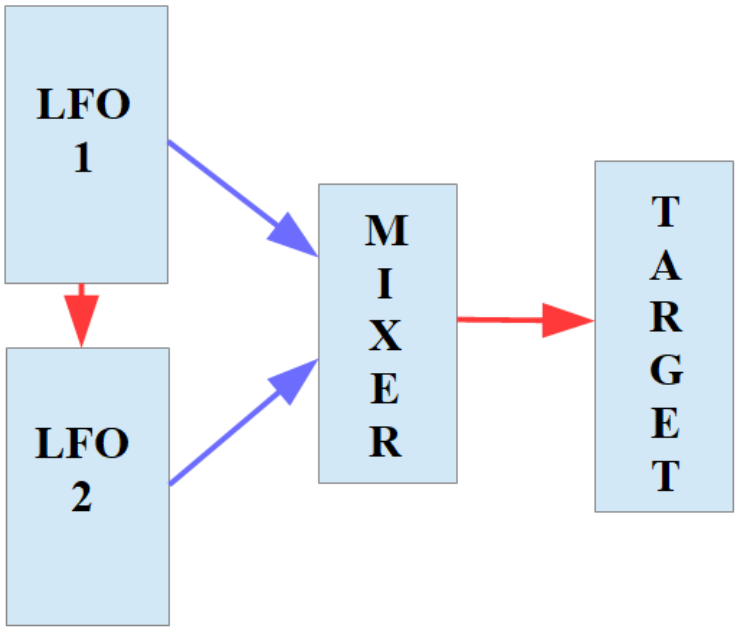
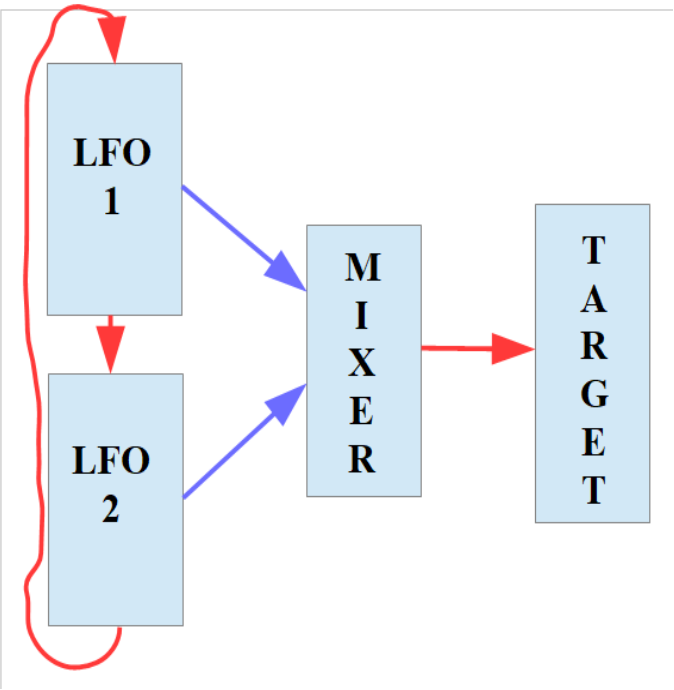
The preset “FB_twoChannels.vcv” (comes with the original e-book, see https://dev.rofilm-media.net) gives you the patch of the video for experiments of your own. But now I´m going to continue in our system and talk about combining additive and serial LFO networks.
The least complex network of this kind consists of two LFO, one of which modulates the other, but both send their outputs to a mixer from where the resulting CV is patched to a modulation target (sound, filter etc. - see chapter 2).



This constellation can be described as “additive combination of two LFOs, one of which producing a complex CV shape”.
The preset “SerAdd_1.vcv” shows this constellation, and in the video behind the following link I´m messing around with it a bit.
https://youtu.be/FyZETF05Gq8

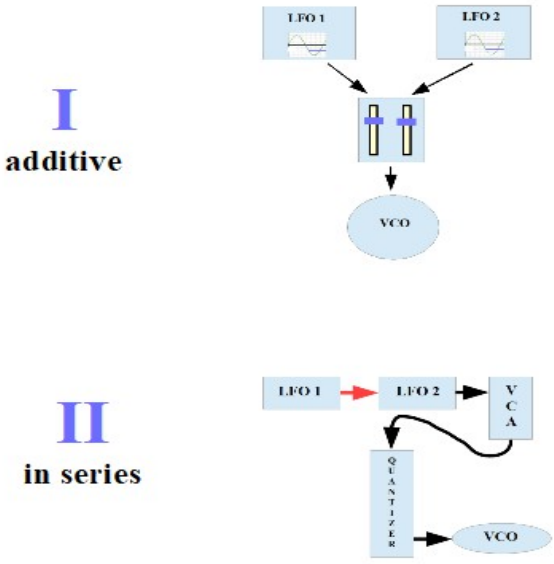
Like with all additive (parallel) LFO networks it is the relation of the frequencies of the LFOs which determine the length of the overall cycle (and with that decrease or increase the impression of ever changing randomness). And it is **the same frequency relation**, that determines the complexity of the resulting development of the CV over time, as it (the frequency relation) determines the shape of the output of the modulated LFO (LFO 2 in the picture above). The relation $\mathbf{f_{LFO1} : f_{LFO2}}$ has a double function therefore.

The next step is introducing feedback to the setup, as the following graphic shows.



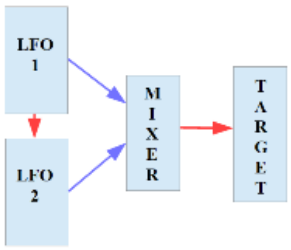
We can describe this patch as “additive combination of steps 1 and 2 from the comprehensive explanation of feedback above”. The preset “SerAdd_2.vcv” (in the e-book) and the video behind the following link deal with a setup like this.
https://youtu.be/GUA8dJuFCpk

We have met all basic networks containing only LFOs now. Let me give numbers to them:

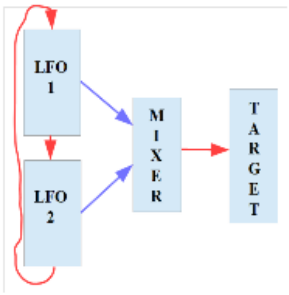


III
In series feedback

IV
in series and additive



V
in series feedback and additive



VI
one LFO feedback

I have added patch a VI to the diagrams (the self-modulating one LFO) to be able to stay systematic in the following examples.

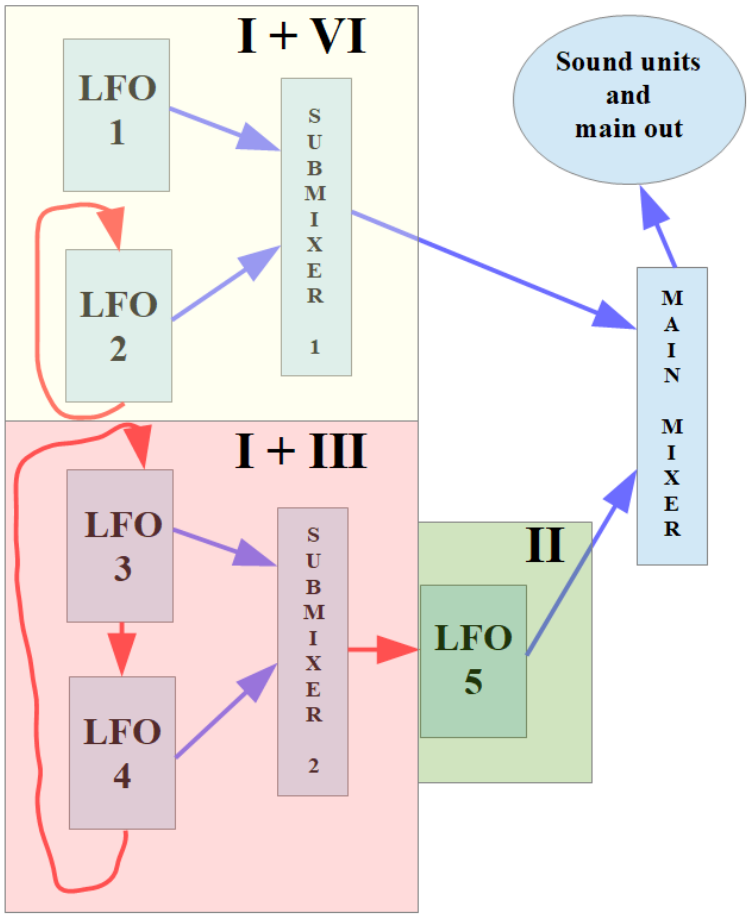
Our matter now is setting up more complex networks by combining these 6 basic building blocks. By doing so we leave the **field** of LFO networks, yes, we even leave the Earth and enter the **universe** of LFO networks, as there are unlimited possibilities. We can replace each part in each of the 6 building blocks by any other of the building blocks – or even by the

“mother” block itself.

An example will come in handy here. I take 5 LFOs and three mixers (as well as a couple of VCAs for later modulations. I equip each LFO-VCA combination with a scope for better understanding and patch the modules as follows.

Two LFOs are patched parallel into a submixer. One of the LFOs modulates itself. The mixer outputs the summed CV into the main mixer.

Two of the other LFOs I patch parallel into a second submixer. Additionally the two LFOs build a feedback loop. From this second submixer I patch the CV into LFO number 5, from where it goes to the main mixer. In the graphic I have used the above shown system of numbers to label the three main functional blocks.



Preset “complex_1.vcv” and the video behind the following link will help you to a deeper understanding and working out some experience of your own with the patch – which causes a “generative feeling” to a quite big

amount even if it is completely without random elements (so far).
https://youtu.be/Cxod25xsqH0

All our LFO networks have been aiming at modulating the frequency, the rate of an LFO so far. Let me spend some words (and a video) on modulating the other LFO parameters now. Everything that we have met when we were talking about our LFO networks is independent from the modulated parameter. The system of our 6 building blocks is valid whether we modulate frequency or amplitude or phase or wave shape.

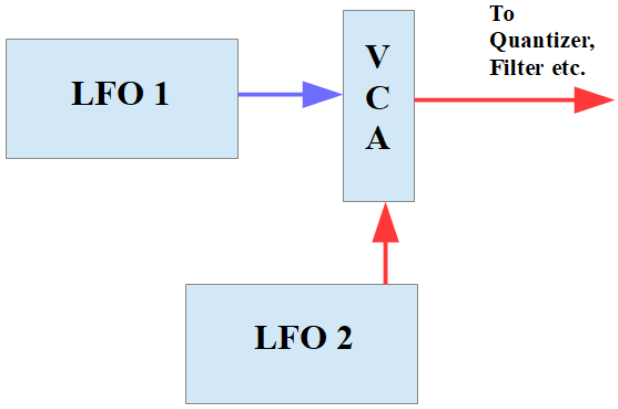
Therefore it will be sufficient to introduce some examples without going deep into the matter a second time (modulating amplitude), a third (modulating phase) and a fourth (modulating shape) time.

But let me say it even here and by now: There are more ways to set up our networks of repeating cycles than only by LFOs. I´ll return to this aspect later in this book.

Alright, some examples then, modulating amplitude first. A bit earlier in this book I said, that patching LFOs in a parallel way by sending their outputs to a mixer will increase the overall CV amplitude. When we set up networks modulating amplitude we have to take care about this fact even more and more carefully, because these added amplitudes are changing over time.

Let´s start with modulating the output of only one single LFO. The CV range – and with that the range of the modulated parameter, e.g. the pitch of a VCO, changes – and that´s all. I´ll use VCAs to modulate parameters in all my examples, because not every LFO module might have a CV-in jack to modulate its output, and I promised at the beginning of this book, that you would be able to follow and to do all experiments here yourself, no matter what system you´re using.

The above mentioned patch looks like in the following graphic therefore.



And from here we can go ahead and use our well known networks from before and continue experimenting with modulating amplitudes (instead of or additionally to modulating frequencies).
The preset “amplitude_1.vcv” represents the above shown simple patch, and the video behind the following link demonstrates its characteristics.
https://youtu.be/QiCtvNxHIcs

And I can do both, modulating the output amplitude of an LFO as well as its frequency. I can do it with one and the same modulating LFO, or I can modulate these two parameters with different LFOs at different frequencies. But be always aware of the fact, that modulating the amplitude of an LFO, which acts as a modulator in a patch means modulating the strength of the modulation, that this LFO is causing.
When I use the square wave output of the modulating LFO I can switch certain modulations and even whole modulation paths and building blocks on and off – longer duty cycles (= shorter zero-level times) of the square wave are advantageous quite often. The preset “FandA,vcv” is based on the last mentioned preset and the video behind the following link messes around with this preset at bit.
https://youtu.be/ksbg29yZBnc

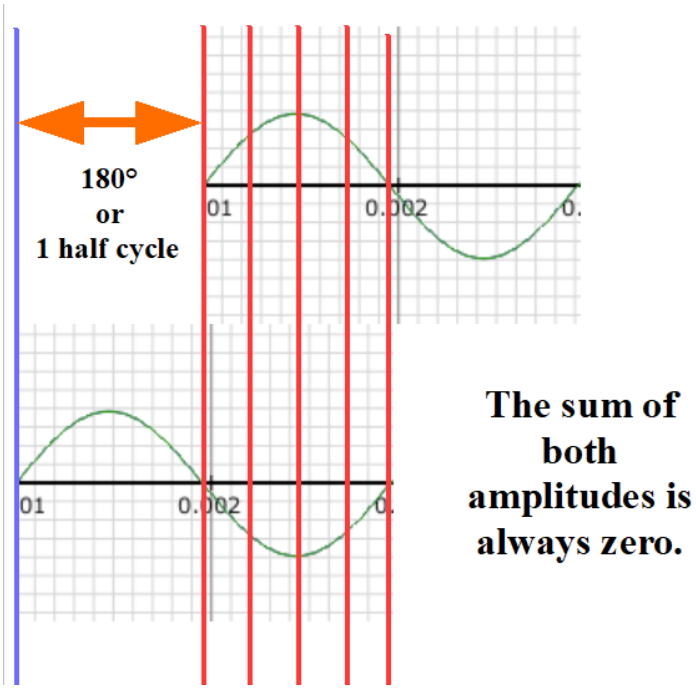
In the next example (preset “nextFandA.vcv” the speed of the arpeggio and the pitch range of the arpeggio are modulated by one and the same modulation source. Just follow the link:
https://youtu.be/bN5otR3gDK4

Let only mention it here: Later we are going to modulate different kinds of modulation targets from different points in the modulating network. We are going to modulate not only VCOs/Quantizers, but also filters, switches, effects and a lot more (see chapter “What to Modulate And Trigger”.

We have modulated the **rate**/frequency of an LFO, we have modulated the **output** (modulation strength) of an LFO, but there are LFO modules out there, which allow even their wave **shape** being modulated. Let´s do so now. The preset “waveshapemodulation.vcv” gives you an easy start to modulating wave shapes of LFOs, and the video behind the following link demonstrates some possibilities.
https://youtu.be/MjR6UghunxE

Last parameter to modulate: **phase**
Well, modulating the phase of a wave or the frequency/rate of the wave

leads to quite similar effects. There is a famous example in the world of audible frequencies: Yamaha called their iconic DX series (DX 7, DX 21 etc.) “FM synths”, even if it was phase modulation, and not frequency modulation what´s going on in these synths. Modulating the phase of an LFO wave will be interesting mostly when I want to play with phase cancellation effects in an additive setup of two or more synths. For example a phase shift of 180° leads to complete cancellation of two otherwise identical waves. So, when I´m aiming for changes in the timing of the modulation I prefer modulating the rate/frequency, because the results are easier to calculate and to predict, but when I want to get some (random sounding) changes of the modulation strength, **and** changes of the speed, then I go for phase modulation. Here it´s phase modulation, which is easier to predict. And what´s more, modulating the LFO´s rate/frequency needs attenuation of the modulating signal to get sensible results quite often, whereas phase modulation can be done directly from the un-attenuated modulation source most of the times.
The preset “phasemodulating.vcv” and the video behind the following link demonstrate such situations.
https://youtu.be/DWBCbjAl3g0



Let me summarize what we have so far. We can tell apart 6 basic constellations of how to patch CV sources, that produce regular cycles. Each constellation can be a part of any of the others, quite complex networks, which generate complex and long lasting regular cycles can be set up. And in these networks I have the choice to modulate the

rate/frequency of each of the cycles, their phase, the wave shape and the strength of modulation. But how shall I decide with this amount of different ways to patch my network?
Well, this question is answered by your compositional will, by what you – as the composer – are aiming for on behalf of art and music. In the chapter "Compositional Aspects" I´m going to talk about that, and there you´ll get some methods of how to make the above mentioned decision(s).

But at first we need to talk about other kinds of modules, which are able to produce regular cycles of CV, modules, which are not LFOs. This is the topic of the following chapter 1.2

… to be continued.