

Vintage Synthesis on the AWE32/64

by Ian Wilson, 1998

Why Emulation?

Before I move onto vintage synthesis, you're probably wondering why anyone would want to emulate these synths on the AWE when you could quite easily sample them! The answer is simply, RAM. If you've got 128Mb of RAM onboard your sampler or soundcard, you will still reach a point where you feel you need more - it's one of those absolute truths you just can't seem to avoid! Beyond this, uploading several megabytes of samples to your AWE can be a daunting task, and sometimes the sonic results aren't as good as the size of the Soundfont would suggest! How often have you downloaded huge Soundfonts off the Internet only to find that they are absolutely rubbish! This isn't exactly funny when the sound files run into Mb sizes!!! Besides requiring huge amounts of RAM to get an accurate representation of a vintage sound (try loooong filtered sounds - Bye-bye memory!), where do you get these sounds cheaply and easily? On the internet? No, not really! Those that are there are often of sub-standard quality, either due to shoddy editing, low sampling rates, or just plain bad sampling. A good example of this is a Linn 9000 I saw sampled at 22Khz - The result was a bunch of samples which didn't bare much resemblance to the original sounds. Even sample-CD's don't cover every vintage sound you've dreamed of having, so you have to buy several of them. This can of course set you back the price of buying an actual vintage synth in the first place!? Another flaw in these sample-CDs is the fact that some contain waveforms sampled from samplers!! Knowaddimean!? You end up inheriting all the inadequacies of the original loop-points, sampling frequencies ... etc. Not a pretty site at all! What is the solution then? Well, if you can't get the vintage sounds into your AWE RAM, then get your AWE RAM to output these sounds! I studied up on vintage synths to find out how they think and operate, then I ported this knowledge across to the AWE in an attempt to emulate these synths. Here's what I found ...

What is Vintage Synthesis?

Vintage Synthesis can best be described as emanating from synthesizers which many people regard as outdated, but which still provide a wealth of sounds often bearing little resemblance to realistic sounds. They are usually based on some mathematical and electronic circuit principles which don't rely on sampling (usually!) or software for their sound-generation. This is essentially what makes them so unique and varied, and so sought after. However contradictory this may seem, it is for this very same reason that some of their sounds have become so cliché and overused. This can of course be attributed somewhat to sampling itself - People just can't get enough of vintage sounds so many have been sampled to death. Samplers seem lost without analogue sounds from Roland's TR808 and TR909 drum-machines. People still crave the sound of a Rhodes electric piano, or perhaps a harpsichord (Yuk!!) - A bit strange for equipment which should be technically and sonically far more advanced??!

Who could forget the Yamaha DX7 electric pianos? What about that Roland TR808 cowbell, or the thumping TR909 kick drum? No self-respecting dance music would be found dead without some of these sounds in their arsenal (or at least samples of these sounds!?) Instead of sampling vintage synths, wasting time and RAM, why not just buy one of them? The reason is simple - You could if you were the Sultan of Brunei or Bill Gates! You're looking at people trying to sell of an old TR909 machine for over \$1200! Their prices have been blown way out of proportion by the huge demand for new (or is that old?) sounds. Fortunately some manufacturers have picked up on this - Novation with their Drumstation and Basstations, Roland with their MC-303 and JP-8000, Yamaha has their AN1x and EX synths, and Korg has the Z1 and Prophecy, to name but a few. Here you may find offerings of vintage sounds at prices comparable and sometimes lower than original vintage equipment, with all the modern conveniences of MIDI and polyphony. Make no mistake, I love vintage sounds, but the sampling era has helped push some of them into monotonous oblivion. A new approach to sampling these beasts is to emulate them on a sampler or wavetable synth like the AWE. The severe complexity involved in this process alone should at least rid us of many of the clichéd sounds, not to mention inventing some surprisingly new ones. So how do we achieve this?

The Architecture of a Vintage Synth

Firstly, to understand exactly how to emulate vintage synthesizers on your AWE, we need to take a look at the architecture of vintage synthesizers. How do they generate their sounds and how are these sounds processed before reaching their final output? The answer to these questions should provide a fair idea of the basic building blocks required for emulating vintage synths on the AWE. Now before you take the following paragraphs as gospel truth about vintage synths, let me explain that I have had an extremely low amount of exposure to real analogue synths. In fact, the only analogue beut I ever played around with was the Yamaha CS5, so there! I am however reasonably knowledgeable in sound-processing on synths and samplers, and in terms of the workings of vintage synths. So, expect an error here or there, but by all means correct me if you think I'm wrong.

Firstly, every synthesizer must have at least one oscillator. An oscillator in the simple sense is a wave-generator, or the initial sound-generator if you like. When you pluck a guitar string, the vibrations (oscillations) of the string produce a sound. So too does a synthesizer produce oscillations, albeit a lot more simple than those of a guitar string. Whether these oscillations are generated by analogue circuitry, mathematical principles or the physical plucking of a guitar string is immaterial - They are all oscillators. Obviously the more oscillators available, the more creative potential you have at hand. Luckily the AWE allows you to layer sounds and process them individually, giving you several potential oscillators to work with. Exactly how many are available I don't know, but since the polyphony is around the 32 mark (30 or 31 I think), I would guess you have around that many oscillators to work with.

Secondly, the oscillator must be passed through a filter with a cutoff frequency. This changes the colour of the initial sound by removing and accentuating certain frequencies present in the oscillated source - A bit like the way the shape of your mouth changes

an "eeeeee" to an "ooooohh". This is a major part of analogue synthesis (subtractive synthesis), and the AWE has a pretty good filter to work with.

Thirdly, this filter can be controlled by a Filter Envelope Generator. This means that the intensity of the filter can be set to vary according to a specific pattern over time (ADSR Envelope). This allows certain frequencies to be dulled and accentuated at different levels over time. The AWE has this feature too, but unfortunately this ADSR (see explanation later) envelope is shared by both the pitch and filter of the AWE - you can only assign the envelope to one or the other, but not both. What a pity!

Fourthly, the resulting sound must then be passed through an Amplitude Envelope Generator, which signifies how the volume of the sound should change over time. This determines whether your synth sounds like a flute or a piano! How fast does the sound reach it's maximum volume (Attack)? How slowly does this volume fade away after releasing the key (Release)? This is most commonly referred to as the ADSR of a synth - Attack, Decay, Sustain and Release. Obviously this feature is also on the AWE otherwise it would sound like an organ.

Low Frequency Oscillators (LFOs) are then applied to the volume to create tremolo effects, or to the frequency to create vibrato effects, and also to filter properties ("Wah-Wah") of the resulting sound. The AWE has 2 LFOs : One reserved for vibrato, tremolo and wah-wah ; the other for vibrato only. Both can be programmed to kick in after a specified time (delay), which is quite a useful feature also found in most other synths. An LFO is basically the same as any other oscillator, except that it has an extremely low frequency which is inaudible as a sound to the human ear. The LFO effect can however be heard as a change in the sound. Unfortunately the AWE (well, the Vienna software at least!) only provides a sinewave LFO. The addition of others (Random, square, sawtooth ... etc) will hopefully be implemented on newer cards, but I wouldn't bank on it. Actually, the addition of other LFO waveforms would be an extremely welcome addition to the sonic arsenal of the AWE cards.

Oscillators - The Beginning of a Sound

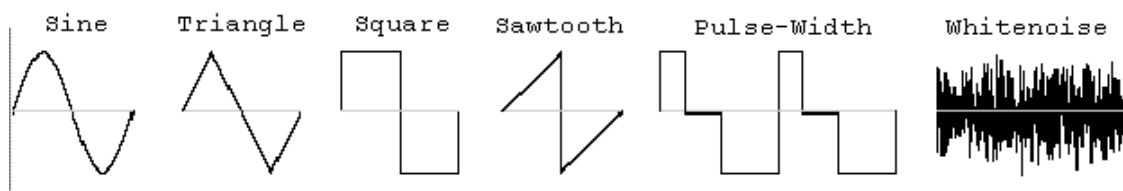


Figure 1. Vintage Oscillators - The Main Waveforms

A Sine wave is very smooth in character, and ultimately doesn't change much when passed through a filter. This is due to the fact that a filter actually smooths any wave in the direction of a sine wave. For example, a filter can smooth the squareness of a square wave so that it begins to emit the characteristic smooth sound of a sine wave. The transformation is not exactly from square to sine wave, but the similarity between a filtered square wave and a sine wave is definitely noticeable. Consequently a sine wave has a more limited use than other waveforms in vintage synthesis. It can however be used for very low, throbbing bass sounds and analogue percussion sounds like kick and tom drums.

A Triangle wave is slightly brighter than a sine wave, and is more susceptible to a filter. It can be used for flutey sounds, very synthetic cheap-synth sounds, and also extremely harsh, thumping bass drums, like TR909 kicks put through a bit of distortion. Remember the Casio VL1 VL-Tone keyboard? A mixture of triangle and square waves is the primary source of it's sounds. El-cheapo, here we come!!

The Square wave is extremely bright, almost to the point of being quite harsh. It can be used for very bright woody-flutey sounds, and is perfect for synth-pop sounds. This is a great waveform for emulating Yazooish (can I say this?!) sounds, and especially Depeche Mode sounds from their Speak and Spell era. Remember that "psuedo-cowbell" sound from Soft Cell's "Tainted Love"? Square waves! When filtered it can fit right up there in the mix with real retro synths.

The Sawtooth is the crux of vintage synths. It can be harsh and grinding in it's raw form, and used hand-in-hand with filters this is the epitome of retro-pop. It can be used for synth-bass and various string sounds, and for those sounds that I like to call the ZZZZZ sounds - Roland MC202 bliss! Especially for those TB303 lovers out there, this is where the AWE can become your resident TB303 master - Heavily filtered sawtooth sounds on the AWE are TB303 heaven! This is sweep city!

The Pulse-width waveform is a modified Square wave and it doesn't vary much therefrom. It's sound is easily identifiable though because it has a square-wave sound with a more grungy edge to it. Generally it is a square wave with the width of the pulses altered in some way, causing a characteristic change in sound. It is often used as an alternative to the Square wave because it is variable and provides more interesting basic sounds, especially when filtering is used. I honestly haven't paid much attention to this waveform mainly because I never wrote any routines to generate them, and as far as I know [Cool Edit](#) (shareware sample editor from Sytrillium Software) doesn't generate them either.

Whitenoise is a high-frequency random waveform. There is no structure at all to the waveform, except to say that it is a series of random pulses. In it's simplest form it sounds like the hiss of a radio which is not tuned into a station properly. There are different colours of whitenoise which can be generated, like pink or brown noise. The reason why we use the term colours as opposed to pitch is because whitenoise, being random pulses, doesn't have a pitched waveform. It can however be altered quite easily using a

filter. Whitenoise is used mainly in soundfx, as well as percussion instruments requiring noise (snare, hi-hats ... etc). It can of course also be used in the emulation of calliopes, steam-flutes, choirs ... etc.

By combining these oscillators together, as well as the filters, envelope generators (EG) and LFO's on the AWE, quite complex sounds can be generated. Since the AWE has all the aspects of a vintage synth, all we need do is create the basic waveforms as shown in the diagram above, and then process them through the AWE. A simple way of doing this is to use Cool Edit to produce the waveforms, and then once we have these waveforms, the AWE has the power to perform many of the other functions which vintage synths are famous for.

Creating the Waveforms

The easiest way to create these waveforms is as I said before, to use [Cool Edit](#). It generates all the above waveforms, except the Pulse-Width waveform. I won't go into detail as to how to create specific synth sounds, except to say that you should as far as possible try and limit your waveforms to 1½ to 2 cycle wavelengths (the diagram above shows single wavelengths). This way you can loop the waveform and it will, despite its tiny size, give you an accurate representation of the original sound. This means you can cut your soundfont down to a fraction of the size you would normally encounter with sampling, but still have a workable sound. The whitenoise is usually the only exception to the 1½ - 2 length rule because of its random quality. You will have to determine the optimum loop length of a whitenoise waveform yourself.

Although synth sounds are relatively simple to create, percussion sounds are an absolute nightmare to synthesize. The basis for vintage percussion on the AWE is a Sine Wave and Whitenoise. With these waveforms you can generally create a whole TR808 drum machine. Let me start with a discussion of what constitutes the basic structure of the main percussion sounds :

1) Bass/Kick and Tom Drums

The first sound emanating from a bass drum is the noise created by the pad hitting the surface of the drum, creating a loud, very short click. This is followed by the fading "hum" of the resonating drum cone. This hum goes from it's original pitch to a slightly lower pitch, although due to the very low frequency and the shortness of the sound this is often not consciously heard. The reason for the pitch change is very simple ... When you first strike the drum, the skin of the drum is initially tight but fades back to a lower tightness after being hit. This causes a drop in frequency because the tighter skin has a slightly higher pitch, which lowers as the drum skin returns to it's original tightness. Depending on the makeup of the bass drum, this effect may vary considerably, but it is generally not very noticeable on a kick drum. Thus there are 3 qualities needed (the first two being all important) :

a) The initial click as the pad hits the skin.

b) The fading resonating boom after being hit.

c) The lowering pitch.

a) and b) can be created in one go using a sine wave: Generate a sine wave at about 70-100 Hz. Clip it so that it starts at a maximum waveform value (as far away as possible from the zero crosspoint). Since the waveform starts away from the zero-crosspoint, it makes a click sound when the wave is output - This is the initial click of the kick drum. When looped beyond this click, you will have the resonating drum boom sound.

You can also just layer a very quick decaying whitenoise wave to form the initial click rather than altering the Sinewave as in above, but for TR sounds this doesn't work well. The decreasing pitch can be obtained using the AWE's pitch ADSR after the waveform has been successfully looped. Use a quick lowering of the pitch with the ADSR to create the right sound. For a TR808 kick, the above works perfectly, but for TR909 kicks the pitch ADSR doesn't quite have the "oomph" it needs. The pitch envelope just doesn't shift far enough for that sharp, heavy kick sound.

2) Tom Drums

The Tom drum has the same format as the bass drum except that the pitch is higher and the decay time usually a bit longer. Also it is here that the pitch change becomes more noticeable, as well as the drop in frequency. An additional feature to the Tom scenario is to layer a very short whitenoise wave at the start of the Tom, at a relatively low volume and low pitch. Depending on how you filter and pitch this whitenoise, you can give the Toms a bit of a grungy sound rather than the usual clean boom sound. The TR808 Toms use this format. The TR909 toms are a little more complex - it sounds as if there is more than one waveform at work there. You could also try using layered sinewaves for Toms as well, in an attempt to introduce a bit of inharmonic content into the sound. This might bring you closer to the sound of TR909 toms. Also, bongos use a variation of the tom sound in vintage synths.

3) Snare Drums

For this you need whitenoise and a kick drum (as above). A Snare is similar to a bass drum, with the major difference being the noise generated by the springs attached to the underside of the drum skin. Generally, use the above bass drum at a higher pitch (since a snare drum is smaller than a bass drum) layered with a looped whitenoise waveform decaying as desired. This is the basic building block of your snare drum. You can filter the whitenoise to a desired colour, and also layer more whitenoise at different frequencies to vary the sound. I have found that higher frequencies (colours?!) of whitenoise are the best for snappy snares like those of the TR808 and TR909. You can create a whitenoise wave in Cool Edit, and then filter it with the quick filter, pushing up the high frequencies and excluding the lower ones. This generally gives the most impressive high-frequency whitenoise waveforms rather than using the AWE's filter. Be careful not to over-filter the whitenoise because this makes your snares sound puny, which is awful unless you're looking for vintage Casio/Yamaha home keyboard drum sounds or mini-pops (remember the Casio PT-68 or old Yamaha PSR keyboards). Also, adding a bit of reverb to the snares can be quite effective, although the same doesn't apply to chorus - it makes the snare sound very awkward.

4) Hats and Cymbals

For the hats, use heavily filtered whitenoise layered with an ultra-high frequency sine, square or triangle wave. The volumes of the whitenoise and high-frequency wave will have to be juggled a bit, but generally the hats sound better with the filtered whitenoise louder than the high-frequency wave. If possible, use Cool Edit's Quick Filter to boost the highest frequency and remove all lower frequencies in the whitenoise wave. The need for the AWE's filter may not even be necessary if you use this method. In fact, sometimes heavily filtered whitenoise doesn't need another hi-frequency tonal wave layered alongside to make the hat sound convincing. The cymbals are similar, except I find it better to use more than one high-frequency wave and detune them. This improves the inharmonic quality (as opposed to the hissy quality) of the cymbal. Also, you can layer a slightly lower frequency whitenoise waveform with a very short decay to imitate the actual striking of the cymbal.

5) Cowbells

Well, depending on what type of cowbell you're trying to emulate, you can rely on some additive waveforms in the shape of square and triangle waveforms, with the lower pitches of the additive wave set at volumes much higher than the high-pitched ones. You can also add a very short decay whitenoise wave as well. Basically, for a TR808 cowbell you could use a mixture of square and triangle waveforms making up an additive waveform. Layer a minimum of 2 of these in a Vienna Instrument, and set one with a max volume and short decay, and the other at a much lower volume and longer decay. This will give you the general shape of the 808 cowbell output, which is a very sharp attack and decay, with no sustain and a longer release time.

General Vintage Considerations

When attempting to emulate vintage synths, it is important to note that there are several ways of creating convincing clones. Some have already been mentioned, but here is a more detailed list :

1) Chorus

There are two types of chorus which are most prevalent in modern synths and samplers. One takes copies of the original sound and plays them out-of-phase. This produces a richer and more evolving sound, which analogue synths are often characterized by. You can simulate this on the AWE by layering two identical sounds into one patch. The other method takes copies of the original sound and outputs them at a slightly different pitch. This produces an effect which is essentially identical to the first method. Technically they are very different, but the effect on our ears is often too similar to be noticed. I'm not sure which method the AWE uses, but in any event it is an integral part of emulating vintage synths. My advice is to use lots of chorus on synth sounds, but hold back on the percussion sounds. Using chorus is an easy and effective way of getting that unstable quality which analogue synths are renowned for, and the AWE has this in abundance. The great thing about chorus is that it fattens up the sound - essentially making a single oscillator sound like a few oscillators.

2) Detuning

Ahhhhh, this is where we reach an important, often overlooked part of analogue synthesis! Although chorus can sometimes achieve a detuned effect, for really tearing vintage sounds, detuning is a must. Many vintage synths have more than 1 oscillator per sound. Output these at slightly different pitches and they simulate a chorus effect. Fortunately further detuning allows wide variations in the pitches of these oscillators, and this can go way beyond a chorus effect. If you're looking for acid licks then this is your baby! The AWE allows you to layer many oscillators, so the effect of detuning these can become monstrous at times! The method I frequently use is to layer 2 or more identical oscillators in an instrument. Use similar ADSR, filter and LFO properties for each of these oscillators. When I say similar, use slightly different rates of attack and decay of filters, LFO speeds and values ... etc. This will create a more evolving sound, almost to the point of being ever-changing - an analogue necessity! Then use the AWE's fine tune to detune some of these away from the base pitch. When the goose bumps settle after hearing this effect at work, you'll know that you've got what you wanted! If you don't detune enough then the effect won't be more than a chorus. Of course using both detuning and chorus will bring tears to your eyes, mark my words! You can of course utilise waveforms panned left and right as well to give you that ever-changing sound. Heavy detuning can give aggressiveness to your sounds.

3) Filters

You're not going to get very far in your vintage quest without this, believe me. Use it often and use it abundantly whenever possible. If oscillators are the voice of an analogue synth, then this is the mouth through which it speaks - literally! Opening and closing a filter is similar to opening and closing your mouth when you talk - it cancels and emphasizes frequencies.

4) LFO'S

Here's another vintage necessity which must be used in abundance for strange and off-the-wall sound FX. Subtle use is of course necessary too, and it gives your sounds an animated feel.

Finishing Words

So, to recap, some of the most important waveforms you could generate from Cool Edit are :

- Sine Wave
- Square/Pulse Wave
- Sawtooth/Ramp Wave

- Triangle Wave
- Whitenoise Wave
- Modulated Waveforms - FM (Frequency Modulation), PD (Phase Distortion), ring-modulation
- Additive Waveforms

Generally speaking you can get away with just generating different 440Hz waveforms at 16-bit, 32Khz, but to get really harsh basses from a sawtooth, or that thumping quality of a TR808 kick, you really need to generate some 110Hz sounds as well. Also, try using lower sample rates like 22Khz or even 16Khz for some bass sounds. They can really kick!

If you have any comments, please eMail me at the address below. Also, look out for my vintage synth Soundfont called Vintage Synth Dreams v2.0. It contains a full compliment of 128 vintage instruments, as well as 8 drumkits (TR808, TR909, CR78, Kraftwerk, Analog, Electronic, TR808-2, TR101). This all fits into the default 512Kb of an AWE card!! The Soundfont is available in the [HammerSound SoundFont Library](#) (stored under the category 'Collections').

Also, look out for the following albums and bands if you want to hear some good examples of vintage synths at work :

- *Vince Clark* - This especially includes his latest stuff with Erasure, but also with early Depeche Mode and Yazoo.
- *Depeche Mode* - Look out for the albums Speak and Spell and A Broken Frame.
- *Human League* - Take a listen to Dare!, Reproduction, Travelogue.
- *Blancmange* - Any Blancmange album will do - similar to Yazoo (Yaz).
- *Yazoo (Yaz)* - Look out for Upstairs at Eric's and You and Me Both.
- *Ultravox* - Listen to Rage in Eden.
- *Howard Jones* - Human's Lib.
- *Visage* - Anything.
- *OMD* - Any early stuff.
- *Kraftwerk* - Anything.
- *Thompson Twins* - Quick Step and Sidekick (Sidekicks).
- *New Order* - Mostly their earlier stuff.