

Studio One 8

White Paper

Intelligent Harmonic Core

Intelligent audio processing through global harmonic control of overtones and their partials, controlled by data obtained from advanced AI analysis of both the macro, (whole song) and micro, (individual parts), for the first time will be incorporated within the core foundation of the DAW. Thus, allowing audio processors to adapt to the chordal structure of the composition in real time, adjusting the tonality of audio, FX and virtual instruments to the songs harmonic structure, effectively tuning the DAW.

Abstract

To artist/producers it can seem that there is often scant connection between the functioning of audio processing tools and the artistry and emotive aesthetics of Music. The available tools tend to be somewhat 'dumb', passive, unaware of the underlying harmonic structure of a song, their control circuits are only aware of basic frequency based information, and they are not advanced enough to alter the inner architecture of sound in a way that is directly related to music.

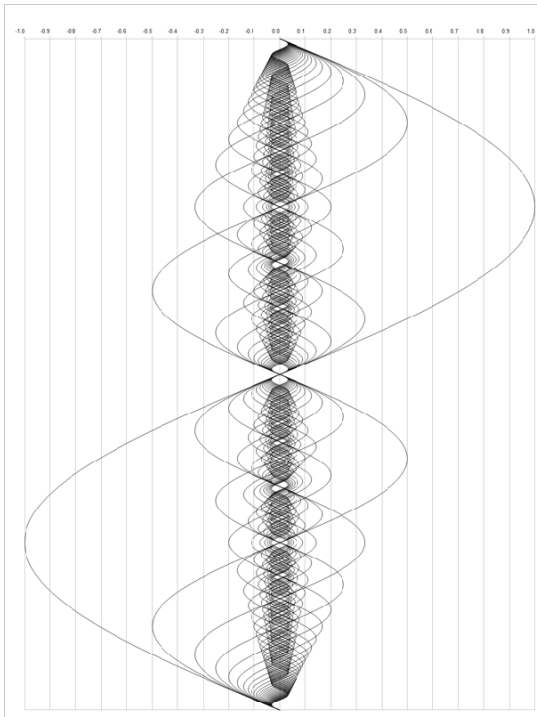
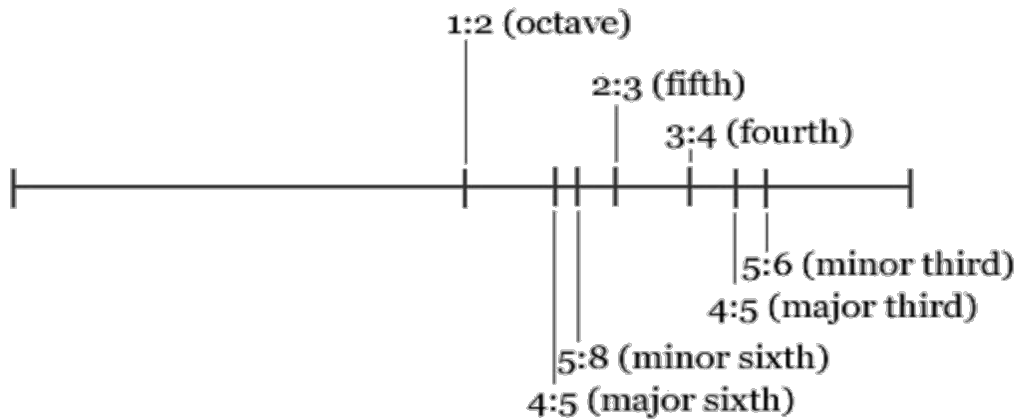
What is proposed here is a new direction, intelligent audio processing through global harmonic control of overtones and their partials, controlled by data obtained from advanced AI analysis of both the macro, (whole song) and micro, (individual parts), incorporated within the core foundation of the DAW. Allowing audio processors to adapt to the chordal structure of the composition in real time, adjusting the tonality of the sounds to the songs harmonic structure, effectively tuning the DAW.

Background

Western music is based upon the third harmonic of the overtone series, the interval of the 5th. Take a string, divide it in two, pluck it and you have a note an octave higher than when the whole string is sounded. Divide it again in the ratio of 3/2 and you find the interval of a 5th. Continue to divide the string and you will discover the basis for the intervals used in music from every culture.

In fact, strike any object that sounds and the overtone structure produced will contain to a greater or lesser extent, depending on the material, all of the intervals used to create musical systems of expression. The origins of music and harmony are found in the very fabric of the physical World; could this be built into the foundation of a DAW?

Harmonic Divisions of a String



From the cycle of 5ths the 12 keys found in western music are derived.

The roman numeral numbering system for chords and the simplified version known as the Nashville chord system, show a songs harmonic structure regardless of key.

Much western music is based around chord I, chord IV and chord V of any given key.

In the key of C major, chord I would be a C major chord, chord IV an F major chord and chord V a G major chord. The root note of chord I (the tonic chord) is the tonic or fundamental pitch of the scale.

Each note in the diatonic scale functions according to its relationship with the tonic. Sounded or not, the tonic is the basis from which the qualitative emotive experience of melodies and chords within a composition are felt by the listener.

It is interesting to note that the very best engineers work at the feeling level. They mix, for example, in a way that moves and emotionally connects the listener to the music.

The Qualities of the intervals

Each interval found in the overtone series has a qualitative nature and evokes certain feelings within the listener.

For examples:-

Qualities of the 5th –Balanced, open, centred.

Qualities of the 7th -Highest degree of tension, scintillating, wants to propel the music forward.

Qualities of the 4th – Hard, clear, wide awake.

Harmonic Chord Track Intelligent Harmonic Detection

Information obtained from advanced analysis of the song's harmonic structure, and the unique configuration of partials that make up each sound, will be available to the control circuits of a new plug-in format. The 'harmonic chord track' representing this underlying analysis will show the key and chord structure of the composition as well as, brief modulations and key changes.

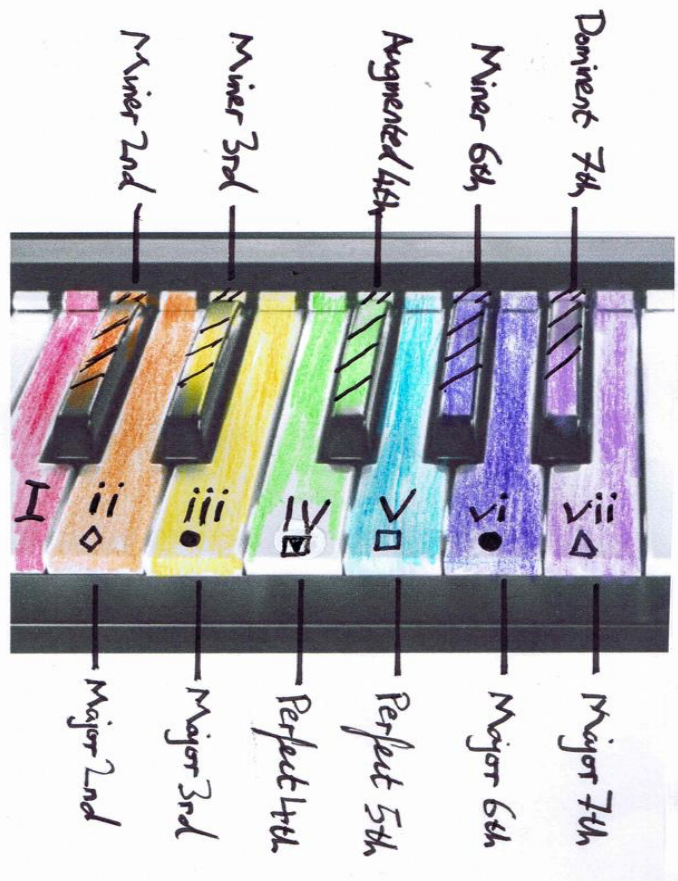


Through the analysis of individual audio tracks, the AI machine learning algorithms will create a detailed map of the audio. It will know that the overtone structure of a piano for example is very different from a cello and thus be able to apply the harmonic processing in a way that was effective for any given sound.

The new IHC (Intelligent Harmonic Core) plug-in format will 'read' in real time, both the overall harmonic structural information and the individual harmonic map of each sound.

For simplicity most of the following examples are in the key of C major. The system will however work for all keys.

Each harmonic interval and chord (in relation to song key) will be assigned a colour and a roman numeral.



The colours with slanted lines represent the augmented, minor and dominant intervals.

IMPORTANT: -The roman numerals and colours represent both the chord number, within the chordal structure, and harmonic intervals in relation to the tonic of any given key.

Focusing on harmonic chord structure and intervals in relation to the tonic, represented by colours and roman numerals, as opposed to chord and note names, will make the system universally understandable for all keys; thus allowing the composer to see and modify the underlying harmonic building blocks of music quickly and intuitively.

This is not a dumbed down representation of music theory, more a way of showing its inherent complexity in a way that will make it immediately accessible, thus opening up new creative possibilities.

Chord and note names will also be shown within the more universal system.

Intelligent Harmonic Core (IHC) Plug-ins

A new era of AI based audio processing tools has already begun but up until now the plugins work on their own, disconnected from the DAW that hosts them.

Dulfuss: - An EQ plug-in that performs hundreds of highly complex signal adjustments per second with just a few simple controls.

<https://www.soundtheory.com/home>

Sound Radix Surfer EQ: - A pitch tracking equaliser plug-in that tracks a monophonic instrument or vocal, and moves the frequency bands selected for processing with the music.

<https://www.soundradix.com/products/surfer-eq>

Sonible smart EQ2: - A basic AI adapts the processing to the characteristics of the signal that is to be processed.

<https://www.sonible.com/smarteq2>

Melodyne: - Aspects of the proposed system have already been implemented in melodyne. A new integration will open up unheard of creative possibilities.

<https://www.celemony.com/en/melodyne/what-can-melodyne-do>

Harmonic Volume Control

It will be possible to adjust the volume level of the partials that make up sounds, in relation to the harmonic progression of a song.

For example: -

A rock track with a popular verse/chorus chord structure lacks contrast between the two sections. Using the harmonic volume control set to **key mode**, the more uplifting qualities of the 5th and 4th intervals could be emphasised in the chorus sections. The qualities of the 2nd and 7th could be brought out more in the verses. The partials related to the intervals mentioned would be boosted, in reference to the tonic note of the chorus and verses key signature, thus affecting the mood or feeling of each section.

iHVC HARMONIC VOLUME CONTROL								KEY	CHORD	CUSTOM
LINK	I	ii	iii	IV	V	VI	vii			
<input type="checkbox"/>	Auto	Auto	Auto	Auto	Auto			Number of partials		
<input type="checkbox"/>	⊖	⊖	⊖	⊖	⊖	⊖	⊖	Overtone/Undertone		
<input type="checkbox"/>	⊖	⊖	⊖	⊖	⊖	⊖	⊖	Phase Shift		
								Mid <input checked="" type="checkbox"/> Side		
							Side Chain <input type="checkbox"/>			

Each plug-in will have an option to 'follow' either key, chord or a custom setting.

Key- In this mode the harmonic controls work from, and process the audio, in relation to the tonic. For example, pulling down the blue (V) fader would reduce harmonics connected with the interval of the 5th for all chords or melodic notes on the audio track chosen for processing.

Chord - In this mode the changing chord structure would be the basis from which processing takes place. Reducing the red (I) fader will pull down the root note of each chord in the chord sequence. Boosting the yellow fader will increase the volume of the major third interval note found in any major chord. For example, if chord one (C major) was playing in the key of C major it would affect the E note of the chord.

Selecting a minor third (yellow with black lines) for processing will give control of the minor third interval note found in any minor chord. For example, if chord two (D minor) was playing in the key of C major it would affect the F note of the chord.

Within a chord the interval of the third is important as it determines whether a chord is major or minor. In the above plug-in illustration only a major third volume control is shown, adding a fader for the minor third interval would facilitate the modification of both the minor and major chords within the sequence.

Number of Partial-

Auto: In **chord** mode the selected interval note, and its associated partials will be affected.

Numbers: A setting of 1 will just affect the fundamental frequency of the selected interval note of each chord, as the plug-in control pot increased, more harmonic partials would be affected, beyond a certain point the fundamental will be steadily reduced, then, just the partials affected.

Overtone/Undertone- This control will be a bit like a harmonic exciter. A positive value could generate richer overtone partials; a negative value would artificially create undertone partials.

Thanks to the underlying AI, the user will be able to achieve their desired musical result in a creative way, using just a few simple and understandable controls. The advanced theoretical and psychoacoustic knowledge that the AI will use for processing, will in the most part be invisible.

Harmonic Tuner

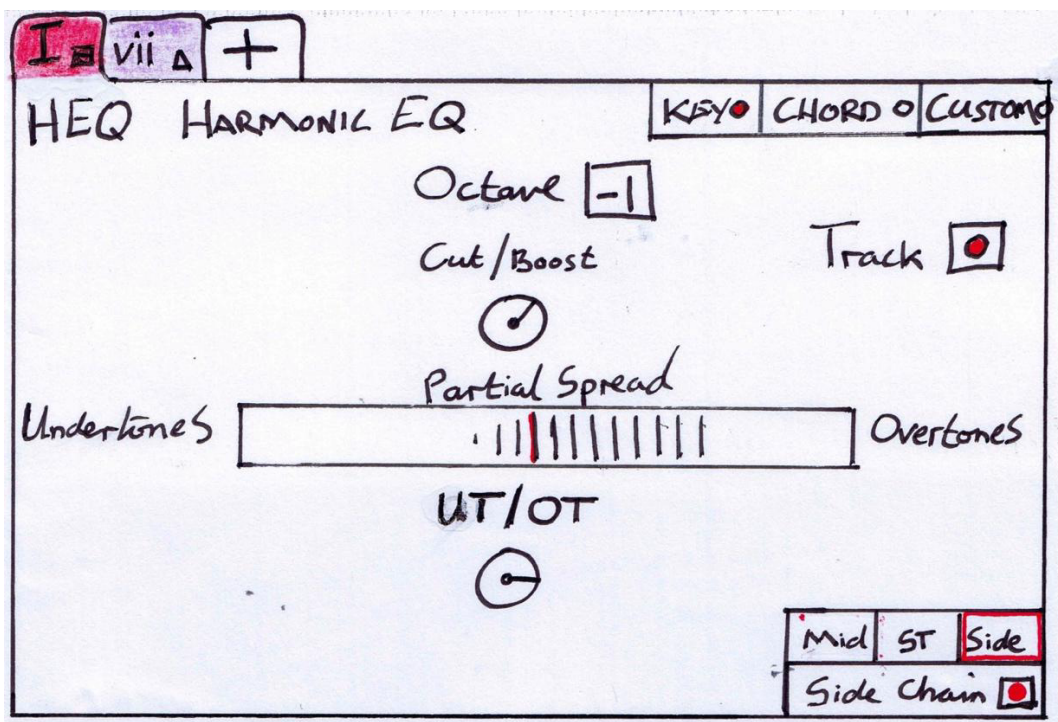
The harmonic tuner will be able to both tune the overtones of any given sound in relation to the fundamental, or tune the overtones of a sound to an external reference, via a side chain input.

For example, an 808 bass drum is playing the lower part of a bass line, it is layered with a bass sound richer in upper tone colour than the 808. Through the side chain input the 808s overtones could be tuned to that of the layered bass or vice versa.

Harmonic EQ

The harmonic EQ will make it possible to boost and cut partials related to interval qualities, whilst automatically tracking the harmonic structure of a song.

A mid and side capability will open up some most interesting possibilities. For example, in chord mode, imagine being able to boost elements of the 5th interval note of the playing chord in the (mid) mono part of the sound and elements of the 7th interval note of the chord in the stereo (side) part.



Harmonic Delay

With the harmonic delay it will be possible to create, for example, a quarter note delay for a single harmonic. In the example below the 5th, 3rd, and dominant 7th interval notes of the presently playing chord would be delayed.

A reggae guitar chop is playing a simple VI, IV, V, I chord progression. When playing chord IV, the delay would sound only the 5th interval note of the F chord (C). (remember we are in C major) When playing chord VI, it would sound just the 5th interval note (E) of the A minor chord and so on...

Adding a delay that just sounded the vii and iii interval notes would create a jazzier vibe for example.

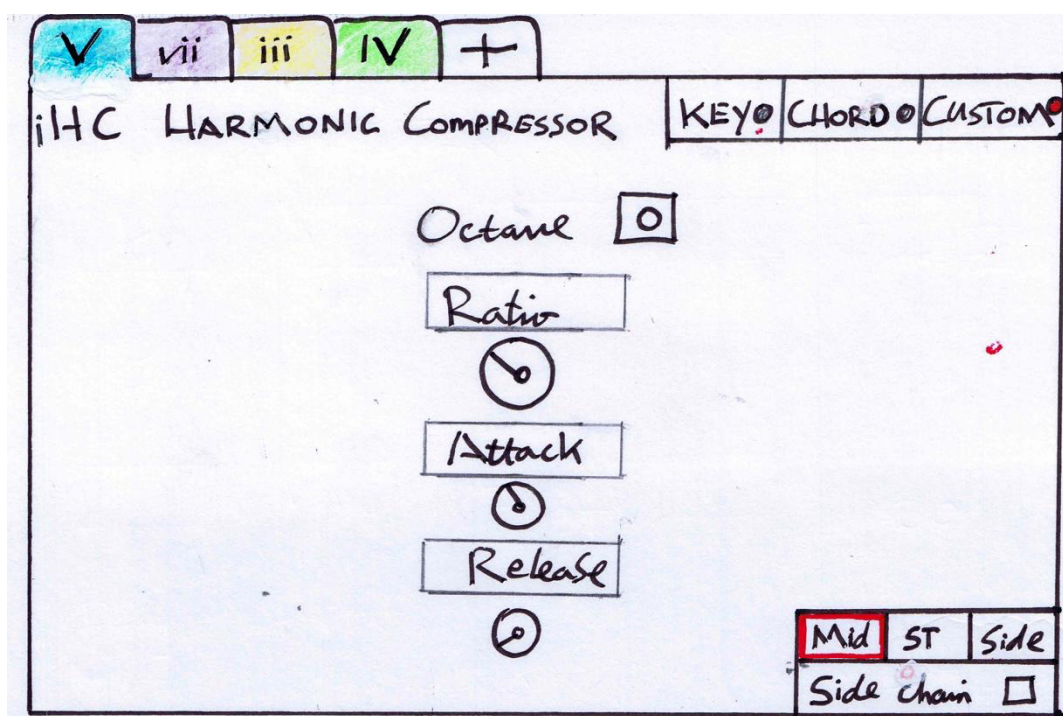
iHD HARMONIC DELAY				KEY <input type="radio"/>	CHORD <input checked="" type="radio"/>	CUSTOM <input type="radio"/>
<input type="text" value="1/4"/>	<input type="text" value="V"/>	<input type="text" value="+10"/>	<input type="text" value=" "/>	<input type="text" value="40"/>	<input type="radio"/>	Interval
<input type="text" value="1/4"/>	<input type="text" value="iii"/>	<input type="text" value="+6"/>	<input type="text" value=" "/>	<input type="text" value="10"/>	<input checked="" type="radio"/>	
<input type="text" value="40ms"/>	<input type="text" value="vii"/>	<input type="text" value="-6"/>	<input type="text" value=" "/>	<input type="text" value="30"/>	<input type="radio"/>	
Delay	Interval	Feedback	Partials	Filter		
				Mid <input type="checkbox"/>	Side <input checked="" type="checkbox"/>	
				Side Drain <input type="checkbox"/>		

In key mode the delay would sound harmonics related to the chosen interval in relation to the tonic.

Harmonic Compressor

It will become possible to compress the individual building blocks that make up sound.

For example, just the fundamental frequency of each note in a bass part could be compressed, or if side chained from the kick drum, just those frequencies could be ducked. Thus, reducing overlapping energy draining bass issues with little change in the perceived character of the bass sound.



Harmonic Saturation

It would be possible to saturate just the overtones related to the changing chord sequence of a song.

Harmonic Sampler

The harmonic sampler will split the partials that make up any sound across the keyboard. It will then be possible to play all the keys at once for full spectral reproduction, or a combination of keys for 'partial' combinations. The information from the harmonic chord track could be used to trigger just the partials related to the harmonics of the currently playing chord.

A special platform, utilising ultra high sampling rates, in order to reduce any artefacts introduced as the sounds are split into their spectral components is being developed.

Melodic components

Every note apart from a sine wave is made up from combinations of partials, some of which correspond to intervals related to the tonic. When working with single note melodies the system could modify the partials related to the interval qualities selected for processing.

Compositional Feedback

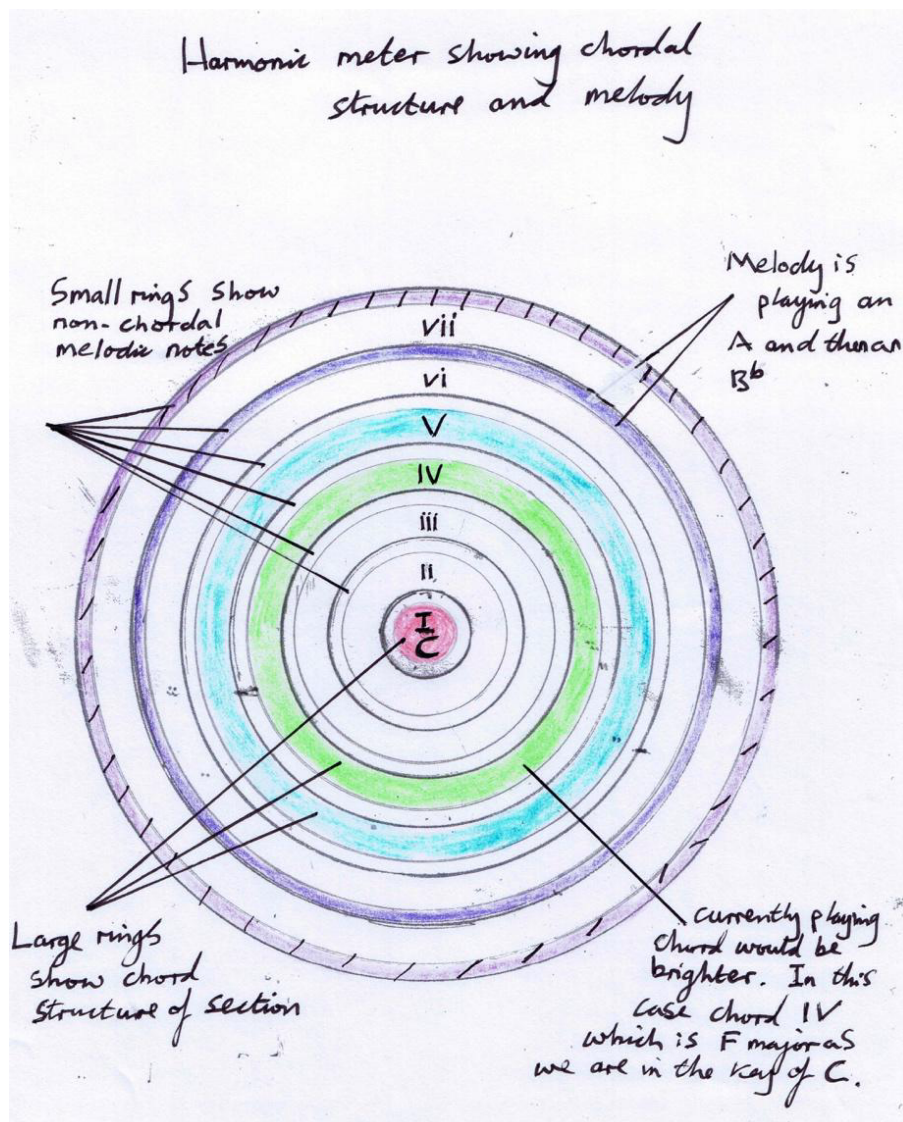
The data from the advanced analyse of the song and its components will be used for compositional tools.

Harmonic Arrangement meter

At a glance, the meter will show for any particular section, the interval qualities it contained. For example, a chorus from a standard commercial pop song would likely display mostly red, green and blue colours. (from chords I IV and V)

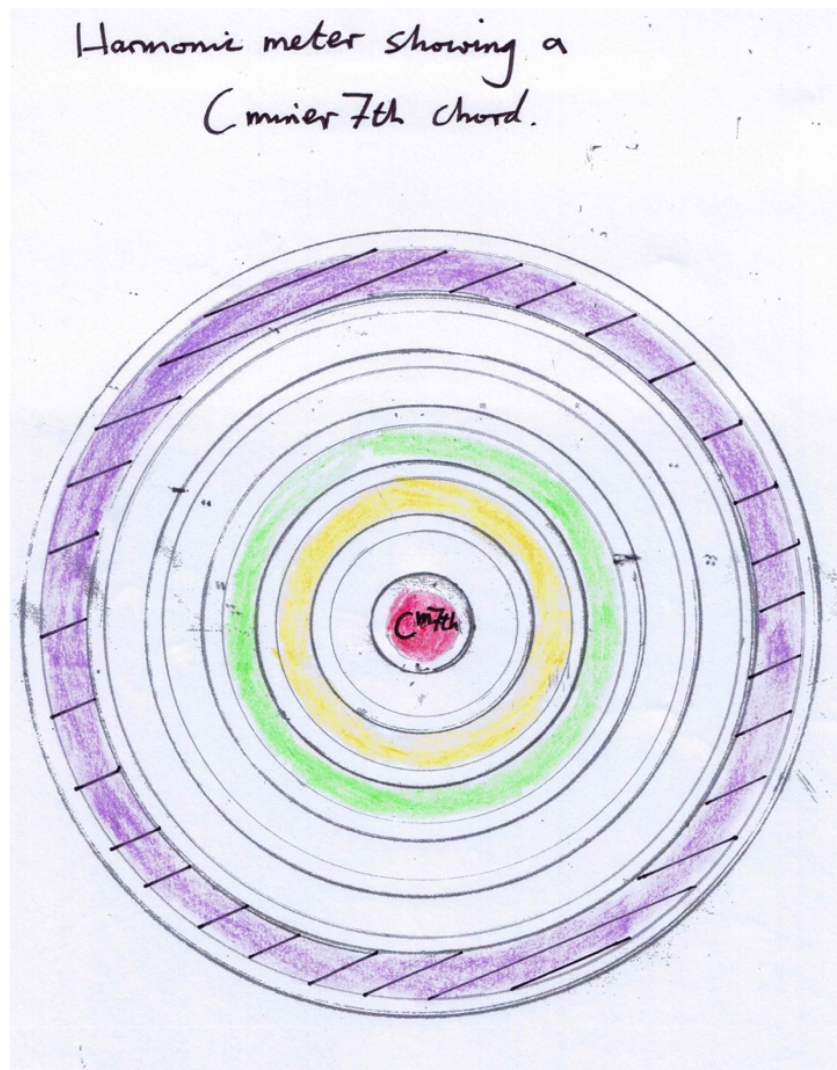
A jazz piece would display more yellow, indigo and violet shades. (from chords ii, VI and vii)

The meter below shows a chorus section using a I, IV, V chord progression. Two notes of a melody are also shown on the thinner rings.



Harmonic Chord Meter

The chord meter will respond to live input or recorded information. It will show chordal information on the large rings, and melodic notes on the thinner rings. For example, it could show the harmonic colour of a chord being played by the left hand and how a melody being played by the right hand related to it.



As you compose or improvise, the DAW, knowing what key you are in, will display, using colour, which harmonic shape or feeling you are creating. A slow decay speed setting, of the coloured rings, will allow whole sections to be visualised.

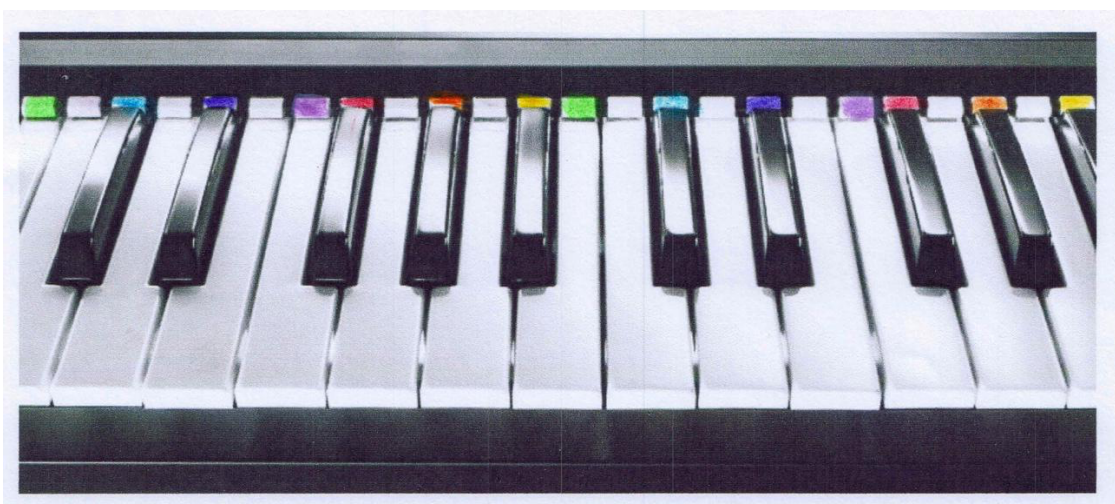
Controllers

Newly developed controllers such as keyboards or pads will show the harmonic relationship of the notes within a key to the tonic. The controller 'display' will adjust in real time to key changes etc.

Keyboard Showing the Key of C major



Keyboard Showing the Key of F# major



For the harmonic sampler, the keys will show interval colours related to a sounds unique configuration of partials.

Conclusion

It is as if music theory and the scientific method used to understand it, have become separate and disconnected from music itself. Without this disconnect the depth of intellectual understanding we have achieved, would, perhaps, not have been possible. Studio One 8 will reunite our hard won understanding once again with its source, music.

By connecting the complexities of music theory and engineering, to the feeling qualities that music represents, the DAW will become inherently musical.

High Fidelity Mode

Studio one 8 will also have a new high fidelity mode that will directly send the audio data to the lowest level in CoreAudio, bypassing the driver audio mixer and the format converter.

Play a finished mastered track in a DAW such as Logic, Studio one, Cubase, Protools, Reaper etc or in a dedicated music player such as Audivana, itunes, Amarra etc and it will, in each case sound different, due to the way in which the audio engine of the particular piece of software is coded.

This is the case when zero processing or gain change is applied.

A study of modern computer technology, microprocessors, memory, etc; reveals that they require error correction circuits in order to function. The way that code interacts with these circuits affects sound quality. Digital technology is not perfect, if it were it would not need error correction!

Direct Mode: In this mode Studio One 8 will bypasses completely CoreAudio, including its low- level layers. This enables a further shorter audio signal path for better sound quality, and gives the possibility to enable Integer Mode.

Integer mode: In this mode Studio One 8 will directly send the audio data to the lowest level in CoreAudio, bypassing the driver audio mixer and the format converter. This enables to achievement of higher sound quality.

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