The Secret Of The Big Red Button

Synth Secrets

- Synthesizers > Synthesis / Sound Design, Synth Secrets

By Gordon Reid

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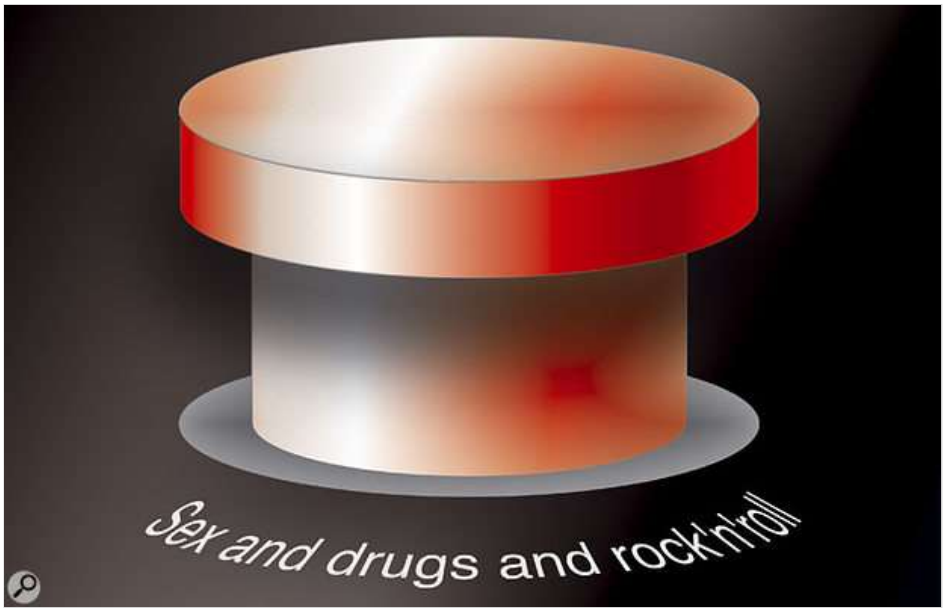

Figure 1: The Big Red Button — surely it's in there somewhere?

After more than five years, Synth Secrets reaches its conclusion (and conclusions!). Will we ever look at synthesis in quite the same way again?

Every few weeks, my colleagues at Sound On Sound and I receive a telephone call or email demanding to know which is the best synthesizer. When these requests come directly to me, I have often replied, asking the enquirer what he (it's invariably a he) wants to achieve, and what criteria he deems to contribute to the term 'best'. And, every time I do, the response is, "Look, never mind all that... just tell me which one is best. I know you know — why won't you tell me?"

Sometimes, I have tried to help the caller by asking him to think about what is most important to him — huge polyphony, sequencing, complex arpeggiation, suitability for live use, ethereal floaty sounds, heavy bass, rhythm sections, and so on. And the reply is invariably, "Look, never mind all that... I'm not interested in all that technology. Just tell me which one is best. I know you know — why won't you tell me?"

You might think that this attitude is rare, but it isn't. If anything, it's becoming more common, perhaps because manufacturers are determined to convince you that you will become the latest, biggest, and richest musical phenomenon the world has ever seen if you simply buy the latest version of their Argon Megastation with the added wotsit and optional thingies.

There's even a second stage to this delusion. It's the feeling that, hidden somewhere on the Argon Megastation, there's a Big Red Button marked 'Number 1 hits, free drugs, and more sex than you can handle'. Few musicians admit to searching for the Big Red Button, but many believe that it exists, and some are really sore that I won't tell them where it is.

In this article...

In this Series

The Secret Of Synth Secrets

Somewhat over five years ago, the very nice people at Sound On Sound and I were discussing the belief in the elusive Big Red Button, and we agreed that it would be interesting to publish a series that explained some of the less frequently discussed aspects of sound and synthesis. The idea was to avoid the introductory tenor favoured by other such series (your VCO-bone's connected to your VCF-bone, your VCF-bone's connected to your VCA-bone... and so on) and to tell you things that you didn't even know you wanted to know. Even at the start, it was clear that no single approach would be suitable for all readers. One respondent described the first two parts of the series as 'condescending', even comparing them to a nursery rhyme, while others simultaneously claimed that the same parts were far too intense and mathematical. Nonetheless, over the ensuing five years, we have covered more ground than any previous SOS series on sound generation and synthesis.

But now I find myself just a handful of paragraphs from the end of the final part, and I would like to leave you with one overriding idea that, in my opinion, sums up everything we've discussed. I hope that this will help you to become a better sound designer and player, although this seems a tall order for just one article.

To attempt this, I'm going to offer you an alternative to the manner in which most people approach their synths. I call this 'modular synthesis', but you won't need a £10,000 wall of vintage modular synthesizer modules to take advantage of it.

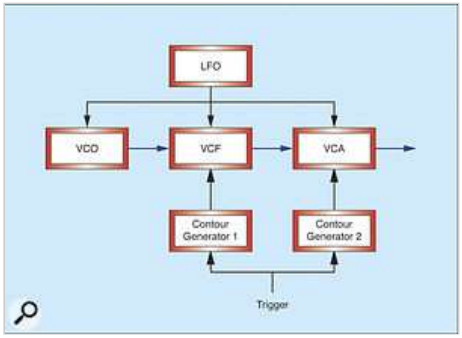

Figure 2: A simple synthesizer architecture.

A Different Way Of Thinking

Many books on synthesis begin by explaining that sounds can be characterised at each point in time by three qualities: pitch, timbre and loudness. This idea is then extended to state that you can partition most synthesizers into oscillators that determine the pitch, filters that determine the timbre, and amplifiers that determine the loudness. Just throw a couple of contour generators and low-frequency oscillators into this brew and you have (so some would say) everything that you need to synthesize every sound imaginable (see Figure 2 above).

However, I find this approach to be rather limiting, so, instead of viewing synthesizers in this way, I'm going to propose that you consider them in terms of three major classes that I call Sources, Modifiers, and Controllers (see Figure 3).

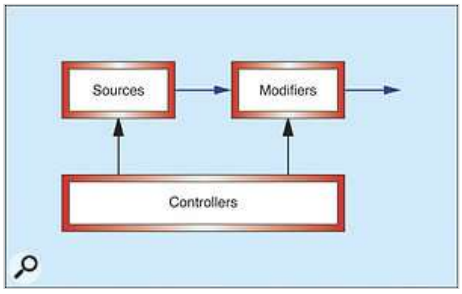

Figure 3: Thinking about the synthesizer in a different way.

Sources

The most common sources on synthesizers are audio-frequency oscillators (such as those shown in Figure 4) although there are others, including noise generators and the external signal inputs offered by, for example, the Korg MS20's ESP section (see Figure 5 below).

The range and quality of the sources in your synth will place tight constraints upon the sounds that you can create. Clearly, you can't easily synthesize a hollow sound without an initial waveform that has that characteristic, nor can you create brassy sounds without waves (or, for that matter, samples) that offer the appropriate harmonic structure.

Figure 4: The Prophet 10 oscillator section offers a range of common waveforms.

So it's a good idea to learn to recognise the sounds of various waveforms, especially the ones commonly found on synths, such as sawtooth, square, pulse, and triangle waves. If you can hear a sound — whether produced acoustically or on another synth — and judge the waveform or combination of waveforms that is most appropriate to emulate it, you've taken a huge step toward earning the title of synthesist. Likewise, if you can imagine a sound, and choose the right waves to make it a reality, you're well on the way to becoming a sound designer.

Figure 5: The external signal processor (ESP) from the Korg MS20.

Of course, it becomes harder to identify waveforms as the patches that contain them become more complex. You may think that if you envelope them, pass them through a filter or two and apply various forms of modulation, it would become impossible to identify the waves themselves. But you might be surprised. The ear/brain combination is a remarkable tool, and once you have learned to recognise waveforms in isolation, you'll be amazed at your ability to identify them in more difficult circumstances.

Modifiers

Modifiers are those parts of the synthesizer that modify the signals produced by other parts of the synth. Most obviously, these are the filters and amplifiers illustrated in Figure 6. Unfortunately, many synth users seem to have become obsessed with the class of modifier known as the low-pass filter. Every discussion about synths seems to centre on similar questions: 'What filter does it have?' or 'What is its cutoff slope?'

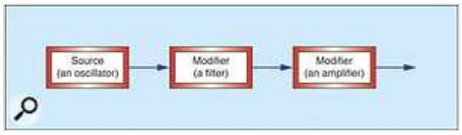

Figure 6: Thinking in terms of sources and modifiers.

To be fair, the characteristic sound of a synth's filters is a major arbiter in the sounds that you can obtain from it. Nonetheless, we should not concentrate only on low-pass filters, because there are many other modifiers. High-pass filters, band-pass filters, band-reject filters and comb filters all have their place in shaping the timbre of your signals. Less obvious modifiers include sample & hold generators, ring modulators, frequency-shifters, slew generators, reverbs, and even chorus units, all of which have been described in detail during this series. There are no rules that say where these should lie in the signal chain, and if you want to modify your audio signals using, say, reverb and chorus before any form of filtering or loudness shaping, there are plenty of synths that will let you do so, especially affordable software-based ones.

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Controllers

The third major class in this scheme is that of the 'controllers'. These generate the signals that determine how the other parts of the synthesizer are operating. Again, there are obvious examples of these, including contour generators, LFOs, pitch-bend wheels, and joysticks... all of which can transmit control signals to modifiers such as amplifiers and filters, as well as to sources such as oscillators.

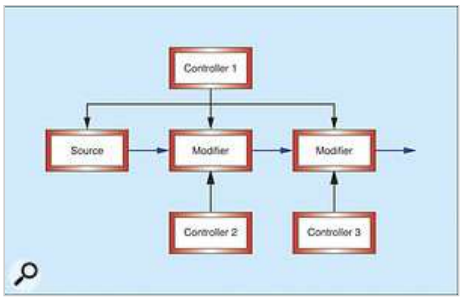

Figure 7: Viewing a simple synth as a set of sources, modifiers and controllers.

We can therefore reconsider the synth architecture in Figure 2 (earlier) and draw Figure 7 (right), in which each of the constituent parts is viewed in a much more general sense as either a source, a modifier or a controller. I like this representation because, although it is explicit about the shape of the patch, it does not fix the exact natures of the building blocks within it.

Source, Modifier Or Controller?

Up to this point, I've kept everything simple, and although I've introduced the concepts of sources, modifiers and controllers, I haven't stepped far beyond the ideas of oscillators, filters, amplifier, envelopes and LFOs. But now I want to make everything more interesting by demonstrating that things are not always what they seem, and that there are many synthesizer modules that do not fit snugly inside a single classification.

Take, for example, the simple architectures shown in Figures 8 and 9 (below), both of which contain two audio frequency oscillators and a mixer. In Figure 8, the outputs from the two oscillators pass as audio to the mixer, so we can say that both oscillators are acting as sources. But in Figure 9, the output from the second oscillator is being fed into the pitch control input of the first, so we can say that while Osc1 is still a source, Osc2 is now acting as a controller. This means that the classification of the oscillator is not determined by its operation, but by its position in the patch!

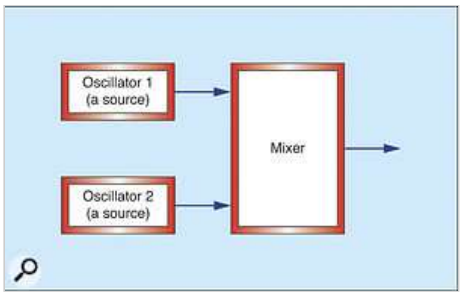

Figure 8: Two oscillators operating as sources.

You don't need a huge modular synth to encounter this. A perfect example exists in the world's first pre-patched, integrated synthesizer, the Minimoog, on which a knob in the Controllers section of its front panel determines whether Osc3 is acting as a modulator (a controller) in addition to, or instead of, its role as an audio oscillator (a source).

Here's another example. Anyone who has read this series will be conversant with the fact that filters with two poles or more (ie. with 12dB-per-octave or steeper cutoff slopes) can exhibit 'resonance' and that, if pushed to the limit, the accentuation of the gain at the cutoff frequency will turn into sine-wave oscillation. This idea is illustrated very clearly in Figure 10 (below), which shows how you can use the oscillating filter to obtain a third pitch from a synthesizer — the Roland Juno 60 — that has just one oscillator. In other words, the filter is no longer acting just as a modifier, it is now a source.

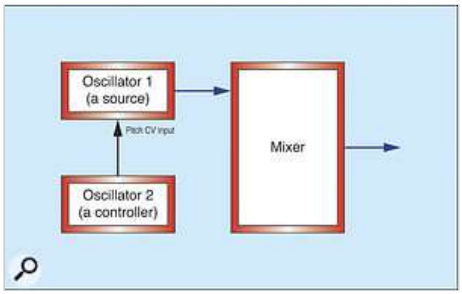

Figure 9: Two oscillators; one a source, the other a controller.

Clearly, you don't need a modular synth to think in a modular fashion, but thinking in these terms becomes even more useful as your synthesizer become more sophisticated. Take, for example, the trapezoid generator in the EMS VCS3. In normal operation, this acts as a contour generator; that is, as a controller. However, there is also a repeat mode in which the contour becomes a low-frequency cyclic waveform and acts as an LFO, which is another form of controller. But if you make the contour brief enough, the oscillation starts to move into the

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audio spectrum, at which point you could use it as either a controller or a source. It's now up to you to decide which is most appropriate, and to patch it into your sound in the way you feel to be most suitable.

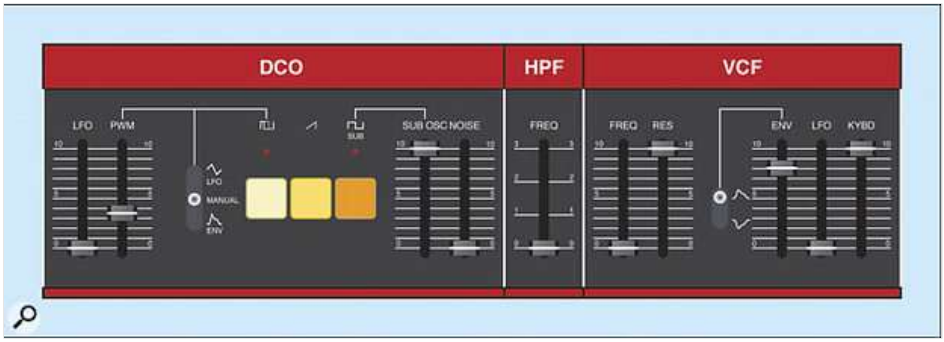


Figure 10: Using the Juno 60 filter as a source in an organ patch.

So here we have three very different synthesizers, the groundbreaking Minimoog, the simple Juno 60, and the complex EMS VCS3, all of which contain one or more modules that can act ambiguously as sources, modifiers or controllers. The same also applies in the modulation matrices of modern digital workstations; oscillators become controllers, modifiers become sources... and so on. As you can see, 'modular synthesis' can be a valid idea on almost any type of synthesizer.

Controlling Controllers

Now, there's nothing stopping you from modifying control signals, just as you modify the audio signals generated by the sources. Indeed, placing controllable amplifiers in the signal paths between controllers and the things they are controlling is the basis of almost all synthesis, and you will find many VCAs (or their digital equivalents) in even a modest synthesizer. But there's no reason to limit yourself to using amplifiers... you can filter control signals to create new control signals, or shift their frequencies, or chop them up using S&H units, and apply a thousand other ideas.

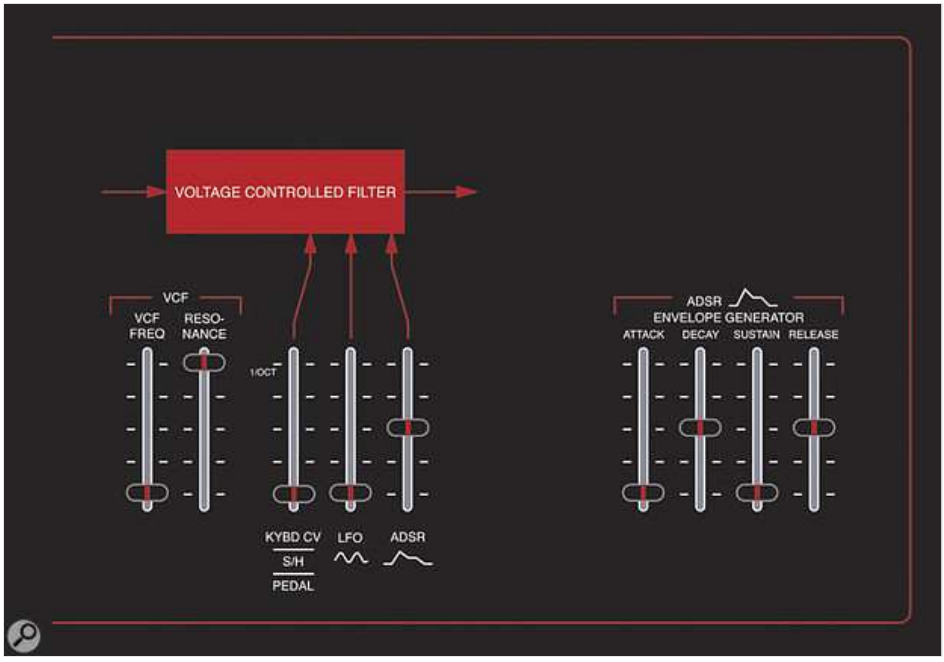


Figure 11: A modifier, some controllers, and lots of modifiers controlling the controllers.

A simple example to illustrate this idea of controlling the controllers lies in Figure 11, which shows the filter section and contour generator of an ARP Axxe. In this case, the filter is a modifier, the ADSR envelope generator is a controller, and the three additional faders in the centre of the diagram (marked Kybd CV-S&H-Pedal, LFO, and ADSR) control the gain of three amplifiers (which are themselves modifiers) that determine how much of three controllers are applied to the modifier's cutoff frequency.

Yikes! That's a heck of a sentence, so let's look at Figure 12 (right), which is the block diagram for this patch. This is much clearer, and if you learn to think of your patches in this way, you can be very much more explicit about what is happening when you create a sound on a synthesizer.

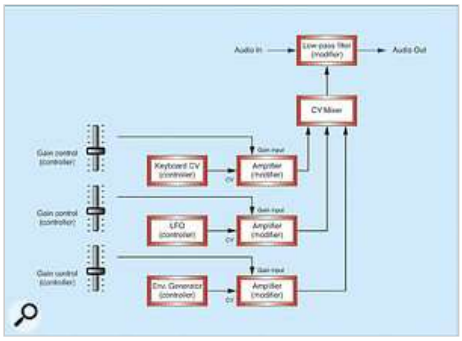


Figure 12: Representing Figure 11 in modular fashion.

Adding A Bit Of Interest

Even if you have a clear idea how to use the building blocks of your synthesizers, there are still a few other things it's a good idea to consider when designing and playing sounds. For example, it's sensible to think about timing signals, and be clear about the differences between triggers and gates. You should also make sure that you know when it might be preferable to use single-triggering, multi-triggering, and the various types of key priority, as well as when monophony is superior to polyphony. You'll find all of these discussed if you look back over the course of this series.

But not everything is cerebral. Just as important as your understanding of sounds is your ability to play them. If you want to sound good, it makes sense to develop good techniques for using controllers such as pitch-bend and modulation wheels, joysticks and aftertouch. Unfortunately, the number of synthesists who ignore articulation and expression has led to an oft-quoted statement, usually made by guitarists of the teeth-clenching, groin-thrusting variety, who believe that wringing the neck of a bit of dead tree constitutes a purer form of music. They claim that "synthesizers are just a big collection of soulless switches."

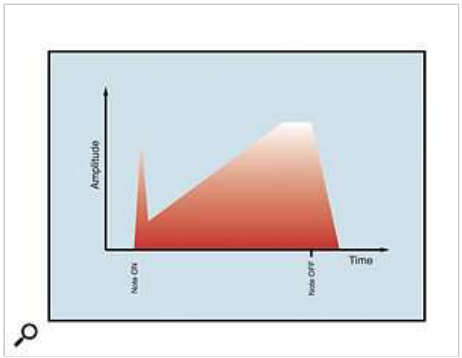
They're wrong, of course, but the inability of many keyboard players to coax even a modicum of expression from a synth lends credibility to their views. You can't solely rely on contour and modulation generators to do the hard work for you. While their great strength is that they make everything consistent and repeatable, so that a sound is recognisably the same from one note to the next, their great weakness is that they make everything consistent and repeatable, so that every note sounds the same from one to the next.

So, next time you're making music, why not try using the physical controllers on your synth to adjust the way in which a note 'speaks', or add expressive vibrato (or tremolo, or growl) using the pitch-bend wheel or ribbon, rather than (say) relying on an LFO which always produces the same effect. It doesn't matter whether you're playing in an orchestral style, or prog-rock, or dance, or industrial techno... you might be surprised at the possibilities this opens up.

Strengths & Weaknesses

If you are going to apply modular thinking to a range of synths, you have to become aware of each one's limitations as well as its strengths. Let me give you an example...

'Sforzando' is the name of a type of sound in which the loudness peaks very quickly, dies away, and then swells later in the note. Generating this contour (shown in Figure 13, right) requires a minimum of five stages. Unfortunately, ADSR contour generators have only four stages. Perversely, each of the three envelopes on the cheap, often denigrated Korg EX800 has five stages, and many cheap digital synths have envelopes with five, six, or even eight stages, meaning that they are capable of producing a sforzando brass patch, whereas



the 'mighty' Prophets, Jupiters, and Memorymoogs can not.

Figure 13: A five-stage sforzando envelope.

Consequently, you can't assume that all the facilities available on a cheap synth will be available on an expensive one, or that an expensive one can generate all the sounds that you can obtain from a cheap one. Nor can you make sweeping statements like 'analogue synths are better than digital ones'. If you want to create the sound of an overdriven low-pass filter sweeping through the spectrum of a sawtooth wave, it's probably true. If you want to imitate a brass instrument or an electric piano closely, or create a lush, evolving texture, it's probably not. You must therefore choose your instruments carefully so that you can produce those sounds if you want them.

Why Bother?

Consider the following statement: the best way to develop a new recipe for a meal is to take random ingredients, throw them in a pot, and see if anything edible ensues.

It's rubbish, isn't it? If you were invited to a dinner prepared in this fashion, you wouldn't return for seconds. So, whether you want to imitate existing sounds or program interesting new ones, it's vital to be able to select the appropriate sources, the right sort of modifiers, and the controllers that can shape the sound and let you control it in the ways that you want. If you do not, it's likely that your random twiddlings will generate another filter sweep that sounds little different from a billion other filter sweeps created over the past four decades.

That's why I've spent the past three years showing you how it's possible to analyse sounds as diverse as brass instruments, guitars, orchestral percussion, electronic percussion, pianos, strings, woodwind and electro-mechanical organs, and how you might use the building blocks of common synths to emulate them. I've tried to make everything as general as possible, and have provided examples using a wide range of synths. Unsurprisingly, a handful of readers objected... they simply wanted me to show them how to set this voltage-controlled wotsit to that value, and thereby obtain the sound used on the latest chart-topping smash. In short, they wanted to know where the Big Red Button was. However, the point was not to show you the settings that synthesize a particular sound, but to teach you how to think in a modular fashion, no matter what synths you might own, and thereby allow you to work out the settings for yourself.

Of course, you may not be interested in understanding how and why synthesizers do what they do, and you may be perfectly content with serendipitous experimentation. If so, that's fine. But if you want to get the best from your instruments, I think you ought to go further than twiddling and hoping. Even modest synths allow you to think about synthesis in a modular fashion, so why not try it?

So — which is the best synthesizer? That's easy. It's the one that allows you to obtain the sounds you want. But whichever one you use, you should remember one last thing... there is no Big Red Button.

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