TDL® Technology, Inc. – Case Study Number 1

Restoration of music on 50 year old, 1/4 inch reel-to-reel magnetic tape
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In the 1950s I borrowed popular music 45 RPM records from my friends and copied them to 1/4 inch reel-to-reel magnetic tape using a Bell (not Bell and Howell) recorder running at 7.5 inches per second. I liked the simplicity of the Bell machine: you changed the record and playback speed by changing the diameter of the capstan that pulled the tape across the heads. There was no mechanical switching of any kind to get out of adjustment.

The tapes are now at least 50 years old but they looked in pretty good condition so I decided to try to recover the music. Since most of them weren't labeled, I first had to play them to find out what I had. Frankly, they didn't sound too good. My current playback system is much better than it was in the 50s so I heard a lot of tape hiss as well as a lot of power mains hum. The tapes are, of course, mono since the 45 RPM records were mono, as was the tape recorder.

I used an *Otari* model ARS1000 [1] playback deck and connected the deck's left (mono) output to both the left and right inputs of one channel of a TDL® model 457 Audio Control Center to serve as a volume control. Although the tapes are mono, I wanted to record in stereo. One of the model 457 output channels was then connected to the computer sound card's line input. (The sound card was a Waveterminal model 192X [2].) I played each side of each tape, without recording, to set the peak input level to about -2 dB. Then I played them again and saved each one as tape1.wav, tape2.wav, etc.

Next, I copied all the "raw" unrestored wav files to CD so that I could get back to the beginning of the restoration precess, if I needed to, without having to re-record the tapes.

As the first restoration step I used *Wave Corrector* version 3.1 (the current version is 3.2) from *Ganymede Test and Measurement* [3] to remove the tape hiss. *Wave Corrector* is very useful as a "first pass" for both tape and vinyl restoration so I use it quite often (it's also rather inexpensive). *Wave Corrector* names the resultant files as tape1cor01.wav, tape2cor01.wav, etc. I listened to the corrected files and felt encouraged because virtually all the hiss had been removed.

I used *Cool Edit*, which is now owned by *Adobe* and named *Adobe Audition* [4], to normalize each of the corrected files to -1 dB and then to separate the "tape" files into individual track (song) files which I named in arbitrary sequence as track01.wav, track02.wav, etc. Most any audio editor would have worked for these steps. I used *Cool Edit* because I've used it a lot and am very familiar with it. Normalizing the whole tape file before separating it into tracks has the advantages of being faster to do and preserving most of the intentional loudness variation between songs (tracks).

But I still had the hum to deal with so I used *Spectrogram* [5] to look at the frequency spectrum of one of the track files. (Any track would do because they all had a lot of hum!) Again, most any spectrum analysis program that can scan a file would have done the job. I found 60 Hz and 120 Hz lines at about equal amplitude and only about 10 dB lower than the music peaks. Notch (band reject)

filters looked like the best way to remove the hum because the power mains frequency is (and was 50 years ago) very stable so I could use a very narrow notch filter. This is important because even a narrow filter will remove some music with frequencies near the notch frequency. Most, if not all, audio restoration programs contain notch filters, and some are better than others. I used *Dart XP Pro* [6] because I've used its notch filters before and I've found them to be effective. I set the center frequency to 60 Hz and the -3 dB bandwidth to 1 Hz (the smallest value allowed). I ran this filter twice on each "track" file. Then I set the center frequency to 120 Hz, the bandwidth to 1 Hz and ran this filter twice on each track file. Why twice? Because I could still hear a bit of hum after just one pass.

Some tracks, especially those near the starting ends of the tapes, were not of real good quality probably because the tape itself was not as well protected from the "elements" as tracks farther into the reeled tape. But at this point I had done all I could do so I copied the tracks to CD using *Roxio Easy CD Creator* [7]. I'm using version 5, which is not the latest, but it works fine so I can't see a good reason to upgrade.

Audio restoration is a science but it is also an art. The "art" part comes with experience, that is, experimentation. The best way to learn is to record an old 78, 45 or LP (the worse it sounds, the better) to your computer and see what you do with it. Save a copy of the "raw" un-played with file so you can easily get back to your starting point if everything you try just makes things worse (this sometimes happens!). It's an axiom that you can't have too much restoration software – and some of the "good stuff" is rather inexpensive. (Please see my revised *Audio Restoration* chapter on Software.) Pick a program that does "Click and Crackle" removal and try it. If you get good results, that's great – if not, try another program. Keep notes because as time passes you won't remember (I've been there). If everyone who is at least half-way interested restores a bit of old music to share with family and friends, it won't be lost. The record companies can't do it because there is just too much old music. (OK, I'm getting off my soapbox now.)

REFERENCES

1. This *Otari* playback deck was obtained from a radio station when they went to CDs. This model is not currently produced but this one has been restored and it performs quite well.

2. The *Waveterminal 192X* sound card is available from http://www.tracertek.com.

3. The *Wave Corrector* software is available from http://www.wavecor.co.uk. The registration fee is $45 USD and upgrades have been free (since version 2.4).

4. *Adobe Audition* is available from http://www.adobe.com. The last time I looked, *Cool Edit Pro* was still available from some of the discount companies. You could try a *Google* search.

5. *Spectrogram* is available from http://www.visualizationsoftware.com/gram.htm. I'm using version 8.5. The current version (October 2005) is 12.3 and the registration fee is up to $49.95 USD.

6. *Dart XP Pro* is available from http://www.dartpro.com. You can check their web site for the current version and price.

7. *Easy CD Creator* is available from http://www.roxio.com.

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