Thursday June 28th

Opening Ceremonies

Keynote

Bob Ludwig

The Formats of My Career (All of Them Need Archiving)
The speech will cover the many formats that Bob Ludwig has worked on in his long and illustrious career, providing context for why we are all engaged in such an important field: to protect and preserve our culture’s audio heritage.

Block 1: Physical/object based preservation & material science I

Paper 1

Andrew R. Davis, Eric B. Monroe, Fenella G. France

Understanding Magnetic Tape Degradation by Polymeric and Material Testing
While magnetic tape degradation has been studied for at least 30 years, questions and uncertainties remain in understanding how best to evaluate tape degradation and how best to intervene when necessary to ensure playback and preservation. New research will be discussed using state-of-the-art equipment and experimentation to further clarify and unify our understanding of magnetic media degradation, specifically in polyurethane-based audio tapes both before and after baking. This work examines experimental tapes from the Library’s Preservation Research & Testing Division, in order to expand on prior knowledge of tape degradation processes and develop improved methods for the rapid non-destructive identification of sticky tapes.
**The impact of thermal treatment on magnetic tapes: An exploratory study combining chemical analyses and audio features**

This article presents the methodology and the first results of an exploratory study aimed to determine the modifications that thermal treatment induces on magnetic tapes and on the audio signal memorised on the tapes. In order to do so, a tape is tested before and after treatment: a set of chemical analyses are conducted on tape samples, and audio analyses on the corresponding digitised signals. The results are consistent with the hypothesis that the treatment does not have negative effects on a healthy tape nor on the signal. Future work includes testing tapes showing signs of degradation. This study contributes to the long-term goal of building a structured knowledge base about diagnostic tools and recovery methods for magnetic tapes.

**The impact of thermal treatment on the mechanical properties of magnetic tapes: Tensile tests**

This article presents the method and the results of a test aimed to determine the tensile properties of magnetic tape samples before and after thermal treatment. The goal is to investigate whether thermal treatment has an effect on the tapes mechanical properties. A tape showing no symptoms of degradation has been used. No modifications have been observed, which is in line with the hypothesis that thermal treatment has no effect on 'healthy' tapes. Thermal treatment is expected to restore the elasticity of damaged tapes, making them more resistant to mechanical stress and therefore less prone to break. This study contributes to the long-term goal of building a structured knowledge base about diagnostic tools and recovery methods for magnetic tapes.

**Workshop 1**

**Workshop on Sticky Tapes. Abstract to follow.**
**Block 2 Preservation by digitization: Best practices and how to improve I**

**Paper 4**  
Jamie Howarth, John K. Chester

**An Overview of Advancements in Magnetic Playback**
A Comprehensive overview of recent advancements focusing on the minimization of time domain errors ranging from drift, wow and flutter to phase response. Discussion of standards and measurements, and the use of record bias to provide a time reference for time base correction and for precise azimuth adjustment. The advantages of more accurate digital de-emphasis and the implementation of phase equalizers compensate for such errors in the recording process, including modeling in DSP the frequency response and phase characteristics of well known recorders. We conclude by considering the ethics of preserving artifacts of the recording which can be of service to future restorations. Examples of preserving artifacts of the recording which can be of service to future restorations. Examples of antique and recent wire, film and tape recordings will be presented.

**EB 1**  
Richard Hess

**Azimuth Investigations**
Setting proper azimuth is an important task in optimizing media playback. This paper looks to quantify azimuth error and look at what can and cannot be done in post processing. Examples of azimuth error based on error angle, speed, and track width are calculated and graphed. Solutions for optimizing two-track recovery are explored.

**Block 3 Preservation by digitization: Best practices and how to improve II**

**Paper 5**  
George Blood

**On Determining Speed and Stylus Size for pre-1923 Acoustic Discs**
The early decades of sound recording are a period of rapid change in recording technology and performance practice. Primitive recording equipment, minimal documentation, and musical pitch, varying by time and location, make it difficult for archivists to know the proper playback stylus size and playback speed. Using 4 very large data sets, this study investigates the level of accuracy attainable when selecting stylus size and playback speed. The analysis shows it is possible to determine, with high certainty, the correct playback stylus size per record label during this period of early sound recording. The analysis then shows that the distribution of pitch follows a Gaussian distribution of randomness: it is not possible to know with certainty the proper playback speed.
Expert Disc Transfer Techniques: Emphasis 101
This tutorial explores all aspects concerning the pre-emphasis and de-emphasis that may be applied to a modulated groove. The characteristics, in terms of frequency vs. amplitude response, of the different cutting and replaying processes (mechanical, electromagnetic, optical, etc.) are comprehensively exposed. The goal is to answer most of the where, why, and how questions, to build a solid background that will help choosing and applying the correct de-emphasis, both in the analog and the digital domains. The presentation, although supported by a number of sound examples, is very technical, and easier to understand for those who are already familiar with this topic, or who have attended my presentation in the Expert Transfer Techniques series of last year.

Digital De-emphasis of Gramophone Recordings
Reproduction of gramophone recordings requires the use of suitable de-emphasis filters to provide the intended tonal balance. Often, the emphasis curve applied when cutting the master cannot be securely asserted, or its definition requires iterative research. Digitizing a non-de-emphasised version preserves the unaltered off-carrier signal, opening up choices for applying the adequate de-emphasis later on, and it provides better results when removing click and crackle artefacts for access copies. Using digital de-emphasis filters instead of analog circuits provides several advantages. Digital filters are free of component tolerance. With their filter parameters documented, de-emphasis processing is completely reversible. Thus, the handling of dual version sets -one filtered and one unfiltered-becomes obsolete, leading to simpler workflows. Providing the filter characteristic as metadata leads to an intrinsically documented process. Simplified implementations of digital de-emphasis filters may not meet their analog pendants properly, though. Compared to analog filters, transition of higher frequencies is too low when reaching the Nyquist frequency. Introducing the Neumann constant adds an additional turnover term, leading to a pole in the digital domain. By adapting this constant properly the differences in amplitude- and phase response can be reduced significantly. Using digital de-emphasis filters improves and simplifies the work of the archivist. In combination with high-quality linear pre-amplifiers and A/D converters, gramophone digitization in surpassing quality may be realized.
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<th>Workshop 2</th>
<th>Stefano S. Cavaglieri, Jean-Hugues Chenot, Nadja Wallaszkovits</th>
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<td><strong>Block 4 Preservation by digitization: Best practices and how to improve III</strong></td>
<td><strong>Expert Transfer Techniques: A Special Focus on Mechanical Discs</strong> The workshop leads through the problems of transfer, digitization, and restoration of historical obsolete disc formats. Starting with the possibilities, advantages, and limitations of a conventional mechanical transfer, the discussion will outline some of the most proven and tested optical transfer methods and technologies and their special usability with broken/ delaminated/ damaged discs. The different approaches will be presented, including various audio examples.</td>
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<td><strong>Using Imaging To Reevaluate Legacy Media Playback</strong> New methodologies for the transfer of legacy media not only provides new options but often leads to a reevaluation of traditional methods. Imaging as a technique for extracting audio signals from physical carriers designed for physical playback is in its still evolving. The Preservation Directorate at the Library of Congress is performing a series of studies to examine media wear and comparisons of playback achieved by stylus and imaging. The approach is to use quantifiable measurement techniques, so differences can be evaluated for long term preservation standards. Current research and results will be presented along with future directions.</td>
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<td><strong>A Methodology for Preserving the Content on Lacquer Discs</strong> This presentation will outline the principles used by Indiana University’s Media Digitization and Preservation Initiative to create the workflow used in the preservation of lacquer disc recordings. These principles include: adhering to best practices, evaluating risk, limiting physical stress to the carrier, optimizing workflow efficiency, keeping signal flow simple, attaining the highest level of accuracy possible, maintaining the option of making subjective judgement decisions again in the future, and maintaining the physical carrier. We will discuss key parts of the workflow such as: using a microscope to evaluate grooves, cleaning discs by hand, creating different file types and the roles they play in the preservation system, establishing a signal chain, choosing a stylus, choosing a de-emphasis equalization curve, dealing with tracking problems, and the use of custom made enclosures.</td>
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The Library of Congress maintains a large collection of wax cylinders, many of which containing ethnographic field recordings from as early as 1890. Wax cylinders can present with several conditions issues including cracking during storage. To understand the cause of these issues, guide preservation of these materials, and to develop methods for cleaning cylinders for preservation and reformatting, we have undertaken a multi-pronged approach to identify compositional changes resulting from aging with a focus on early brown wax cylinders. This work has included the recreation of period formulations as well as the detailed chemical and physical characterization of the formulations.

How Parallel Transfers Work...And Why They Will Save the Day
According to a recent study, there are an estimated 250 million audio recordings in the US alone that are worthy of long-term preservation but have yet to be digitized. While it is widely accepted that digitization is necessary to defeat the forces of degradation and obsolescence, employing large-scale digitization is essential if we hope to preserve anywhere close to this number. In this presentation, Indiana University's Mike Casey will explore parallel transfer workflows for the digitization of archival audio recordings. He will identify classes of recordings that are appropriate for this methodology as well as those that are not, and will discuss the risks inherent in both parallel and 1:1 workflows. This presentation will use the IU MDPI project as a case study, detailing specific workflow steps and the procedures and hardware/software that are used to mitigate risk. Finally, he will report on IU's experience comparing the results of parallel and 1:1 digitization workflows.
**Best Practices in Worst Case Scenarios: The Realities of Audio Digitization**

Nearly all audio engineers who work with archival audio aim to meet or exceed established best practice standards. How that plays out in the field can vary dramatically, depending on access to tools, training, funding and other support systems. This panel looks at the realities engineers face when theory meets practice. How do we as technicians - especially those of us located outside major institutions - adhere to standards and produce high caliber work when media varies widely in quality and format, advanced training opportunities are limited, and budgets are small or nonexistent? Panelists Jane Pipik (NEDCC), Kabir Hermon (MARS), Andrew Dapuzzo (Memnon), and Jessica Thompson will share their experiences digitizing audio in less-than-ideal circumstances. They will discuss how they have developed innovative workflows, partnerships, and solutions, proving that to preserve creative work, we must also find and utilize equally creative avenues.

**Extended preservation workflows: Derivatives of high resolution archive material: a case study**

The handling of high resolution archive files in daily business applications is sometimes inconvenient. For better usability, derivatives have to be created for end-user-friendly environments. Correct handling of metadata, renaming, logging of the process history and validating checksums are only a few requirements that have to be implemented according to specific user requirements. The presentation outlines a post digitization workflow that creates derivatives in an automatic process.

### Block 7 Preserving Legacy Professional Formats: Multi-track Tapes and Obsolete Digital Formats

**The Challenge of Archiving Multitrack Recordings**

Multitrack recording utilizing magnetic tape started around the 1950's. By now there are 10's of thousands of multitrack master tapes from recording projects in existence. Additionally, some 30 years of modern born-digital recording and production have added to the continued use of master recording on analog multitracks, continually increasing the quantity of multitrack resources. Although the mixes from all of these many projects endure as representative of artists' intent, virtually all of these interim multitrack masters embody and reveal a wealth of creative content and teachable workflow. Multitrack masters need to be preserved, archived, and made accessible. Analog Tape Multitrack, Digital Tape Multitrack, Workstation Multitrack, and associated Metadata will be covered in this panel.
Block 8 Digital Restoration of Historical Audio

A novel steganographic process to ensure error-free digital recording and transmission of audio

Ever since general-purpose computers have been used for digital audio recording, users have been plagued by reliability issues caused by unsuitability of these devices for the task. In critical applications, recorded material has to be carefully listening-checked, which is time-consuming and error-prone. A new DSP process is described which allows recorded audio files to be rapidly and reliably checked for any such errors. The same process can be used to verify digitised audio streams in real-time.

Recent Advances in Noise Reduction: From Multiband Gates to Machine Learning

Since 1940-s, single-band and multiband gates dominated the field of static noise reduction in audio signals. FFT processing enabled by digital computers has dramatically increased the number of bands, but hasn't gone far from the multiband gate concept. Recent advances in deep neural nets are able to break free from the multiband gate approach by learning to predict signal features.

This talk by iZotope's Principal DSP Engineer Alexey Lukin will describe company's evolution of noise reduction algorithms and provide some insights on what the future may bring for the restoration community.

Block 9 Preservation Issues For Emerging High-end Audio Formats

Preservation Issues For Emerging High-end Audio Formats. Abstract to follow
**Working in the Time Capsule**

As proprietary technologies progress and become obsolete, content owners are struggling to access some of their well-preserved library archives from as little as ten years ago. This is not due to poor conditions of their archives, but to the obsolescence of operating systems, software versions and hardware used in once-common DAWs and archive solutions.

We find ourselves having to preserve entire now-defunct systems in order to access assets that are inaccessible to modern audio and archive applications. These challenges can be a pedestrian as maintaining an NT2000 server for the purposes of restoring DLT backups. However, more critical challenges can present themselves, such as reviving a 1999-era OS9 G3 Mac with Sonic Solutions v 5.4 to restore an Exabyte backup in order to export an 8-channel EDL to WAV files. Hence the notion of working in a time capsule. With the amount of data stored in our clients’ various tape libraries, how do we ensure that their assets remain futureproof and migration ready?

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**Block 10 Storage and Access Technology: Current State / Future Development of Digital Archives**

**Managed Preservation Repositories**

This panel discusses the role of the managed preservation repository in the preservation of audiovisual material. Subtopics include object management, underlying storage layers and their relationship to the managed repository, metadata and format migration strategies, and delivery system integration.


From Studio to Smartphone

This panel discusses and demystifies the purpose, practical application and value of capturing metadata at the point of inception - in the studio. This panel will engage all those with a vested interest in the collection and propagation of quality metadata, including; engineers, producers, production engineers, songwriters, performers, seconds and production coordinators across different genres and parts of the industry - thereby creating a cross section of contemporary voices to add insight to this crucial aspect of industry growth.

Discussion points:

• What are the current practices of capturing metadata in the studio? Why is it important to collect metadata in the studio?
• What tools are currently being used in the collection of this metadata? Further points of inquiry and interactive engagement will include:
  • What is the importance of metadata?
  • What is the value of collecting metadata in the studio, and point of creation?
  • What are the realistic needs and future needs of production stakeholders?
  • What is the workflow post-metadata capture - how does the asset travel through the digital supply chain?
  • How does the DDEX RIN Recording Information Notification message enable the assets to better flow into and subsequently through the digital supply chain.
  • During this panel, a short use case video (2-3 minutes), collectively developed by DDEX members, will be shown.
  • The video will have been shown at the 32nd DDEX Plenary in Paris (April 2018).
• With a focus on demonstrating RIN’s value, through implementation, the video shows how credits flow through the digital supply chain: from studio to the consumer.
Audio Preservation and Access: Overcoming the Challenges

The British Library is home to the nation’s Sound Archive, an extraordinary collection of over 6.5 million recordings, from the 1880s to the present day. In 2017, the Library received a significant grant from the Heritage Lottery Fund to support a major digitisation project, Unlocking our Sound Heritage: an initiative that will help save the UK’s sounds and open them up to everyone.

While years of digitisation have produced robust preservation workflows, such a major project presents a challenge: how to develop these workflows to operate at scale while enabling access to collections in a streamlined way. This paper will describe the challenges that marrying the requirements of preservation and access presents, and the solutions the British Library has developed.
The Linguistic and Cultural Diversity of Humanity or Why is UNESCO Concerned about Magnetic Tape? One of the predominant aims of UNESCO, the UN Agency for Education, Science, and Culture, is the support and the preservation of the cultural and linguistic diversity of human kind. The knowledge of this diversity has enormously profited from audiovisual recording technologies – audio, film and video – which specifically over the past 60 years have assisted to provide profound insights specifically into orally transmitted cultures and languages beyond the dominating main stream cultures of the written word. Portable tape recording equipment, audio first, later also available for video, enabled linguists, anthropologists, ethnomusicologists and folklorists to produce documents that became the primary sources for our present day knowledge of the richness of cultures around the world. Most of these documents, however, are outside archival custody, and while most of the professional audiovisual documents have been already transferred for sustainable accessibility to digital repositories, the greater part of the academic recordings still sits on the original tapes, loosing soon retrievability through the lack of replay equipment.

UNESCO is concerned to avoid an unprecedented situation with thousands of written documents permitting to read about the diversity of cultures and languages, while leaving us unable to view and hear to their original recordings.
**The Chemistry of Magnetic Tape**

Theories and speculation about Sticky Shed Syndrome have abounded over the years, however there has been precious little actual chemical research on the subject and many unanswered questions remain:
- What exactly are those white deposits?
- What is the chemical makeup of that sticky goo, and what mechanism creates it?
- What exactly happens chemically when sticky tape is baked?
- Why does baked tape, even when placed in an environmentally controlled vault, get sticky again?
- Will tape go sticky even if it is in a vault?
- Will tape decay in a vault?

This paper discusses the chemical basis for and laboratory research that answers these questions and more.

**First do no harm: Safety considerations in analog magnetic tape playback**

Recordings archive professionals working with analog master tapes typically take precautions to avoid physical damage to the carrier, such as might be caused by playback using wrongly designed tape transports or headblocks. Also routinely taken are precautions to avoid magnetic degradation of the recorded program, as might be caused by a residual magnetization of any ferromagnetic components in the tape path that could overwrite DC noise onto the recorded program. Losses to the signal level of very short recorded wavelengths that are sometimes observed with repeated playings might be attributed to the phenomenon of magnetostriction. Yet, a further possible source of recorded program degradation exists: faults in the playback electronic circuitry itself.

Investigation by the authors suggests that even a very small current flowing into a reproducing head coil from the associated reproducing electronics' first gain stage can generate a magnetic field in the head sufficient for causing partial over-write or erasure of the recorded program. The authors have surveyed a number of popular legacy professional tape playback circuitry designs commonly in use by archives today with the intent of identifying those which incorporate circuit design features that would prevent such unwanted currents.
Survey of suggested treatments for removing acidic exudation from vintage lacquer discs Many older acetate (lacquer) discs exhibit a white, waxy build-up on their surface, which is the visual outcome of the exudation of palmitic acid or stearic acids in the lacquer surface as a result of oxidation of the plasticizer. Over the years, various treatments have been developed and used by audio engineers. Some of these treatments work well; some work better on different types of exudation than on others; and a few solvents are outright dangerous to some lacquers. This brief attempts to sample a cross-section of brands and types of discs from the 1940s and 1950s containing various types of exudations, and test old and new treatments side by side.

Performance Testing for ADCs: New FADGI Guidelines & ADCTest Software
The Federal Agencies Digital Guidelines Initiative (FADGI), in collaboration with AVP, has been working on a longterm project to advance performance testing for audio analog to digital converters (ADC). The results to date include two levels of guidelines, one focused on high quality and the second on low cost. The second guideline provides users with the ability to perform a routine protocol that establishes a norm for a given ADC, so that failures within that system are able to be identified. To facilitate the low cost option, AVP has developed the ADCTest open source application which provides simple pass-fail reporting for the tests detailed in the FADGI Low Cost ADC Performance Testing Guidelines, as well as more detailed results.