BASIC AUDIO EFFECTS

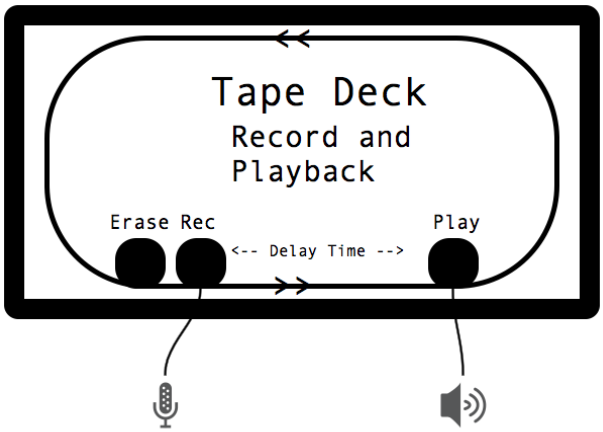

FIGURE 1. Basic [Tape] Delay (Distance between 'record head' and 'play head' determines 'Delay Time').

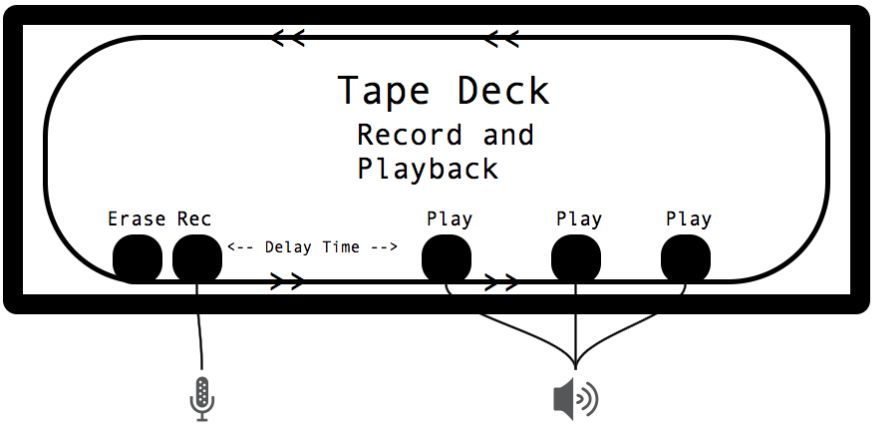

FIGURE 2. Multitap [Tape] Delay (Multiple 'play heads' means multiple repetitions of sound).

Delay with Feedback

The first use of a tape delay effect with feedback was by Terry Riley in music he wrote for a play named *The Gift*[1]. The Jazz trumpet player Chet Baker had only just arrived in Paris[1, 216] so Riley suggested he should also be involved. While working on the piece one of the recording

[1] http://mikailgraham.com/terryriley/audio.htm

engineers designed the first tape delay with feedback, under instructions from Riley and which he lated dubbed the "Time-Lag Accumulator"[3, 105], and the resulting piece relied heavily upon it. Chet Bakers band performed a rendition of the Miles Davis piece *So What*, Riley then spliced and re-arranged segments of the recordings[3, 106] and used the feedback control of the "Accumulator" to create "repetitive textures over the modal harmonies"[2, 165].

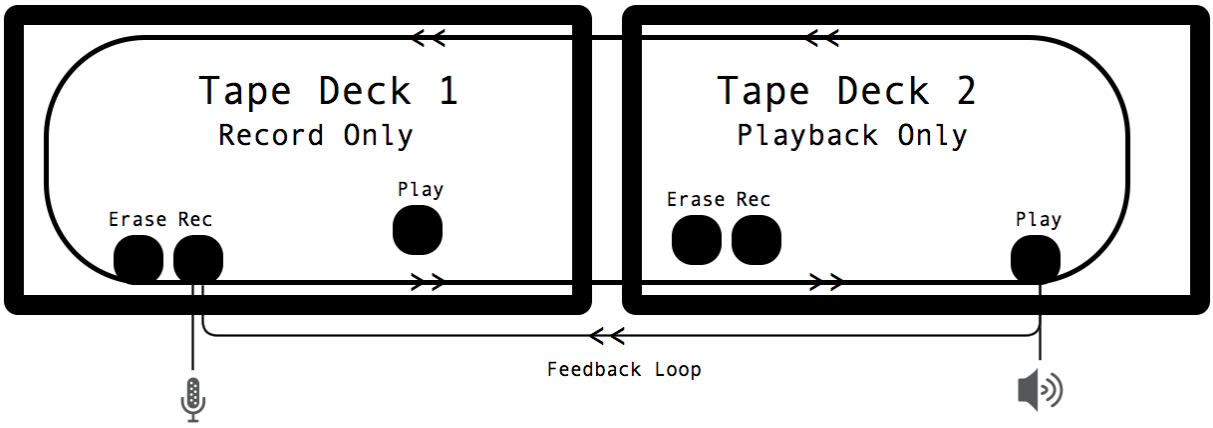

FIGURE 3. "Time-Lag Accumulator." i.e. [Tape] Delay with feedback (Output of 'play head' is "fed back" into delay loop).

Changing Delay Times w/Feedback as a musical effect (i.e. the 'bouncing ball effect')

Aphex Twin - Bucephalus Bouncing Ball (throughout, but most prominent from 3:00)

Autechre - Drane2 (starts at 0:48)

Doppler Effect

Change in **frequency** of wave as the source is moving towards/away from observer. (Think fire engine/police car siren).

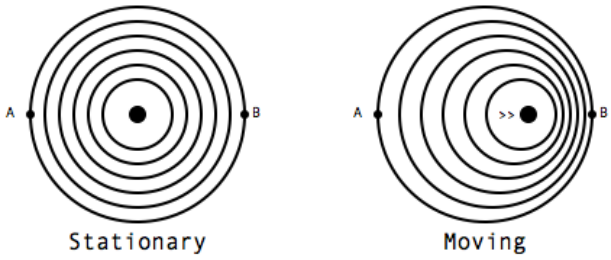

FIGURE 4. "Doppler Shift Effect" - As source is moving towards point B, the frequency is stretched (i.e. becomes longer - lower pitch) behind, and contracted (i.e. becomes shorter - higher pitch).

Pitch Shifting

Pitch Shifting with Delay lines is very similar to the doppler effect. By changing the delay time we get changes in pitch.

- If the delay time gets longer, we are essentially moving away from the source - i.e. the frequency gets longer, pitch gets lower.
- If the delay time gets shorter, we are essentially moving towards from the source - i.e. the frequency gets shorter, pitch gets higher.

Obviously we can't keep increasing/decreasing the delay time indefinitely (for one thing we can't have a delay time of less than 0...). So instead:

- We go between *'0 and X'*, and then start again from 0, (i.e. **increasing delay time**) at a **constant rate** to **decrease the frequency**. The faster we increase the delay time the lower the frequency becomes.
- Or, we go between *'X and 0'*, and then start again from X, (i.e. **decreasing delay time**) at a **constant rate** to **increase the frequency**. The faster we decrease the delay time the higher the frequency becomes.

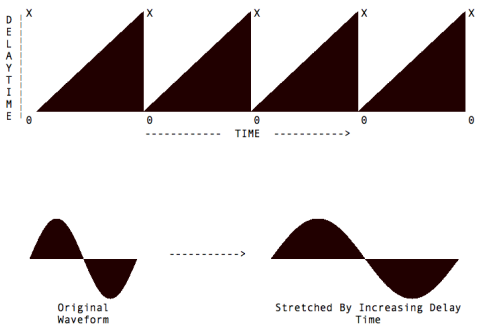

FIGURE 5. Increasing delay time at a constant rate to lower pitch of sound.

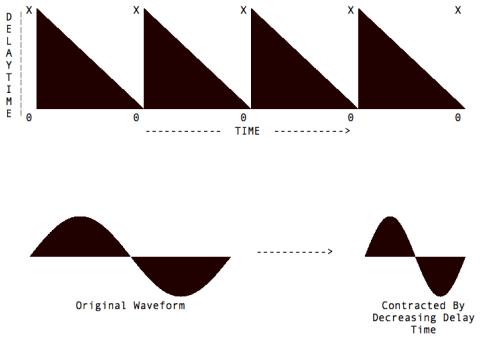

FIGURE 6. Decreasing delay time at a constant rate to higher pitch of sound.

Phase of a Wave

The **phase** of a wave is its position through its **cycle**. If two identical waves happen at the same time, i.e. their **peaks** (high points) happen at the same time, and their **troughs** (low points) also happen at the same time, they are said to be **in phase**. At any other point they are **out of phase**. The amount **out of phase** is either discussed in degrees (0 or 360 degrees being in phase, 180 degrees being completely out of phase) or as a percentage/fraction (0.0 being in phase, 0.5 or 50% being completely out of phase).

Combining Sine Waves & Phase Cancellation

All sound is a combination of different sine waves. When two (or more) sine waves interact (i.e. sound at the same time), they are summed together. The result is:

- If a **peak** (high points in the wave) happens at the same time as a **trough** (low points in the wave) they **cancel** each other out (see Fig. 7)

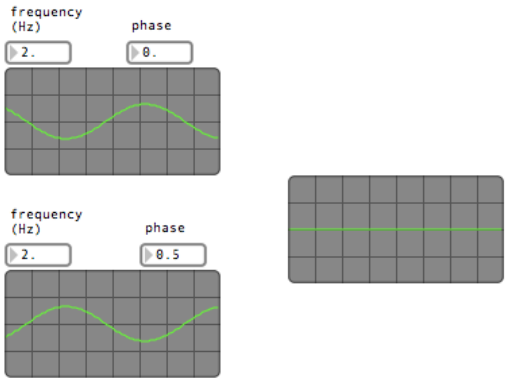

FIGURE 7. Two identical, **out of phase**, sine waves cancel each other out creating silence (this is essentially how noise cancelling headphones work).

- When **peaks** (high points in the wave) happen at the same time the become larger (i.e. higher) (see Fig. 8)
- When when **troughs** (low points in the wave) happen at the same time they also become larger (i.e. lower) (see Fig. 8)

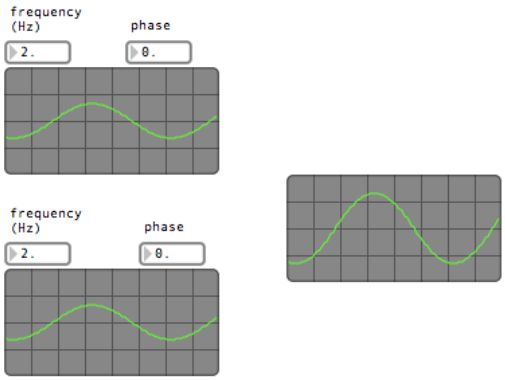

FIGURE 8. Two identical, **in phase**, sine waves are added together to create higher peaks and lower troughs.

- When we add multiple sine waves together, the result is a more complex series of troughs and peaks which takes longer to repeat (see Fig. 9).

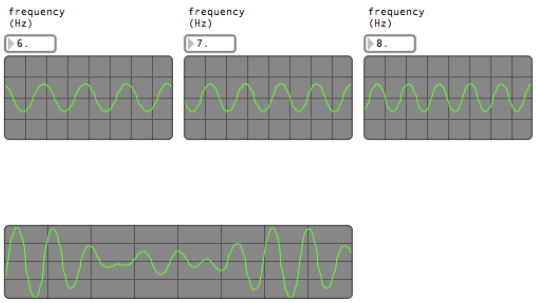

FIGURE 9. Multiple different sine waves added together produce a more complex sound. This is the basis of all the sounds we hear, a complex combination of sine waves.

Flanger

If, instead of changing delay time constantly in one direction, we change a very short delay time (usually less than 20 milliseconds) back and forth (i.e. longer delay time, then shorter etc.) at a **smooth** rate we get a filtering effect called **Flanging**. Essentially we are moving the **flanged** audio **out of phase** with the original sound to create moving **phase cancellation**. Flanger uses a **sine wave**[2] to oscillate the delay time back and forth in a **smooth** manner. (This has been used in any number of pop/rock songs[3])

- The **delay time**(if available) and the **depth/intensity** determine the **maximum and minimum pitch shifts**
- The **rate** determines the **speed** at which the **frequency oscillates** between maximum and minimum values.

[2] http://www.citejournal.org/articles/v5i3seminal4/sine%20wave.html
[3] https://en.wikipedia.org/wiki/Timeline_of_recordings_with_a_flanging_effect

Chorus

Chorus is very similar to **Flanging**, however in this case we usually use slightly longer delay times, and change the delay time between the maximum and minimum values **randomly** - giving constant, and unpredictable, variations in both pitch and delay time. This approximates the effect of a choir, or any large ensemble, where multiple people sing the same note, but with minute differences in pitch and starting time. (Again, this has been used in any number of pop/rock songs[4])

- The **delay time**(if available) and the **depth/intensity** determine the maximum and minimum pitch shifts
- The **rate** determines the speed at which the frequency changes.

References

[1] David W Bernstein. *The San Francisco Tape Music Center: 1960s Counterculture and the Avant-Garde*. Univ of California Press, 2008.

[2] Richard Glover. Minimalism, Technology and Electronic Music. In *Ashgate Research Companion to Minimalist and Post-Minimalist Music*, pages 161–180. Ashgate, 2013.

[3] Keith Potter. *Four Musical Minimalists: La Monte Young, Terry Riley, Steve Reich, Philip Glass*, volume 11. Cambridge University Press, 2002.

[4] http://www.sourceaudio.net/blog/post/the-top-10-greatest-chorus-effect-recordings-of-all-time