# The Wersi Sound Factory Master Classes

Master Class 4 : April 2013 : The Filter-Map Tab

We now return to continue looking at the tab sections of Sound Factory and the next one along from Sample is the Filter-Map, so that is the subject of this Master Class which is divided into two sections. In the first section we consider the essential characteristics of Filters and relate these to the controls found within Sound Factory. In the second section Ian Terry provides a number of examples to demonstrate the operation, utilisation and effect of Filters and Jeff Ormerod details an example of how an existing sound might be improved by using the Filter-Map controls.

Here is a screenshot of the Filter-Map tab.

The Filter-Map screen

The Sample whose Filter-Map parameter values are displayed in the tables to the right of the screen is highlighted in orange
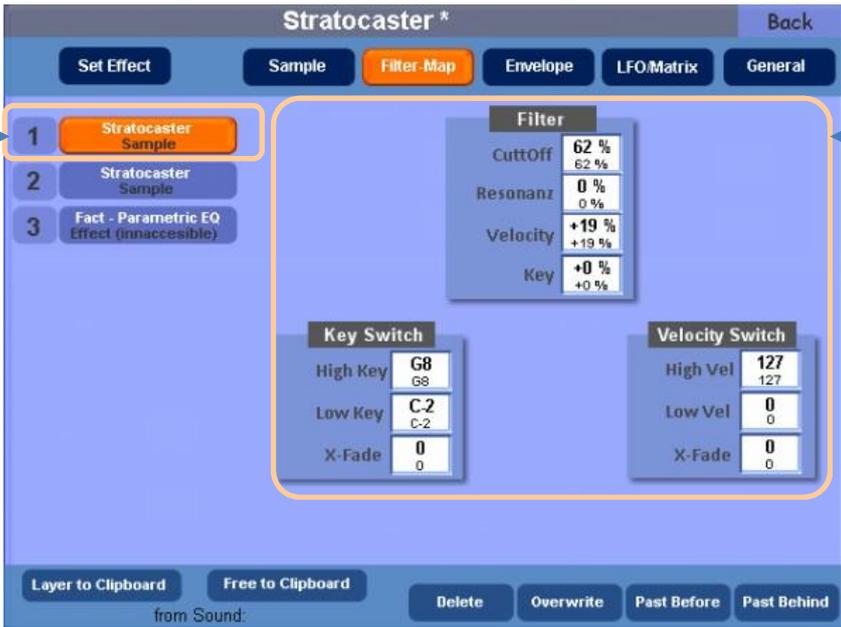
We shall look at each of these three tables of parameter values in turn

Meaning of the word "Filter"

Filter

A good question to ask before we go any further would be: exactly what is a Filter and what does it do?

The general meaning of the word "Filter" is a device or process which separates items in a mixture. You may remember this from Chemistry lessons at school. You had a circular piece of filter paper which you folded into a funnel shape and placed it in a glass or plastic filter funnel. You then placed that funnel into a test-tube or into a funnel stand over an empty beaker. You possibly had a beaker of muddy water which you then poured into the filter paper in its funnel. Then the magic occurred - all the water coming through the filter paper was crystal clear and the mud was left in the filter paper.

You may also remember your Physics lessons when light filters were taught. These could have been colour filters to separate individual colours out of the mixture of colours we call "white light", or they could have been polarising filters to separate one angle of polarised light out of the full 360 degrees of light we normally see - you may have a pair of polarised sunglasses which work in that fashion.

In electronics there is often a mixture of frequencies making up an electrical signal. These can be audio frequencies or radio frequencies. Here we're dealing with electrical signals composed of audio frequencies. It is often assumed that the human ear can hear frequencies between 20Hz (a very low rumble, often felt more than heard) and 20000Hz (an extremely high-pitched whistle). As one becomes older that top limit drops away with increasing age.

Meaning of the word "bandwidth"	When an electronic Filter receives an electrical signal it will either let the signal through (pass) or block it, just like a water filter or light filter. The factor that determines if the signal will be passed or blocked is the Filter's bandwidth. The bandwidth is the frequency range of the electronic signal that the Filter will allow to pass through. Any electronic signal that has a frequency outside of the Filter's frequency range (bandwidth) will not pass through the Filter.
Pass a bandwidth	For example, radio signals occupy a particular bandwidth within the radio frequency spectrum. If you want to receive your local radio station you tune your radio set to its transmission frequency. This means you've used a Filter inside the radio to block all radio frequencies other than the one you want to receive, which is allowed to pass. That's a very finely-tuned Filter with a very narrow bandwidth. When sound (audio) frequencies are involved, as with our organs, a wider bandwidth is involved. An example of one of those is the tone control, or the separate bass and treble controls, which your radio may have. They adjust the amount of high and low frequencies which are allowed to pass through to the speakers. In fact the word "pass" is used in preference to "block": it's just the other side of the same coin.

The Filter in Sound Factory has four adjustable parameters: CuttOff (sic), Resonanz (sic), Velocity and Key. Let's look at each in turn.

CutOff (shown as "CuttOff" on the screen)

Meaning of the parameter "CutOff"

The range of values available here is from 0 to 100. At a value of 100 the Filter is described as being completely open. It passes all frequencies and it's as if it doesn't exist. This is the default value. At a value of 0 the Filter is completely closed and passes no frequencies. Between these two opposite values there is a gradual closing of the Filter as the values drop from 100. But what does that mean: a gradual closing of the Filter? What does the listener notice is happening to the sound?

There are two kinds of Filter which can be used: a Low Pass Filter or a High Pass Filter. Most of the Filters in Sound Factory are Low Pass. In a Low Pass Filter, progressively lower values of CutOff lower the frequency at which the Cut-Off occurs, acting as a kind of treble control which will reduce the volume of high harmonics in the sample's sound. In other words, low frequencies are passed, hence Low Pass Filter. Higher frequencies are cut off.

For completeness, a High Pass Filter passes the higher frequencies but cuts off the lower frequencies, producing a rather "tinny" sound.

Resonance (shown as "Resonanz" on the screen)

Meaning of the parameter "Resonance"

The Resonance control inserts a peak in the volume of the sound at the Cut-Off frequency; the higher the Resonance value the more noticeable is this effect. The range of values available is from 0 to 100. The default value is 0 when no Resonance is applied.
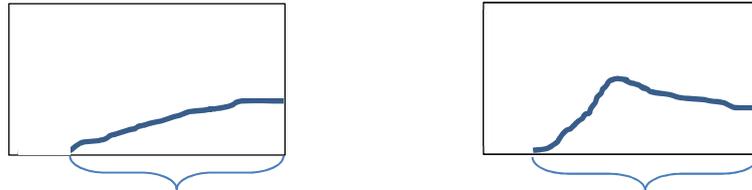
Here are graphs of a Low Pass Filter with the CutOff set to approximately 1kHz.

a)   With no Resonance applied   b) With 25% Resonance c) With nearly 90% Resonance
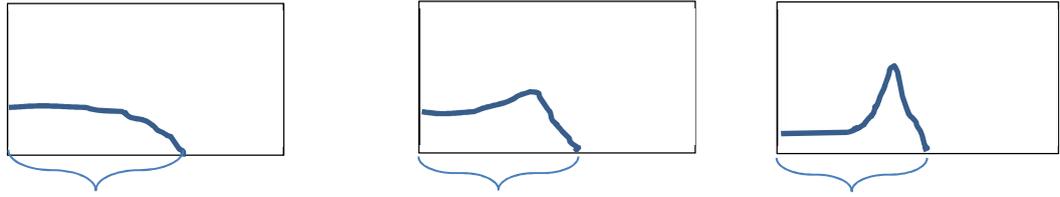
Here are graphs of a High Pass Filter with the Cut-Off set to approximately 1kHz.

a) With no Resonance applied.   b) With approximately 45% Resonance

In the above graphs, frequency is from left to right (0Hz – 22kHz), amplitude (volume level) goes from bottom to top (-96dB to +24dB; 0dB is approximately three-quarters up). The brackets show the range of frequencies passed.

The effect of Resonance varies according to how much is used, what the Filter CutOff is set to and the type of Filter. It also depends on the harmonic content of the waveform being filtered. Essentially it's a case of trying different values and listening to the result. Obviously in Sound Factory it's not possible to set up a situation where you know what the Resonance frequency actually is nor where you know the amplitude value of the result.

Velocity

Velocity - how the Filter is controlled by the way of playing the keys

This uses the keyboard key-down speed to calculate a value. That value is then sent to the Filter where it can be used to open or close the Filter by how hard you play the keyboard. Dynamic (in Selectors) must be On for this to take effect otherwise you will get a constant value supplied to the Filter. Also the Filter CutOff needs to be set to a value less than 100% (Low Pass) before Velocity can add any values to the current Filter setting.

Ensure "Dynamic" is ticked under "Selectors"

The range of values is from -100, through 0 to +100. The default value is +100 when the Velocity has no effect on the Filter. At a value of 0 the Filter is closed until a key is hit with a higher velocity (harder) when the Filter then opens up proportionately to how hard the key is struck. Thus harder playing gives a brighter sound. Negative values reverse this - harder playing gives a duller sound.

Key

Key - how the key played can be set to affect the Filter

This adjusts the result according to the position of the key that you are playing on the keyboard. Each key supplies its own individual key number, some Maths is then applied to the key value and that is then routed to the Filter. You could set this so that the bottom end of the keyboard opens the Filter fully whilst the top end closes it: or the reverse/inverse of this.

The range of values is from -100, through 0 to +100. The default value is 0 when all keys have no effect on the Filter. Positive values have the effect of closing the Filter when keys to the left of the keyboard are played (low frequencies), while keys to the right of the keyboard have the Filter opened up (allowing high frequencies through). Negative values have the reverse effect.

This parameter is not associated with the Velocity parameter.

Key Switch

There are three parameters: High Key, Low Key and X-Fade (Cross-Fade).

High Key

This sets the highest key which will sound the selected Sample Layer. The full range of C-2 to G8 is available. Setting G8 as the value does not limit the Layer. If you set G4, for example, the Layer will not sound when any key above G4 is played. Remember, C3 is Middle C.

Low Key

This sets the lowest key which will sound the selected Sample Layer. The full range of C-2 to G8 is available. Setting C-2 as the value does not limit the Layer. If you set G2, for example, the Layer will not sound when any key below G2 is played.

X-Fade

The range of values is 0 to 127. If 0 is set, the High Key/Low Key effect happens totally at the set keys. It is like a switch setting. However, if a X-Fade value of 12 is set, for example, then the High Key/Low Key effect happens by a gradual change in volume for 12 semitones beyond the set Key, up in the High Key case and down in the Low Key case.

Velocity Switch

There are three parameters: High Vel(ocity), Low Vel(ocity) and X-Fade (Cross-Fade).

High Vel and Low Vel

The range of values is from 0 to 127. A value of 127 allows all velocities to sound the Layer. If High Vel is set to 117 and Low Vel to 100, for example, the particular Sample Layer will sound only between that range of velocities. Play harder than 117 or more gently than 100 and it will not sound.

This clearly requires a trial and error judgment for setting the values.

X-Fade

This allows a "smearing" of the effect, much like X-Fade under Keyswitch. If you were to set a value here of 12, for example, using also the values given as an example under High Vel and Low Vel above, that would extend the High Vel value up to 127, but between 117 and 127 there would be a gradual change in the effect. The Layer would still sound when hitting the keys hard but less so the harder they were hit. A similar, though opposite, situation would apply to velocities below 100, when down to a value of 88 hitting the keys less hard would still cause the Layer to sound, on a sliding scale.

This is best experienced by trial and error but make sure that "Dynamic" is ticked under "Selectors" otherwise there will be no effect at all!

By now you may well be saying to yourself that all the above is very interesting but how can it be used? The simplest way to answer that is to provide some examples and that is exactly what Ian has done for us. Here they are.

We are going to start with the most commonly found Filter (a Low Pass Filter) and try a couple of different samples to help assess the results on the instrument. First load the following sound into any free Total Preset: 090-000-019 ; Pan Pipe 1 *. Make sure that Select 1 - Dynamic is on in the Selectors tab. I've selected this sound because we don't need to do too much programming to hear the Filter working on the sample.

Once it's loaded, go into the SF/Expert Edit/Matrix page. Mute layers two and three, make sure layer one is selected, and then set all the Destinations to Off. We shall be covering the Matrix page in many Master Classes to come - it's an extremely important and useful part of Sound Factory and its effects relate to all aspects of the software. Therefore, to look closely at other aspects of Sound Factory we sometimes, like here, have to nullify the Matrix first.

Go to the Filter Page and change the value of the parameter called CutOff from 100% to 75%. Play the keyboard and by changing the amount of velocity with which you play the keys you can change the Filter setting. As you'll have noticed, the Filter attenuates the higher frequencies present in this example depending on the note velocity value: play with high velocity and the sound becomes more mellow.

This is called a 'Dynamic Filter': it moves or changes its CutOff frequency according to the modulation that is presently being sent to it. At the moment 'Velocity' is the modulation assigned to control the values. By adjusting the parameter called 'Velocity', (in the Filter's sub-menu), we can 'tailor/fine tune' just how much velocity is needed to produce the effect you require to open and close it.

Next, change how the 'Dynamic Filter' behaves by changing the 'Velocity' value from '66%' to '0%'. Play the keyboard again; this time the sample appears to be how it was before we started. By altering the CutOff again, (change it to 60%, for example), there is some filtering present on the source signal, but now it has a 'Static Filter Type' of behaviour. There is some filtering occurring but no modulation of the CutOff by the velocity with which the key is played, so it is not really considered 'Dynamic' in nature. This opens the door towards using the Filter as a type of 'tone control' where you would want to increase some of the harmonics at and around the CutOff frequency point.

Advice about Mixer and Outputs Equaliser settings

At this point it is worth mentioning a few considerations as well as a health warning. Firstly, as we've now mentioned the words 'tone control', you will already be aware that both the Mixer and the Outputs tabs offer global tone controls in the form of simple graphic equalisers. If you already have any of those set to provide a more mellow tone (one with little emphasis on higher frequencies), attempting to use the CutOff Filter may not show much change because the frequencies are already being reduced by the Equalisers. You should therefore ensure that, in these Filter-Map demonstrations, you are using Mixer and Outputs equalisers which allow the higher frequencies to be clearly heard.

Warning about keeping volume low

Secondly, before playing any keys from now on, ensure you start with the expression pedal well back. This is because some very loud sounds can be created by changing the Filter parameter values and your ears and your instrument will thank you by not subjecting them to that sort of shock. This is particularly important if you are using headphones by which to listen. In fact, in synth/audio engineering circles this parameter is considered to be dangerous if not handled with care.

Using the Resonance parameter

In order to increase some of the harmonics at and around the CutOff frequency point, the parameter marked Resonance is used.

First, set the CutOff to 75%. Make sure that Resonance, Velocity and Key (short for Key-follow), are all set to 0%. Play the area around middle 'C' to get used the sound's present settings and then set Resonance to a value of 35%. At this point there only is a tiny increase of harmonic content at the CutOff.

We can go a bit further before things start to become uncomfortable to our speakers/hearing. Increase the Resonance further to somewhere between 50% and 60%. At this point it should becoming clear (if your speakers/hearing are working well), that there has been a change to the 'Breath' or 'Breath Noise' content of this sample. That makes sense as the Filter is set to a high value and therefore is working with the most effect at a higher frequency than the fundamental of the sample.

Carefully increase the value of Resonance to 75% (use 80% if you feel you must!). This sample now has a different character when compared to the original. It is still a 'Pan Flute', but the high end is different. It is brighter than the original.

Ian's second Example

Let's use the Filter on a different sample now. First set Resonance back to 0% and then set the CutOff to 100%. Go to the Sample Page. From the same Sample List (currently Panflute), change this to CD-Theater. Whilst on this page set Wave Start and Velocity to '0%'. (Again, the different parts of the whole Sound Factory package all have an interplay and to investigate one single part we need to nullify the effects of other parts.)

Go back to the Filter-Map Page and then have a play and listen to this sound. Does it sound like there are two sounds combined together into a single sample: a 'string' type of sound and a sort of 'vox' sound?

We're now going to use the Filter to remove or attenuate the brighter/string part and just leave the vox part to play. In order to assess what the CutOff needs to be set to (in order to remove the string part), you need to keep playing and adjusting the value until you're happy with the result. So by playing a single note repeatedly whilst adjusting the CutOff should help you find some suitable values. Here are my findings:

At a value of 90% I'm not aware of any changes, so I keep decreasing the CutOff value.
At 70% I'm becoming more aware that the Filter is affecting the sound of the sample. At 60% there is definitely some filtering of the string content, but still not enough to remove it completely. Finally at 40% I'm happy with the basic Filter setting.

Changing a Static Filter into a Dynamic Filter

Although it's fine on and around middle C, move away from that keyboard area and I'm not so happy. The problem is that the Filter is actually behaving in a 'Static' fashion and set to a specific frequency. It would be better if I could get the Filter to be 'Dynamic' and follow the note position and change the frequency value according to the note(s) I play across the keyboard. To help with this we use the Key parameter in the Filter sub-menu. This will keep the Filter 'tuned' into the frequency across the entire audio spectrum. I'll set it to 100% as I want each note to have the correct Filter setting and not one which has been offset in some way by using the other values available. Try different Key values at this point. There are negative values as well as positive ones available. When you change a value, note what happens at both ends of the keyboard. Some values will make the low/high end 'brighter' whilst others will make it 'darker'; they usually work as an inverse pair. Once again, if used with the 'Matrix' it's possible to make both ends 'bright' and the middle area 'darker'… but that's for another time!

After playing with this for a little while I changed two values, the CutOff to 44%, and Key to 80%, but that's just my taste! (Later, when we look into the 'Matrix', we'll connect the Filter CutOff in order to open and close it from a Controller to bring back the 'string' part when needed - that's just a taster of what's to come!).

Try some other Samples of your choice. I know there are a few sound samples which to my ear are too bright or shrill for my taste and a little bit of filtering goes a long way with me to make them more playable. In the Digital Church Organ, for example, filtering makes it a bit more like the real thing.

Real instrument sounds also benefit from having the Filter closed slightly, and then by using a certain 'Matrix' setting can be made to sound a little bit more authentic.

Demonstrating a High Pass Filter

All the above, as with most of the sound samples available, refers to a Low Pass Filter. If you want to experiment with a High Pass Filter, have a look at 081- 000 - 073 ; Thin Air Pad. Beware of changing the Resonance value in this Filter as well. This time everything is attenuated from the bottom upwards. Also be aware that the value for the Filter to be fully open is in fact 0%, and to be closed or almost closed a value of 100% is needed. This behaviour is correct when compared with other synthesiser/sampler based instruments.

Here are a few points to keep in mind.

1. The samples in the data base are different from each other. Each one has its own sonic finger print (audio spectrum). Some differ only by very small amounts, others are chalk and cheese. Because of this fact, you will find that most of the time a Filter setting that works for one sample will not necessarily work for another. In a sense, each sample really could/should have its own Filter setup and in most cases there can be more than one setup that works.

2. When editing the Filter parameters, check your Matrix first if you can for CutOff and Res (short for Resonance). These are possible danger signs to your instrument speakers and ears! Set them to Off in the Matrix.

3. Assuming that your Matrix is safe from the above, it will help if you change the CutOff before any other parameters, as this seems to be set to either open or almost open most of the time throughout the database.

4. Filtering is a bit of an art; you need to practise with it to get the best out of it.

Jeff Ormerod has tried out the above investigations already. Here is how he described what happened next.

Jeff identifies a group of sounds that would benefit from improvement. These are the Orchestral Percussion sounds, particularly the Celesta, Glockenspiel and Music Box. To my ear, he says, they sound nothing like their orchestral counterparts, the main problems being some tonal inaccuracy and a very pronounced attack strike that sounds like the instrument might have been hit with one of those large heavy hammers that Wheeltappers use on the railways to detect cracks and defects in the wheels!! I'm particularly keen to get a decent sounding Celesta, but adjustments to the Celesta sample proved unsuccessful in achieving the required tone. Perversely, employing the Glockenspiel sample worked out quite well. The following is my 'recipe' for the Celesta using mostly the Filter controls and the Wave Start function covered in Master Class 2.

1. Load the Glockenspiel * sound (090-000-009) into Sound Factory and select the Filter Map page.

2. In the Filter section set the CutOff value to 65%. Leave the Resonance value at 0, Velocity at +100 and Key at +100. This will tonally adjust the bright sound of the Glockenspiel to that of the more mellow Celesta.

3. Select the Sample page and in the Sample Edit section set the Wave Start value to 50% and the Velocity to -100%. Leave the Random value at 0. This will tame the pronounced strike attack.

4. Reducing the CutOff value of the Filter also reduces the volume of the sound, so in the Volume section of the Sample page set the Volume dB value to its maximum of +12 dB. If you require more volume you can also increase the Volume slider on the initial Sound Controls page. [Ian has an alternative to this, by using features in the Matrix. Later.....]

The reference Celesta sound I'm aiming for is that featured as a solo on the Buddy Holly recording of "Everyday".

Jeff has provided an audio download on the Sound Factory page of the WersiClub International website to demonstrate his Sound Factory Celesta sound, using that "Everyday" Celesta riff.

Key Switch and Velocity Switch Example - both are used in "Bright Orchestra"

Key Switch - I think the initial explanation of this is quite straightforward. If you want a particular sample sound to occur only when a certain range of keys is played (eg timpani below G2) then this is where you set that up.

Velocity Switch - this is where you set up a sound sample to be heard only when a key is struck with a particular velocity. In the timpani example above, this can be used to cause the timpani to sound on those selected keys only when those keys are hit hard.

The next Master Class (number 5) will be in June 2013 when we shall look at the Envelope tab.

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