ByteNoise

Subtractive synthesis

Whereas additive synthesis involves adding various waveforms together to produce different timbres, subtractive synthesis is based on starting off with a simple yet harmonically rich waveform and then removing parts of it with filters and attenuators.

Producing a sound: oscillators

An oscillator produces the actual initial sound. The most common ones produce sine, square, pulse, triangle, ramp and/or sawtooth waveforms. Originally, analogue oscillators were used to produce the starting sound. These days it is far more common to see PCM samples of basic waveforms used as the starting point, whether using ready made samples stored in the ROM boards of sound modules or sounds you have bought or created yourself in the RAM chips of samplers. Digital oscillators and samples are more reliable than analogue ones, which is seen by some as an advantage (they won't drift out of tune) and by others as a disadvantage (being everso slightly out of tune can sound more natural and produce thicker sounding timbres). Most sound modules using samples of initial waveforms now include the option of slightly detuning them from one another in order to sound closer to the original analogue sound. Samplers also offer greater flexibility, allowing you to capture not just basic periodic waveforms but many seconds of sound, allowing artists like Fatboy Slim to make a living

rummaging through old records and using snippets of them in ways most people wouldn't dream of.

Making it interesting: filters

Oscillators and samples on their own can sound pretty boring, which is where filters come in. A filter takes the initial sound and removes some of its frequencies based on the filter's cutoff point (hence *subtractive* synthesis - it's all about removing parts of a sound). A low pass filter removes all frequencies above that point, a high pass filter removes all frequencies below it, and a band pass filter removes pretty much everything except for the cutoff point itself. There are other types of filter, such as notch and comb filters, but these are somewhat rare.

Most filters offer a variable amount of resonance, which means they boost the frequencies near the cutoff point. This is, for example, what makes the (somewhat overrated) Roland TB-303 sound so nice. Some filters can even resonate to the point where they self-oscillate, producing a sine wave of their own. Each filter has its own distinct character, and plays a big part in making a synth sound as good or bad as it does.

Changing the volume: attenuators

The annoying thing about oscillators, from a musician's point of view, is that they will never stop oscillating until you unplug them. Synths need a way of changing a sound's volume over time, which is why they have attenuators, or amps as they're more frequently (but incorrectly) called. They make the entire signal fed into them quieter, and are usually controlled by contour generators.

Changing a sound over time: contour generators

Contour generators, or envelopes, change their output over time. They usually control filters or attenuators in order to make the timbre and overall volume change over time. The most popular type of contour generator these days uses the ADSR envelope (short for attack, decay, sustain, and release), which attempts to make the volume of a note over time loosely emulate that of a piano. A simple decay on its own is also useful, and is often used in drum machines. A trapezoid shaped envelope can be used for organ-like sounds. Some subtractive synthesisers offer much more powerful contour generators, such as ones where you can set many different points for the envelope to rise and fall between, but most just have the plain old ADSR envelope.

Getting more hands-on: controllers

Controllers let you alter the sounds produced by letting you change the settings of any of the above components. The most obvious one is the keyboard, which changes the frequencies of the oscillators. Old monophonic synths such as the Moog Minimoog and Roland SH-101 have a different slider or knob for every single setting, allowing you to very quickly tweak the sound until it's exactly what you're after. Most modern synths instead opt for more parameters, but less physical appendages to let you modify them. These days it is not uncommon to see a synth whose sole interface is an LCD, a few buttons and a dial.

Some synthesisers offer much more versatile controllers. For example, Doepfer's A-100 modular synthesiser has Theremin style aerials and old Moog style ribbon controllers available for it, and Roland have a D-Beam fitted in several of their

keyboards and grooveboxes.

So what else is there?

Lots of things, such as white noise generators, LFOs and sequencers. However, they would best be talked about within the context of synthesisers in general as they don't just apply to subtractive synthesis (as would contour generators, ideally, but I thought it would be best to give an example of a timbre changing over time).

So that's pretty much all these is to subtractive synthesis. Start off with a simple waveform, change its shape with a filter and change its volume with an attenuator. You'll be playing like Wendy Carlos in no time.