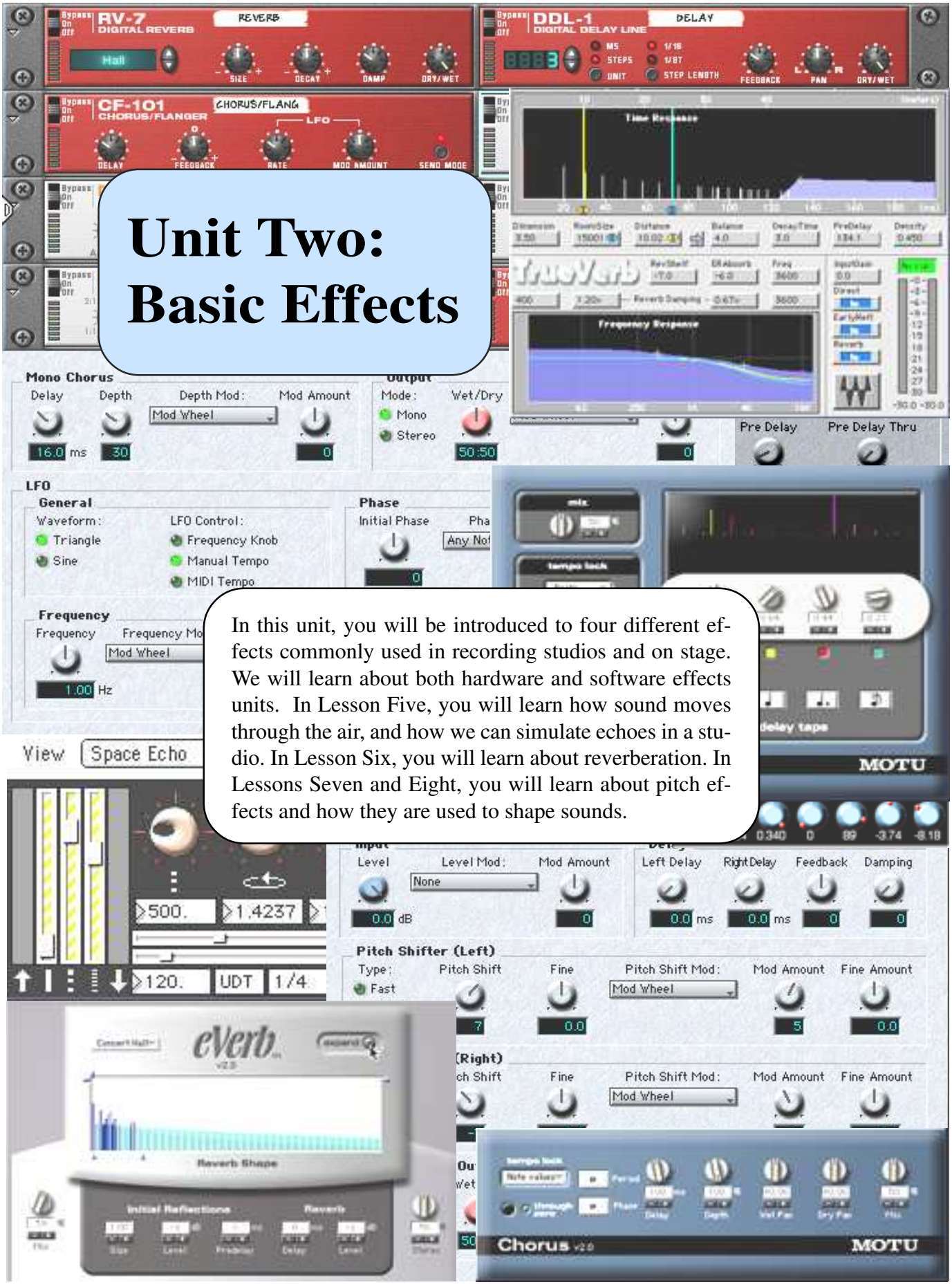


Unit Two: Basic Effects

In this unit, you will be introduced to four different effects commonly used in recording studios and on stage. We will learn about both hardware and software effects units. In Lesson Five, you will learn how sound moves through the air, and how we can simulate echoes in a studio. In Lesson Six, you will learn about reverberation. In Lessons Seven and Eight, you will learn about pitch effects and how they are used to shape sounds.

LESSON
5

Digital Delay

After completing this lesson, the student should be familiar with the following concepts:

- Sound moves through the air in waves and that waves can be reflected off of certain surfaces.
- Some construction materials tend to reflect sound waves, while some have a high absorption coefficient.
- Echoes are perceived when a sound wave returns to the listener after a sufficient time period from the perception of the original sound.
- In a small room, reflections are usually perceived as ambience.
- There are three basic types of Delay: Mono, stereo and Ping-pong.
- Most delay devices offer at least two basic parameters: delay time (which is measured in milliseconds) and feedback or regeneration (measured by percentage).

Glossary for this Lesson:

Ambience- The sound one perceives when reflections in a room return to the listener's ear so quickly following the original sound that the listener is unable to perceive a distinct echo. Our ears have become so accustomed to ambient sounds that we all but ignore them until they are missing or do not match what our eyes perceive.

Delay- An effect commonly used in recording studios. A delay unit produces this effect, which sounds like an echo. There are several different kinds of delays. Delay units can be a dedicated hardware delay unit, part of a multiple effects unit, or even a software program.

Delay Time- The amount of time between the beginning of the original signal entering a digital delay unit and the start of that signal's echo. This time is measured in milliseconds. By changing the delay time, we can make the echoes seem to occur more quickly or more slowly.

Echo - Another term for reflection. Echo is also sometimes used as a layman's terms for delay.

Feedback - The amount of delayed signal (echo) that is fed from the delay unit's output and returned to the delay unit's input. (This does not affect the amount of signal emerging from the delay unit's output.) Increasing the amount of feedback causes the delay unit to repeat or echo more times. E.g. when the delay unit is set to 0% feedback, it will produce one reflection or echo. As the feedback amount is increased, the echo will repeat several times. Each repeat is softer than the previous one until the volume of the repeating sound becomes too quiet to perceive.

Millisecond- One one-thousandth of a second.

Mono Delay - A simple form of delay in which both the right and left outputs of the delay unit put out the same delay at the same time.

Ping-Pong Delay- A kind of delay in which the delayed signal alternates between the left and right outputs of the delay unit. When connected to a stereo speaker system, the delayed signal seems to bounce back and forth between the two speakers.

Reflection- A single sound wave which has struck a surface and returned to a listener's ear. A reflection is also called an echo.

Regeneration - Another term for Feedback in a delay unit.

Repeat- Another term for Feedback in a delay unit.

Stereo Delay- A more complex form of mono delay. Stereo delay is essentially two mono delay units, meaning that you can set delay times and feedback amounts completely separately for the left and right channels of a stereo digital delay unit.

Let Your Student Explore and Learn More

Echoes and other sound phenomena are all around us all of the time. We have become so accustomed to them that we ignore them most of the time. Have your student point out to you different places in your house that have different ambiences. A finished stairwell is one place with unusual ambience. The typically uncovered parallel walls tend to create standing waves and flutter echoes. A shower or bathtub is another such place.

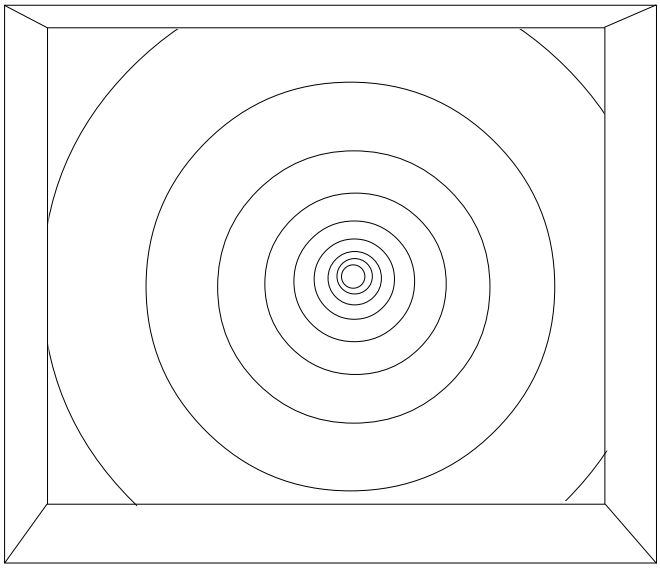
Have your student identify digital delays used in popular recordings. You can hear delay on just about every CD made in the past 20 years. Students just need to be made aware of these sounds in one recording, and they will know what to listen for.

LESSON 5

Digital Delay

How Sounds Move Through The Air

When you clap your hands, you create sound waves. (Sound waves are just sound energy moving through the air.) You can hear these sound waves, and anybody else in the room with you can hear these sound waves. When sound waves are created, they move out in all directions. If your friend claps, you can hear her clapping no matter where you are in the room, since the sound waves are moving out in all directions, as you can see in the picture in the middle of this page. As they continue moving out, they also spread out more and more and lose energy, and the sound seems to get softer. This is why a radio gets softer and softer as we walk away from it.



Sound waves can actually bounce off of some things. Sound waves bounce best off of things with a flat surface that are fairly hard. For instance, the carpet in most rooms is pretty flat, but it is not hard enough to make sound waves bounce off of it. Carpeting and other soft materials like fabric and people's skin tend to absorb sound waves. When an object absorbs a sound wave, it takes some energy out of the sound wave. This means that the sound wave will not be reflected as much.

When sound waves hit a smooth, hard surface, they bounce off, just like a bouncy ball on a glass table. Sound waves do not lose as much energy when they hit a hard, smooth surface as when they hit a soft, uneven surface. When a sound wave hits a smooth surface that is hard enough, it will bounce off. If the sound wave reaches your ear after it bounces off, you can hear the same sound again!

Echoes and Reflections

When you are outside, and stand far enough back from a wall (like one side of your house) you can hear a sound wave bounce back to you. If you clap your hands and listen carefully, you will hear another clap just after the sound of your clap. This is because the sound waves you made by clapping are hitting the side of the house, and bouncing back to your ears. The second clap you hear is called an echo. Another name for an echo is a reflection. It takes a little while for the sound waves to hit the house and come back to your ears, which is why you hear the reflection a little after you clap.

Where is the Echo?

If sound waves are all around us all of the time, and they can easily bounce off the walls and ceiling in most rooms, why don't we hear echoes all the time when we are inside? The answer is that we actually do hear these echoes all of the time, but we have gotten so used to hearing them that we usually just

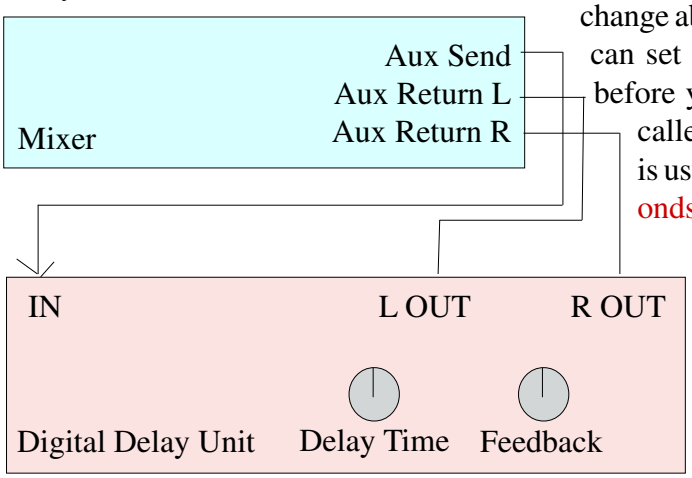
STRANGE BUT TRUE

The first delay units were actually tape recorders! Musicians would set up two reel-to-reel tape recorders. The first one would record the sounds on tape. The tape would then travel through the air to the next tape recorder, which would play the tape back. To increase delay time, you had to increase the distance between the two machines!

ignore them. When we are in a small room, the sound waves bounce back to us very quickly, because they don't have to travel far to the walls and ceiling. Because the echoes return to our ears so quickly following the original sound, we don't hear separate echoes. The sound we do hear is called ambience. It can be very hard to hear ambience, because our ears are so used to ignoring it. One of the easiest ways to hear ambience is to take it away for a short time by putting acoustic tiles near our ears. The acoustic tiles will absorb much of the room's ambience. You will be more aware of it when the tiles are taken away.

Digital Delay

In a studio, there are many times when we want to create an echo on one instrument or voice in a piece. To create this echo, we use an effect called digital delay (which is often just called 'delay'). There are three basic kinds of devices which create delay effects. First, we have devices which only produce delay effects. Second, we have device which can produce many different kinds of effects, only one of which is delay. Finally, we have software which can create delays.



Getting Hooked Up

There are many different ways to connect a digital delay unit in a studio, but the easiest and most common way to connect it is by using the mixer's aux sends and returns. That way, we can instantly put as much delay as we want on any signal in the mixer. The mixer's aux send jack should be connected to the delay unit's input using an instrument cable. The delay unit's outputs should get connected to the mixer's aux return jacks so that we can hear the delay's output.

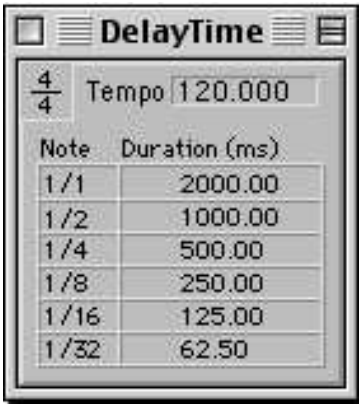
To put delay on any channel, we just have to turn up the correct aux send knob on that channel. We can control the gain of the delayed signal by changing the aux return's gain.

It is important to understand that none of the signal that we send to the delay unit actually comes back to the mixer. The only signal that comes back to the mixer is the delayed signal.

Kinds Of Delays

There are several kinds of delay that are commonly used in the studio, but we will concentrate on three of them. Mono delay is very simple. It is just like the echo you hear outside when you clap your hands. There are usually two different things we can change about mono delay. First, you can set how much time will pass before you hear the echo. This is called delay time. Delay time is usually measured in milliseconds. A millisecond is one one-thousandth of a second! When delays get smaller than around 15 milliseconds, we can't really hear a distinct echo anymore. It just sounds like the ambience we hear in a room. Secondly, we can change the feedback or regeneration (sometimes called repeat). Feedback determines how many times the echo will repeat as it fades out.

Stereo delay is just like mono delay, but instead of setting a single delay time, we set two delay times; one for the right input, and one for the left input. One of the most common ways to use delay is to create echoes on the beats or twice per beat (eighth notes). It can be difficult to calculate how many milliseconds will give us the right delay



time for the correct tempo. To help us with this problem, there are several different music calculator programs which you can run on your computer. Many of them are freeware or shareware. On page 27, you can see a program called DelayTime. After entering a tempo, DelayTime tells us how many milliseconds of delay we need to match the delay to the song.

The final kind of delay is called ping-pong delay. Ping pong delay is a kind of stereo delay. The delayed signal you hear will first come from the left side, then from the right. The delay will alternate sides back and forth until it dies away. Of course, you can set a feedback amount for ping-pong delay.

How Is Delay Used?

Delay is used many different ways in the studio. The most important thing to understand about delay is that when we use stereo delay or ping-pong delay, it takes a mono signal and makes it stereo. The original signal will still be mono, of course, but the listener will hear that the delay is different in the right and left sides, and this helps to create the impression that the original signal is actually stereo.

The most obvious use of delay is to create a subtle echo effect on a singer's voice or on another prominent instrument in the mix. While delay is very helpful and useful, it is important to understand that we don't want to put delay on every instrument in a mix. It is better to use delay on just one or two instruments to keep the mix from sounding cluttered.

Another important use of delay is to move instruments out of the middle of the stereo field. By delaying either the left or right side of the mix with no feedback, we can cause the instrument to seem to move from the middle of the stereo field out to the edges of the stereo field. (We must connect the delay unit to a channel's insert to accomplish this since we need to completely replace the original signal.)

Experiments:

1. Put acoustic tiles near your ears and listen to the sounds in a room. Now, take the tiles away and see if you are more aware of the room's ambience.

2. Try connecting a hardware delay unit to a mixer. Which controls do you need to use?

3. Can you figure out how to change the delay time and feedback? Can you change the delay type? What does it sound like when you use only 5-10 milliseconds of delay? When you use a very high delay time? What happens when you add lots of feedback?

4. Try adding delay to different instruments in a mix. What begins to happen when you put delay on every instrument in the mix?

5. Add delay to different instruments in a mix, first with a delay time that doesn't match the song's tempo, then with a delay time which is calculated to match the song's tempo.

6. What effect do you get with a very short delay time and a very high regeneration amount?

7. What is the shortest delay time you can hear?

8. Can you use delay to move an instrument's sound to the sides of the stereo field?

Let's Review

1. What happens when a sound wave hits a hard surface? What causes an echo?
2. Why don't we always hear echoes when we are in a room? What is this called?
3. What is delay? What are the three kinds of delay?
4. What are the two things that we can change about delay? How do we measure each of these?
5. How do we usually connect a delay unit to a mixer?
6. Why is it advantageous to connect a delay unit to the mixer's aux sends and returns instead of connecting one instrument directly to the delay unit?
7. How are delay effects used in mixing?
8. What is another way we can connect a delay unit to a mixer? When would we want to do this?
9. Why is it important to match your delay time to the tempo of a song?

Words to Know:

Do you know the meaning of these words?

Ambience	Echo	Mono Delay	Regeneration
Delay	Feedback	Ping-Pong Delay	Repeat
Delay Time	Millisecond	Reflection	Stereo Delay

Brain Strain

We measure delay time in milliseconds, which are one one-thousandth of a second. What is the formula that lets us figure out which delay time works with each tempo? Can you figure it out? You might start by figuring out an easy tempo like 60 beats per minute....

The formula is:
(60/tempo) x 1000= delay time

On the Web:

If you would like to see pictures of some real delay units or read more about them, check out the following sites :

http://www.MOTU.com/
http://www.tcelectronic.com/
http://www.RolandUS.com/
http://www.lexicon.com/
http://www.alesis.com/
http://www.rane.com/
http://www.xta.co.uk/dp100.htm
http://www.davecentral.com/5991.html
http://www.dspfx.com/
http://www.bigbriar.com/