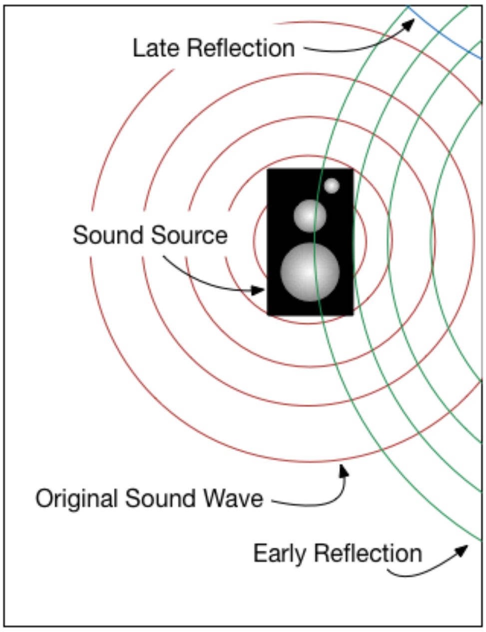
Digital Reverb Explained

How algorithmic and convolution reverbs work

In the physical world, when a sound is made it propagates outwards in all directions from its source. As it travels, the sound wave encounters various surfaces, which reflect some of the sound wave's energy. These reflected sounds are known as **early reflections**. The early reflections propagate outwards in all directions from the point of reflection and, when they encounter other surfaces, they are reflected again. These secondary reflections are known as **late reflections**. Each time the sound wave is reflected, it loses energy, so over time the reflections decay until they are no longer audible.



This behaviour of sound waves is known as **reverberation** (or **reverb**), and occurs naturally when we listen to music in any live environment. The amount of reverb and its character depends on the size of the space, the location of the surfaces within it relative to the sound source and the material those surfaces are made from. Because of this, the same sound will have a very different reverb character in a small room than it would do in a large cathedral for example.

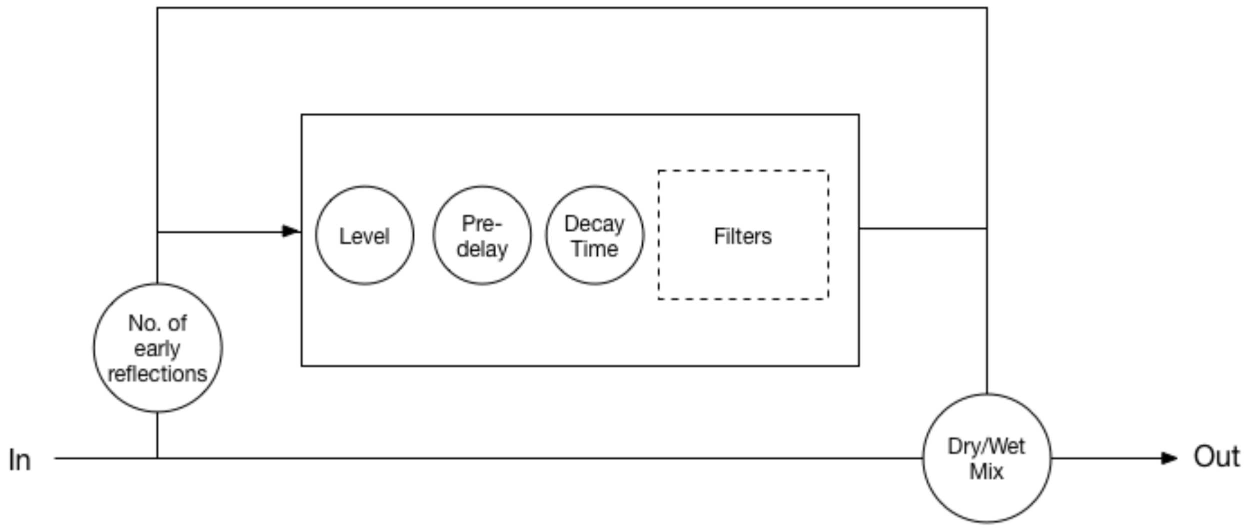
In audio recording we usually want to start with as clean a sound as possible, so reverb during the recording process is often not desirable. For this reason many studios or recording spaces are equipped with **anechoic surfaces** that absorb rather than reflecting sound, in an attempt to eliminate reverb. Once the sound has been recorded however, it is often desirable to add reverb back in to the mix - simulating the reverb characteristics of various spaces.

Before digital recording became a reality, this was achieved with various analogue devices. The three most common types of analogue reverb are an **echo chamber**, in which the sound is played back and rerecorded in a chamber designed to cause reverb, a **plate reverb** in which a large metal plate is made to vibrate and the vibrations are measured and turned back into an audio signal, and a **spring reverb**, which works in a similar way to a plate reverb, but using a metal spring instead of a plate.

With the advent of digital recording it became possible to create solid state reverb devices that could simulate reverb in a variety of spaces.

The first types of **digital reverb** devices were **algorithmic** - that is to say, they used a computer programme to calculate the timing, amplitude and timbre of the reflections. The algorithms used in digital reverbs vary widely, but the basic principle is that the original signal is delayed a set number of times to simulate a series of early reflections. The reverb enables the producer or engineer to control the level of the delayed signal, i.e. how its amplitude changes from the original signal. Late reflections are usually created by a feedback loop that adds the reverb output back into the input and, again, the level of this feedback can be set. More sophisticated reverbs will allow the reflections to be shaped further using a variety of filters and envelopes.

Many digital reverbs come with a choice of presets representing a variety of spaces (or simulations of analogue plate and spring reverbs).



While digital reverbs can simulate a space, the reverberation they create is artificial and can only ever approximate the reverberation in a real space. With the increase in computing power and the decreased cost of providing it over the last few years, it is now possible to create reverbs that can accurately recreate the reverberation in a real space. These are known as **convolution reverbs**.

These work by using data gained from recording the impulse response of the space, that is, how it responds to a single sound (this is usually a starting pistol or a sine wave sweep). The response is fed into a convolution processor, which removes the original sound and prepares the response to be applied to sounds in the studio.

Convolution reverbs give a much more realistic reverberation, which is useful if you want to place your classical magnum opus in the Royal Albert Hall in London, for example. The disadvantage of a convolution reverb over an algorithmic reverb is that, because it is modelled on a real space, it offers less options for adjusting the characteristics of the reverb. Sometimes an algorithmic reverb is preferable because you want an artificial sounding reverb - one that is perfectly synchronised to the beat for example, or that shapes the reflections in interesting ways.

The audio example demonstrates the same drum loop in its original dry form, processed by an algorithmic reverb emulating a small room, and processed by a convolution reverb emulating a concert hall.

https://soundcloud.com/laurence-scotford/digital-reverb-demo/s-C079N