The WSA and the basics of sound synthesis

Part 1 of the Technics WSA1 basic programming course

There is no reason to be afraid of a synthesizer. It's just another musical instrument.

That might be a rather obvious remark but think about it for a minute. What is an instrument? A good definition could be: A device into which you put tactile information which is then turned into audible noise.

So, at least when seen as a preset device, a synthesizer is nothing other than any other instrument.

- You get inspired
- You fumble around on the keys
- A sound comes out. Hopefully a musical one

But what is music?

Better still, in this context, is to ask: What does music consists of?

1. PITCH: How high is the note we hear?
2. TIMBRE (Character over time). What quality does the sound have? Is it soft and mellow or bright and harsh? Does the brightness stay the same or does it change? Etc…
3. AMPLITUDE (Loudness over time): How long does the sound last? But again also: What does the amplitude do over time? Does the sound suddenly start or fade in? Does it sustain? Does it suddenly die out or fade out slowly? Etc…

Everything else is a matter of things becoming more complicated by putting them in a bigger context. More pitches with their individual timbres and durations make a musical piece. The basic principles do however always stay the same.

Why concentrate on these overall principles in a piece about synthesizer basics? Well, they can actually help to explain the basic operation of 99% of the synthesis engines out there. Every synthesizer has to produce sound that conforms to the main parameters mentioned above.

1 PITCH

A sound source, typically called an OSCILLATOR in synth speak, generates one or more defined frequencies at a time, thus, while following the information we put in via the keys, producing a monophonic line or chords. Because the lowest pitches in these sounds are dominant we perceive these as musical notes.

The sources for these sounds can be varied, from analog waveforms, to samples to additive synthesis to virtual modeling, blahdiblah, whatever you call them, they produce oscillations. Therefore the word OSCILLATOR is actually a nice, widely accepted general label.

2 TIMBRE

We also want the synthesizer to produce a wide range of tone colors. So again: Every synthesizer needs a facility to change the timbre or tonal quality of the sounds it produces. The easiest example of a device that does that sort of stuff for us is the FILTER, which is called the VCF or Voltage Controlled Filter in an analog synth. If the Filter is closed the sound is mellow and if it is open the sound is bright.

Remark: In most synthesizers the overall timbre is actually already generated in the oscillators in the shape of a raw waveform but this basic sound already contains a wide range of frequencies with many overtones. With the FILTER we typically take control over that wide-band signal. So the analogy at least is still rather valid if one looks at the filter as the most important timbre shaping tool.

3 AMPLITUDE

To ensure we hear anything at all the sound that the synthesizer produces has to be pre-amplified to a level that can be used in headphones or by an amplifier. In analog synthesizers we normally speak about the VCA, the Voltage Controlled Amplifier. This does, however, not only amplify the overall volume but can also be used to shape the amplitude of the sound in real time. Just like an organ player might use the volume pedal to add expression to his playing.

4 ENVELOPES

4? Why 4? Well, in the 3 point elemental subdivision above, I already mentioned that the qualities of of timbre and amplitude should preferably be controlled over time. In other words: Things should not sound static if we hold a key over a longer period. Otherwise we could just as well be playing organs now, couldn’t we?

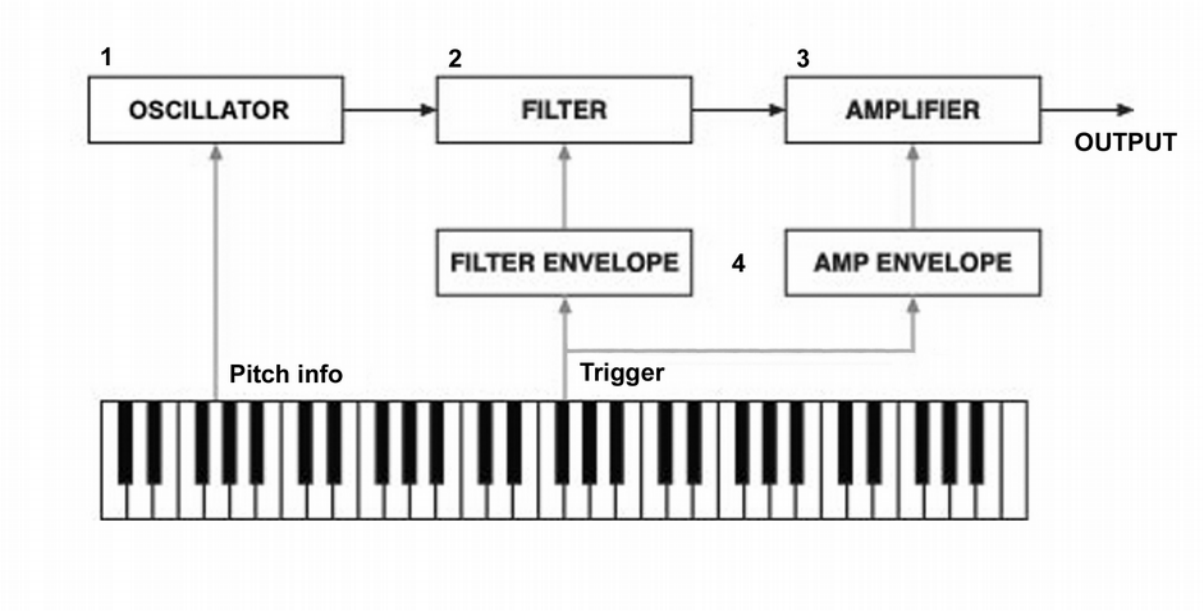
Now a “real” musician can do that sort of stuff in real time by being very adapt in handling a bow or pick or whatever. Synthesizers typically help us to create such subtleties. They provide ENVELOPE GENERATORS (often abbreviated to E.G. but also often called ADSR's) to do that sort of trick. We push a key and they add a

certain contour or envelope to the signal. The typical advanced synthesizer has at least 2 E.G.'s. One for the Filter (to control the timbre over time) and one for the amplitude (to control the loudness over time).

So again: Why create an extra point 4 and not mention the E.G.'s under points 2 and 3 respectively? Well, because E.G.'s are in synthesizers normally also described as loose identities.

Presto: We have now defined the most important and common basic building blocks of a synthesizer. In the accompanying picture you can see a schematic of these elements.

Whatever synthesizer you hear, see, play, own, analog or digital, hardware or software, it is based on the same principles: To produce sounds that are musical to our ears in as wide a range as possible they have to make these 3 major sources freely available to us. The means and names of the tools may differ but the basic principles never do.



This subdivision actually gives you a tool for understanding specific synthesizer designs. Always project that basic structure onto it. Just ask yourself these basic questions:

1. Where are the bits that produce the pitch (where are the oscillators or their equivalents)?
2. Where are the bits that change the tone color (the filters or their equivalents)?
3. Where are the bits that control the output volume (the amplifiers or their equivalents)?

Well then: Where are these things in the WSA?

Select whatever preset you like, although a sustained sound with not too much effects laden onto it is the best for the purposes described here.

1. Press the EDIT MODE – SOUND button
2. Look at the main screen:
    - Behind The MODELING and PITCH buttons you'll find all OSCILATOR type functions
    - Behind the FILTER button you'll find all, you've got it, filter functions.
    - Behind the AMPLITUDE button you'll find most volume and amplitude functions.

(No, I will NOT explain here why Amplitude is actually served before Filter in the WSA because that would only cloud the present issue!)

This is your homework:

Press MODELING.

1. A page will open that shows you 4 layers. Select layer 2 and press MUTE.
2. Repeat the same for layers 3 and 4.
3. You will now only hear layer 1. The “oscillator” now uses 1 sample / waveform to base its pitched rough material on.
4. If you do not like the basic sound you can change it by selecting another sample via the GROUP and DRIVER buttons, but the principle stays the same: You play a key and raw, unprocessed waveforms are created at the right pitch.
5. Now turn to the FILTER and AMPLITUDE sections and start tweaking the available parameters.
6. And where are those envelope generators to be found? In both the Filter and Amplitude Pages you'll find a square in the upper right corner of the screen that says ENV. Press the accompanying switch and a page will open in which you can see and edit the envelopes.
7. Now play around with all variables in these 4 windows until you get sick of it! In the meantime keep comparing what you do with the 3 main principles

described above. When are you influencing pitch, when timbre, when amplitude?

8. One remaining general remark: Make sure that you always stay within the confines of editing layer 1. Otherwise you might be editing something with no audible results.

You are now doing some serious programming already and if you like what you hear, why not save the results and go on from there? Before you know it your WSA will be filled with your own sounds

It's so simple when you think really hard about it but at the same time allow yourself to ignore the really complicated bits.