Plate* and Platter** Preservation*** – Sound

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"The phonograph record is a relatively new type of historical document. Although the sound recording as a means of preserving musical performance is its best-known form, music is not the only subject which has gained by the invention of the phonograph. Today there are public and private industrial libraries each of which contains several hundred thousand instantaneous recordings of broadcasts of political and literary significance. These are mostly in the forms of discs and magnetic tapes. Many of these recordings are rare, if not actually unique, and most of them are of great historical importance. There was a time when only large research, university, and industrial libraries collected sound recordings, but now the inclusion of phonograph records in the collections of even small circulating libraries is standard practice. Moreover, the number of private individuals collecting sound recordings and recording equipment has grown enormously, particularly since the advent of the long-playing record and the magnetic tape machine. The phonograph has become very valuable as an aid in the development of the appreciation of music, literature, and other fields of learning."

The above view was expressed simultaneously some 20 years ago by both Quincy L. Mumford, of the Library of Congress, U.S.A., and Dil. Egabrag of the International Record Collector's Association. The statement applies to the current situation in Australia where educationists and conservators are slowly entering the audio-visual technological age with varying degrees of trepidation and enthusiasm. The historical reluctance of some groups to involve themselves with sound recording preservation is associated with an ignorance concerning the many forms of sound recordings that have evolved over the past hundred years.

It is for this reason that this paper first indulges in a brief chronological history of technical developments relating to sound recording and reproducing equipment.

History

1877 *18 April.* Frenchman Charles Cros deposited at the French Academy of Sciences a sealed packet containing details of a photomechanical system of recording and replaying sound, accompanied by instructions that the package should not be opened until 3rd December of the same year. There is no evidence that Cros ever put his system into working practice.

1877 *24 December.* Thomas Alva Edison, of Menlo Park, New Jersey, USA, filed the first patent application for a phonograph or speaking machine (USA Patent 200 521). The patent described a cylinder recording system and is generally regarded to be the prime invention of the recording industry. By the time of filing, Edison had already succeeded in making the described machine work – albeit only to record and reproduce first the word, "Hallo" and eventually the phrase, "Mary had a little lamb."

1887 *4 May.* Emile Berliner, of Washington DC, USA, patented a method of groove cutting which enabled the mass duplication of recordings and paved the way to eventual takeover from the cylin-

* "Plate" was a 19th century term employed during the pioneer days of gramophone development for a 7" single-sided disc.

** "Platter" is a 20th century term in vogue during recent times to describe a modern LP recording.

*** "Preservation" is a traditional Australian public service term for storage and restoration of historical documents at minimum financial outlay and staff allocation. It derives from the Greek "oppreservio" meaning "never to be kept under optimum conditions".

der by the disc as a domestic recording medium. But Edison had in fact, ten years earlier suggested both the use of a disc as an alternative to a cylinder, and the mass reproduction of copies.

1888 *May*. Berliner demonstrated a working prototype of a disc-playing gramophone.

1893. Gramophones and pressed discs first appeared on the market in the USA. (Various forms of cylinder records co-existed and competed vigorously with various forms of disc up to the 1914-1918 War after which cylinder sales declined rapidly).

1900. Valdemar Poulsen of Denmark exhibited his magnetic wire recorder at the Paris Exposition. But Sumner Tainter had made proposals for magnetic recordings ten years previously.

1914-1918. (The Great War period) saw the decline of the cylinder as a commercial record medium although the Edison Company continued their production up until the end of 1929.

Mid 1920's. Advances in the microphone and electronic valve amplifier made all-electric gramophones and recordings available at domestic level (previously recordings had been made and reproduced acoustically). Electrical recording commenced in Australia in 1926.

1931. British inventor, Alan Dower Blumlein, invented the first workable method of storing two separate stereo channels of sound in a single recorded groove on disc.

1934. BASF in Germany produced the first magnetic recording tape for use with a magnetic tape recorder developed by AEG and shown at the Berlin Broadcasting Exhibition in 1935.

1948. Dr. Peter Goldmark of CBS produced a workable commercial longplaying record (attempts at producing slow running discs date back to 1904). The new disc ran at 33-1/3 rpm instead of 78 rpm, relied on new materials and contained far more grooves per inch, thus giving rise to the term 'microgroove'. The first LP discs to be manufactured in Australia were marketed in 1952.

1950's. Stereo records became widely available in the shops, delayed mainly by controversy in the industry over which of several possible methods of recording the channels to adopt. The method adopted most closely resembles that invented by Blumlein in 1931. However, it took until around 1960 for the 78 r.p.m. disc to disappear from most shops in the Western world. Its disappearance was speeded by the development of the small 7" disc running at 45 r.p.m. Stereo recording in Australia commenced in 1960.

1970's. Quadraphonic recordings were made available, 4 channels of sound being recorded in a single record groove instead of two for stereo. Confusion still exists over which of several possible techniques are best and should be made standard. This confusion is largely responsible for the failure of quadraphonic recordings to become a commercial success.

Local History

Both cylinder and disc recordings have been commercially available in Australia since the 1890's Prior to the mid 1920's all sound recordings available in Australia were imported, chiefly from England, Europe, U.S.A. and Canada. During the mid 1920's local manufacture commenced giving local artists the opportunity to be recorded in their homeland. Since that time the recording of Australian performers has been quite extensive and continues to accelerate today.

Australians buy more gramophone records each year than they do books which indicates the importance of the industry as well as the significant contribution recordings make both for enjoyment and education. Archivists are likely to encounter three main physical types of sound recordings, these being cylinder phonograph records, gramophone discs, and magnetic tape.

Some of the physical forms of these recordings are not archivally permanent no matter how suitable the conditions under which they are stored. Such recordings are best described as "temporary" items, as opposed to permanent forms of recordings, such as modern LP's.

Here is a brief initial summary of each of the three types of sound recordings most encountered in record collections:

Cylinder Phonograph Records. The wax cylinders are most fragile and can only be described as temporary. Where the importance of the contents warrants such action the wax cylinders should be copied on to tape for eventual re-mastering as LP pressings. The more common Blue Amberol cylinders (made out of celluloid 1912-29) and other similar indestructible cylinders are permanent in nature.

Gramophone discs. Commercial 78 r.p.m. discs (1890's-1960) and modern LP discs are permanent in nature and under correct storage conditions should last indefinitely. However, a great deal of valuable material is recorded on 78 r.p.m. acetate discs (glass or metal based) and these will eventually break-down so re-recording is necessary. In most cases acetate discs were made for private or special purposes where only one copy was required which often makes them all the more important.

Magnetic Tape. Despite its many virtues and valuable uses magnetic tape is not accepted as a means of permanently preserving information. It suffers from a number of physical shortcomings which

modern technology has not yet overcome to the satisfaction of archival requirements.

Causes of Deterioration.

An obvious cause can be incorrect or inadequate playback facilities. However, we shall concern ourselves primarily with the reasons for physical deterioration and correct storage procedures.

Reasons for Deterioration

The degradation in sound recordings is induced by the process of manufacture, light, heat, moisture, dust and atmospheric contaminants. The degradation may be physical or chemical. These changes are, however, interdependent and take place simultaneously in the plastic material. Such changes cause permanent deformation, embrittlement, cracking, loss of adhesion between laminates or loss of strength.

Manufacture. The life span of a plastic article under ideal conditions is a property which is built into the article when it is manufactured. The uncontrolled variables are the basic resin, the materials added to the basic resin to alter its properties to the ones desired and the manufacturing process. Presence of certain chemicals even in traces or changes in process techniques such as changes in cycle time, temperature or pressure cause internal stress and changes in retained solvent. Such changes initiate chemical degradation of the plastic.

Light and Heat. Light whether natural or artificial has a deteriorative effect. All sound recordings are sensitive to ultraviolet and deteriorate on exposure to sunlight and artificial light rich in shorter wave lengths.

Thermal energy, on the other hand, causes both physical and chemical changes. Plastics have high co-efficient of thermal expansion and low thermal conductivity. Their viscosity also changes with the change in temperature. Combination of all these factors results in changes in size and shape of the plastic thereby causing permanent deformation. It has been observed that chemical changes are accelerated by increase in temperature.

Moisture. Moisture is both a physical and a chemical agent of degradation. Changes in moisture content cause large dimensional changes in the plastic base and fillers and affects physical properties such as impact strength. Excessive moisture also brings about chemical change either by hydrolysis or by acting as a catalyst or by its solvent action. In hydrolysis water reacts directly with the plastic base. As a catalyst, it catalyses other reactions. As a solvent, it enables those reactions to take place which can occur only in solution. Besides, it helps migration of compounds from one place to another within the material. Excessive moisture is also conducive to biological deterioration.

Dust. Dust and grit cause both physical and chemical degradation of sound recording materials. Physical damage is caused by scratching of the surface or embedment of dust particles on the surface. These affect the playback qualities. Further, dust is not an inert material. It provides both acid radicals as well as metallic ions which catalyse degradation processes. Dust films attract moisture which is essential for starting chemical action on materials. The thermoplastics are electrostatically charged from the moulding process. Since they are poor conductors, the surface charge remains for a long time. This surface charge gets renewed during handling and playback. It attracts dust to the surface and holds it there.

Oxygen. Depending upon the nature of plastics and environmental conditions, oxygen can cause minor as well as serious chemical degradation. For example, chemical changes that occur in the plastic during the process of manufacture or on exposure to light and heat, provide sites for oxidative reactions which lead to degradation of the plastic. It has been observed that all the presently made materials are quite stable to oxygen in the absence of light or excessive temperature, certain trace impurities and excessive moisture. It has also been observed that properly packaged materials are not affected even in heavily contaminated environments.

Fungal Action. Fungi are a significant cause of deterioration of the organic ingredients used in sound recordings. They consume the plasticizer and affect the surface by the variety and kind of chemicals they manufacture. They excrete both enzymes and acids which attack not only the nutrient media but other materials also. Excellent fungi nutrients incorporated into sound recordings are plasticizers, fillers and extenders. The basic resins are fungi resistant except cellulose nitrate and cellulose acetate. Of these, cellulose acetate is the most resistant of the cellulosics. Many of the packaging materials used in storage provide carbohydrates, proteins, waxes, cellulose and lignin for fungi nutrition.

Fungi require an adequate amount of moisture to be active and destructive. Most dusts and lints are hygroscopic to a degree and tend to maintain a higher moisture level on a surface than would otherwise exist there. Finger prints also provide a good culture media.

Other biological agents, such as bacteria and insects, do not seem to be a problem for sound recordings.

Other Factors. Degradation may also be induced by deterioration of the constituents of a plastic such as plasticizers, fillers and extenders. The

physical properties of a basic resin are changed to the desired ones with the help of plasticizers. These plasticizers may be lost either by volatilisation, extraction, exudation, wicking, chemical degradation or biological consumption. This loss induces chemical degradation and results in damage to the plastics. Fillers are used to modify the physical properties of a resin, such as in shellac, or for economy as in vinyl discs. These fillers are protected by their resin coatings, but can be attacked by anything which diffuses through the resin such as moisture due to changes in humidity.

An extender is an organic material blended with the basic resin. They are less stable than the basic resin and reduce the potential storage life of the plastic. They are attacked by the same degradative agents as other organic materials and the resin are and are responsive to the same environmental changes.

Shelf Life

Most sound recordings have been designed for playback qualities and low cost and not for long-term storage. They are subject to both physical and chemical degradation as a result of the action of deteriorative agents on a number of materials that go to make them. At present, because of the limited experience relating to the ageing of plastics, it is not possible to predict precisely their potential shelf life. However, studies do indicate a certain trend and give an idea of their potential life.

Acetate Discs (Temporary). They have a limited shelf life because of the known instability of the material. It has been observed that under ordinary storage conditions acetate discs of the older formulations have a maximum known life of about 15 years, while the modern acetate discs have a slightly longer life.

Shellac Type Discs (78 r.p.m.). These discs have survived for more than 70 years and appear to be still in excellent condition. However, under adverse conditions, some of them have deteriorated in less than a decade. These discs appear to have excellent storage life when properly protected against the deleterious effects of moisture, heat, fungi, etc.

Vinyl Discs (LP's). They show resistance to chemical degradation in an ordinary storage environment. However, under poor storage and environment they can undergo rapid physical damage, such as warpage and may become unplayable. Such damage seems to be of far greater significance than chemical degradation. If kept properly they appear capable of lasting a century or more.

Magnetic Tapes. They undergo both physical and chemical degradation. Most of these were not designed for long-term storage but for playback qualities and low cost. Their life is adversely affected by their winding under tension. Such windings create high radical pressures in the roll of tape which diminish in intensity from the hub outwards. This pressure causes longitudal warping. It has been observed that any unevenness in stress distribution in the tapes results in localised permanent deformation which impairs their playback qualities. The difference in properties of the film base and coating results in curl, i.e. transverse warping of the tape. Another cause is magnetisation. The tapes are affected by the magnetisation induced by temperature, time, A.C. and D.C. fields which often result in print-through.

It should be noted that cassettes are inferior generally to reel-to-reel tapes due to the low recording speed (the faster the tape speed the better the quality of reproduction) and the physical problems that beset cassettes due to their design and mode of operation. All tapes are subject to breakage, especially during their later life.

Recommendations for Storage.

Gramophone Discs. In order to store records for a long period of time, it is necessary to take several precautions to protect them from the deteriorative action of heat, light, moisture, atmospheric contaminants, etc. It must be ensured that in the storage areas the temperature and humidity are maintained at a reasonably constant level. To maintain an environment of 50 ± 10% R.H. and temperature 70° ± 5°F, day in and day out, it would be necessary to air-condition completely the entire archive area. If this is not possible, the playback and storage rooms should meet these standards and in other places the temperature and humidity should be maintained at a reasonably constant level. The entire area should be dust free. Discs should be kept clean both for playback and storage by means of a special applicator.

For preventing fungal damage, the discs should be clean and packed for storage in packing material free from fungal nutrients. At the time of packing, the moisture on the disc surface should be below the amount required by fungi to be active.

Care should be taken in lighting the stack and playback rooms. Sunlight or artificial lighting of shorter wave lengths such as certain mercury vapour fluorescent lights should neither be allowed to enter nor used.

The discs grooved surfaces should never be handled with bare hands. Rubber gloves should be worn by the persons concerned. The discs should be removed or inserted in the packages without touching the grooved surfaces or permitting sliding contact between the grooved surfaces and the

packaging material. Most commercial packaging materials used for disc storage are all unsatisfactory in one regard or the other. The proper packaging material should not only be resistant to the degradative agents but should protect the discs against any damage. It should present a smooth surface to the discs so as to permit withdrawal and insertion without sliding contact between the disc and package. The package should also have structural strength to help vinyl and shellac discs resist warping. It should not itself deform and cause surface damage to disc by high contact stresses. The most satisfactory material appears to be a laminate of polyethylene, paperboard, aluminium foil and polyethylene.

Record sleeves sealed during manufacture with an organic glue can etch vinyl discs causing faulty reproduction. Thus an inorganic glue should be used for sealing record sleeve edges. Prior to insertion, both the disc and the envelope should be in equilibrium with an atmosphere of 50% R.H. and 70°F. A conditioning room is recommended for the purpose. The humidity content should never be higher than the recommended one at the time of packing as it may result in damage to the disc. After packaging the discs should be stored in the vertical position without pressure on the disc surface. Also it should not provide opportunity to the disc to slip to an off vertical position.

The standard method of maintaining discs in an upright situation is to use dividers every 4" or 5", which permits about 25 to 35 discs to be stored in each section. It is kept full of either packaged discs or fillers and packaged discs in such a way that the discs remain upright and can also be removed or placed back without exerting any force.

Physical inspection for warping, fungus action or other visible evidence of deterioration should be carried out periodically. This would help to re-record the recordings when necessary to ensure preservation.

Magnetic Tapes. The precautions necessary for preserving the magnetic tapes are the same as in the case of discs in regard to temperature, humidity control, lighting and packaging. However, additional care is necessary in use and storage of magnetic tapes. For example, for winding tapes only metal reels with unslotted hub should be used. If the flanges of these reels are deformed or get deformed they must be replaced.

Reels should be packaged in sealed metal cases or sealed boxes of a material such as polyethylene, cardboard paper, aluminium foil and polyethylene laminate. The tapes should be packaged only when they are in equilibrium with 70°F and 50% R.H. For storage, the boxes should be stacked on edge in the shelves. Packaging and playback rooms and stack areas should be maintained at the temperature and humidity recommended for discs. But in the case of seldom used and vulnerable tapes the storage should be in special vaults having a temperature of 50° ± 5°F and humidity of 45 to 50% R.H.

Stray external magnetic fields should not be permitted in the stack, playback and packaging rooms as they adversely affect the magnetic tapes. All current bearing wires have associated magnetic fields. Therefore, all electric circuits should be properly installed and balanced. Then there would be no cause for trouble as the fields will cancel out.

Playback of tapes should be limited to the minimum necessary, for wear and tear will do more to shorten the life of any sound recordings than any other factor. Tapes suffer more damage from the handling required to load and unload the playback unit than from the actual playback itself. For this reason care should be taken to avoid twisting, tearing or soiling the tape. Finger prints on the tapes should be prevented by the use of gloves. Equipment used for playback should be separate from the one used for recording so as to avoid accidental erasure during playback. Equipment and tape should be kept clean and dry to ensure proper reproduction and to avoid any damage to the recordings. Dust and particles of the tape coating often collect on the recorder heads where they not only affect the quality of the reproduction, but also abrade the tape.

The first and the last fifteen feet of the tapes should not be used for programme recording to enable the blank tape to be used for inspection purposes. Tapes should be aged in the packaging room for six months prior to recording. While recorded tapes, which have been exposed to other than the prescribed environments, should be conditioned in the packaging room for six weeks prior to packaging.

The tapes should be inspected and wound after each playback. Besides they should be inspected every two years and then rewound so that the curvature of the base is opposite to the direction of the previous curvature. The inspection should include spot check at the tape and next to the hub for coating adhesion or delamination. The rewind will help in reduction of creep induced curvature and print-through. Regular inspection and rewinding will further limit the cumulative effects of print-through and will reveal the need for re-recording of the tape before deterioration has destroyed the information.

Storage shelves should be of wood or a non-magnetisable metal and free from vibration or shock.

Sound archives which include tape material of historic importance should give consideration to undertaking an archival re-recording program so as to transfer such material eventually to LP vinyl pressings where deterioration is minimal.

This process whilst not cheap is far superior to attempting to re-record say every ten or twenty years on to new tape, with progressive gradual loss of sound quality with each copying process.

The Australian National Collection of Sound Recordings

The National Library of Australia established a national collection of sound recordings in August 1973 and over the past three years the collection has grown from just under 500 items to 250,000 recordings, incorporating one million titles. This collection is the largest of its type in the southern hemisphere and one of the ten largest collections of sound recordings in the world. The collecting policy is not restricted and covers all physical types of recordings from those pre-dating Federation to deposit by gift of current manufacturers latest releases.

The collection embraces all types of music from hillbilly to opera, and includes a wealth of non-music material, including spoken word, educational, current affairs, interviews, radio, film and television soundtracks, bird calls, sporting events, poetry, and so on.

A feature of the collection is the radio transcriptions (1935-1955) featuring 60,000 discs, the output of Australian actors, musicians, composers, producers and writers. Another well-represented area are speeches by prominent Australians, including many by politicians, sportsmen, and performing artists, recorded from radio broadcasts over the past 40 years.

The Sound Recordings Sub-Section staff of two officers is responsible for collection building, acquisition, storage, cataloguing, accessioning, selection, cleaning, and general organisation, as well as providing a national listening and copying service to all sectors of the community, including educationists, students, historians, and the Australian broadcasting, publishing, film and television industries.

No sound recording engineers or technicians have been appointed to provide professional service or permit archival re-recording to be undertaken. The collection is stored in cardboard cartons in a warehouse.

Sound recordings are cultural assets worthy of preservation that are of great value as tools for both education and enjoyment. There is ever increasing pressure for access to such deposits of information for incorporation in audio-visual teaching aid programmes.

Very few Australian conservators and institutions have undertaken to treat sound recordings as a document worthy of similar treatment to that afforded longer established historical documents, such as books and physical objects. In particular the time is opportune for conservators to explore the use of oral history interviews as a means of gathering information. This technique is a most exciting and rewarding method of documentation which is gaining increasing acceptance overseas but is neglected in this country. Readers are welcome to use the resources of the National Library of Australia should they seek to gain further information concerning the use and preservation of sound recordings for gathering, preserving, and making knowledge available.

Recommended Reading

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The Talking Machine Review, published six times a year. Ed. E. Bayly, 19 Glendale Road, Bournemouth BH6 4JA, England.

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The Phonogram, published six times a year, by the Victorian Division of the Phonograph Society of Australia, Ed. Mr. A. W. Savery, Box 321, North Melbourne, Victoria.

The Phonographic Record, published six times a year by the Vintage Phonographic Society of New Zealand, Ed. Mr. W. T. Norris, "Waipapa", Swannanoa, Rangiora R.D. 1, New Zealand.

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