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Recording and Voice Processing 1

History and Generalities

Jean-Michel Réveillac

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Preface

If you want to know if this book is for you, how it is constructed and organized, what it contains and what conventions will be used, you've come to the right place, this is the place to start.

Target audience

This book is intended for all those who, amateur or professional, are interested in sound recording, recording and mixing in the field of singing and voice or musicians, performers, commentators and composers.

The work presented in some sections requires minimum knowledge in the field of acoustics and digital audio.

You must have a good knowledge of your computer's operating system (paths, folders and directories, files, names, extensions, copying, moving, etc.) and know how to handle a DAW (Digital Audio Workstation), such as Avid Pro Tools, Apple Logic Pro X, Ableton Live, Steinberg Cubase, FL Studio, MOTU Digital performer, Cockos Reaper, etc., or a digital integrated studio, such as Tascam DP-03SD, Tascam DP32, Roland VS-1680, Akai DPS16HD, Yamaha AW4416, etc.

Structure and contents of the book

This work is composed of two volumes:

- 1) history and generalities;
- 2) studio work.

Volume 1 presents a preface, specifying the contents and the writing conventions used, then an introduction followed by four chapters, a conclusion and five appendices:

- recording history;
- voice;
- microphones;
- acoustic environment.

The conclusion summarizes the main topics discussed and introduces the concepts that will be addressed in the second volume.

Appendices 1–5 provide some additional information. You will find in this order:

- sound unit;
- audio connectivity;
- audio processing plugins;
- tube and JFET mic amplifiers;
- microphone pairs.

Volume 2 presents a preface and an introduction identical to those of Volume 1 followed by four chapters, a conclusion and five appendices:

- processing hardware and software;
- configuration and audio channel;
- voice recording;
- special effects.

Appendices 1–4 are taken from Volume 1 to complement the previous chapters by including:

- sound unit;
- audio connectivity;
- audio processing plugins;
- microphone pairs.

Appendix 5 of Volume 2 provides details on the types of software plugins available from different vendors and operating systems.

The conclusion sheds light on the whole book and gives a brief overview of the future evolution of voice recording.

Each volume can be read separately. While there are concepts that are dependent on another chapter, references to the relevant sections are given. However, the first two chapters of Volume 1, devoted to the history of recording and to the human voice, provide a contextual basis for the understanding of several notions that you will find in the following chapters.

If you're a novice on the subject, I strongly advise you to read them first, to discover the basics of the subject of this book.

For the others, I hope that you will discover new notions that will enrich your knowledge.

At the end of each volume, you will find a reference list and a list of Internet links.

A glossary is also present; it will explain some acronyms and terminologies very specific to sound recording, recording and mixing.

Conventions

This book uses the following typographical conventions:

Italics, which are reserved for important terms used for the first time in the text which may be present in the glossary at the end of the book, mathematical terms, comments, equations, expressions or variables.

Remarks are indicated by the presence of the keyword: NOTE. They complete the explanations already provided.

The figures and tables all have a legend that is often useful for understanding.

Vocabulary and definition

As with all techniques, voice recording has its own vocabulary. Certain words, acronyms, abbreviations, initialisms and proper names are not always familiar and will be included in the glossary.

Acknowledgments

I would especially like to thank the ISTE Ltd team and my editor Chantal Ménascé, who trusted me.

Finally, I would like to thank my wife, Vanna, and my daughters Océane and Léa who supported me throughout the writing of this book.

August 2021

Introduction

Since Plato and Aristotle, we have often heard this quote, “*The voice is the mirror of the soul*”. It is true that before understanding the meaning of a word, we must understand its emotional side; we recognize the intonation that makes a voice more or less unique. The paralinguistic characteristics of a voice, that personalize it, take priority over the meaning of the message that is delivered. They express the emotional aspect of the interlocutor and favor the transmission of emotions.

It is also necessary to take the environment into consideration; the voice exists only through its medium, the air which surrounds us. The numerous acoustic variables, vocal cords and different morpho-anatomical cavities of the individual form the timbre of the voice, which can be modified during its diffusion by the environmental medium in which it is established.

Each individual has a different timbre that represents a sound signature. The voice is the reflection of the body and the spirit, but let us not assume that its characteristics are as static and reliable as the genetic code or fingerprints. They are variable, determined by numerous parameters linked to morphology, imagination, environment, affect and even gestures, even if many of these elements do not affect the hard core that builds the essence of a voice.

The recorded voice brings different sensations that often flout the canons of the direct voice, spoken or sung, but it is far from being unpleasant and it has become, by force of things, a standard. Our world is constantly saturated with music or recorded voices; few people can claim to have heard a particular performer with his or her live voice. Voices are optimized for recording and broadcasting; they must remain intelligible and are sometimes enriched, or even placed in a virtual environment, but our ears have become accustomed.

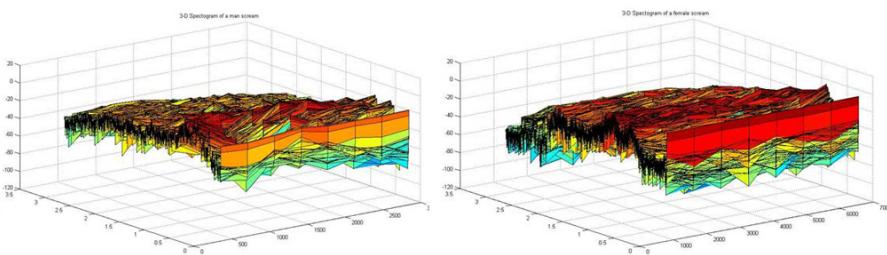


Figure I.1. Vocal differences in the same sentence. 3D spectrogram of a male voice, on the left, and a female voice, on the right (source: www.projectrhea.org). For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip

It is in part the facts I have just mentioned that led me to write this book, to which I would add the pleasure of bringing, to one or more performers, the possibility of discovering and hearing themselves on a medium such as a CD, DVD, streaming platform, podcast, etc.

I will not forget the listeners nor the public for whom we all work *in fine*: artists, commentators, singers, sound engineers, technicians, etc.

This work, as its title suggests, is above all devoted to the recording and processing of the voice. I have tried to aggregate a set of elements that contribute and intertwine in this same field, taking care of the ins and outs.

I remain convinced that in order to understand the techniques and handle certain hardware or software, it is useful to know what surrounds them. Throughout the book, I have often specified the historical context without forgetting the personages to whom we owe these wonderful inventions. They made it possible for us to listen to the voice, whether spoken, whispered, sung or shouted. At the beginning of the 21st century, and for more than 120 years already, this seems so common, so futile, so banal, but what would our ancestors from the past centuries think of it?

Volume 1 of this book, more oriented towards theory and generalities, will begin with a short history of the recording of the spoken and sung voice from the first machines until today, which will be followed by an outline of the mechanisms and specificities that characterize the human voice.

With these elements, we will approach microphones, an essential and necessary tool for voice capture, to then understand the recording environment, whose influence creates the conditions for a good recording.



Figure I.2. A wire recorder, the Webster Chicago 180-1 (1949). For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip



Figure I.3. The famous Neumann U67 tube microphone and its power supply. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip

Volume 2, oriented towards studio work, will describe the hardware and software tools that are useful for efficient processing during recording and will include them in the audio chain that will support them. Different examples of configurations will be presented, from the most modest to the most advanced.

After this first approach, we will be ready to carry out the sound recording, not without taking some precautions with regard to the performer and their immediate environment. We will place the various essential materials while respecting the rules necessary for a correct recording.

Later, we will discuss the constraints of recording a group of performers, a choir and a voice-over.

Once the sound recording has been done, it is time for processing and mixing by implementing various hardware or software processes that will ensure a correct sound rendering, while respecting the style and coloration you want to apply.



Figure I.4. *The famous EMI Abbey Road studio 2 control room with its REDD.37 console (1958–1964)*

Finally, additional effects or corrections can be made to finalize your project.

I hope that the eight chapters that make up these two volumes will provide you with a broader and more precise knowledge of vocal recording, a key area of our daily ultra-mediatised world that seems trivial, but whose mastery is not trivial.

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 Martinville¹, 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.

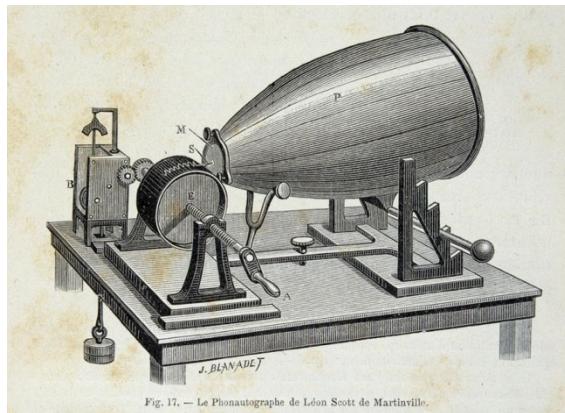


Figure 1.1. *The phonautograph. For a color version of this figure, see www.iste.co.uk/reveillac/recording.zip*

1.2. When it really started

On April 18, 1877, the Frenchman Charles Cros² 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 Edison³ by a few days. Indeed, Edison filed his patent on December 24 for a recording device with tin foil lying on a cylinder.

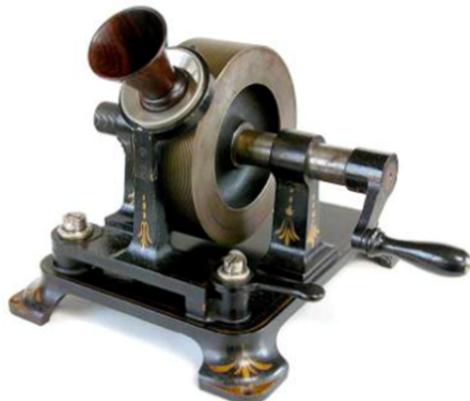


Figure 1.3. Edison's phonograph

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 Bell⁴ and Charles Tainter⁵ 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 engravés 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. Bettini⁶ and E. Berliner⁷ 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 galvanoplasty⁸. Edison created the Edison Phonograph Company.

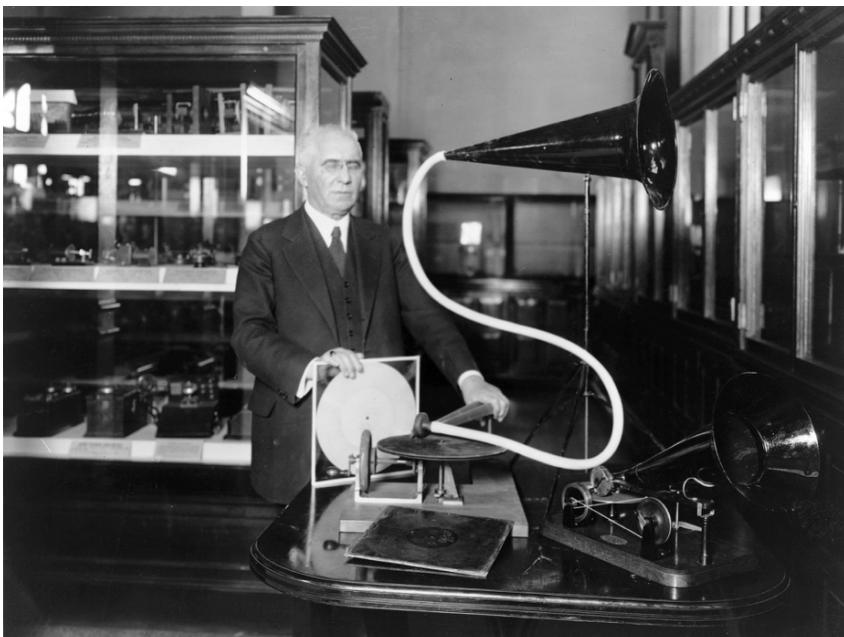


Figure 1.5. Emile Berliner and his first phonograph (source: Wikipedia)

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-box⁹), 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.