EXTRACTING AUDIO SIGNALS FROM 4-TRACK ANALOGUE TAPE AND DIGITAL STANDALONE MULTITRACK MACHINE MATERIAL AS A PART OF PRESERVATION

Ahmad Faudzi Musib

Department of Music, Faculty of Human Ecology, Universiti Putra Malaysia,
contact: faudzimusib@upm.edu.my

Abstract

In facing ever-growing technology of audio peripherals, there is a concern of balancing in delivering technical knowledge to students dealing with audio recordings in the Music Department at Putra University, Malaysia (UPM). It seems to be difficult for them to do current multitrack recordings and at the same time maintaining the aesthetic aspect of past technology. In other words, if one preserves the recorded item, they have also to care about the specific features coming with these recordings. It is not the primary recorded subject alone they may have to consider. There is an urgency to migrate the recorded material such as cassette tapes that come in varying forms ranging from Ferric-Oxide, to Cro2, and Metal. These carriers are warranted to be extracted and migrate onto a more stable medium, not only in general as everywhere in the world, but also since it has become the university policy that equipment's exceeding certain years will be disposed of. The selection focuses on the recording materials that includes live musical performances, multitrack musical compositions, and final recording projects. In this context the 'recording' may just mean the audio information. It is important for any archive to establish a general policy with regard to the limits of its collection as was pointed out repeatedly (Schuursma, 2010). Viewing from the perspective of preservation (Musib, 2015) of content, a lack of awareness in handling these carriers may lead to complications when extracting the signal from still available machines. The paper is intended to discuss the challenges and requirements in the process of signal extractions using exemplarily the two formats, namely the 4-track recorder and the digital standalone multitrack machine.

Keywords

Signal extraction, 4-track cassette recorder, digital standalone multitrack recorder, cassette types, sound aesthetics

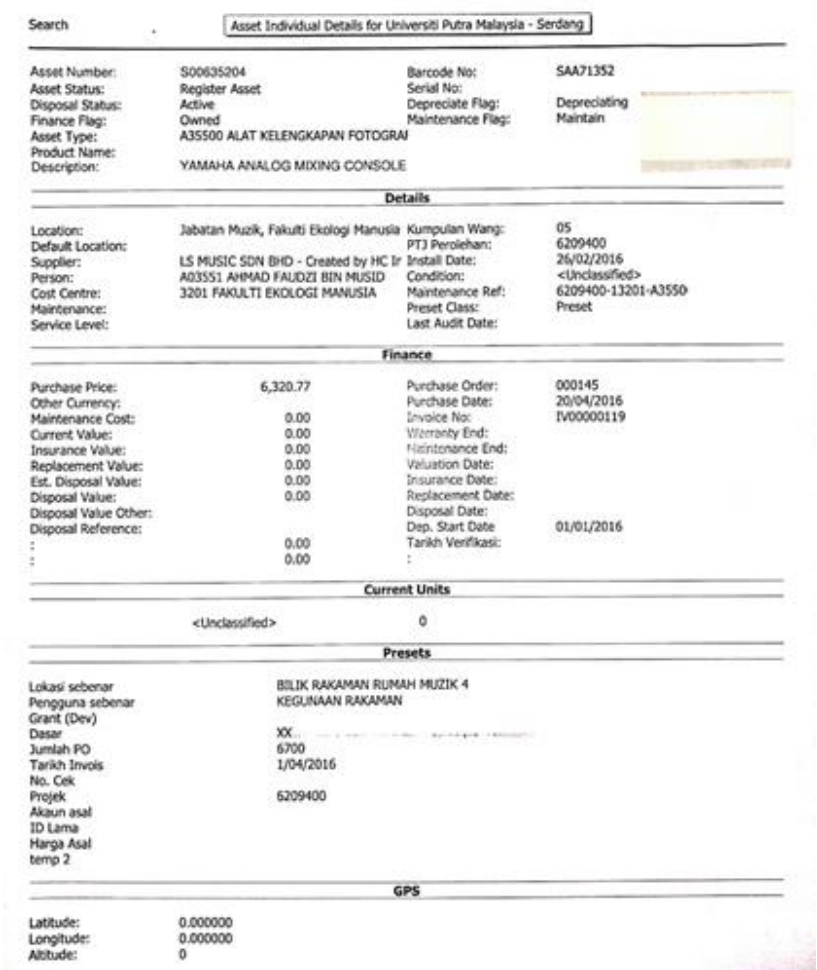
BACKGROUND

During its early establishment, the Department offered three focus areas for music majors. Bachelor's degree in music performance, music education, and music technology. Later to single major and that is Music Performance, and now it became Bachelor of Music offers a four-year program that focuses on classical performance, jazz performance, album production, music technology, music composition, music education, music therapy, ethnomusicology, and musicology. Since then, the Department of Music at the Faculty of Human Ecology, University Putra Malaysia, has undergone several curriculum revisions.

Although it is a single program, infrastructure is of major concern. It implies that, apart from owning the infrastructure, it is the responsibility of the Department to maintain the equipment and ensure that the equipment works in its optimum condition. The ISO (International Organization for Standardization) system is used to ensure that the musical instrument is

Musib, Ahmad Faudzi. 2020. Extracting Audio Signals from 4-Track Analogue Tape and Digital Standalone Multitrack Machine Material as a Part of Preservation. *AEMR-EJ,* 5: 25-38. **DOI: 10.30819/aemr.5-4**

functioning at its optimum level. The process aims to ensure the satisfaction of the client (students). That requires the control of the location of its operation and the regular maintenance schedules for the services necessary. In the ISO system (Standard Popular, 2008), every equipment purchased by the university shall receive serial number (barcode) stickers. This is to indicate the equipment details. Figure 1 is an example of the form used when a piece of new equipment, namely an audio mixer purchased in 2016.



Search

Asset Individual Details for Universiti Putra Malaysia - Serdang

Asset Number:	S00635204	Barcode No:	SAA71352
Asset Status:	Register Asset	Serial No:	
Disposal Status:	Active	Depreciate Flag:	Depreciating
Finance Flag:	Owned	Maintenance Flag:	Maintain
Asset Type:	A35500 ALAT KELENGKAPAN FOTOGRAI		
Product Name:			
Description:	YAMAHA ANALOG MIXING CONSOLE		

Details

Location:	Jabatan Muzik, Fakulti Ekologi Manusia	Kumpulan Wang:	05
Default Location:		PTJ Perolehan:	6209400
Supplier:	LS MUSIC SDN BHD - Created by HC Ir	Install Date:	26/02/2016
Person:	A03551 AHMAD FAUDZI BIN MUSID	Condition:	<Unclassified>
Cost Centre:	3201 FAKULTI EKOLOGI MANUSIA	Maintenance Ref:	6209400-13201-A3550
Maintenance:		Preset Class:	Preset
Service Level:		Last Audit Date:	

Finance

Purchase Price:	6,320.77	Purchase Order:	000145
Other Currency:		Purchase Date:	20/04/2016
Maintenance Cost:	0.00	Invoice No:	IV00000119
Current Value:	0.00	Warranty End:	
Insurance Value:	0.00	Maintenance End:	
Replacement Value:	0.00	Valuation Date:	
Est. Disposal Value:	0.00	Insurance Date:	
Disposal Value:	0.00	Replacement Date:	
Disposal Value Other:		Disposal Date:	
Disposal Reference:		Dep. Start Date	01/01/2016
:	0.00	Tarikh Verifikasi:	
:	0.00	:	

Current Units

<Unclassified>	0

Presets

Lokasi sebenar	BILIK RAKAMAN RUMAH MUZIK 4
Pengguna sebenar	KEGUNAAN RAKAMAN
Grant (Dev)	
Dasar	XX
Jumlah PO	6700
Tarikh Invois	1/04/2016
No. Cek	
Projek	6209400
Akaun asal	
ID Lama	
Harga Asal	
temp 2	

GPS

Latitude:	0.000000
Longitude:	0.000000
Altitude:	0

FIGURE 1: Asset of Individual Details for University Putra Malaysia. (Scheme of the author).

Equipment which is unusable or beyond repair must be disposed of. All assets which, in the condition mentioned, must be disposed of by reference to the ISO system. All details such as, the date of purchase, purchase order number and the asset number as shown in Figure 2 must be entered into the asset management system of the University.

FIGURE 2a, b, c, and d: Details such as the date of purchase, purchase order number, and the asset number (Photographs by the author).

This refers to all equipment ranging from 9-foot Steinway, upright pianos for each practice room, baby grand pianos for two Music Houses, families of orchestral instruments, computer-aided music education systems and audio mixers, electronic keyboard, sound modules, MIDI devices, magnetic tape multi-track recorder, hard disk recorder for students of Music Technology. Acoustic instruments are not as prone to extinction as electronic musical instruments are. Most electronic instruments often become extinct when there is an enhanced version of similar applications on the market. Hence, many worn-out electronic musical devices were disposed of. Among that were the standalone hard-disk recorder, boxes of multi-track cassette tapes, and others are of the DAT and VHS tapes. There is an urgency to migrate the recorded material such as cassette tapes that come in varying forms ranging from Ferric-Oxide, to Cro2, and Metal. These carriers are warranted to be extracted and migrate onto a more stable medium, not only in general as everywhere in the world, but also since it has become the university policy that equipment's exceeding certain years will be disposed of. The selection focuses on the recorded materials that include two-track live musical performances, multitrack musical compositions, and final recording projects.

Back in the late 1980s and early 1990s, the four-track machine was one of the tools used by students to record their audio assignments and final projects. Most of the time, it is used to record and mix sound combinations where MIDI instruments could not be supported. It includes electronic music composition, harmony, and arrangement involving either a mixture of synthesizers, electric guitars, bass or acoustic instruments and vocals. What is interesting, in the rapidly growing development of audio technology, each of the tools created, and their technical design, requires specific operating techniques. From the viewpoint of signal migration for audio preservation, the discovery is about past technological advances. It is an opportunity to expose my audio students to past technologies such as the four-track system and hard disk recorder. In this paper, the focus will be on the challenges and issues about to migrate audio signals in the two formats exemplarily, the cassette tape of the 4-track recorder and the data from the virtual standalone multitrack system, its challenges its demands in the process of retrieving signals.

DEVICES SPECIFICATIONS

The FOSTEX 160 Multitracker Recorder/Mixer (Fostex Corporation, 1987: 4) was made in the year 1987 uses a single compact cassette deck. It comes with a 4-track, with 4 input modules that serve as a mixer as well as recording console. Each head comprises of 1 x 4 Track record/replay heads, and 1 x 4 Track erase head. The single DC servo motor runs at 9.5 cm per-second or runs at 3 3/4ips - twice the normal cassette speed. The machine able to encode 40Hz to 14kHz of frequency responds on Cr02 magnetic tapes (IASA-TC04 2009, 50) with signal to

noise ratio (SNR) of 70dB (Dolby C[1] noise reduction). The noise reduction (NR) mode of the FOSTEX 160 allows for the user to manage the noise down, which derived from the cassette tape without unduly damaging its sound quality. The NR is an on-off switch that allows the user to select the feature. Most of the time recording was done via multi MONO. The block diagram shown in Figure 3 is a representation of the FOSTEX 160 input and the output sections.

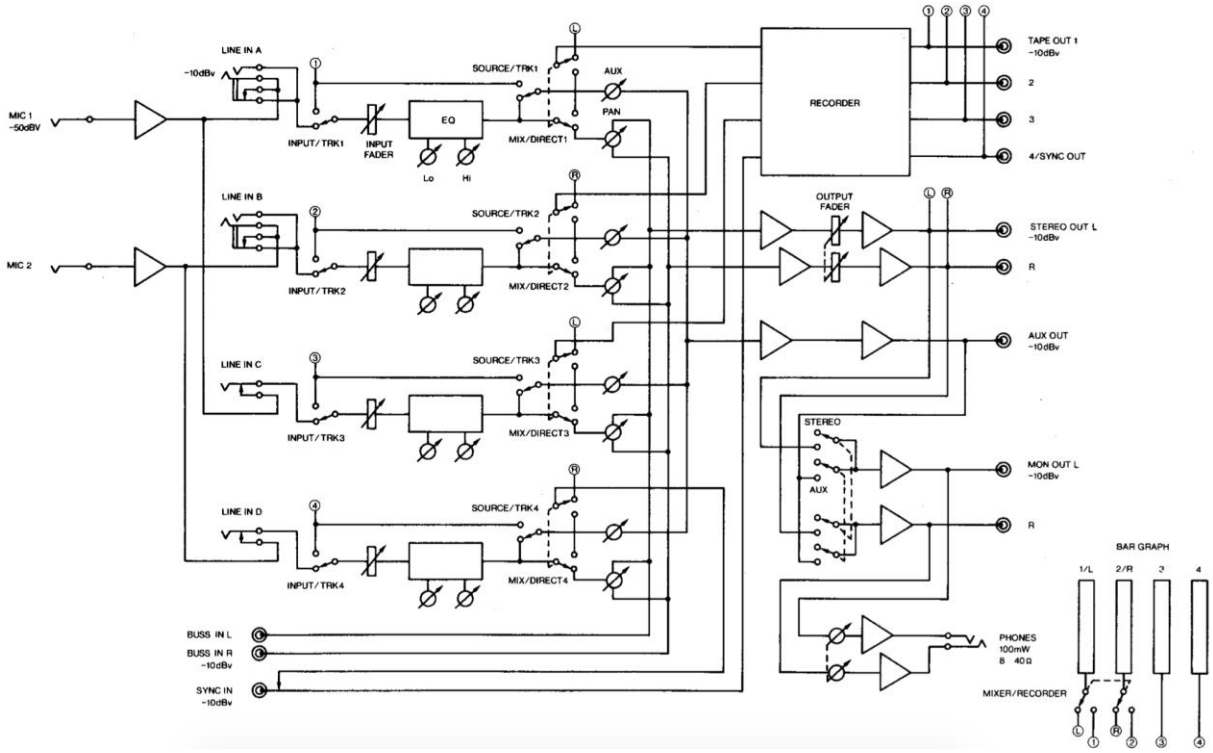


FIGURE 3: Block diagram of the FOSTEX 160 Multitracker Recorder/Mixer, a representation of the input and the output sections of the device.

The ROLAND VS1680 was made in 1993 (Roland Corporation, 1998). It enables users to record 16 tracks of digital audio recording with 16 virtual tracks. The device comes with a 24-bit (20-bit A to D and D to A converter) multitrack professional recording mode. Its quality allows for ample headroom and its dynamic range, with 10 analog audio inputs. This includes two balanced XLR-type inputs with phantom powering for condenser microphones or direct injection boxes, 6 balanced 1/4" inputs, and 1 stereo digital input (optical TOSLINK and coaxial). At the rear of the ROLAND VS1680 were 8 RCA-type outputs. This includes master auxiliary A and B and monitor outs. The device comes with built-in multi-effects independently on each channel as shown in figures 4 and 5. The front panel was its controller, and the rear was the sockets for other possible connections. This includes a direct audio CD recording, SCSI port for data backup.

[1] Dolby C-type noise reduction starts to take effect in the 100 Hz region and provides about 15 dB of noise reduction in the critical 2,000 to 10,000 Hz hiss area, around 400 Hz and 20 dB.

FIGURE 4: The front panel and its controller; Figure 5 the rear are the sockets for other possible connections (Photographs and all following photographs of the author).

METHODS

To ensure the extraction is at its optimal performance, a separate procedure is required before and during the retrieval process. The following in Figure 6 is the process flow in conducting signal extractions of two different platforms, namely the multi-track cassettes magnetic tape and the hard disk recorder.

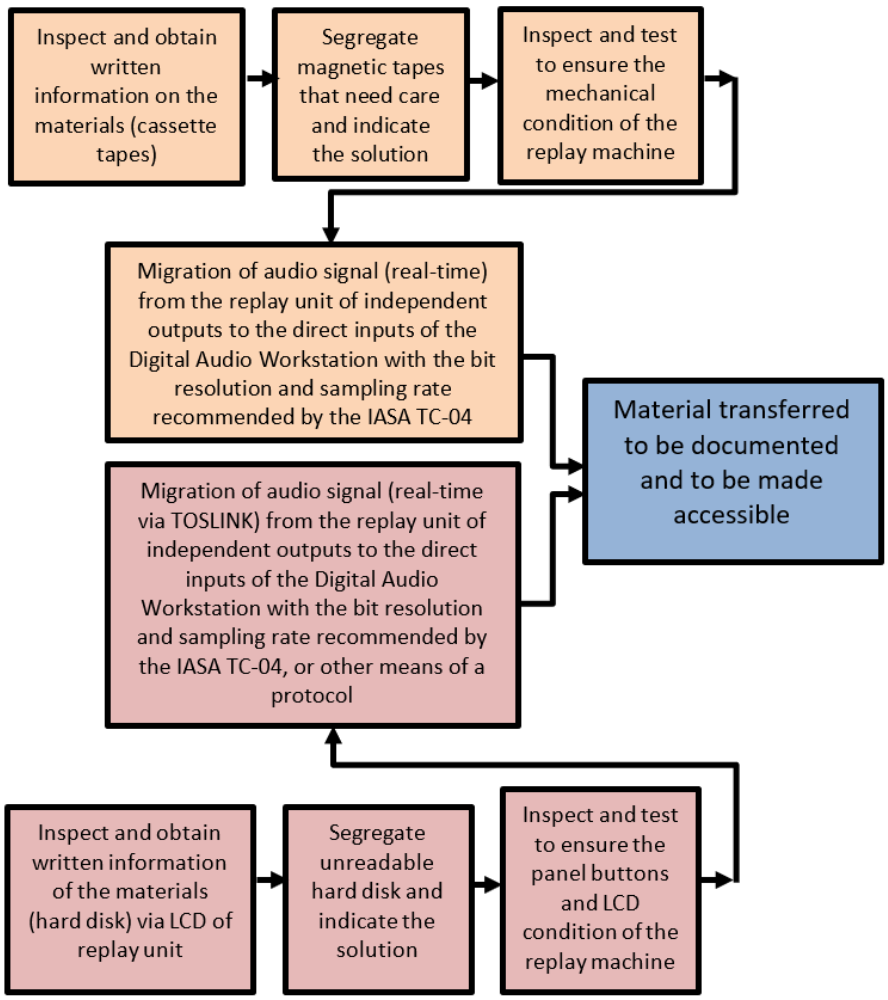


FIGURE 6: Signal extractions of two different platforms, namely the multi-track cassettes magnetic tape and the hard disk recorder replay machine (scheme and all following schemes by the author).

CHALLENGES AND DEMANDS

It is indeed unexpected things occur in the course of signal migration of the two different platforms of audio devices. However, it is possible to address the difficulties and problems related to the process according to the process flow shown in figure 6.

During the inspections, it is found that less or no information is written on the cassette tape cover. Information such as the date and year, the title of the song or piece, tape speed in which the music was recorded, tape directions either A side or B, and the number of recorded tracks used in the sessions. Others have been just the title of the music, which requires a playback for identifying the audio content within each track. Although the audio content has been identified, the tape speed raises another obstacle. However, most of the recordings contained in materials that require migration are at two speeds. That is pre-set speed or half of the pre-set speed (slower) as shown in figure 7.

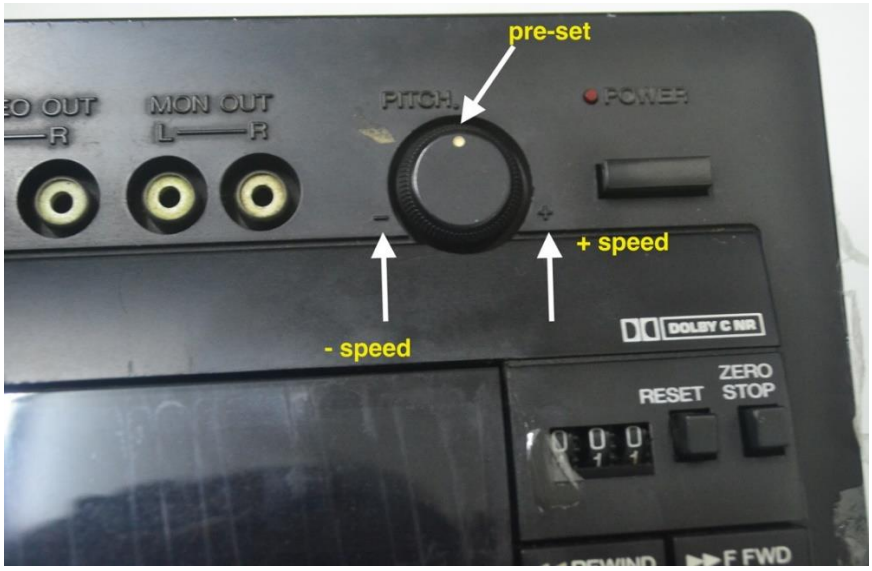


FIGURE 7: Tape speed of the replay unit.

Segregate magnetic tapes that need care due to physical deterioration (fungus, brittle as the binder's lubrication is lost, sticky, broken even dirty tapes) or mechanical problems. Figure 8 and 9 is an example or the deterioration due to fungus and mechanical issue such as a missing pressure pad, or a rusted magnetic shield, to name a few.

FIGURE 8: Deterioration due to fungus; FIGURE 9a and b: Mechanical issue such as broken tapes, rusted magnetic shield.

Through inspection and assessment of the multi-track tape machine, the obvious issue were the machine operating voltages and its polarity. Since its operating voltage is at 110 volts, the FOSTEX 160 Multitracker Recorder/Mixer requires a step-down transformer. Unlike the Roland hard-disk recorder does not need any transformer, as it is already operating at 220 volts.

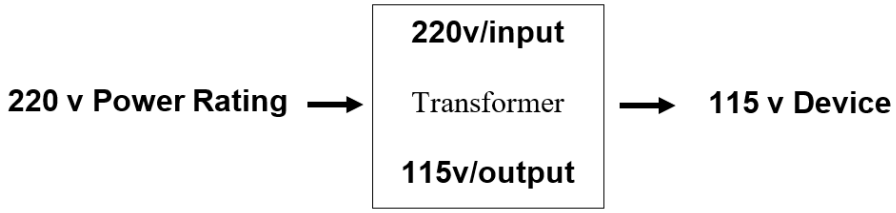


FIGURE 10: Scheme for this process.

FIGURE 11a and b: Transformer from 220 volts to 115 volts.

Another would be the mechanism such as the tape speed, functioning rewind and forward playback buttons, all faders and knobs, peak program meter for correct level monitoring, pre-set and variable speed control are in working condition. Unfortunately, it was found that tape engage and disengage from the tape head is not functioning. Hence the multi-track tape machine is to open and inspect the malfunction mechanism.

FIGURE 12a and b: The front and rear.

FIGURE 13a, b, c, and d: Four screws have to be removed, with the last being attached to grounding of the circuit board.

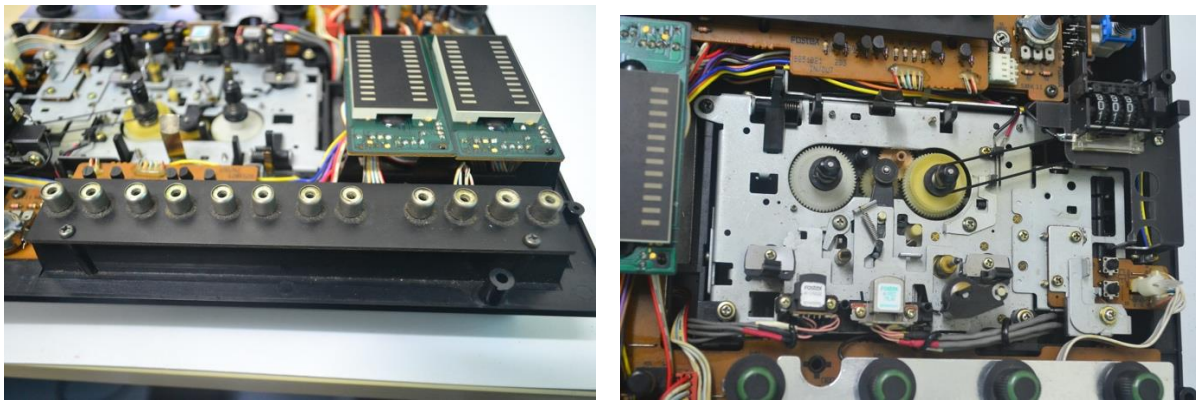


FIGURE 14: The front cover is removed, that allows for an assessment of the supply and the take up tapes.

Is to be found that the driving belt mechanism is at the back of the supply and the take up reel, dismantling the front mechanism is a challenge.

FIGURE 15: All the monitors, stereo, synchronization and the 4 direct out circuits.

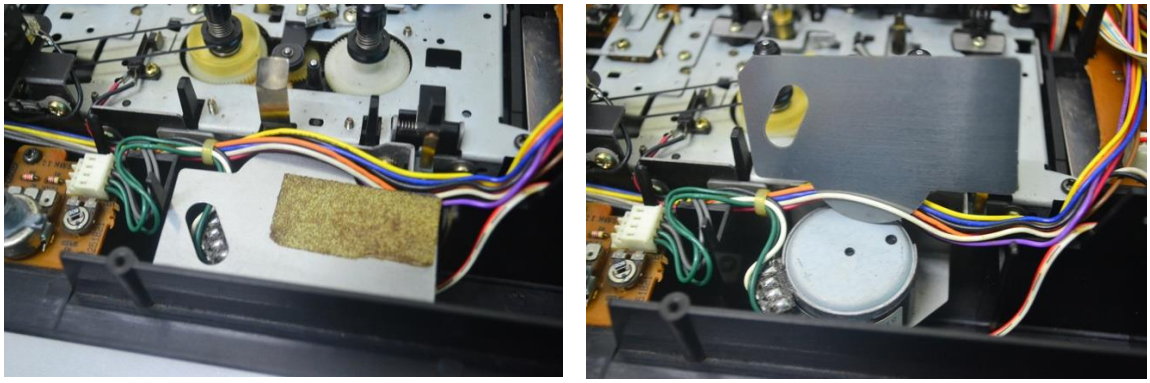


FIGURE 16: A protector of magnetic fields derived from the single DC servo motor 3 3/4ips - twice the normal cassette speed.

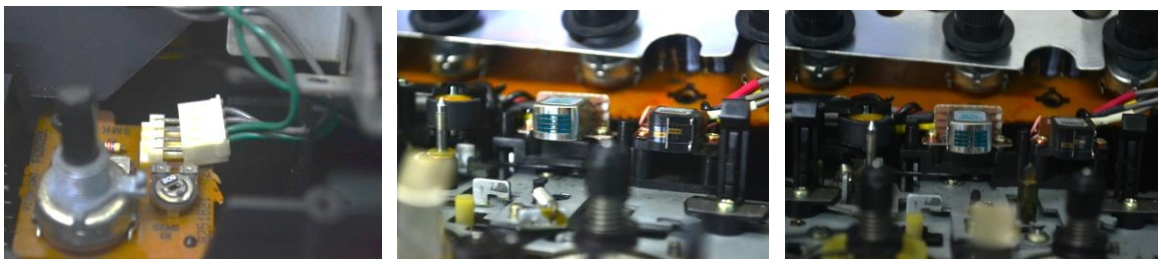


FIGURE 17, 18: Removal of the variable speed control switch. FIGURE 19: Azimuth and Zenith adjustments for clearer sound quality.

The azimuth and zenith positioning of the playback head should be at its correct position for a quality replay signal. The playback head should be clean[2] after 4 hours of running time. Upon the removal of the rear concealment of the multitrack machine, the cause of malfunction tape engages and disengage mechanism is due to the decay drive belt.

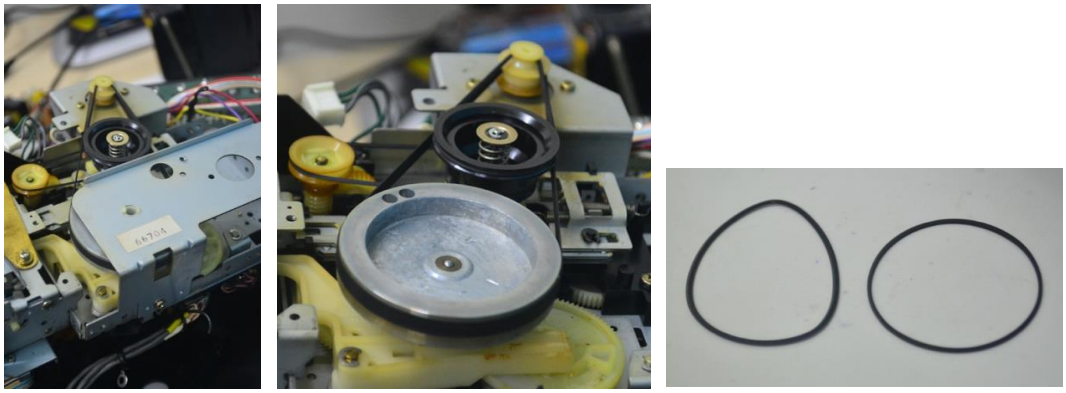


FIGURE 20: drive belt mechanism and decay tape belt might output an incorrect and unstable pitch.

A broken grounding chassis cable was found and to be fixed via soldering iron. Failed to restore the connection might yield an unwanted buzzing the overall output.

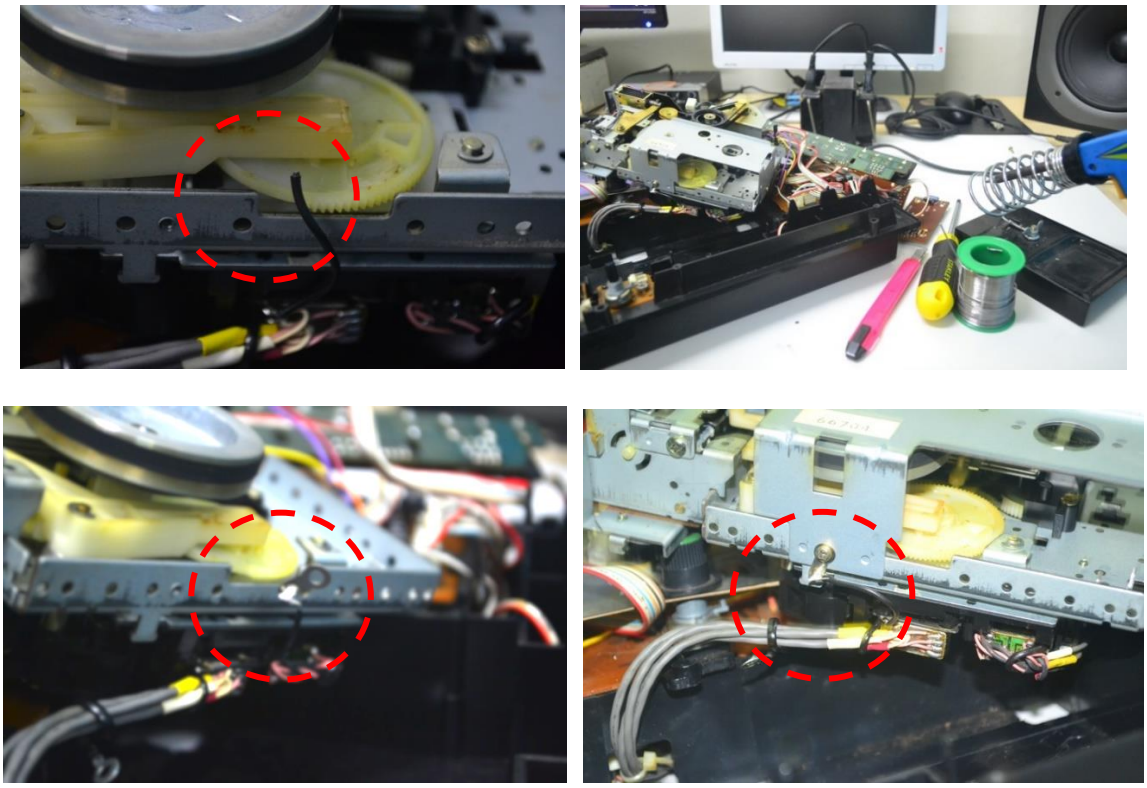


FIGURE 21a, b, c, and d: broken grounding chassis cable that required fixing.

Migration of the replay 4 track tapes direct out of the replay unit were sent in as a direct signal out, to the direct inputs of the Pro Tools via Digi design 003 audio interface at 24-bit resolutions 44.1kHz sampling rate. A 1 core 1 shield cable RCA to ¼ inch was plugin into the input of the Digi design 003 audio interfaces. It is important to understand the block diagram of devices, as

[2] Analogue equipment requires regular alignment to ensure that it continues to operate within the specification. It is recommended that heads and tape path must be thoroughly cleaned every 4 hours of operation, or more frequently if required, using a suitable cleaning fluid such as isopropyl alcohol on all metal parts. Rubber pinch rollers should be cleaned with dry cotton buds or with cotton buds dampened with water as necessary.

it will determine whether the migration of the audio signal has achieved its proper standard operating level. As shown in figure 22 below, all output will be at -10 dBv.

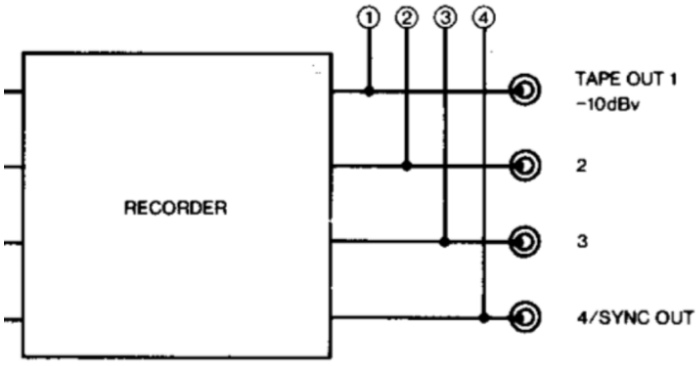


FIGURE 22: all output is at -10 dB.

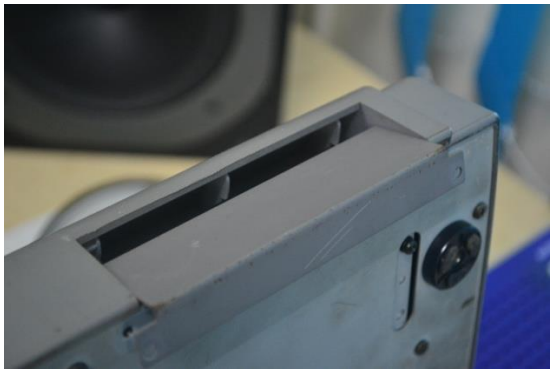
FIGURE 23a and b: Direct RCA outputs – 10dBv to the inputs of audio interface independently.

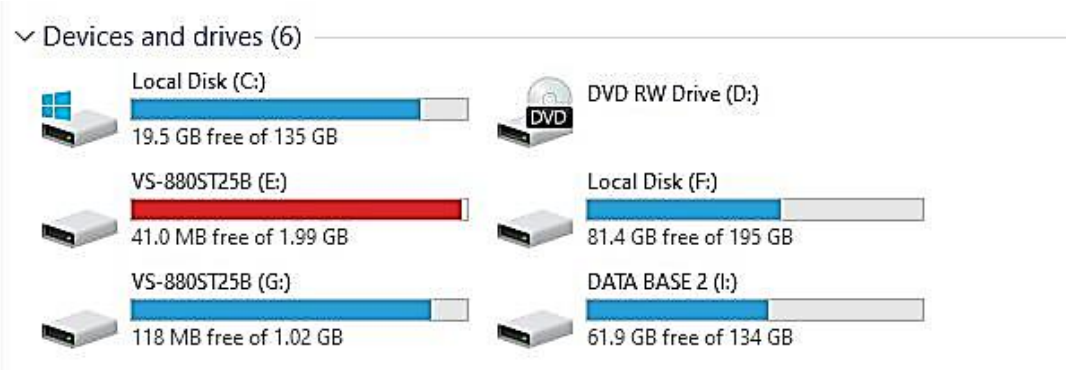
FIGURE 24a and b: Migration of audio signal (real-time) from the replay unit of independent outputs to the direct inputs of the Digital Audio Workstation with the bit resolution and sampling rate recommended by the IASA-TC04.

STANDALONE HARD DISK RECORDER

The VS1680 signal migration is of the TOSLINK or analogue can be made available, provided replay unit able to playback or decode audio signal information or otherwise further steps to be carried out, particularly ways to extract the data of the VS1680. Through the inspections, it seems impossible to obtain any information from the LCD replay unit. This was because the lifetime of the liquid crystal display has just ended. Nothing can be read or retrieved from the display. Based on that, another process can be done via physically remove the hard disk.


Roland




Devices and drives (6)
Local Disk (C:)
19.5 GB free of 135 GB
DVD RW Drive (D:)
DVD
VS-880ST25B (E:)
41.0 MB free of 1.99 GB
Local Disk (F:)
81.4 GB free of 195 GB
VS-880ST25B (G:)
118 MB free of 1.02 GB
DATA BASE 2 (I:)
61.9 GB free of 134 GB

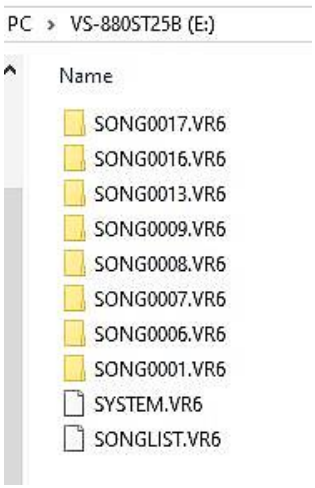


FIGURE 25 a-h: Extract via hard-disk using the IDE to USB cable to retrieve data and the resulting screens.

VR6 files were unassigned file type that requires an extension. The VirtDisk.com software seems to be the best choice as to extract and convert all the necessary per folder onto individual wave tracks that can be accessed via any DAW.

CONCLUSION

Data migration is a steadily evolving process, and each process technically is unique its way. The uniqueness derives from each and every technology that was created in the past. As an audio archivist, one should not disregard in handling such materials and its replay machine.

This study has shown that the proposed model is the notion of thinking and understanding sound in multi-dimensional ways, rather than ways proposed through conventional two-dimensional sound collections. It's not only about preserving the content, but also preserving the both the material and its replay unit as important content. Preserving content, material that holds the content, the replay unit as well as the knowledge in retrieving through past technology understanding. The archive material is not restricted to only audio-visual materials, but to other content that is tangible to be preserved. As stated by Joey Springer in her keynote address

" Many documents continue to disappear through neglect, destruction, decay, and the lack of resources that contribute to an impoverishment of the memory of mankind." (Springer, 2014).

REFERENCES

Bradley, Kevin, ed. 2009. *Guidelines on the Production and Preservation of Digital Audio Objects. Standards, Recommended Practices and Strategies*, IASA TC-04. Auckland Park: International Association of Sound and Audiovisual Archives (IASA).

Standard Popular. 2008. Jabatan Standard Malaysia, Kementerian Perdagangan Antarabangsa dan Industri [Department of Standards Malaysia, Ministry of International Trade and Industry]. Accessible via http://www.jsm.gov.my/ms/ms-iso-9001#.XbK5R44zaM8, last accessed 25 October, 2019.

Fostex Corporation. 1987. Owner's Manual Fostex Model 160 Recorder/Mixer. 560-3, Miyazawa-cho, Akishima, Tokyo Japan. Accessible via URL: - https://www.fostexinternational.com/docs/tech_support/manuals.shtml (Retrieved 20th October 2019)

Musib, Ahmad Faudzi. 2015. *Contextual sound preservation of selected local string instruments.* PhD thesis, Universiti Putra Malaysia.

Roland Corporation.1998. Owner's manual 24-bit Digital Studio Workstation Roland VS1680 - 2036-1 Nakagawa, Hosoe-cho, Kita-ku, Hamamatsu, Shizuoka 431-1304, Japan.
Accessible via URL: https://static.roland.com/assets/media/pdf/VS-1680_OM.pdf, las accessed 26 October, 2019.

Schuursma Rolf. 2010. *Problems of selection in research sound archives*: IASA Special Publication No.5. International Association of Sound and Audiovisual Archives (IASA).

Schuursma Rolf. 1981. IASA with the International Association of Music Libraries, Archives and Documentation Centers Conference in Budapest, Hungary. Unpublished ms.

Springer, Joie. 2014. *Preserving Audio-visual Documents: An International Perspective*. Keynote address at the 18th SEAPAVAA Conference, Vientiane, Laos, 26-30 May 2014.