The following appeared in edited form in Muzik ETC in Graham Collins' Synthesizer Basics column.

Ok I tricked you. You thought that this article was going to be all about a synthesizer's amplifier section didn't you! So far, in our ongoing series on synthesizer basics we have discussed the synthesizer's 3 main components--the Oscillator, the Filter, and the Amplifier. Well, in this third installment we will indeed be looking at the Amplifier section and what it's purpose is. But guess what? It's so short and simple that after briefly covering it we will be moving on to bigger things!

We have come to use the term 'amplifier' to mean a loudspeaker power amplifier as in 'guitar amp', 'keyboard amp' etc. Properly, an amplifier is simply a circuit that can increase (amplify) or decrease (attenuate) the output of a given signal. In a synthesizer, the Amplifier refers to that final portion which simply controls how loud or soft the overall output from the instrument is going to be. Not very interesting, but what you can do *to* it may or may not make for an interesting sound. Maybe if you rapidly moved the Amplifier section's gain control up and down very quickly it might sound interesting. "GEE, IF ONLY THERE WERE SOMETHING THAT COULD DO THAT AUTOMATICALLY TO LEAVE MY OTHER HAND FREE, LIFE WOULD BE COMPLETE.." Funny you should ask, as we are now ready to proceed from the 3 main components head first into Controllers. First however, a brief diversion...

At the beginning of grade 12 chemistry, my teacher recapped everything we learned the previous year and then set out to tell us why it was all a lie and that *this* is really the way atoms work. A temporary caressing of the truth to help our little minds understand the world around us a little piece at a time. The reason I'm mentioning this is that *that* is what I'm about to do to you. While it is true that the Oscillator, Filter, and Amplifier sections are the three main components of a synthesizer, I failed to mention that they are the 3 main components ***in the audio path.*** Sure, when we press a key on the keyboard, oscillators then create raw sound material only to be filtered and ultimately amplified and output to be heard by all. BUT in almost all cases these components can have their qualities tweaked by other elements within the machine--Controllers.

The two main types of control elements are known as Envelope Generators (EG), and Low-Frequency Oscillators (LFO). These controllers by definition make no sound at all, but *affect* the overall sound in some way. A standard Oscillator produces a sound of specific *frequency* or *pitch,* but what determines what that pitch is? True we can play a different note on the keyboard and just change it manually, BUT we can also set the machine to alter the pitch itself automatically using a control element. The same is true for the tone of the sound as it comes out of the Filter, or similarly the overall volume of the sound coming out of the Amplifier.

An LFO is just like a standard Oscillator in that it 'vibrates' back and forth at a specific frequency. The vibrations however, are typically in the 1-20 Hertz range--below the threshold of hearing for all but the subsonically sensitive. When applied to one of the main three components however, we experience a new phenomenon. When the LFO is applied to an Oscillator, the perception is one of a wavering in pitch--*vibrato.* When instead applied to a Filter, we perceive a rapid fluctuation in tone similar to a 'wah-wah' pedal (being played by a guitarist with a severe foot-cramp no doubt). If the LFO is applied to an Amplifier, we perceive a modulation in the volume--*tremolo*. Guitarists might note that their vintage amp may have something labeled 'vibrato' (oddly enough a misnomer which ought to be labeled *tremolo* as it is on other amps). In both cases however, this is a perfect example of an application of an LFO to an amplifier circuit. Like regular Oscillators, LFOs can use different waveforms resulting in some interesting 'shapes' to the sound.

An Envelope Generator is identical to an LFO in that we don't hear it directly, but *indirectly*. Where they differ however, is that an LFO is cyclic in nature, while an EG is linear with a clear start and end. It starts when triggered by a key on the instrument and eventually tapers away after releasing the key. Typically, EGs are comprised of 4 stages, a variety known as an ADSR (Attack, Decay, Sustain, Release). 'Attack' is the initial stage and is a time measurement of how long it takes to reach its maximum level. 'Decay' is a measure of time to then decrease to a predetermined 'Sustain' level. Upon releasing the key, the

'Release' time controls how long before the signal reduces back to zero. Overall, by presetting these variables we control the overall 'shape' of the sound. If we were to apply an EG to a synths's Amplifier section, an organ sound would require a very low Attack and Decay time followed by a maximum Sustain level and a quick Release. A trumpet would have a moderate Attack and Decay followed by medium Sustain and moderate Release. A drum sound would have zero Attack, a quick Decay, followed by...well, nothing. The drum sound would have already decayed to silence so the Sustain and Release segments wouldn't be used. EG's can of course be applied to Oscillators and Filters as well, thus controlling respectively the pitch and tone of the sound.

Next time we're going to start putting all of these things together and getting creative!

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