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Recording music and sound

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Introduction

This free course, *Recording music and sound*, provides an historical introduction to music and sound recording and offers some guidance about making your own recordings, should you wish to do so. Many of the processes that have been developed and the issues that have been raised in the first 150 years of recording are still relevant today, and a solid grounding in them will help you understand the wide range of recording techniques currently in use.

This OpenLearn course is an adapted extract from the Open University course A232 *Music, sound and technology*.

Learning Outcomes

By the end of this course you should be able to:

- appreciate the tasks required to organise and create commercial music
- demonstrate knowledge of the history of sound-recording technology
- recognise the impact of technological change on sound recording
- understand some of the decisions made by contemporary sound recordists, including the placement of microphones.

1 Recording production

For many people today the recording process is very simple. A recording device is placed in front of a musician, a few takes are recorded, any editing that is necessary is quickly done on the computer and the resulting piece of music is available for immediate distribution on the web. All this can be accomplished in the room of someone's house and in some instances the presence of a live musician is not even needed. But for many commercial recordings the process is much more complex and involves many more people. For a Virgin Classics' CD recording of *A Venetian Coronation 1595* (Virgin Veritas 59006) produced in 1990, the list included:

- performers
- executive producer
- music editors
- balance engineer
- cover designer
- photographer
- advisers to the conductor
- organ tuner.

In addition, the credits for such a recording might include all those responsible for organising the venue, providing hospitality, manufacturing the CD, printing the booklet, etc. In reality, dozens of people will have been involved in making this product.

1.1 Recording roles

So what did all the people working on *A Venetian Coronation 1595* actually do? In the model of recording western art music that held for large projects in 1990, and still holds in some cases today, the producers, who are responsible for bringing a recording such as this to the marketplace, take on two specific tasks. First comes the creative activity of selecting the music, choosing arrangements, getting the desired sound, planning the cover and insert notes, etc. Then there are several administrative tasks to be undertaken, i.e. booking the musicians, agreeing the recording venue, selecting the support staff, balancing budgets and preparing reports. Producers are supported by the people who sign the artists to record labels and oversee the projects.

Next, the budget for the production must be agreed, performers and engineers booked, and a suitable venue, or venues, secured along with all the necessary support services.

The musical director may have done some homework on stylistic questions of the performance which may be shared and rehearsed by the musicians as the recording engineer works on the recording set-up, trying microphones (and perhaps the musicians themselves) in various locations. Once everything is in place several recordings, or takes, will be made and carefully documented. Nothing is discarded. During the session the producer, engineer and performers may listen back to sections of the recording, but the final editing will be left to a later time. At this later date the producer and engineers will edit

the various takes in order to produce a master copy which is usually signed-off by the Director.

Towards the end of the process a master recording is taken and adapted to the chosen distribution medium, offering a final opportunity for limited changes to be made before distribution. A decision may be taken by the marketing department to put an extra track onto the recording to make it more attractive to the public. This track may be from a completely different source with a quite different sound, in which case the mastering engineer would have to adjust the sound to make it compatible with the existing material. In other scenarios an album may be compiled from many separate recordings. As you will see from this digital booklet, the producer, recording engineers, musicians and other personnel change from track to track on Adele's 2015 album *25*, whose 11 songs were recorded with 11 different producers in 11 different studios (in some cases, single songs were recorded in more than one location). The mastering process in this instance must have been extremely complex.

Data specific to the medium is also added at the post-production stage. For a CD or download this would include information about track separation, track numbers and the length of each track. Once all the digital audio and associated data is finalised, the master recording is stored. At the same time as all this is going on, any accompanying text and artwork is finalised and, if necessary, printed. Distribution follows.

2 Early revolutions in sound recording

The kind of processes described in Section 1 are essentially those developed by the recording companies over the first century or so of sound recording. These processes were, in turn, shaped according to the technologies that were used. The first part of this course traces the history of recording technology to around the end of the last century.

2.1 The pre-recording era

The first sound recording of a human voice, of the nursery rhyme ‘Mary Had a Little Lamb’, was made over 150 years ago. Within 25 years sound recording had become a global industry.

Before sound recording was possible, few people had the opportunity to hear music in the way we take for granted today. Apart from expensive musical boxes and mechanical music players, the only way music could be heard was in live performances. Take a moment to think how your life would be without being able to listen to music through a sound system, via the web, or in public places. How often would you listen to music if you could hear it only by attending performances or making it yourself? No two answers to this question will be the same, because each person’s experience would depend on where they lived, the kind of repertoire they might seek out and the resources at their disposal to travel, or to gain entrance to live events. The following activity pursues some of these ideas

Activity 1

Allow about 10 minutes

Think of how people listened to music before the advent of sound recording. Try to put yourself in their place and make a list of the various ways in which you might hear music. Is there a common thread that you can discover about the experience?

Discussion

You might have thought of the following:

- places of religious worship (singing hymns, listening to the organ, etc.)
- at school (nursery rhymes, group songs and dance)
- in the home (listening to a singer, or instrument, perhaps accompanied by the piano)
- live organised musical events (listening to the band in a local park, going to the music hall, a classical concert or a musical theatre performance, for example)
- dancing (to music from local bands).

Of course, the sort of music to which people listened depended on their resources and social class, as well as where they lived, but a common thread that runs through the list above is that on many occasions music was created by people meeting together – at church, school or the local public house for example. Almost all of the music was live, with just the possibility of hearing a mechanical instrument such as a barrel organ. Of course, music was not necessarily heard only on occasions when several people met

together – nursery rhymes, humming, or whistling generally have an audience of just one or two.

The evidence of historical listening accounts suggests that listeners in pre-recording eras heard a much less eclectic mixture of styles than we do today. We hear music in a great variety of places – for example, in shops, restaurants, bars, on television, in the car, at home, at concerts, etc. – so we are likely to be familiar with the sound of a range of, for example, popular music as well as orchestras, singing groups and musical styles from other cultures. Earlier listeners were much more constrained in the variety of music to which they were able to listen and what is interesting in some of their accounts is the impact of listening to unfamiliar styles. The nineteenth-century character Samuel Midgley illustrates the point. He was born in 1860, the son of a miner and shop-keeper, and had little experience of large-scale orchestral and choral sound, describing in his memoirs the rarity and wonder of hearing such a performance:

> I had not been able to attend good concerts. Money was scarce, and more than once I had looked with longing eyes at the outside of [Bradford's] St. George's Hall when big concerts were in progress.
>
> One memorable evening, when the temptation was immensely strong, I quietly stole up the steps of the South gallery and listened outside the door to the glorious music.
>
> (Midgley, 1934, p. 16)

If you are interested in listening to other accounts of early listeners you can do so at The Listening Experience Database.

2.2 Edison

Figure 1 Thomas Edison with his phonograph, 1870–80 (glass plate photograph), American Photographer, (19th century)

In 1877 the young American inventor Thomas Alva Edison (1847–1931) finally completed development of an invention capable of capturing, recording and playing back sounds. Edison called it the phonograph, from the Greek meaning ‘sound-writer’. It is pictured with the inventor in Figure 1.

Activity 2

Allow about 10 minutes

Listen to the following track. It is a recording of Edison speaking the nursery rhyme 'Mary Had a Little Lamb' made in 1927, 50 years after he made his original recording in 1877 (none of his original 1877 recordings have survived). What are the most striking features of the recording?

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Discussion

The sound quality in the clip of Edison speaking that you have just listened to is very poor in comparison to what we have come to expect today. This is because the system used a recording method in which an individual shouted into a horn and the sound was transmitted onto a recording device (Figure 2). The fact a person had to shout indicates that the recording machine was very insensitive. This was due to the mechanical stiffness (inertia) of the mechanism that cut the groove into the recording medium, which in this case was tin-foil. This had a direct effect on the range of sound that could be recorded on mechanical recording machines.

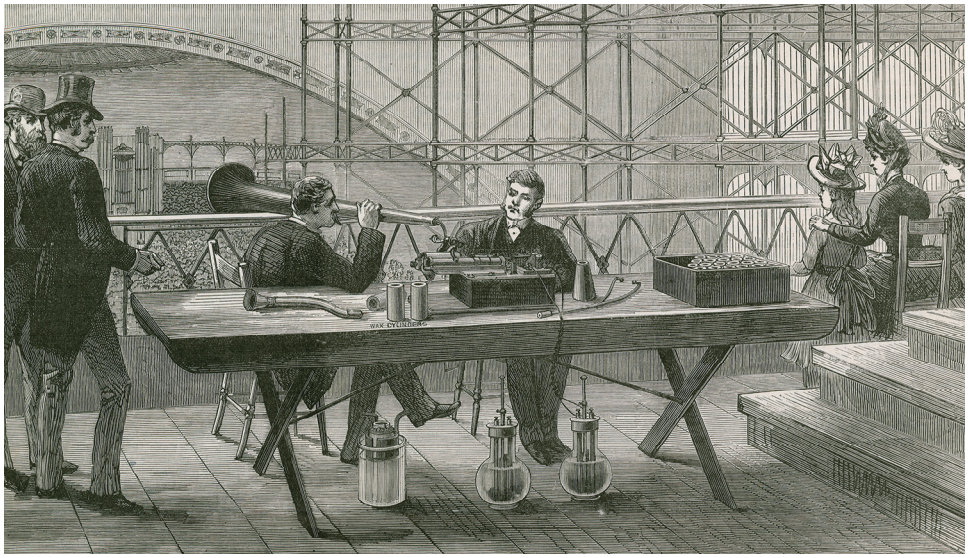

Figure 2 Edison's perfected phonograph in use in the press gallery during the Handel Festival at the Crystal Palace (engraving), English School, (19th century)

2.3 Bell and Tainter

Figure 3 ‘Graphophone’ Gramophone with Horn and Cylinders, c.1900, English School, (20th century)

Following his invention of the phonograph Edison took a break from working on recording technology. Alexander Graham Bell (1847–1922), who had risen to prominence through his invention of the telephone, set about developing a recording machine with the assistance of his cousin Chichester Bell (1848–1924), a chemical engineer, and Charles Tainter (1854–1940), a scientist and instrument maker. By 1887 Bell and Tainter had succeeded in producing a recording machine they called the graphophone (meaning ‘sound-pencil’). The graphophone was largely similar to the phonograph, but in place of tin-foil they used cylinders of hard wax coated onto cardboard sleeves as the recording medium. This was a great technical advance, for it not only gave much greater quality of reproduction but also allowed the recording to be replayed many times.

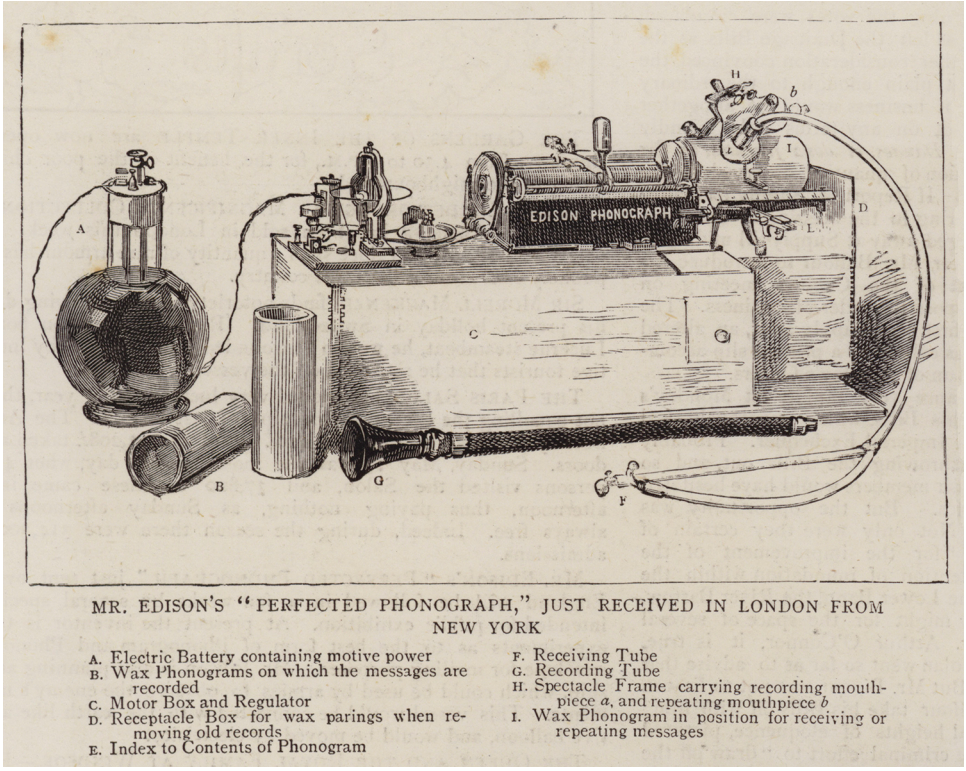

Figure 4 Mr Edison's 'Perfected Phonograph', just received in London from New York (engraving), English School, (19th century)

When Edison returned to recording technology, his 'Perfected Phonograph' looked remarkably similar to the graphophone. However, Edison used a solid wax cylinder rather than a wax-coated cardboard sleeve. This allowed the cylinder surface to be shaved, erasing the original recording and allowing the cylinder to be re-used.

The Columbia Phonograph Company recorded popular songs of the day on cylinders. They could be played back using specially adapted 'coin-in-the-slot' phonographs, which were situated in public places such as drugstores and saloons. Popular songs could be heard 'for a nickel a time'. Their popularity demonstrated a public demand for recorded music.

By Christmas 1897 a $10 clockwork-powered graphophone was offered. To compete, Edison offered his clockwork-powered 'Home Phonograph' for $20 which, apart from minor modifications, sold for over 30 years.

2.4 Berliner

Emile Berliner (1851–1929) became interested in recording sound through studying a device called the phonoautograph. This apparatus inscribed sound vibrations as a lateral trace onto lamp-blacked paper using a diaphragm and stylus. Berliner thought that this lateral motion could offer superior recording quality to Edison's vertical method. He also decided to use a disc, which he called a plate, which was rotated at a fixed speed, rather than a cylinder as the recording medium. This overall design was sufficiently different from the phonograph to allow it to be patented in 1887 using the name gramophone.

Berliner made his plates from a tough rubber-based compound called vulcanite, allowing for a deep groove. This deep groove allowed cheap, replaceable steel needles to be used in place of the delicate jewel stylus found in the cylinder machines. This made the

gramophone (Figure 5) cheaper to manufacture than the competition. In 1894 Berliner's United States Gramophone Company released their first single-sided 7 inch (18 cm) diameter disc.

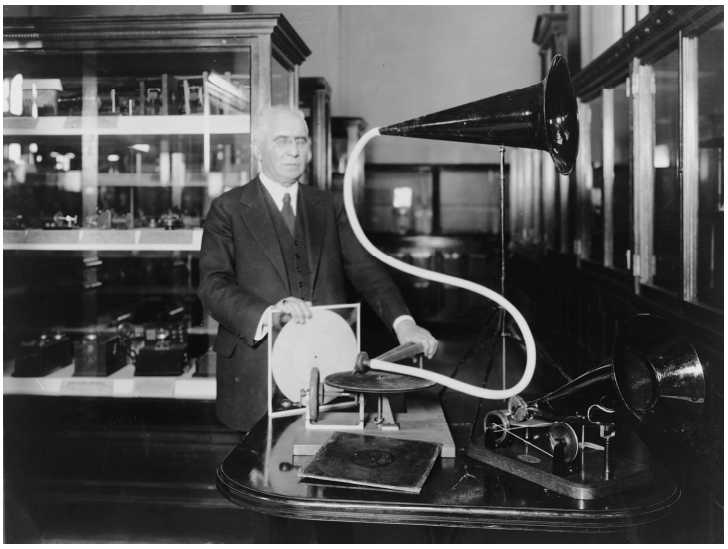

Figure 5 Emile Berliner, 1910-1929 (b/w photo) with the model of the first gramophone machine which he invented, American Photographer, (20th century)

An important point to note is that unlike its rivals, the gramophone had no means of recording sounds – it was designed from the outset only to play back pre-recorded sounds. This demonstrated a high degree of faith by Berliner that people would be happy just to listen to sounds (and music in particular) in their own homes.

Activity 3

Allow about 10 minutes

Listen to these two tracks. The first track contains an original recording by Emile Berliner made in 1889 and this is followed in the second track by a repeat of Edison's recording that you have heard already. Remember that this recording of Edison was made in 1927, 50 years after his first attempt. How do you think Berliner's recording compares with that of Edison? How would you describe the differences?

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Audio content is not available in this format.

Discussion

The recording by Berliner was taken from an original 5 inch (13 cm) diameter vulcanite disc. I think you will agree that the reproduction is poor compared with the recording of Edison; the distortion and noise make the words spoken by the voice barely audible. Edison's recording gives the voice much greater clarity. Even so, it still suffers from a limited frequency range and the noise which is concomitant with the level of technology with which it was produced.

Berliner was aware that Edison had problems duplicating cylinders. Initially copies were made from a master cylinder using a mechanical engraving process. Unfortunately this method caused the master cylinder to wear out after making just a few copies, so performers had to be asked to record several masters to ensure enough cylinders could be duplicated. An improved recording system allowed multiple master cylinders to be made by feeding several recording phonographs from one horn, but the cylinder-copying process was still far from satisfactory.

It took Berliner six years to perfect disc duplication but it was time well spent, for the principles are still used today to manufacture CDs.

The owners of the original hand-cranked gramophones were instructed that the standard velocity for ‘seven-inch plates’ was about 70 revolutions per minute. The owner was also warned that failure to turn the plate at the correct speed would lead to a lowering of the pitch if turned too slow, or a raising of the pitch if turned too fast. It is doubtful if true reproduction of the recorded sound was ever achieved by the owners of these machines! A better power source was needed and as electric motors were far too costly, a suitably powerful and inexpensive clockwork motor was used. It was designed and built by Eldridge Johnson (1867–1945), who would later form Victor Talking Machines and Victor Records, which would become RCA-Victor. The clockwork motor proved an immediate success, Christmas 1896 seeing the Berliner Gramophone Company of Washington, DC ahead of all the competition, with the factory being unable to keep up with the demand. By mid-1897 the ‘Improved Gramophone’, with a new Johnson-designed motor and soundbox, was launched. This model was destined to become one of the most familiar icons in the recorded music field for it was immortalised, along with a small dog called Nipper, in a painting by Francis Barraud (Figure 6). The painting became the trademark of the HMV (His Master’s Voice) Company in Europe and Victor Records in the USA.

Figure 6 Advertisement for Victor gramophones, from ‘The Theatre’, c.1910 (colour litho) (detail of 189520), Barraud, Francis (fl.1878-d.1924) (after)

The recording and playback speed would ultimately be standardised at 78 revolutions per minute (rpm), although recording speeds varied from under 70 to over 80 rpm. To cater for these differences a speed controller was fitted to most gramophones.

Disc diameters also varied, but 7-inch (18 cm) playing for two minutes, 10-inch (25 cm) playing for three minutes, and eventually 12-inch (30 cm) playing for up to five minutes became standard. Eventually recordings were put on both sides of the disc – known then, as now, as the A and B sides – offering better value and greater convenience to users.

2.5 Popularising recordings

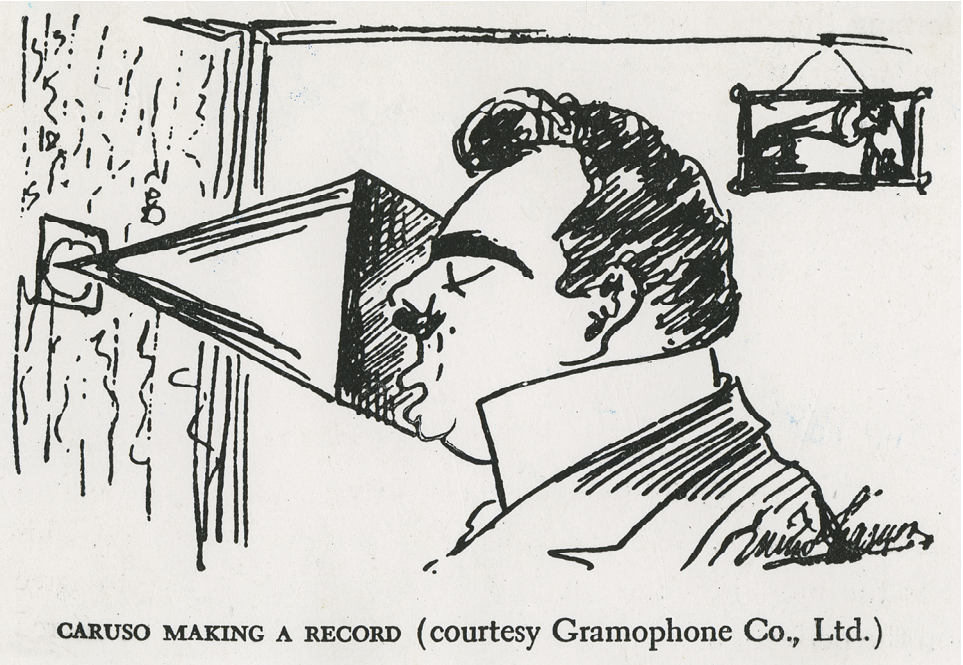

Figure 7 Caruso making his first gramophone recording, 1902 (drawing), Caruso, Enrico (1873-1921)

The limitations of the recording techniques discussed so far restricted the sounds that could be reproduced. Instruments tended to be limited to brass and piano, and middle-register voices (alto and tenor) were the most suitable. So why did the disc succeed over the cylinder? The answer has little to do with technology and much more to do with the tenor Enrico Caruso.

Activity 4

Allow about 10 minutes

Listen to this track. It is a recording of Enrico Caruso (1873–1921) singing 'Questa o quella' from the opera Rigoletto by Verdi (1813–1901). This was the second of ten recordings made by the recording engineer and important early recording producer Fred Gaisberg in March 1902. What extraneous sounds can you hear in this recording?

Audio content is not available in this format.

Discussion

In addition to the music you may notice that Caruso clears his throat at the end of the first verse (around 1:03 in the recording), which underlines a fundamental difference between early recordings and their later counterparts – no editing facilities were available. This recording has been restored by Ward Marston (we will return to the issue of recording restoration in a later section).

2.6 Good times and bad

Figure 8 Record Cover for 'Lotte Lenya sings Berlin Theatre Songs by Kurt Weil, with texts by Bert Brescht and Georg Kaiser', (litho)

By 1924 the burgeoning of radio broadcasting in the United States proved of great importance to the record industry. The sensitive microphones and electronic amplifiers used in broadcast studios offered improved characteristics that were exploited in the record industry through the development of an electromagnetic cutting head by the American company Western Electric. Electric players rapidly replaced the older machines, as they were able to exploit the improved characteristics of the electric recordings. In particular, the new recordings were able to use equalisation (i.e., the process whereby the volumes of specific parts of the audio spectrum are altered relative to the other parts of the sound) to improve the replayed sound quality.

Following the Second World War (1939–1945), demand for records increased dramatically. An example of the upsurge is demonstrated by the figures for sales of an early recording of a popular piano concerto, which sold 102 copies in 1935 and 62,756 copies in 1946. Consumers, though, were no longer satisfied with excerpts of symphonies or musical works shortened to fit to one or two sides of a disc. Record companies began to make full-scale symphonies and choral works available as sets, but the recording media were not particularly convenient or conducive to an enjoyable musical experience. For example, Bach's St Matthew Passion (approximately 3 hours of music) came on eighteen double-sided 12-inch records, but listening to this work involved changing records 36 times!

In 1948 Peter Goldmark (1906–1977), head of research at Columbia Records in America, demonstrated a 12-inch (30 cm) non-breakable microgroove vinyl disc capable of playing 23 minutes each side. Columbia called it the LP (for long-playing) disc. It revolved at 33⅓ rpm with up to 300 tracks to the inch (120 per cm). The rival company RCA-Victor seemed not to be impressed with the LP. They responded with a 7-inch (18 cm) microgroove vinyl disc that revolved at 45 rpm, the so-called 45, which had a similar track pitch to the LP and played for up to 4 minutes. The 'Battle of the Speeds' commenced.

Fortunately for the record companies a truce was declared by 1950, with the 78 rpm disc the loser. The LP was adopted for classical recordings and the 45 for popular music. In Europe the change took a little longer, but by the end of 1952 LPs were available from European manufacturers.

The LP is not quite the end of the story of the gramophone record. As far back as 1931, the British engineer Alan Blumlein (1903-1942) designed and patented a stereo recording system that used two sound channels to create a virtual sound 'stage' where an individual sound source (instrument, voice, etc.) could be located at any point between two loudspeakers placed at the front left and front right of the listener. The location of the source is determined by the relative intensity in the two channels. The patent covered two possible ways of cutting the groove in the record to allow two separate channels to be recorded.

This brings to a close the story of the record (cylinder and disc), the main source of recorded sound for nearly a hundred years. Apart from refining manufacturing techniques, little change to the technology took place. Despite the recent up-turn in sales of vinyl recordings, other means of reproducing sound have long since come to the fore.

3 Magnetic recording

Figure 9 Gallery of electric machines, Exposition Universelle, Paris, 1900 (b/w photo), French Photographer, (20th century)

Sounds, pictures, measurement data, financial statistics, personal details, etc. can all be recorded and stored on magnetic media, i.e. materials that are able to be magnetised to store information for future retrieval. During the twentieth century magnetic media increasingly came to the fore in the recording industry, culminating in the tape recording technology with which some people today are still familiar.

A paper published by Oberlin Smith (1840–1926) in an 1888 issue of Electrical World discussed the possibilities for recording sound using the property of magnetism. He envisaged a cotton thread impregnated with steel dust passing through a coil carrying a current controlled by a microphone. The variations with the sound in the strength of the current would cause corresponding magnetic fluctuations in the magnetic medium. Unfortunately he dismissed his own idea, which remained theoretical as he never performed any experiments. However, by the end of the nineteenth century Valdemar Poulsen (1869–1942), a Danish electrical engineer, had demonstrated Smith's hypothesis. Poulsen's 'telegraphone' was patented in 1898. It used steel wire wrapped around a brass cylinder as the magnetic medium. At the Paris Exposition of 1900, Poulsen made a recording of Emperor Franz Josef of Austria that is the oldest magnetic recording now in existence.

At this stage the telegraphone could not compete with the gramophone, but the development of an electronic amplifier using the thermionic valve (vacuum tube) enabled the tiny magnetic fluctuations in the steel wire to be magnified to a usable level and by 1924 a German engineer, Dr Curt Stille, had developed a machine that could record sounds on a steel tape.

3.1 Magnetic tape recorders

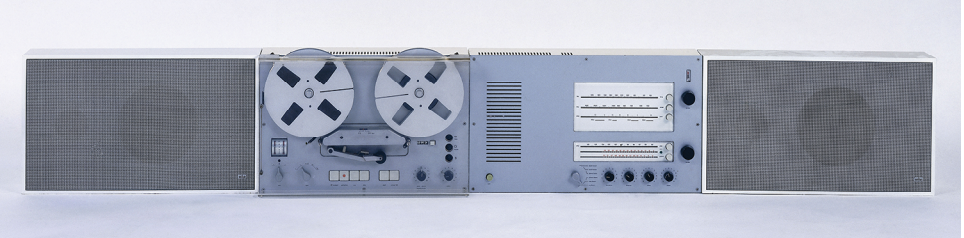

Figure 10 TS45 receiver; a wall-mounted system comprising of reel-to-reel tape, receiver and pair of speakers, 1964 (aluminium, plastic, tape), Rams, Dieter (b.1932)

Experiments showed that the use of paper tape coated with iron oxide particles significantly improved the signal-to-noise ratio. A plastic-based version of this magnetic tape, developed by the German company BASF, led to the development of a commercial tape recorder with audio characteristics that could nearly match those of the gramophone record, but not at an economical price. Secret work on tape recorders was undertaken by the Germans throughout the Second World War.

Soon tape recorders were in use by the American radio networks for pre-recording their broadcasts, the entertainer Bing Crosby being one of the greatest proponents of the technology. Recording companies were also quick to embrace the benefits of tape – especially the ease with which mistakes could be edited and retakes inserted. Also the ability to record for longer periods (30 minutes or more) meant less need for recording sessions to be split into short takes. Early domestic recorders were used primarily for playing stereo recordings, but they were costly in terms of both the hardware and the media: a pre-recorded stereo tape cost five times that of the equivalent mono LP disc. The sales of pre-recorded tape plummeted once stereo LPs became available in 1958. From that point on, domestic tape recorders were used mainly by enthusiasts for home recording.

An important feature of the use of magnetic tape is the effect on the sound of the speed at which the tape travels. The audio bandwidth of a tape recorder is determined to an extent by the selection of the tape speed, i.e., the rate at which the tape is drawn across the record and play heads. The wavelength of the audio signal recorded onto the magnetic tape is proportional to the tape speed. As the tape speed is increased, a greater proportion of the tape is used to store the audio signal, allowing higher frequencies to be retained on the tape. Because high tape speeds are less economical on tape usage, tape recorders had speed controls to allow users to select the tape speed to suit the audio quality. The figures below give you some idea of the variation of tape speed that was used for different purposes.

Speeds are measured in cm/s (centimetres per second) and ips (inches per second).

Table 1 Tape speed, bandwidth and their uses

Tape speed	Bandwidth	Use
38 cm/s (15 ips)	20 Hz-20 kHz	studio recording
19 cm/s (7½ ips)	30 Hz-15 kHz	high-quality home recording
9.5 cm/s (3¼ ips)	40 Hz-13 kHz	general domestic music and speech
4.8 cm/s (1 7/8 ips)	50 Hz-6kHz	recording speech (dictation)

3.2 Tape at home

The use of magnetic tape for home use was always somewhat problematic. While it offered several advantages over discs, being capable of high-quality sound, substantially free from surface noise and able to make personal recordings, tape never became so popular as to make any serious inroads into the sales of discs. Why should this be the case? The answer is one of convenience, for magnetic tape has always been difficult to handle compared with discs – threading the tape through the machine onto the take-up spool was fiddly, and the tape could easily become damaged, stretch or snap.

Many companies developed tape cassette systems based on standard quarter-inch tape but none succeeded in gaining enthusiastic acceptance by consumers. The compact cassette system, shown in Figure 11, was developed by Philips Gloeilampenfabrieken in 1963 for recording speech. Philips called their cassettes compact to distinguish their system from other audio cassette systems and they made no pretence of achieving high-quality sound, deciding to use a slow tape speed (1 7/8 ips) and a new narrow one-eighth-inch-wide tape to keep the whole system as small as possible. The convenience of slotting cassettes into the machine rather than having to thread tape around guides and tape heads made this format much more suitable for consumers. Along with the introduction of the Sony Walkman in 1979, this was one of the key technologies that drove the portable music market from which the iPod and mp3 players, and smartphone music streaming services, have grown.

Figure 11 A compact cassette system

3.3 Multi-track tape recording

The importance of tape recording to record production cannot be overemphasised. From its development until the late 1970s, the tape recorder was at the heart of the professional music recording studio. Initially, the full width of the standard quarter-inch tape was used for making monophonic recordings. Stereo needed two tracks – one for each channel.

Rather than doubling the tape width, a decision was made to halve the track width by incorporating two discrete heads one above the other in a single head assembly. As technology advanced, more tracks were able to be added. By also widening the tape, even more tracks could be incorporated, so allowing individual instruments to be recorded on separate tracks for down-mixing at a later date. Figure 12 shows a professional 24-track analogue tape recorder using special 5 cm (2 inch) wide tape. These complex machines are capable of reproducing high-quality sound for each track and they represent the pinnacle of analogue multitrack tape recorders.

Figure 12 A 24-track analogue tape recorder

The expansion from mono through 2, 4, 8, 16 and up to 24 tracks over the course of the late 1950s to 1970s allowed the development of recording and production techniques (and beyond that via the synchronising of multiple tape machines even 48 tracks were common). For example, the early mostly ‘live’ recordings found in early Beatles recordings were recorded using several microphones all mixed down to a two track tape machine. But since most radio broadcast and portable record players only supported mono reproduction, all of the Beatles records were primarily mixed down to mono. Stereo versions were also produced at the request of the record label, but these were of secondary importance to the producer George Martin, who delegated the task to other engineers.

When EMI started using 4-track tape machines at their Abbey Road Studios in 1963, a greater degree of freedom entered the recording process. The additional tracks allowed different parts to be added to the recording at different times. It also allowed tracks to be ‘bounced’. If three tracks contained, for example, drums, bass guitar, and lead guitar, these could be mixed together and recorded onto the fourth track on the same tape, allowing those original three tracks to be re-used for additional instruments. Of course, the mix had to be right, because it was not possible to return to the original tracks and try again once they had been replaced.

As the capability of tape machines expanded to 8 and 16 tracks in the late 1960s and 24 tracks at the start of the 1970s, the need to bounce tracks, and to commit to mixing decisions decreased. It was still a very useful technique, but usually the main elements of the recording would be kept separate. A typical use for bouncing tracks in a 70s recording session might be to record the main parts on the first 16 tracks, and then use 6 tracks for backing vocals. Once all of the backing vocals were recorded, those 6 tracks could be mixed and bounced onto a single track, leaving plenty of tracks for overdubbing other instruments.

It was possible to link up two tape machines so that they were perfectly synchronised. In practice this was tricky, but it allowed bands to record onto 48 tracks. More tracks obviously allows more options, and increases the potential for different approaches to making a recording, and that applies just as much to orchestral recording sessions, with one channel for each section of instruments, as to a popular recording. The trade-off is that this process can be much more costly, and decisions about mixing can be made far more complicated and subject to change, thus making the whole process far more time consuming.

3.4 Editing

Before the use of tape, recordings had to be started at the beginning and stopped at the end. Once a groove had been cut on a wax cylinder or a disk, it was not possible to go back and recut any part of it. Tape, however, is a fundamentally different medium and allows for two kinds of manipulation after the original recording event.

Firstly, tape can be cut and stuck back together. Cutting and splicing tape allows the rearrangement of music after it has been recorded, which means that whole sections may be easily removed, either to improve the music or because they contain mistakes. Secondly, tape can also be erased and reused easily, and it is possible to record onto any selected tracks of a multitrack tape while the other tracks are playing. It is also possible to ‘drop in’ short extracts, thus correcting any mistake by re-recording only that small section in which the error may have occurred.

Overdubbing does not change the overall length of a recording, but editing can allow fundamental changes to the duration and ordering of a recording. By editing, it is possible to add in additional, subsequent or previous recordings, simply by using a razor blade and sticky tape. The next logical step is to start to construct music by editing tape together, and not necessarily using tape that contains recordings of musical instruments.

Figure 13 The Canadian Pianist, Glenn Gould

This leads to two kinds of practices, one exemplified by Glenn Gould and the other by Pierre Schaeffer. Glenn Gould (Figure 13) was a concert pianist who saw the possibilities of recording and especially editing very early on. He notably gave up giving concerts and instead devoted himself to making studio recordings instead. He would often record pieces bar by bar so that he could concentrate on getting exactly the right nuances of performance for every detail, later editing all of these takes together to make the master recording. By doing this he could create a ‘performance’ of a piece that was impossible to achieve in a single take.

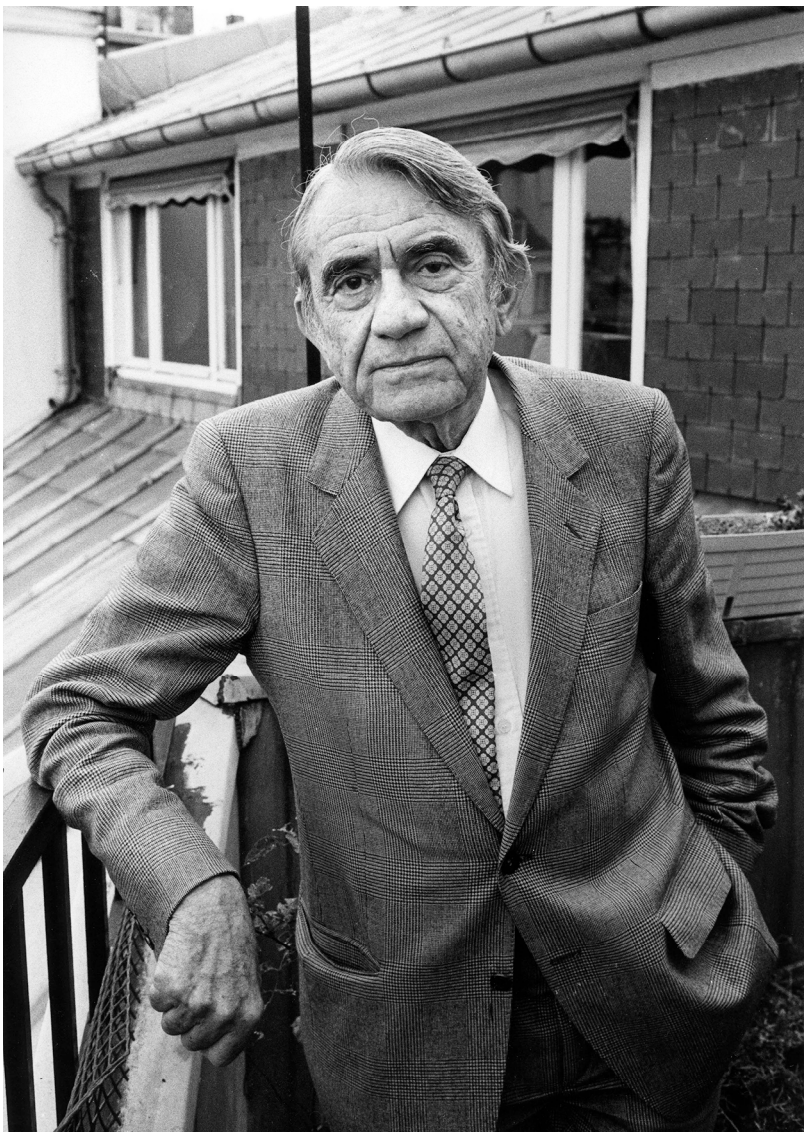

Figure 14 Pierre Schaeffer

Pierre Schaeffer (Figure 14), on the other hand, developed a new way of making music by using all kinds of recorded sounds, and editing them together. He started in the 1940s by using records, and would make indents into the surface to create ‘sillons fermés’ – locked grooves. When tape machines became available the potential for editing together different sounds by using certain techniques such as repetition, reversal, and transposition all increased. Schaeffer called this kind of music Musique Concrète. There was also a parallel movement of making tape music using electronically generated sounds such as sine waves and noise, primarily based in Cologne, with key figures being Herbert Eimert and Karlheinz Stockhausen.

Activity 5

Allow about 5 minutes

Listen to the following piece of music made using the above techniques. Can you hear the difference between naturally repetitive sounds and those sounds that have been artificially repeated?

Audio content is not available in this format.

Discussion

Some of the train sounds we hear are naturally repeated whereas with others Schaeffer has created a degree of repetition artificially. The use of repeated rhythmic sounds is a familiar feature in much popular music and especially in electronic dance music. This recording is one of the earliest examples of using recordings to artificially create repeated rhythmic elements, and is in many ways a precursor to some of the techniques of sound manipulation used in contemporary music production.

4 Practical recording

Now you have an understanding of the history of sound recording, in the rest of this course you will be exploring the kinds of issues you might face when making your own recordings using a small portable recorder. You may wish to invest in such a recording device but do not need to do so to understand the issues facing sound recordists.

All recording situations require some degree of planning, and the right amount of planning can help you get results even when many elements are beyond your control. If you have one, it is a good idea to get into the habit of taking your recording device with you wherever you go, and being ready to capture sounds around you that you find interesting, or that you think may be useful later. I have built up quite a wide-ranging sample library in this way. You should give yourself every advantage to be able to capture sounds indoors or outdoors. At the very least you need to make sure your batteries are charged and that you have enough storage space in your recorder. If you have a windshield for your recorder, and some headphones, that is even better, but this can still be a highly portable rig.

Outdoors, the biggest enemy is the wind. Microphones work by having a very lightweight diaphragm that responds to changing sound pressure, but when the air is moving this has a much greater impact on the diaphragm of the microphone and can easily cause it to reach its limit of movement and therefore to distort the signal.

4.1 Microphone distortion

Distortion caused by too much air movement is not just a problem in outdoor recording. Any microphone placed close to a source of moving air can be susceptible to distortion. The human voice is such a source, as are several wind instruments. The amount of air moved by a vibrating drum skin, especially a bass- or kick-drum can easily enough to cause a microphone to distort, and in the case of a ribbon mic, the air movement can be enough to break the ribbon.

Figure 15 Shure SM58 dynamic microphone

Figure 16 Electrovoice RE-20 dynamic microphone.

Some microphones such as the Electrovoice RE20 and Shure SM58 as pictured in Figures 15 and 16 have a foam shield mounted inside the wire basket surrounding the capsule which greatly reduces the effect of air movement. These two microphones are both designed primarily for voice, and so this foam combats the air movement generated when making plosive sounds (‘p’ and ‘b’ sounds). There is a trade-off between robustness and sensitivity in these kind of dynamic microphones, which makes them less well suited to recording quieter sounds. Conversely, the more sensitive microphones that you may have in a portable recording device may need some additional protection when used outdoors.

Many microphones come with external foam shields, which can be added when needed, and your portable device could have such a wind shield included. For really serious outdoor recording, a more sophisticated wind shield is needed. You might have seen the kind of hairy blimp style microphone shield, particularly at sporting events where the sound has to be captured from many different locations around the pitch, arena, or field of play in all kinds of weather.

Figure 17 Rycote windshield

Several companies make these, but they have become synonymous with the manufacturer Rycote. You may have a simple foam windshield or even a furry cover for your recording device. Usually these simply fit over the microphones. Some covers are available as add-ons, so if you want to record outdoors, you might consider your options. Anything you put in front of the microphone will have an effect on the sound, so don't immediately choose the most protective cover unless you really need it. Even a light breeze can cause distortion, so it is always worth using a foam windshield for outdoor recording if you have one.

Figure 18 A condenser microphone, pop-filter and vocalist.

A ‘pop-filter’ (shown in Figure 18) between the vocalist and the microphone, is a similar device used for recording vocals in a studio. Sometimes called a pop-screen or pop-shield, this device uses the same principle as the windshield, reducing the impact of moving air on the microphone diaphragm. A pop-filter is used to prevent any strong blasts of air caused by ‘p’ and ‘b’ sounds from overloading the microphone diaphragm. This allows you to use any kind of microphone to record a vocalist, especially sensitive condenser mics. Without a pop-filter, these sounds can cause ‘pops’ or heavy booming sounds. If you haven’t noticed this before, focus your attention on ‘p’ and ‘b’ sounds next time you hear somebody speaking through a microphone without a pop-filter and see if you can observe this phenomenon.

An effective DIY pop-filter can be made using a wire coat hanger and stocking or pair of tights by creating a wire circle with a diameter of around 15 cm and stretching the tights over this. This is then attached to a microphone stand so that it is about 2-5 cm in front of a microphone.

Another critical factor that tends to be more of a concern in outdoor sound recording is avoiding handling noise. In the studio there is usually easy access to microphone stands and suspension mounts which help to isolate microphones from any vibrations by suspending the microphone by elastic cords. Outside the studio, and particularly in field recording scenarios when portability is a priority, the opportunity for using a specialised microphone stand and suspension mount can be limited.

Anything you can do to remove or reduce the sounds you make yourself is a good thing. If you have a choice of jackets, wool or cotton makes less noise than a brand new anorak, so if you set out to make some outdoor recordings, think about what you can wear that will reduce the likelihood of generating excess noise. Soft-soled shoes might be better than hobnailed boots.

Given that it is difficult to be absolutely silent and still even for short periods of time, always try to put your device on a stable surface rather than holding it, and if you can fix it to a microphone stand then that is even better. Many devices have camera-tripod compatible fixings which allow you to mount your device on a range of different tripods, and some have an adapter that allows you to use a microphone stand. Failing that, you can use tables, tree-stumps, or any other stable base to rest the device on, and if you can protect the device from the wind at the same time, then so much the better. A certain amount of vibration from the environment, especially traffic rumbling, can be picked up by a microphone that is directly coupled to the floor.

5 Recording log

Figure 19 Recording a live performance

A recording log is where you can make notes of many different aspects of your session, and can be absolutely essential when you return to a recording weeks, months, or even years in the future. Details about the session that seem obvious today will have been forgotten next year unless you write them down.

If you are planning on recording a live performance, you will have just one chance to get it right, and you may only end up with one single sound file. The necessity for creating a recording log might seem very low on your list of priorities; however, there are a number of good reasons to get into the habit of making recording logs for each and every session.

Recording logs are valuable whether the recording takes place on location or in the studio, and in this section the use of recording logs across a range of different situations will be discussed.

5.1 General notes

In general, I use a fairly similar recording log independent of where I am recording, but some details are much more useful depending on the situation. When I am recording on location I try to include the following:

- Time and date
- Location
- Recording engineer (usually me)
- Producer (if there is one, often there isn't)
- Performers (names and instruments)
- Title of piece or pieces, plus instruments if non-standard
- Sketch of stage layout with microphone positions

- Name and position of each microphone

All of these elements will appear at the start of my recording log, and to accompany this I always try to take a few photographs of the session, especially the microphone placement.

A sketch of the performers and the microphone position(s) is most useful when you are recording a non-standard setup. When recording a string quartet, for example, you might expect the first violin to be on the far left, then the second violin to the left of centre, with the viola to the right of centre and the cello on the right. In such a scenario, it is easy to check whether your recording channels are the right way around; however, if the players were oriented differently, it would not be so easy to check, and a simple sketch would help.

5.2 Notes on each take

The main body of the recording log of a live recording is quite different to that of a studio session in that a live recording will have far fewer ‘takes’ but may need more notes for each take. A studio, or dedicated recording session will have many more takes, with fewer notes per take.

A list of take numbers should be your key to relate your notes to your sound files. Most recording devices and Digital Audio Workstations automatically number files, incrementing the number by one each time you stop and start a new recording. It is really important to make sure that your take numbers match up with the numbers in your file names. You should double check this very often during a session; otherwise you can end up breaking the link between the notes in your recording log and your sound recordings, and this can cause all kinds of problems when you return to edit the project.

The kind of notes I might make while making a live recording could include:

Change gain -4dB at 12:10.

I will always try to set the microphone pre-amp gain correctly, and to leave it alone once set, but occasionally, especially if there was inadequate opportunity to record the rehearsal, I might have to adjust the gain during the performance. If I note down exactly when I do this, then when I’m mixing the recording in the studio, I can make the appropriate adjustments to balance the levels later. In this case my note indicates that I reduced the mic pre-amp gain by 4dB at 12 minutes and 10 seconds. Ideally this would have been in a natural break such as a pause between pieces, or movements, and not while any of the instruments were playing.

Cough 3:45

It is very easy to hear noises such as coughs, chair squeaks and door slams during a recording when you are present in the space, but it is sometimes harder to notice these on playback. If I hear a sound like this and note exactly when it happened, I can try some different techniques to minimise the effect of the noise later.

Soprano # 11:53

If I have a score I might notice if wrong notes are played, but even without a score it can be easy to hear if particular notes are out of tune (# is shorthand for ‘sharp’). If a high note within a chorus is out of tune, it may be possible to copy a similar note from another chorus and swap it for the out of tune one. Making a note of this kind of mistake speeds up the editing process enormously. Sometimes nothing can be done to fix errors, but it is good to know what to focus on without having to listen all the way through the entire recording.

Whether it takes place in the studio or on location, for example in a concert hall, a managed session requires a very different kind of note for each take. When the performer or performers are not under pressure to get it right first time, as in the case of a live performance, there are many occasions where they will stop shortly after the beginning of the take in order to start again and perform better. There is a danger in starting and stopping the recording device in such instances as it is easy to miss the start of the second performance, so if this happens it is common practice to leave the recorder running and to note ‘FS’ for ‘false start’.

In managed sessions it is much more common to have a copy of the score, so very often notes can be made directly in the score. Bar numbers are a very useful reference point, so before each take I make sure to ask the conductor or performer which bar number they will be starting from and ending on. If you have the score, you can then note bar numbers for any mistakes, or extraneous noises such as page turns. If you don’t have a copy of the score you can at least make sure that there are no bar numbers missing.

In general, you should think of your recording log as the framework for your editing process. Many decisions about which takes are better than others can be made during the recording. For this reason, I include a separate column into which I put a tick or a cross, sometimes half a tick and sometimes two ticks to indicate the general standard and quality of that take. It is then quite easy to scan your recording log before the end of the recording session to make sure you have got a good take to cover all sections. There are different ways of doing this – you might draw a smiley face or sad face, or you might give marks out of 10, gold stars or black marks. The trick is to find an intuitive system that works for you without you having to think about it.

In a live recording situation, a good idea is to use a copy of the concert programme (if there is one) to make your notes in. Much of the information is already there, so it can be a time saver. Otherwise, you should make a table and pre-populate some of the boxes to include the kind of data you most often need. This is an iterative process, and you will make different versions each time you record until you settle on the right balance.

5.3 Field recording notes

When you are recording outside (field recording), it is much harder to make written notes; however, you should still fill out a recording log with some general information at some point before or after you make your recordings. The best way of making notes when you are on the move is to speak them at the start or at the end of each recording you make. You will always have to edit your recordings, so you needn’t worry about ruining them by recording your own voice on them. The best thing about this method is that the notes you dictate will always be attached to the recording unless you deliberately delete them. This is not always the case with handwritten notes!

The more detail you can give the better, especially given the amount of information you will be able to collect with your other senses as you make your recordings. For example, if you are recording a bird song, and you can see that a robin and a blackbird are both singing at once, if you dictate this at the end of the recording, this might save you time later trying to work out what you have recorded. Likewise, if you are recording passing cars, if you notice that the third car was a Ferrari, then mention it on the end of the recording as it may be really handy to know that in a couple of years' time when you are designing some sound effects for a film, or making a ringtone for a friend or relative.

6 Microphone placement

Figure 20 The Symphony Orchestra of the Bavarian Radio (BR), conducted by Bernard Haitink, plays Gustav Mahler's Symphony No. 9 for SZ readers during the public rehearsal at the Philharmonie im Gasteig, 2011 (photo)

In semi-planned situations, the environment will often dictate some of the choices a sound recordist may make, or at least will narrow down the options. For example, to record the dawn chorus, you would almost certainly have to rely on battery rather than mains power. Although a laptop can power a soundcard, which in turn can power microphones, this tends to drain batteries quite quickly and is quite cumbersome and fragile, so a typical choice for field recording is a dedicated battery-powered portable recording device. This may be anything from a sub-£100 Zoom to a professional-level Nagra or Sound Devices machine costing several thousand pounds. The more professional (and expensive) devices usually allow large capacity batteries to be attached, giving several hours of continuous recording time. However, less expensive devices often use less power, so two fully charged AA batteries can also provide enough power for a lot of recording. Since your portable device is likely to be small with few extra features, you should be able to get good battery life out of it. However, given the effort you will dedicate to any recording work, it is good practice to carry spare batteries with you, just in case.

The choice of recording device will also affect the selection of microphones. A professional device won't have built-in microphones, and the expectation is that high-quality external microphones will therefore be used. Your device will almost certainly have built-in microphones but may also allow you to connect external microphones, either as an alternative, or as additional to the built-in ones. If you are using external microphones then you will have the chance to position them carefully before the birds start singing, and monitor the recording from a point further away.

If you choose to record a live concert, you won't have much control over the timing of the event, and you won't be able to get the performers to redo any sections if either you or they make a mistake, so you will have to be ready to go and get it right first time. If you are

organised enough you should be able to set up before the sound-check or rehearsal and get an idea about the best position for your microphones or device and what levels to set while this is happening. Making recordings during rehearsals is a great way to learn how your device works in practice without the pressure of having to capture a one-off performance. Recording is a social practice, so the better the relationship you have with the performers, the better chance you will have of asking them to play a loud bit in rehearsal so that you can make sure you have made the right gain settings.

The visual element of any performance is always going to be important for the performers and the audience, so this will place limitations on where you can place your microphones. It is often the case that the most effective place for capturing the best sound simply isn't accessible because of this reason, so you have to be ready to compromise. Given the presence of an audience, this should also make you think about microphone choice and positioning.

Activity 6

Allow about 5 minutes

Take a moment to write a list of as many different kinds of noises that an audience may make.

Discussion

Your list may include applause, cheering, coughing, sniffling, chair creaking, chatting, rustling or dropping programmes, glass clinking, children crying, and many other sounds. Some of these could be essential to include as part of your recording, but many other can detract from the end result.

Of the two main types of microphones – directional and omnidirectional – the most common choice for live recordings is directional, as this gives you at least some ability to focus more on the performance and less on the audience. This choice might not eliminate incidental noises, but it can reduce their amplitude relative to the performance, and it will still pick up applause very clearly.

Your device may not offer you any choice of microphones, in which case your main focus should be on deciding exactly where to place it in order to capture the right balance between each instrument and the space in which they are playing. This will almost always be somewhere along a line that passes through the centre of the space. If you place your device to one side, you will most likely end up with an unbalanced recording that has one channel quieter than the other or else contains more signal from the instruments on one side of the stage than the other.

In order to find the best distance for your device or microphones, you will have to experiment by making several recordings with your device at different distances from the sound source. It's a good idea to try the extremes of distance first, and then, making careful notes, and taking photographs or maybe even using a tape measure, make more recordings with your mics at different locations. You will probably have to wait until you get home to be able to listen to these recordings properly, so making accurate notes is vital. In this way you should be able to build up a sense of how your device works best, but this will also give you great practical experience of how and why recorded music can sound so different.

6.1 Minimising noise

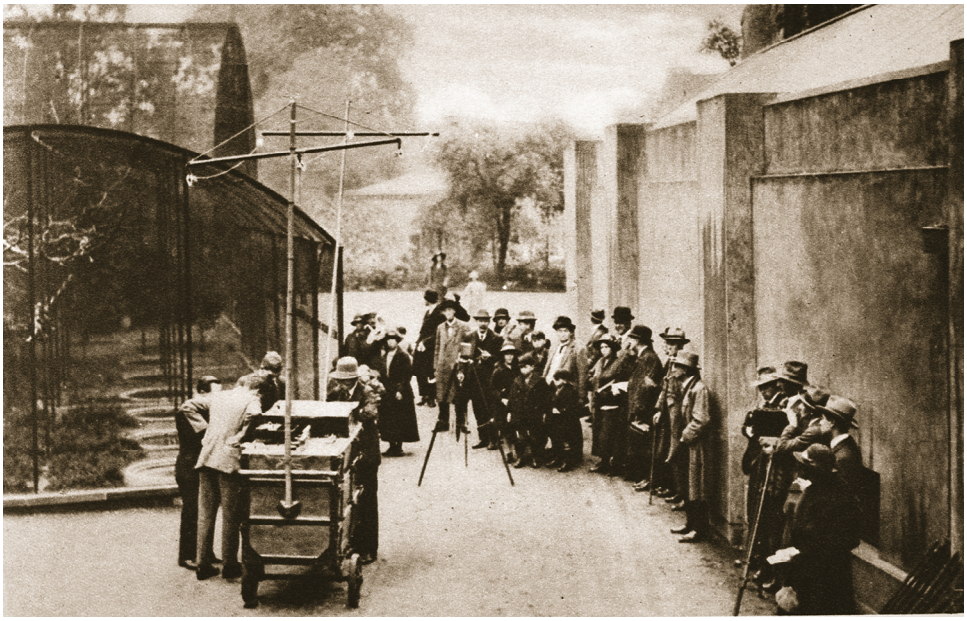

Figure 21 An early outside broadcast by the BBC from London Zoo as technicians attempted to record the sound of screeching from the aviary, from 'Wonderful London', published 1926-27 (photogravure), English Photographer, (20th century)

It is always best to try to reduce any background noise as much as possible. Best practice, as with virtually all audio practice, is to start at the source and not to rely on fixing problems later on. When you are recording at home you can easily address most noise issues. Simple things like closing doors and windows and turning off televisions and radios will help. Less obvious sources of noise are central heating systems and fridges. You may not be aware of central heating noise until you turn it off, at which point you should appreciate the reduction in low-frequency rumble and general background noise.

One of the first things I do when recording on location is to listen for a ticking clock. This is the kind of background sound that can easily avoid your direct perception because it is such a familiar sound; however, a ticking clock can ruin a recording, especially any quiet passages which require the listener to focus on the smallest detail in the music.

In order to move clocks or remove clock batteries, turn off central heating systems, and generally combat other such noise sources in public buildings, it is essential to develop a good working relationship with the custodian or caretaker of the building that you are using for recording. These social interactions are a fundamental part of making successful recordings, and the more sensitive you are when making such preparations for a recording session, the more help you will get during a session, and with future sessions.

It may not be possible to eliminate all types of noise, and in the winter, it may not be possible to turn off the central heating. In these cases you can sometimes compromise by asking to have turned off any particularly noisy radiators, but it might be that you need to reposition the performers and/or your microphones or recording device to move them away from any noise sources.

6.2 Mains Hum

Anything electrical that is plugged into the mains can be susceptible to hum. Mains electricity is an alternating current, whereas something like a battery provides direct current. In the UK the mains voltage is about 240 V, with a frequency of 50 Hz. Most of Europe has a voltage of 220 V at 50 Hz, while the USA has a voltage of 110 V and a frequency of 60 Hz.

The voltage doesn't cause noise, but the fact that it is alternating and not direct current can cause problems. The 50 Hz frequency (in the UK and Europe) can interact with some components inside electrical devices such as transformers, and can cause a vibration which is audible as a hum. The fundamental frequency of this hum is usually 50 Hz, (or 60 Hz in the USA), but just like a musical instrument, this can have a number of additional harmonics.

If you notice any hum in your recording environment, if possible, try to turn off any problematic device before recording.

7 End-of-course quiz

Check what you've learned in the course by taking this quiz:

End-of-course quiz

Open the quiz in a new window or tab and come back here when you're done.

Conclusion

The recording world today is a thoroughly mixed economy. Some people's experience of recording and of recorded music is exclusively through their computers, whereas the experience of others is through much more traditional means – the relatively recent rise in sale of vinyl discs, for example, is noteworthy. Some knowledge of all of the technologies developed in the twentieth century is therefore necessary for an understanding of the range of processes involved in recording today. In this free course, *Recording music and sound*, you have developed an understanding of the history of recording and have gained some appreciation for the kinds of issues that you would need to consider were you to make your recordings.

This OpenLearn course is an adapted extract from the Open University course A232 *Music, sound and technology*.

References

Midgley, S. (1934) My seventy years' musical memories (1860-1930), London

Acknowledgements

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Figure 16 Photo: © Jeff Geerling

Figure 17 Photo: Courtesy of Rycote.

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