ByteNoise

Waveform

A single sound can be thought of as a waveform. To really understand how sound works, then, it helps to learn about waveforms in general first.

A waveform is just something moving back and forth over time, such as a vibrating guitar string or speaker cone. It is usually represented as a two-dimensional graph, with the X-axis (the horizontal one) representing time, and the Y-axis (the vertical one) representing whatever is moving back and forth. As far as analogue synthesisers are concerned, the Y-axis represents the voltage of the electric signal. As far as the actual sound you hear goes, the Y-axis represents the physical position of the speaker cone. It doesn't really matter what this axis represents though, as in practice, all you need to remember is that *something* is moving back and forth all the time. Using a graph, you can see where this thing is at any given time.

Waveforms as shapes

You can look at waveforms this way: they consist of repeating shapes. The amount of time it takes the shape to repeat is determined by the note being played. For example, the note A4 on any instrument has a frequency of 440Hz, which means that it will create a shape that repeats 440 times every second (Hertz is just a fancy term for "this many times a second"). The shape of the waveform is determined by which instrument you

play it on. Different shapes sound different, and are referred to as timbres.

Waveforms as sine waves

In 1822, a French mathematician called Jean Baptiste Joseph Fourier stated that all waveforms are actually made up of sine waves. The sine wave is the simplest type of waveform, and it is now widely acknowledged that it is the building block of all other waveforms.

So you can also look at waveforms this way: they are made up of thousands of sine waves of different amplitudes and frequencies. When you listen to anything, from your best friend talking to you, to Beethoven's ninth symphony, you're actually listening to thousands of sine waves at the same time.

Looking at it this way, the difference between timbres — the difference between any two instruments you can think of — is which sine waves are present. As long as their slowest sine waves are the same speed, your ear can tell they're playing the same note. All the other sine waves that they produce determine the kind of sound you hear. So a piano and guitar playing the note A4 will have the same slowest sine wave — one that repeats 440 times a second — but different faster sine waves. This is what makes them sound different. So the slowest sine wave determines which note you hear, and all the others determine the shape of the waveform.

This means that the kind of sound you hear, the shape of the waveform you can see in a graph, and which sine waves are present in the waveform, are all different ways of expressing exactly the same thing: the timbre of a sound.