School of Music RePlayed: A Case Study in Audio Archiving

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Introduction

This project began in 2014 when, on arrival at the ANU School of Music, music technology convenor Assoc. Prof. Samantha Bennett was shown the School's archive of tape recordings. At that stage, the tape archive was housed in the School's basement and appeared not to have been moved nor attended to, in some considerable time. Featuring predominantly classical music recordings, the School's performance archive is home to more than twelve hundred concert and recital recordings – most on seven-inch reel-to-reel analogue tape – and dates back to 1968. On recognising the need for preservation, Bennett contacted the National Film and Sound Archive (NFSA) and, shortly afterwards, began a digitisation project to preserve the School's archive.

Undertaken within the framework of a memorandum of understanding between the NFSA and School of Music's parent college, the College of Arts and Social Sciences, the project 'School of Music RePlayed' was proposed. The project brought together the technical expertise of the NFSA in archiving and audio digitisation with the School of Music's educational mandate to deliver an accredited, hands-on practical introduction to audio archiving for undergraduate students in a two-week intensive program. The project coincided with the School of Music's 50th anniversary in 2015 and began the process of unlocking the School's recorded history from its extensive collection of reel-to-reel tape. In order to springboard the project, an ANU Linkage for Teaching and Learning Grant was applied for and awarded. This $20,000 cash grant was augmented with further in-kind support from NFSA including provision of facilities, development of training materials and staff time for tours, demonstrations and both theoretical and practical training sessions.

A large team of staff from NFSA contributed to the project, from across teams including Audio Services, Conservation & Research, Collection

Information, Collection Management and Collection Systems. This article focuses on a number of issues concerning the archive, as well as reflects on the design of an audio archiving curriculum. Here, particular attention is paid to School's archival preservation needs, the state of the collection and the creation of a database of accessible digitised recordings. Additionally, this article considers the pedagogical opportunities presented through such a project and the design and delivery of an undergraduate and postgraduate level audio archiving course in 2015, 2016 and 2018.

The Collection

Historically, the ANU School of Music has focused on performance, although the School's facilities include both performance and recording venues. This resulted in the development of a substantial collection of recorded performances that include performances by staff, students, alumni and visiting artists. Beyond cataloguing, little attention has been paid to this collection and, prior to the project commencing in 2014, some School staff were rightly concerned that the collection was at risk. The best-known part of the collection resided in steel shelving in a basement storeroom, entered via a very noisy plant room and surrounded by various musical instruments such as the School's Gamelan, various electronic organs and a variety of large orchestral instruments.

An initial survey of this part of the collection identified some highly significant recordings, for example, performances conducted by luminaries such as Ernest Llewellyn, but also included less significant material such as examination recitals by students over many years, and material of quite low priority such as recorded and broadcast music presumably used as research or study material. The tape collection comprises approximately 1400 tapes in total, on a variety of stock and with varying degrees of technical and descriptive metadata noted on the boxes. The majority of the collection was on stock known to have issues with binder hydrolysis, particularly Ampex, though sufficient examples of more reliable tape brands, including Scotch and Memorex, gave us confidence that we would be able to find some material that could be copied without time consuming rejuvenation treatment, which would not be possible within the initial timeframe for the course. The physical environment where the collection is stored was not conducive

to safe working with the material, and remains entirely unsuitable for storage of magnetic tape, with uncontrolled temperature and humidity and unsealed concrete surfaces. As the project proceeded we identified additional storage areas containing audiotapes, some of which were slightly less unsuitable but still concerning. The School's archival collections also include recordable CDs used for many student recordings in the post magnetic tape era, cassette and DAT tapes, a small selection of processional audio and audio-visual recordings related to publication or broadcast project, published vinyl discs and of course significant quantities of documentation.

Preservation needs and challenges

The potential digitisation of the School's performance archive was addressed in 2014. At this stage, a number of preservation needs were established, to include the ongoing storage of the tape collection in more appropriate conditions than where the collection is currently housed. The current storage conditions expose the tapes to variable temperatures over the course of a year and whilst the conditions are dry, the tapes require an alternative storage solution with regulated temperature and humidity. In a small School, such a space is both difficult and costly to secure and a solution to this issue is yet to be found. Another major challenge to digitisation lies in the condition of the tape collection. The archive has moved at least three times and a range of common deterioration issues have been identified. These include: packing issues such as leafing, ribbing and blocking – some tapes also present with mild windowing; binder hydrolysis, particularly problematic amongst the Ampex tapes; and, general dust and dirt.

Tape Brand	Reel size	Approx. percentage of collection
Ampex 641	7”	20%
Ampex 642	7”	20%
Ampex 651	7”	10%
Scotch 207	7”	5%
BASF SP54R	7”	2%
EMI HDP24	7”	2%
Racal Zonal	7”	3%
Ampex 642	10”	10%
Ampex 444	10”	10%
Scotch 207	10”	2%
Ampex 641	5”	10%
Memorex	5”	4%
Other (EMI, OTARI)	10”	2%

Table 1. Breakdown of tape types in the School of Music archive

In terms of packaging, all tapes are housed in their original cardboard or plastic boxes, most of which remain in good condition. Metadata is present on most tape boxes, although there is significant variation in detail. Most tapes feature information pertaining to date, performer(s), composition(s) and composer(s), tape speed and track numbers. However, some tapes contain no metadata at all and, in a few cases, stickers originally attached to tape boxes have been lost or are detached from their original casing. Additionally, multiple tapes were found on the shelves without any packaging at all. Some of these loose tapes had basic metadata written on the reel, whilst others featured no information at all. These tapes were particularly dusty and featured significant creasing and packing issues due to the absence of end fastenings. In some instances, tapes were found on shelves with loose tape unravelling onto the floor.

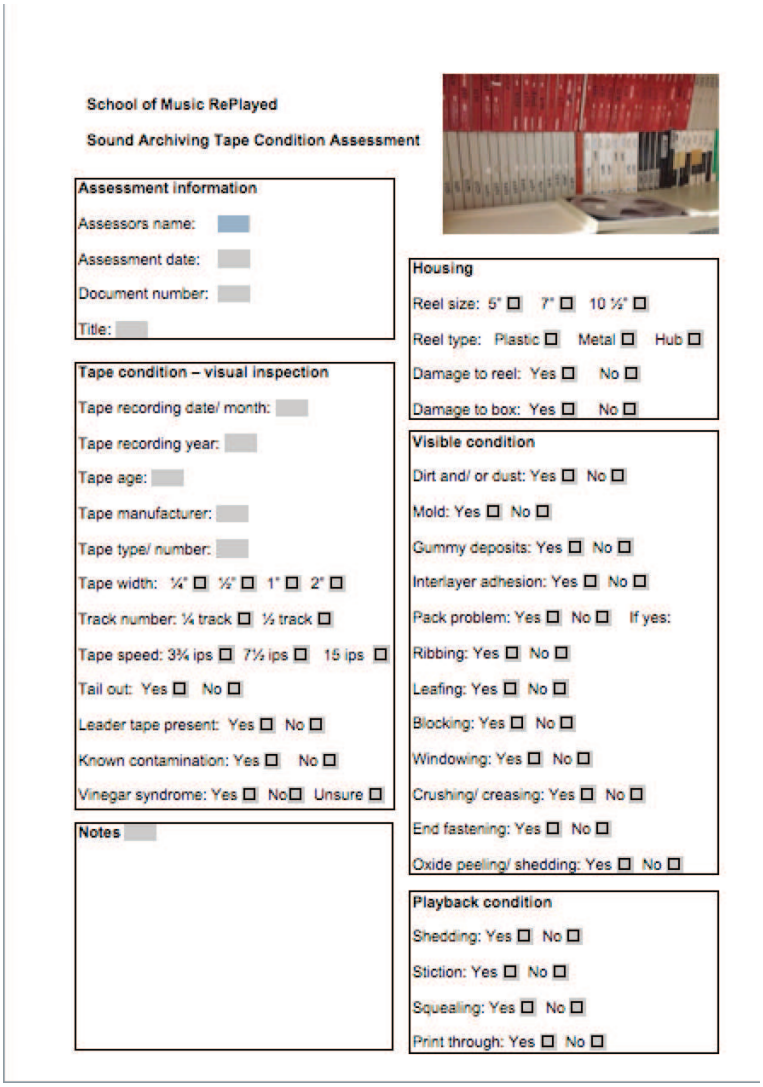
Most reels are in excellent condition and present no signs of damage, suggesting the tapes have always been moved and stored with care. Most of the tapes present 'tail out', yet none featured leader tape and only a few had an end fastening. Where end fastenings were present, many were loose or had become detached from the tape. The general absence of leader tape and fastenings suggests the recordings were made quickly, as documents of events and exams as opposed to professionally recorded for reproduction and/or release. Indeed, there was little to no evidence of professional recording practice, moreover, recordings had been made 'on the fly' with little attention to detail.

By 2016, most of the tapes had been inspected and presented with no signs of vinegar syndrome or mould. Yet by 2018, during the third iteration of the Sound Archiving course, a Scotch tape was found to be mouldy and was quarantined.

Fig. 1. Scotch Tape with Mould (2018)

The tapes exhibit common signs of deterioration and many are dusty. The Ampex tapes, most of which are consumer level 'voice grade' tapes, present with the most problems. On playback in 2015, Ampex seven-inch tapes squealed to varying degrees indicating binder hydrolysis or 'sticky shed' syndrome. Furthermore, oxide shedding from fine particles

to large shreds was present on playback. Conversely, the Scotch and BASF seven-inch tapes, although featuring some packing problems, play back with no issues at all. In order to accurately assess the condition of tapes in the School's archive, a condition assessment report form was designed, based on similar, existing forms used by the National Film and Sound Archive.



School of Music RePlayed

Sound Archiving Tape Condition Assessment

Assessment information

Assessors name:

Assessment date:

Document number:

Title:

Tape condition – visual inspection

Tape recording date/ month:

Tape recording year:

Tape age:

Tape manufacturer:

Tape type/ number:

Tape width: ¼" ☐ ½" ☐ 1" ☐ 2" ☐

Track number: ¼ track ☐ ½ track ☐

Tape speed: 3¾ ips ☐ 7½ ips ☐ 15 ips ☐

Tail out: Yes ☐ No ☐

Leader tape present: Yes ☐ No ☐

Known contamination: Yes ☐ No ☐

Vinegar syndrome: Yes ☐ No☐ Unsure ☐

Notes

Housing

Reel size: 5" ☐ 7" ☐ 10 ½" ☐

Reel type: Plastic ☐ Metal ☐ Hub ☐

Damage to reel: Yes ☐ No ☐

Damage to box: Yes ☐ No ☐

Visible condition

Dirt and/ or dust: Yes ☐ No ☐

Mold: Yes ☐ No ☐

Gummy deposits: Yes ☐ No ☐

Interlayer adhesion: Yes ☐ No ☐

Pack problem: Yes ☐ No ☐ If yes:

Ribbing: Yes ☐ No ☐

Leafing: Yes ☐ No ☐

Blocking: Yes ☐ No ☐

Windowing: Yes ☐ No ☐

Crushing/ creasing: Yes ☐ No ☐

End fastening: Yes ☐ No ☐

Oxide peeling/ shedding: Yes ☐ No ☐

Playback condition

Shedding: Yes ☐ No ☐

Stiction: Yes ☐ No ☐

Squealing: Yes ☐ No ☐

Print through: Yes ☐ No ☐

Fig. 2. Condition Assessment Form (2015)

All tapes in the School's archive had been recorded at different speeds ranging from 15ips, 7½ips and 3¾ips and there were some instances of single tapes featuring recordings at different speeds, as well as some tapes recorded in stereo two-track, whilst others recorded to four-track in stereo on both sides of the tape, presumably to maximise recording time. This presented another significant challenge since, of the School's five playback machines, four are stereo two-track Studer Revox B-77's and one is a stereo two-track A-77; the School does not currently own a four-track ¼" machine. Additionally, many of the tapes that were clearly recorded to four-track were incorrectly labelled as two-track or not labelled at all. This made tape playback unpredictable and the School requires a working four-track machine in order to digitise a portion of the archive. Further challenges arose in the digitisation process, to include the ongoing maintenance of analogue tape recorders.

Another challenge lies in the preservation of metadata. The School's archive has moved at least twice in its fifty-year history and much of the preserved metadata pertains to a library system where the library no longer exists. Many of the tapes feature stickers 'Canberra School of Music Library'; the Canberra school of music was absorbed into the Australian National University in the early 1990s. Also, all tape boxes feature a number corresponding to a file system in a large library reference book. Tape information varies dramatically, from no metadata at all to detailed documents of performer(s), date, performed piece(s), composer(s) along with tape speed information. Many library cards feature further metadata, but a number of these are disconnected from the original tapes and require reattaching. In some cases, this has been achievable due to matching information present on the reel, or immediate recognition of musical pieces on the recording. However, in other instances, library cards remain detached. Some metadata is present on stickers attached to the reels inside the tape boxes, however such stickers are present on a small fraction of the archive and most reels feature no information at all. Additionally, in 2014, inventory management company Stagebitz conducted an inventory of all equipment and instruments in the School of Music, to include tapes in the archive. Documents pertaining to this inventory proved more useful to the project than the original library system and it was from this list that a project log was created to include needs and condition assessments on each audio artefact, as well as charting digitisation progress.

As condition assessments were carried out on the tapes, some were deemed ready for digitisation. In doing so, the project referenced multiple standards for audio preservation and digitisation, to include the AES Standard for Audio Preservation and Restoration – Magnetic Tape (AES49-2005). Additionally, the project referenced digitisation guidelines in the ASRC Guide to Audio Preservation (2015), the International Association of Sound and Audiovisual Archives IASA-TC 03 Safeguarding of Audio Heritage (2005), and the National Film and Sound Archive Strategic Plan (2015). AVID Pro Tools was the digital audio workstation used to capture and digitise the recordings. A Broadcast Wave Format (.wav) preservation master at a sample rate of 48KhZ and a bit depth of 24 bit was created along with an access copy in 128kbps MPEG format (.mp3). The preservation master is held on a LaCie 6TB Thunderbolt RAID hard drive along with high resolution scans of tape box metadata and any program notes accompanying the tape, whilst the .mp3 is uploaded to a database. The Centre for Digital Humanities Research, based in the Research School of the Humanities and the Arts, hosts this database: the Online Cultural Collections Analysis and Management System (OCCAMS). At this stage, digitised versions of the School's concerts and recitals are set to private. Additionally, there are ethical questions arising from the public availability of such recordings where, in many cases, the original performer cannot be traced; discussions surrounding the legalities of the recordings and accessibility are ongoing.

Pedagogical design

The purpose of the *School of Music RePlayed* project was twofold. As the preservation challenges of an historical audio archive were met, this too presented a pedagogical opportunity. The *School of Music RePlayed* project was initially funded by a AUD$20,000 ANU Teaching and Learning Grant and featured an ongoing, educational outcome in the form of a tertiary-level undergraduate and postgraduate course designed and convened by Assoc. Prof. Bennett with input from the NFSA - MUSI3318/MUSI6008 Sound Archiving. In an effort to develop a significant educational outcome simultaneous to the digitisation process, this research-led course addressed a number of key pedagogical issues, including:

- the endangered skillsets of reel-to-reel analogue tape sound (re) production
- real and perceived technological obsolescence and format types
- assessing archive significance and preservation needs
- studying archives around the world
- documenting intangible cultural heritage, to include specialist archiving factors associated with Indigenous cultures
- (re)placing historical and cultural sound artefacts in the digital world

MUSI3318 (undergraduate) and MUSI6008 (postgraduate) is focused on the School's own archive in the main part, but also situates its preservation in a much wider historical, technical and cultural context. As such, the course is heavily informed by research in audio archiving including established global technical standards in audio archiving practice, historical recording practice and ethnographic studies dealing with the preservation of Indigenous Australian, Melanesian, Polynesian and other Pacific recordings. In saying that, plenty of opportunities for discussion are factored in to the course schedule. Students are encouraged to explore wider questions of time and budget constraints on preservation, the importance of archiving, the prioritising of artefacts of historical significance, and the relationship between the archive and other documents including oral histories of the School.

In consultation with experts at the National Film and Sound Archive, a number of key requirements pertaining to future audio archiving skillsets were established. These initial consultations coupled with research into existing audio archiving programs and courses resulted in a skeleton pedagogical framework. A more detailed and focused set of outcomes was then designed around each aspect of this framework, which included technological, preservation, cultural and heritage areas. Once relevant research pertaining to each area had been sourced, the

focus turned to course learning outcomes and assessments. Again in consultation with the National Film and Sound Archive, carefully designed pedagogical outcomes that addressed future skillsets, as well as the historical context of format technologies and archiving were developed as follows:

Upon successful completion of the course, students will have the knowledge and skills to:

1. Communicate historical, philosophical, professional and ethical principles of audio archiving

2. Identify technical features of magnetic tape recorders and magnetic tape

3. Conduct preservation needs assessments on audio artefacts

4. Operate magnetic tape recorders and historical magnetic tape recordings proficiently and professionally

5. Collate audio content descriptions and meta-data information as part of the digitisation process

The course is delivered as an intensive program each working day over a two-week period during the (southern hemisphere) winter semester teaching break. An extensive reading list including IASA's TC03 and TC04, and Ray Edmondson's UNESCO sponsored *Audiovisual Archiving: Philosophy and Principles* as well as a variety of relevant websites and online audiovisual resources was provided to the students to complement the 40 hours of teaching provided in the course. A preliminary draft of Mick Newnham's handbook for preservation of magnetic media was also provided to the students through the ANU's 'Wattle' online teaching resources system. Presentation of the lessons included a mix of lecture style talks, discussions, PowerPoint presentations and practical demonstrations. Where possible we used props, images and audio-visual resources to illustrate the lesson content. Tours of the NFSA's storage vaults and technical facilities gave the students a first-hand look at the operations of a major professional audio-visual archive. A total of eighteen two-hour class slots was scheduled over nine days, during which time the main course content was covered. Class delivery

methods and content included technical seminars, demonstrations and practical tutorials on operational health and safety, conducting preservation needs assessments, condition reporting, analogue tape machines, tools and technology, historical contexts of audio archives, and audio archives from around the world. On the final day, students undertake an archiving exam, which is the main course assessment at 50% of the overall course weighting. This assessment is designed in a way that tests students' abilities to accurately assess the condition and contents of an audio artefact as well as carry out a full digitisation process to a professional standard. The assessment is conducted on a ¼" tape of around two minutes in length prepared by the National Film and Sound Archive. The second assessment requires students to prepare a technical log book of an audio archiving process. This element constitutes 10% of the overall course weighting. Most students opt to complete their log book on a practice digitisation completed in class as opposed to the exam process. Finally, the course features a research essay at 40% of the overall course weighting. This assessment continues in the six weeks following the end of the intensive course duration allowing a longer period of time to conduct extra research and focus in on a topic of interest. Example topic areas are suggested as:

- Digital formats: artifacts (CD, DVD-Audio, SACD, DAT) or lossy/lossless codecs (MP3, ATRAC, AAC, WAV, AIFF, WMA, ALAC)

- Files and storage, future implications

- Analogue formats: cylinders, tape, cassette, vinyl

- Database systems

- Sound archiving history

- Archives from around the world

- Sound archiving and ethics

- Preservation

- Metadata

- Public accessibility

Research essay topic choice is broad amongst the student cohort. Examples of essay subjects include 'Born-digital Media and Preservation', 'Re-examining the Sonic Pacific Colonial Gaze', 'Cassettes: Recent Resurgence and Technostalgia' and 'Analogue Tape Hazards and Health & Safety'.

Reflections on practicalities

The practical dimension of the Sound Archiving course was a real point of difference from previous activities by NFSA in the educational sector. The lack of hands-on experience afforded by courses such as the joint NFSA:CSU (Charles Sturt University) audio-visual archiving post graduate certificate has been a source of frustration for students and educators alike, so it was exciting to be involved in a project where the availability of technical facilities, and collection material afforded students with practical, hands-on experience. This aspect of the course did however present a number of challenges.

In terms of equipment, the School of Music's music technology laboratory is equipped with adequate A/D converters and Digital Audio Workstations (DAWs), and also owns a number of legacy analogue reel to reel machines. Given the numbers of students participating in the course, we needed five reel to reel analogue tape machines, and so we settled on a fleet of Revox machines sourced from the School of Music and from the NFSA. The machines at the School were clearly in need of a major service, and we were not able to identify anyone in Canberra who could take on the work. Instead, the School engaged maintenance engineer and Studios 301 technical officer Greg Cameron to undertake repairs. Despite the kinds of delays that you expect when working on obsolete technology, three machines were delivered in excellent working order, a few days before the course was to commence.

Machines sourced from NFSA and also Assoc. Prof. Bennett's own Revox were presumed to be in working order. Unfortunately, components of the power supplies of these machines had deteriorated, resulting in last minute failures that needed to be rectified at short notice to ensure the course could proceed as planned. Fortunately, the NFSA's audio electronic engineer Dave Heffernan was able to revive these machines. Due to the high level of deterioration in the School of Music

tape collection, the Revox machines proved barely adequate to support our practical sessions. Head configuration and speed issues were a challenge, as it turned out that many of the less deteriorated tapes were at low speeds or in domestic four-track configuration not supported by the machines we had available. It is perhaps ironic that the cheaper 'domestic' type tape stock used for these lower priority, low speed domestic standard recordings has proven more stable than the 'professional' stock used for the high speed two track and full track recordings that our machines were designed to replay. Supplies including solvents for head cleaning, splicing and leader tape, spare reels and boxes were sourced from casstape.com.au.

After investigating the possibility of developing a standalone database for the project, access to the ANU Research School of the Humanities and the Arts existing OCCAMS (Online Cultural Collections Analysis and Management System) database was deemed the most appropriate host, and access was requested. OCCAMS is designed to facilitate the archiving and dissemination of digital research resources. The OCCAMS system is capable of hosting audio files alongside scans of metadata taken from the audio artifact packaging. However, OCCAMS is not capable of managing large files, so high resolution preservation material was stored on a small RAID array.

In 2015, a total of seventeen students completed the Sound Archiving course and all reported a high degree of satisfaction with the course content and delivery. Ten students completed the course in 2016 and seven in 2018; the drop in numbers in 2018 due to scheduling issues during the winter academic session. Due to condition and format issues around ten to fifteen percent of the archive has now been digitised, however, we have gained significant information about the condition and significance of the School's tape collection.

Summary and conclusions

The basic concept behind *School of Music RePlayed* had been considered over several years without any concrete action. While the MoU between NFSA and CASS provided a framework that made this collaboration possible, its fruition depended on simultaneous advocacy and support from within both institutions. Fortunately, the project has ongoing sup-

port. Challenges do, however, persist, particularly with equipment and the deterioration of the collection itself.

Obsolete equipment cannot be assumed to be serviceable, even when it has been working without problems in recent memory. The expertise and capability to undertake repairs and maintenance on obsolete equipment is now endangered. The maintaining of good relationships between industry and institutions is essential. The impact of deterioration on magnetic tape collections is increasing over time. Matthew Davies' initial assessment of the collection (based on extensive experiential expertise) greatly under-estimated the extent of condition problems that we would encounter. We would have benefited from a more thorough preliminary assessment of the collection that included attempts to transfer samples from the collection. The main issues facing the ongoing preservation of the archive are both time and budget constraints. Significant funding is required to ensure the project can be completed. Additionally, the tape degradation issues facing the majority of the collection require urgent attention. It is impractical to bake such a large portion of the archive and this method is not only unpredictable, but will also require significant resources. Presently, tapes known to be in poor condition due to binder hydrolysis or 'sticky shed' have been quarantined. Isolating tapes and using a desiccant to absorb excess moisture is an option currently being explored.

The project has, however, been a significant pedagogical success. Students were highly engaged with a diverse range of interests and perspectives on the subject matter. For some, the old technology was the main attraction, others were more interested in the potential use of music archives for research, and a few had personal connections to legacy audiovisual collections. Given that School of Music students will potentially work in a variety of art related employment where archiving is an issue, from performance and recording to arts administration and curation, exposure to archival principles and practices at the undergraduate level has significant benefits. The structured approach to planning the course, with clear learning outcomes, a detailed timetable and lesson plans, was very effective in supporting the preparation of course material by our subject experts who, in most cases, do not have extensive pedagogical background. Student satisfaction surveys taken after the 2015 and 2016 iterations of the course all resulted in higher-than-average satisfaction

across all areas of teaching and learning. The 2018 student satisfaction results are pending. There are, however, areas for improvement. The main pedagogical challenge lies in the knowledge and skills required to assess analogue tapes and operate analogue tape machines, since most students are what Palfrey and Gasser called 'digital natives'.

School of Music RePlayed was initially conceived as a pilot project to investigate and demonstrate the benefits from both the educational and archival aspects of the project. We have demonstrated that there is an enthusiastic student cohort interested in learning about audio archiving, and that the NFSA and ANU together have the knowledge and skills to prepare and deliver such a course. Indeed, 'best practice' aspects of the course have been noted by academics in Melbourne and Perth, as well as internationally. The archival dimensions of the project are more complex. We have identified a critical need for attention to the School of Music audio archive, however the condition and current accommodation of the collection are such that the approach indicated in *School of Music RePlayed* is not sufficient in itself to meet the needs of the collection. Indeed, this collection is likely to be typical of many important audio-visual collections across the academic and artistic communities.

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