, magnetic tapes are increasingly difficult to find.

Alesis, Tascam and Sony had their digital recorders, but Akai was not left behind and conceived the A-DAM format with its huge player-recorder DR1200 on an 8 mm video cassette, which came out on the market in 1988. Its resolution was 16 bits and its sampling frequency was 44.1 or 48 kHz. It offered 16 minutes of recording on a 60 minute cassette at 44.1 kHz or 14.5 minutes at 48 kHz.

Figure 1.48. *The imposing Akai DR1200 reader-recorder with its bank of vu-meters (DM 1200) and its locator (DL 1200). For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

1.9. Hard disk recorder and minidisc

In the mid-1990s, other types of devices appeared, *hard disk recorders*, multi-trackers that record directly on the hard disk. Many manufacturers have their own models, Alesis, Teac, Sony, Fostex, Studer, etc. They all have different specificities with a number of tracks that can generally go from 4 to 24, with a resolution of 24 bits, at 44.1 or 48 kHz.

Figure 1.49. *The Fostex D80 hard disk recorder – 8 tracks (1996). For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

These machines and their features continued to evolve until the mid-2000s.

In 1992, Sony launched the *minidisc* on the market, a magneto-optical support that it had developed a few years before. The coding used is the ATRAC (*Adaptive Transform Acoustic Coding*), a data compression system that stores 80 minutes of audio recording. This duration increased to five hours with the advent of the Long Play player in 2002, and then to 45 hours with the high-density minidisc in 2004.

The minidisc was presented as a small disk integrated in a plastic case of dimensions 68 x 72 x 5 mm.

In the West, the minidisc never created the expected craze, the material being expensive, both for the minidiscs themselves and the players. The advent of the MP3 format, at the beginning of the 2000s, slowed down the expansion of the minidisc among the general public, even though its quality was clearly superior.

Figure 1.50. *Tascam MX-2424 – 24-bit, 96 kHz, 24-track hard disk recorder (2004) with its RC2424 remote control. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

Figure 1.51. *A minidisc. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

Figure 1.52. *The Tascam MD-801R MKII minidisc player-recorder. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

The year 2013 marked the end of production of audio systems dedicated to the minidisc.

1.10. Microcomputer, direct-to-disk and DAW

Around the year 2000, dedicated multitrack recorders became rarer, with the democratization of microcomputers and the first *direct-to-disk* editing and recording software.

The first recorders available on microcomputers appeared at the beginning of the 1990s, following one of the first tools, *Sound Designer*, intended for editing a music file, most often from a sampler (Akai S900, Korg DSS-1, Ensoniq Mirage, E-Mu Emulator, etc.). It worked on Apple Macintosh (Macintosh Plus, the then Macintosh II).

With the rapid evolution of micro-computing, Digidesign created *Sound Tools* in 1989 together with *Sound Designer II*, an evolution of the first version. Sound Tools was a software that worked with a dedicated electronic card (in Nubus[27] format), still on Apple Macintosh. It was able to acquire from a DAT and managed AES/EBU[28] and S/PDIF connections. Its resolution was 18 bits and it could manage two channels.

The year 1991 saw the advent of the first *Pro Tools* system, based on a modified version of *Deck*, the first digital multitrack recording software, based on a

27 Nubus is a parallel computer bus developed at MIT (Massachusetts Institute of Technology).

28 AES/EBU and S/PDIF are standards that define digital audio transmission interfaces available on many professional audio devices since the late 1980s.

microcomputer, developed by OSC, a small Californian company, Pro Tools based on the *Audiomedia* and *Sound Accelerator* cards designed by Digidesign.

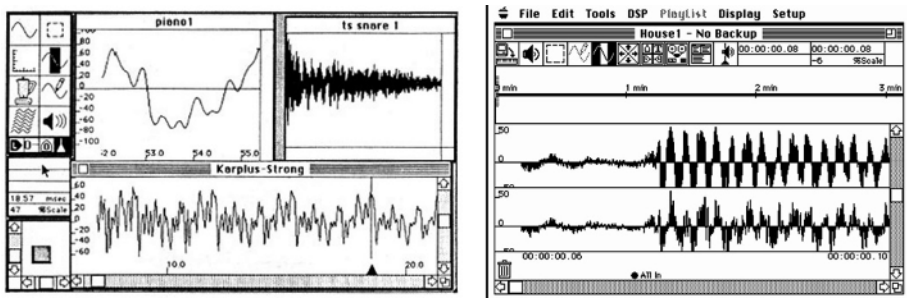

Figure 1.53. *Digidesign sound designer (left) and sound tools (right)*

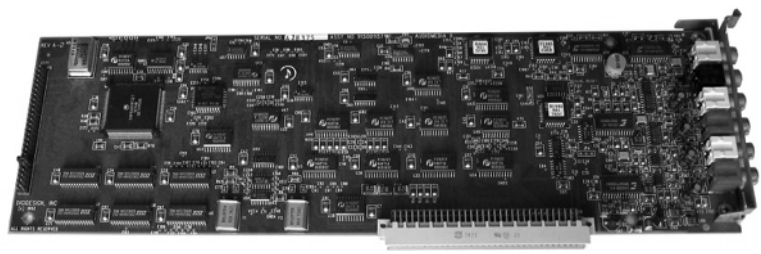

Figure 1.54. *The Audiomedia II board in Nubus format for Apple Macintosh. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

In 1993, Pro Tools II, a completely rewritten version of the first version and correcting its main flaws and weaknesses, arrived on the market. It offered 16 tracks to which plugins could be added and which worked in real time. Pro Tools II became one of the first digital audio workstations (DAW) used by all professionals.

Version 2.5, released in 1994, used a new multiplexing technology. The same year, Digidesign merged with Avid.

In 1995, Pro Tools III offered 48 tracks and two new interfaces named 882 and 888; moreover, a series of plugins were provided by default: equalizers, compressors, delays, reverbs and modulations.

Figure 1.55. *The 888 interface for Pro Tools III. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

In 1996, Apple abandoned the Nubus bus within these machines to switch to the PCI bus, which made the PC and Macintosh world converge. Pro Tools was able to work in the Microsoft Windows environment in 1997.

In the following years, Pro Tools underwent significant improvements and consolidated its position in professional studios, while opening up to the general public (Pro Tools LE – 1999).

Figure 1.56. *Pro Tools 2020 version. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

Today, Pro Tools is still present, but it is no longer alone and no longer has superiority; many other DAWs are present on the market at more competitive prices and with much better features. The general public is no longer interested in Pro Tools, and professional studios are increasingly moving away from it. The competition is tough, and even if its position remains strong, Pro Tools is running out of steam.

My previous presentation on DAWs focused on Pro Tools because it is the precursor in this field, but many other software packages appeared in the early 1990s. It would be difficult to give a history of each one and I prefer to list them in Table 1.1, which shows the chronological order of their appearance. Many of these programs have evolved over time and are still around today. The list presented is far from being exhaustive; I have concentrated above all on the tools with multitrack audio-editing capabilities.

Year	Name	Publisher	Comments
1990	Studio Vision	Opcode	Macintosh, PC
1991	Cubase audio	Steinberg	Macintosh
1994	Music Maker	Magix	PC
	Emagic	Logic Audio	Macintosh
1995	Magix	Samplitude	PC
1996	Twelve Tone Systems	Cakewalk Pro Audio 4	PC
	Cubase VST	Steinberg	Macintosh, PC
1997	Fruity Loops (FL)	Image-Line	PC
	Canam Computers	Quartz Studio	PC
1998	Acid	Sony	PC
1999	Pro Tools 5	Digidesign	Macintosh, PC Integrates MIDI
2000	Nuendo	Steinberg	Macintosh, PC
2001	Live	Ableton	Macintosh, PC
	Cakewalk Sonar	Roland	PC
2003	Traktion	Raw Material Software	Macintosh, PC
	Audition	Adobe	Macintosh
2004	Live 4	Ableton	Macintosh, PC Integrates lunch
	Logic Pro 6	Apple	Macintosh
2005	Garage Band	Apple	Macintosh
	Reaper	Cockos	PC
2006	Samplitude Pro 9	Magix	PC Integrates MIDI
2007	Logic Studio	Apple	Macintosh
2009	Studio One	Presonus	Macintosh, PC
2010	Bitwig Studio	Bitwig	Macintosh, PC-Linux
2013	Logic Pro X	Apple	Macintosh
2017	Digital Audio performer	MOTU	Macintosh, PC

Table 1.1. *Some digital audio workstations (this list is far from exhaustive)*

1.11. To conclude

This presentation has shown that recording devices have not stopped evolving since the middle of the 19th century, with a certain boom during the transition to digital technologies at the beginning of the 1990s. I have deliberately not mentioned the last 20 years, which have not created a real technological revolution. The principles have remained the same; certainly the performances have improved, the storage capacities have grown, the processing speed and the computing power have increased 10-fold and the size of the machines has reduced (today a digital recorder of excellent quality fits in a pocket), but, finally, the principles have remained the same.

It is important to note a contradiction, or rather a countercurrent, which has been grafted onto the evolution of technologies, the return in force of LPs (vinyl) since 2005, as shown in Figure 1.57.

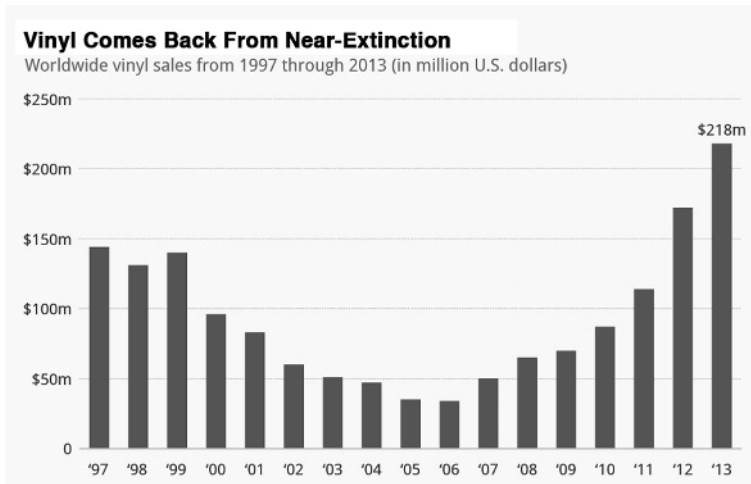

Figure 1.57. *Evolution of the vinyl record market worldwide (source: IFPI.com). For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

Could it be the nostalgia, the sound coloration, so different from digital, the fashion, the object itself? It's hard to say, personally I think it is a combination of all of these and the numbers are growing; you can even find vinyl in supermarkets.

On the recording side, the industry has to face this revival and press the good old tape again. For independent studios, there are even autonomous burning devices that burn blank vinyl by the unit because a demand has been established.

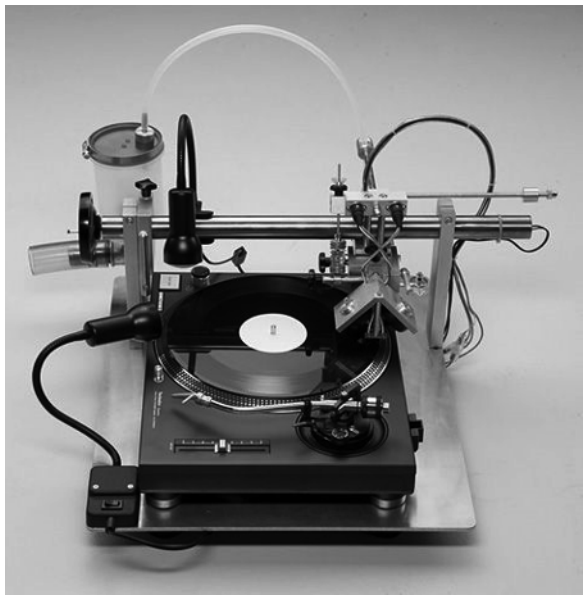

Figure 1.58. *The T560 vinyl engraving bench of the German manufacturer Souri's Automaten. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

Whatever the case, recording remains a never-ending adventure that will never cease to amaze us.