

# NUTS and BOLTS

PART 13

## The Delay

BY ALEX CASE

Part 1 of our look at having audio wait around a bit before hitting your ears

**F**irst some music. Hum or sing along with me the tune 'Comfortably Numb' from The Wall by Pink Floyd. You know the first line:

Hello (Hello...hello...hello). Is there anybody in there?

This is a classic use of a long delay. The dreamy, disturbed, out of mind state of our friend Pink is enhanced by (the entire, brilliant rock and roll arrangement, including) this repeating, gently fading echo.

How's it done? Perhaps the simplest way is to use a post fader aux send from the vocal to the delay, which is returned on a separate fader (see Figure 1a). This sends the voice, with all its compression and equalization, to the delay. We have full control of the return from the delay as it is on its own fader.

Well, almost. Patching it up this way would add a delay to the entire vocal performance, not just the word 'hello.' So we resort to an automated send as shown in Figure 1b. Now we have a fader and cut button dedicated to the control of the send into the delay, not just the return.

This echo send remains cut most of the song. You briefly open it up for the word 'hello,' and presto—that single word starts to echo. Put this into automation and you'll get the perfectly tailored delay every time.

Figure 1 explains what's going on at the console. How do you set up the delay unit itself? Most delays have available the controls shown in Figure 2: input and/or output level, delay time, and regeneration control.

Input/output levels are self-explanatory. Delay time can be fixed or variable—using the three modulation controls (rate, depth and shape)—as we'll see in later examples. The Regeneration control, sometimes called the feedback control, sends the output of the delay back into itself. That is, a delayed signal can be further delayed by running it back through the delay again. This is how the delay is made to repeat more than once, as happens to the word 'hello.'

As we'll see throughout this and next month's article, the simple controls of Figure 2 empower the delay to become a fantastically diverse signal processor. In the case of the long delay used by Pink Floyd, we need to set the delay time to the appropriate length of time and add enough regeneration to make the echo repeat a few times. The other controls on the delay aren't necessary here.

### How long is long?

99.9% of the time these echoes should be set to a time that makes musical sense. That is, don't just pick

a random delay time, dial in a musical delay time instead. Should it repeat with a quarter note rhythm, an 8th note, a triplet,...?

One way to do this is simply by listening. Typically, we use the snare to 'tune' a delay—to set a musical delay time. Even if you plan to add delay to the vocal, the piano, or the guitar, it is usually easiest to use the snare for setting the delay time both because it is a rhythm instrument and because it hits so often. So much of pop music has a back beat—the snare falling regularly on beat two and beat four.

Send the snare to the delay and listen to the echo. Starting with a long delay time of about 250 milliseconds, adjust the delay time until it falls onto a musically relevant beat. This can be mighty confusing. It may help at first to pan the snare off to one side and the delay return to the other.

It's pretty jarring to hear a delay fall at a non-musical time interval. But when you adjust it into the time of the music, you'll instantly feel it. It is easiest to find a quarter note delay, but with practice and concentration, you can dial in triplet and dotted rhythms too.

Sometimes we calculate a delay time instead. How is this calculated? Bear with me here, as some equations

are about to appear. If you know the tempo of the song (we'll call it T) in beats per minute (BPM) and you want to calculate the length of a quarter note delay in milliseconds (Q), do the following:

- First convert beats per minute into minutes per beat by taking the reciprocal:

$T$  beats per minute becomes  $1/T$  minutes per beat.

- Then convert from minutes to milliseconds:

$1/T$  minutes per beat  $\times 60$  seconds per minute  $\times 1,000$  milliseconds per second.

- The length of time of a quarter note in milliseconds per beat is:

$$Q = (60 \times 1,000) / T = 60,000 / T$$

For example, we know a song with 60 beats per minute ticks like a watch, with a quarter note occurring exactly once per second. Let's try using the equation.

**T = 60:**

$$Q = 60,000 / T = 60,000 / 60$$

$$= 1,000 \text{ msec (one second) per quarter note}$$

Double the tempo to 120 bpm.

**T = 120:**

$$Q = 60,000 / T = 60,000 / 120$$

$$= 500 \text{ msec (half a second) per quarter note}$$

I use milliseconds because that is the measurement most delay units expect. Knowing the quarter note delay makes it easy to then calculate the time value of an 8th note, a 16th note, dotted or triplet values, etc.

Some newer delay devices, like the TC D-Two reviewed elsewhere in this issue, let you display delay times in either milliseconds or bpm directly, but remember that you need to know before you look at a bpm value if the delay is calculating a quarter note or some other length.

In the 'Comfortably Numb' example above, they cleverly use a dotted 8th note delay. It is worth transcribing it for some production insight. The tune is dreamy and lazy in tempo, moving at about 64 bpm. The two syllables of 'hello' are sung as 16th notes.

To appreciate the perfection in Pink Floyd's dotted 8th note delay time, let's consider two other, more obvious choices: a quarter note delay or an 8th note delay (consult Table 1).

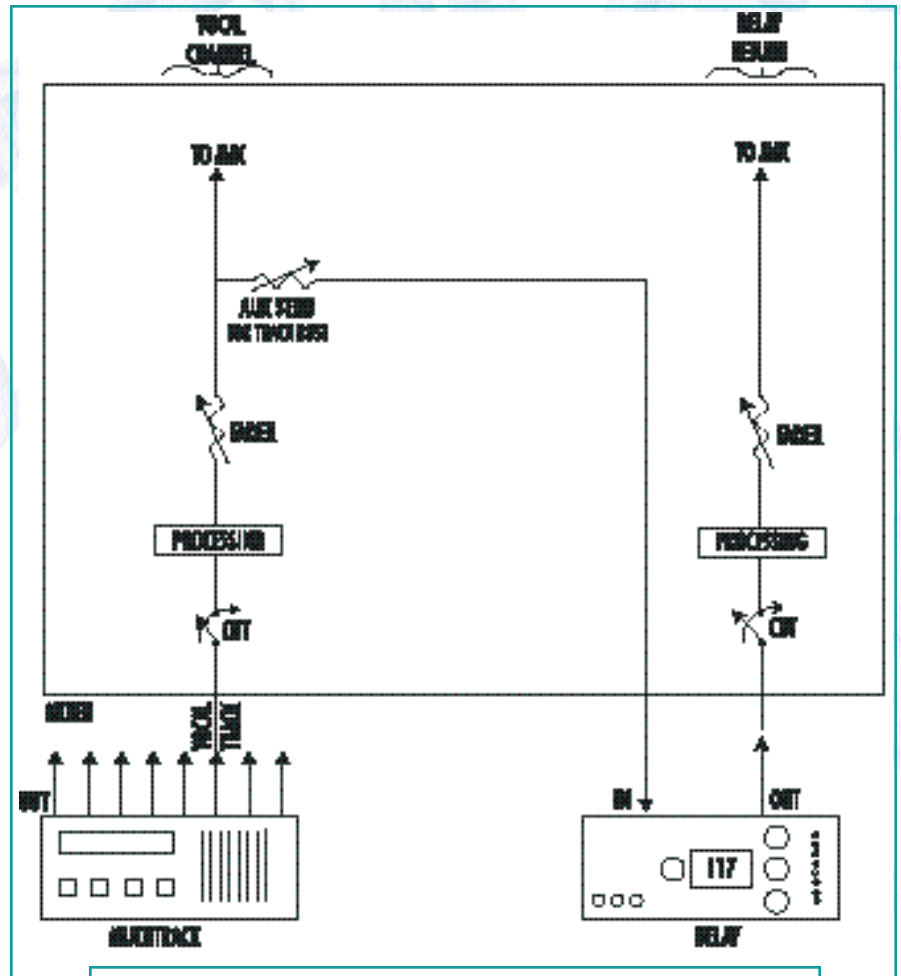


Figure 1a) Constant Send - Use an Aux Send (literally an Echo Send) or Spare Track Bus to send the Vocal to the Delay

The quarter note delay strongly emphasizes the time of the song; it's orderly and persistent. Sing it to yourself as a quarter note delay: Hello x x hello x x hello.... This would make it seem like Pink is being nagged or pushed around. Sing the 8th note delay and you find the repeats fall one after the other, with no rest in between the words: hello hello hello hello. This is just plain annoying.

The delay time they chose has the effect of inserting a 16th note rest in between each repeat of the word. Hello is sung on the downbeat.

The echo never again falls on a down beat. First it anticipates beat two by a 16th note, then it falls on the "and" of beat two. It then falls a 16th after beat three. Finally, it disappears as the next line is sung.

This timing scheme determines that 'hello' won't fall on a beat again until beat four, by which time the next line has begun and 'hello' is no longer audibly repeating. It's really a pattern of three in a song built on four. This guarantees it a dreamy, disorienting feeling. It remains true to the overall 'numb' feeling of our hero Pink, keeping an uncertain, disconnected feel to the story told.

The result is a pre-calculated creation of the desired emotional effect. And it's a catchy hook—a real Pink Floyd signature. (They've used this trick before, to devastating effect: 'Us And Them' from Dark Side Of The Moon, 'Dogs' from Animals....)

Table 1: evaluating the musical timing of delays

								the beat						
1	e	&	a	2	e	&	a	3	e	&	a			
Hel	lo											sung word		
x	x	x	x	hel	-	lo						quarter note delay		
x	x	hel	-	lo								8th note delay		
x	x	x	hel	-	lo							dotted 8th note delay		
x	x	x	hel	-	lo	x	hel	-	lo	x	hel	-	lo	with regeneration
Hel	lo	x	hel	-	lo	x	hel	-	lo	x	hel	-	lo	net effect

# NUTS and BOLTS

## Long delay

It's a funny idea, adding an echo to a singer, piano, guitar, or whatever. It doesn't seem to have any motivation based on reality. The only way to hear an echo on the vocal of a song is to go to a terrible venue (like an ice hockey rink or the Grand Canyon) and listen to music.

The sound of an echo across the entire mix is in fact not a pleasant experience. It is messy and distinctly non-musical.

The echoes we find in pop music tend to be used with more restraint. In some cases the echo is added to a single track, not the whole mix. And it's mixed in faintly so as to be almost inaudible.

In other cases the delay is added only to key words, phrases, or licks.

## Support

If a constant echo is to be added to an entire track, the echo needs to be mixed in almost subliminally, nearly hidden by the other sounds in the mix. A soft echo underneath the lead vocal can give it added richness and support. This approach can strengthen your singer, especially when the melody heads into falsetto territory. Pulsing, subliminal echoes feeding a long reverb can create a soft and delicate sonic foundation under the vocal of a ballad.

Then there's the vulnerable rock and roll singer in front of his mate's Marshall stack. After the last chorus the singer naturally wishes to scream "Yeaaaaaaaah!" and hold it for a couple of bars. It isn't easy to overcome the guitarist's wall of sound. Help the singer out by pumping some in-tempo delays into the scream.

The best "Yeaaaaaaaah!" ever recorded in the history of rock and roll (and I have this from a reliable source) is Roger Daltrey's in "Won't Get Fooled Again" by The Who. The scream occurs right after the re-introduction when those cool keyboards come back in, and right before the line "Meet the new boss. The same as the old boss."

This scream is a real rock and roll classic. Listen carefully (especially at the end of the scream) and you'll hear a set of delayed screams underneath. It's Roger Daltrey, only more

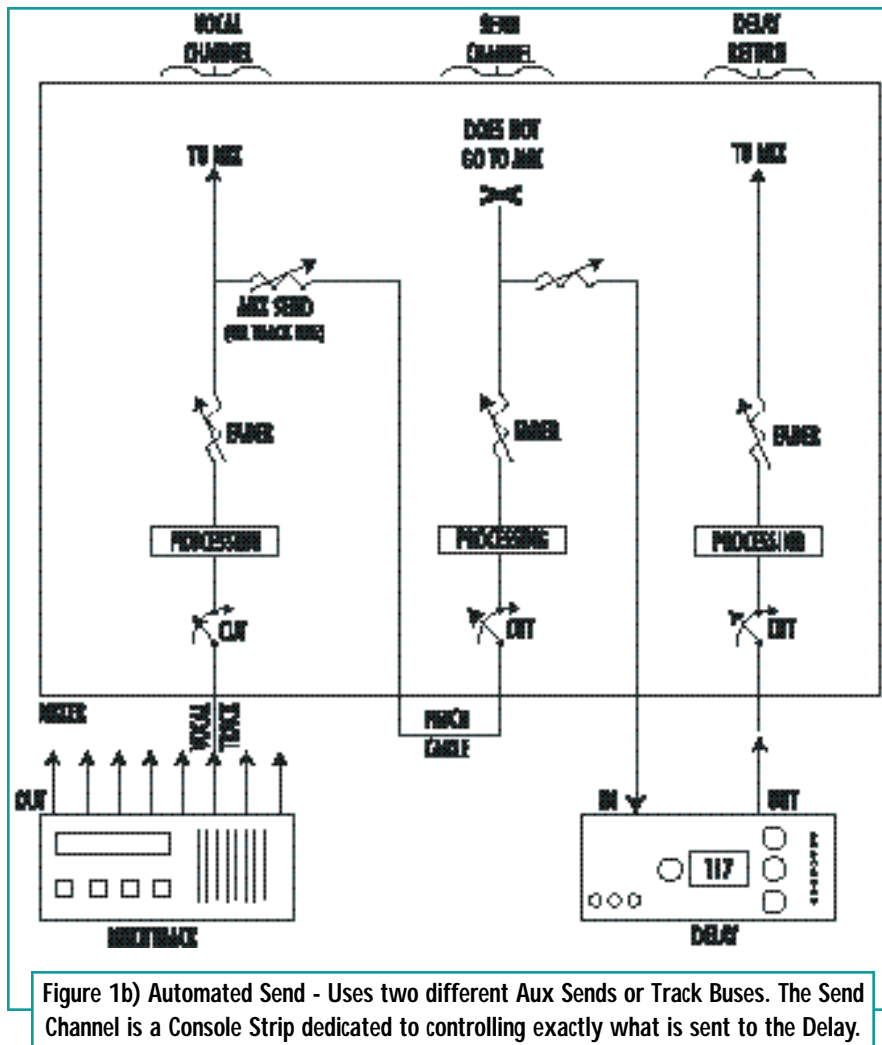


Figure 1b) Automated Send - Uses two different Aux Sends or Track Buses. The Send Channel is a Console Strip dedicated to controlling exactly what is sent to the Delay.

so: it's half a dozen Roger Daltreys. This makes quite a statement.

You can do this too. All you need is Roger and a long delay with some regeneration.

## Slap

A staple of '50s rock is sometimes part of a contemporary mix: slap-back echo. You never heard Elvis without it. Solo John Lennon therefore often had it. And guitarists playing the blues tend to like it.

Start with a single audible echo somewhere between 90 ms and 200 ms. On a vocal you'll instantly add a distinct retro feeling to the sound. On guitar it starts to feel more live, like you are in the smoky bar yourself.

Before the days of digital audio a common approach to creating this

sort of effect was to use a spare analog tape machine as a generator of delay. During mixdown the machine remains in record. Signal is sent from the console to the input of the tape machine in exactly the same way you'd send signal to any other effects unit: using an echo send or spare track bus.

That signal is recorded at the tape machine, and milliseconds later it is played back. That is, though the tape machine is recording, it remains in reprodmode so that the output of the tape machine is what it sees at the playback head.

As Figure 3 shows, the signal goes in, gets printed onto tape, the tape makes its way from the record head to the playback head (taking time to do so), and finally the sig-

# NUTS and BOLTS

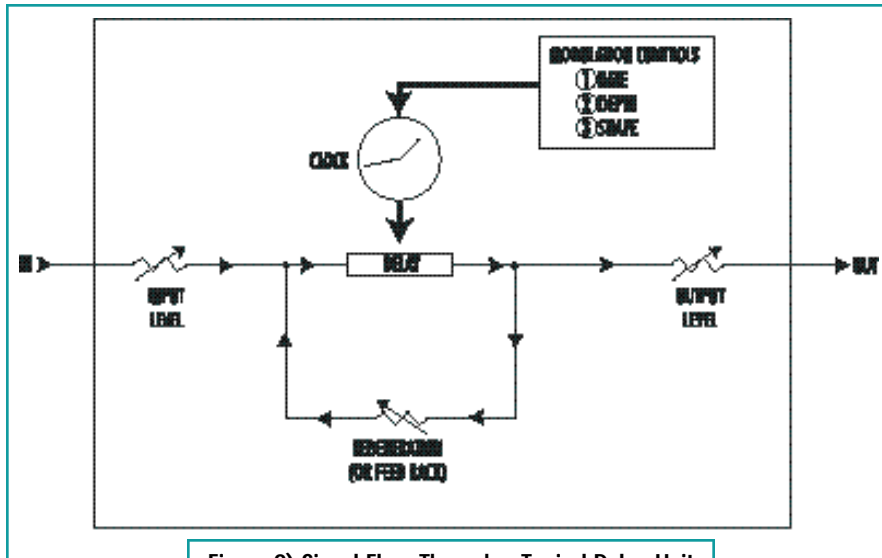


Figure 2) Signal Flow Through a Typical Delay Unit

nal is played back off tape and returned to the console. The result is a tape delay.

The signal is delayed by the amount of time it takes the tape to travel from the record head to the repro head. The actual delay time then is a function of the speed of the tape and the particular model of tape machine you are using (which determines the physical distance between the two heads).

Want to lengthen the delay time? Slow the tape machine down. You might have two, maybe three choices of tape speed: 7 1/2, 15, or 30 inches per second (lovingly called 'ips'). None of these delay times seem exactly right? Maybe your tape machine has vari-speed that lets you find tape speeds slightly faster or slower than the standard speeds listed above.

Can't make these delay times fit into the rhythm of the song? No prob. Go buy another analog 2-track machine, one with a different head arrangement so that the delay time will be different.

Wait a second. A single tape machine, which might cost several thousand dollars, is capable of just a few different delay settings? Yup. A 3-speed tape machine used this way is like a really expensive effects device with three presets. Drag.

Tape delay was originally used because it was one of the only choic-

es at the time. To help out, manufacturers made tape delays, which were tape machines with a loop of tape inside. The spacing between the record and playback heads was adjustable to give you more flexibility in timing the delay.

Here in the year 2000 we have more options. Life is good. We can buy a digital delay that is easily adjustable, wonderfully flexible, probably cheaper than a tape machine, and it either fits in one or two rack spaces or exists conveniently in a pull-down menu on our DAW.

But if you have a spare tape machine that has perhaps been sitting unused ever since you made the investment in a DAT machine, you've got the opportunity to create tape slap. This can even be a cassette deck if it has a tape/monitor switch to let you monitor the playback head while you record.

Why bother? Some people are simply turned on by anything retro. Tape delay is more trouble, more expensive, and we know some great old records used it. That is reason enough for some engineers. I personally am not into retro for retro's sake; I take the trouble to use a tape delay when I want that 'sound.'

An analog tape machine introduces its own subtle color to the sound. Mainly, it tends to add a low frequency hump into the signal, depending on the tape machine, the

tape speed, and how it is calibrated. If you push the level to the tape delay into the red, you introduce that signature analog tape compression, and at hotter levels still, analog tape saturation distortion.

Tape delay becomes a more complex, very rich effect now. It isn't just a delay—it is a delay plus equalizer plus compressor plus distortion device.

This can be darn difficult to simulate digitally. It's sometimes the perfect bit of nuance to make a track special within the mix.

## Emphasis

Adding a long delay to a key word, as in the Pink Floyd example, is a way to emphasize a particular word. It can be obvious, like the 'hello' that begins the song. Simulating a call and response type of lyric, the delay is often a hook that people sing along with.

Alternatively, it can be more subtle. A set of emphasizing delays hits key words throughout "Synchronicity II" on The Police's final album *Synchronicity*. The first line of every chorus ends with the word 'away,' which get a little delay based boost.

Listen also to key end words in the verses: 'face,' 'race,' and, um, 'crotch.' These are a quick dose of several echoes, courtesy of the regeneration control.

The Wallflowers' "One Headlight" on *Bringing Down the Horse* offers a great example of really hiding the delays. Listen carefully to the third verse—the words 'turn' and 'burn' each get a single subliminal dotted quarter note delay.

It's not unusual to low pass filter these sorts of delays. Removing the high frequency content from each repeat makes it sink deeper into the mix. Nice delay units provide you with this filter as an option.

Moreover, there is often the ability to double the delay time on outboard digital delays by pressing a button labeled "X2," meaning 'times two.' This cuts the sampling rate in half. With half as many samples to keep track of, the amount of time stored in a fixed amount of memory effectively doubles, hence the 'times two' label.

# NUTS and BOLTS

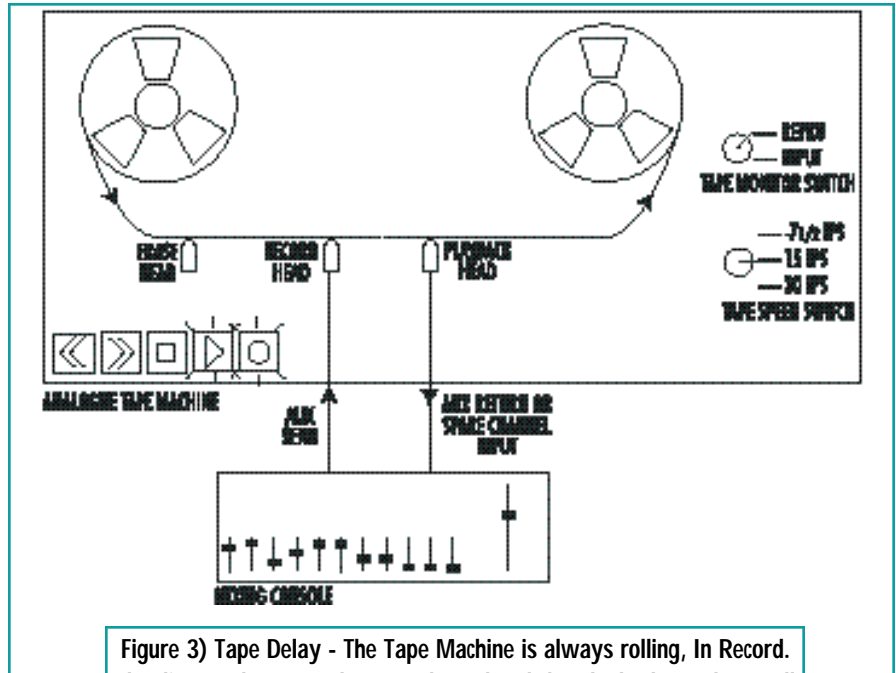


Figure 3) Tape Delay - The Tape Machine is always rolling, In Record. The distance between the Record Head and the Playback Head as well as the selected Tape Speed determine the Delay Time.

Halving the sample rate also lowers the upper frequency capability of the digital device. You know this if you are following the sampling rate wars: 44.1 kHz, 48 kHz, 96 kHz and more. The key benefit of increased sampling rate is improved high frequency resolution (A 'Nuts & Bolts' column dedicated to digital audio is forthcoming).

While sampling rates are creeping up on all our digital toys (especially DAWs and multitrack recorders), we sometimes lower the sampling rate on our digital delays. Low pass filtering the delay is often a desirable mix move.

### Groove

Beyond support, slap, and emphasis, we sometimes reach for delay to fill in part of the rhythm track of a song. Reggae is famous for its cliché echo. Drum programmers have been known to put in an 8th or quarter note delay across the entire groove.

Guitarists use delay too. U2's The Edge has made delay a permanent part of his guitar rig. A classic example is apparent from the very

introduction of U2's "Wide Awake" on The Unforgettable Fire. The quarter note triplet delay isn't just an effect, it's part of the riff.

The Edge has composed the delay element into the song. Ditto for "In the Name of Love" from the same album. An echo isn't just an echo any more, it's a part of the tune.

### Make it short

The delays discussed above are all audible as echoes, repeats of an earlier musical phrase. Delays are sometimes so short that they aren't perceived as echoes. That is, as the delay time falls below about 50 milliseconds, the sound of the delay is no longer an echo. We still hear the delay, but it takes on a new persona as the delay time gets this short.

Next month we explore these shorter time effects.

Alex Case wonders: why are flight delays always long delays? Request Nuts & Bolts topics via [case@acordimg.com](mailto:case@acordimg.com).

