AET 1380 Lecture 14

Analog Recording

ANALOG

Analog comes from the same root word as does “analogous” meaning “similar” or “the same”

In analog recording the waveform of the recording resembles or is similar or is “analogous” to the original sound source

ANALOG

Magnetic Recording Timeline

1877: Oberlin Smith’s diagram/invention of the magnetic recording process in 1877
1893: Valdemar Poulsen invents the wire recorder, Telegraphone
1926 – Fritz Pfeumer events magnetic tape (paper based) in Germany
1936: German Exhibition Recording (Plastic Based Tape)
1947: Jack Mullin and Major John Herbert Orr, were able to bring this technology out of Germany to USA after WWII

ANALOG

Oberlin Smith in his 1888 article said “recording with magnetization had no direct contact with recording media, therefore no deformation” in the recording process”
The waveform of an analog recording is also **continuous** or **unbroken**.

That is, it is a continuous function that is made up of **energy changes** over time that resemble the waveform of the original sound.

**Analog versus Digital**

- According to Alten (the author of Audio In Media) both are equal, in that each has its benefits and drawbacks.

- **Analog**: Continuous waveforms, warmer, less technical problems, less intensive process, less demanding, low S/N, lacks low lows and hi his, smoother?, warmer?

- **Digital**: Uses binary information, noise-free, crystal clear (transparent) sound, flexibility, easier to edit, cheaper, uses eyes more than ears?

**Analog Recording Tape**

- **Base** – A thin film made of Mylar plastic

- **Back Coat** – A carbon film on the reverse side of the tape that reduces print through and static electricity

- **Top Coat** – The binder that adheres the magnetic particles to the base

- **Magnetic Coating** – tiny magnets of ferric oxide
Magnetic Energy

- Stored on tape in tiny magnets in regions called “domains” – have positive and negative poles (pp 107)
- Flow of magnetism/electrons (FLUX) through the record head gap POLARIZES the domains, forcing the magnets into patterns that store information about the amount of energy.

Magnetic Alignment of Domains

![Diagram showing magnetic alignment of domains with labels for no current, very weak current, weak current, strong current, random alignment, and saturation.]

Head Configurations

- Mono
- Stereo
- 4 Track
- Etc. Track

![Diagram of Head Stack Otari MX-55 with labels for various components such as Capstan shaft, Pinch Roller pack, Guide roller, Erase head, Record head, Repro head, Lifters, Capstan, Tape speed 15 & 7 1/2IPS, Hold back/take up tension, and other equipment.]
Analog Recorders - Problems

- One problem with analog tape, besides the inherent noise (cause by randomized domains) is one layer of magnetism is transferred to an adjacent layer.
- Due to one layer of tape sitting on top of another - the magnetic field of one may partially magnetize the other.
- Can result in pre- or post-echo added to the signal. Pre-echoes are more noticeable because they precede the signal they echo whereas post-echoes are often masked by their source sound.
- Listening: Whole Lotta Love
- Prevention: Store tape “tails out” (end of recording on outside)
- Prevention: Back Coat
Analog Recorders - Problems

- In analog when a copy is made from a copy:

Analog Recorders

Sections of the tape recorder are:
1) transport system
2) magnetic heads
3) playback electronics

Analog Recorders – Transport Section

- Tape Transport – the system that moves the tape through the machine
- Tape moves left to right
- Feed Reel (Supply Reel)
- Take-up Reel
- Transport Commands – stop, play, record, rewind, fast forward
Analog Recorders – Transport Section

Constant Tape Speed

Capstan – a steel shaft which is always turning at a constant speed. Pulls tape past heads.

Pinch Roller - When the PLAY button is pushed, the rubber pinch roller squeezes the tape against the capstan and the tape is pulled past the heads.

Vari-Speed Control – effects or adjustment

Constant Tape Tension
Supply Motor and Takeup motor
Tension Levers

Analog Recorders – Electronics Section

- Amplification of signals going to and from the heads

- Equalization – record and play heads – most tape machines add a slight boost at low and high frequencies to improve S/N ratio – accounts for the sound of tape

Analog Recorders – Tape Heads Section

- Professional Analog Tape Recorders (ATR's) have three magnetic heads which the tape encounters in the following order during normal forward transport:

  1) Erase
  2) Record
  3) playback

Pass tape head around – how many tracks?
Analog Recorders – Tape Heads Section

- **Erase Head** – randomizes domains
- **Record Head** – applies flux, transducer converts electrical energy into magnetic energy
- **Playback Head** – reads flux, transducer converts magnetic energy into electrical energy

**Selective Synchronization**

- Uses record head as playback head for previously recorded tracks
- Compensates for time delay between record and playback heads.
- Used only in overdubbing
- Invented by Les Paul
- Without it, we could not overdub
Analog Tape - Care

- Why should we care about tape care?
- Tapes should always be stored either fully fast forwarded or "tails out".
- Tapes should be stored at 60 to 65 deg f. at 35 to 40% relative humidity.
- Never store tapes flat. Store them on end as you would a book. This reduces edge stresses on the tape.

- Keep away from magnetic fields
- Store in an opaque storage case and keep out of sunlight
- If the tape is wrapped in plastic, be sure to use a silica gel desiccant inside the plastic bag.
- Every 3 years at most, the tape should be removed & fully fast forwarded to the end and then rewound on a known good deck.
- "Care of Tape" pp 109 in AIM

Analog Recording Quality

- Tape Widths = dynamic range. Greater = more.
  - ¼, ½, 1, 2 inches
- Tape Speeds = bandwidth
  - 7 ½ IPS, 15 IPS, 30 IPS
- Cost from $150 - $175 per 2 "reel
- At a speed of 30 inches per second (30 IPS)
  - You will get approx. 16 minutes of recording time
  - At 15IPS, Approx. 32 minutes of record time

OTHER TERMS

- Tape saturation – caused by a high input signal; a warm grungy sound (Listening: “Tutti Frutti” – 1955)
- Tape Hiss – too low of a signal random noise created by non-aligned particles
Other Related Analog Concepts

Wow & Flutter – due to a non-consistent movement and tension.

- **Wow** – slow variation in tape speed
- **Flutter** – fast variation in tape speed
  - The more times analog tape is dubbed (copied), wow and flutter become more and more audible.
- **Dropouts** – Missing magnetic domains

Other Related Concepts

- **Tape splicing** – cut diagonally with razor blade and cutting block, leader tape between songs and at beginning. (Beatles – She Loves You, Billy Joel – My Life)
- **Tape echo** – also called “slapback”. Caused by distance between two play heads (Les Paul’s Guitar/Jerry Lee Lewis “Great Balls of Fire”)
- **Tape Bleed** - magnetization on one track, if loud enough, can bleed into an adjacent track.
- **Tape loops** (“Money” by Pink Floyd/Bee Gees)

Other Related Concepts

- **Tape saturation** - the maximum amount of magnetism a magnetic tape can hold. Engineers using analog tape often make use of tape saturation as an effect. By carefully controlling record levels, compression, warmth, and fatness can be added to a signal

- **Tape calibration** - adjusting the VU meters for each track during playback and record so that they read the optimum levels for the type of tape you are using. 1 k 5 k 10 k tones that are printed with project

- **Nano-Webers per meter** - a unit in measuring the magnetic field strength.

Learn how to use tape and you won’t end up like this…
Extra Knowledge (Not on test)
Calibration and Alignment

- Tape alignment -- mechanical adjustments to tape machine including head position (height, skew, and azimuth), and tape speed. (pp 117)