Kepler’s Harmonies

User Manual

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Introduction

“Kepler - a generator for musical orbits” is a distraction, a musical educational tool, a source of visual performance guidance for contemporary music groups needing to use video conferencing, a versatile input of note groups into electronic synthesis, and has potential for giving new ideas on harmonic sequence to the composer or performer. The Windows application and this manual are innovative in showing the potential of ET19, a temperament with 19 equally-spaced pitches in the octave, with no special tuning files or equipment, not even a hardware synth. If you do have an external hardware synth, however, the application will onlock further possibilities for making original loops and ever-changing stochastic sequences.

This manual has five main parts, going into increasing depth:

1) How to instal and start Kepler’s Harmonies
2) Quick introduction to the parts of the screen
3) The main uses of this application
4) Hugo, the musical fabric designer
5) A more comprehensive guide to the sound playback

1) Installation and startup

a) Installation

Simply unzip the file deploy.zip and click on keplersounds.exe. At the time of writing, this application will only function on the Microsoft Windows(TM) operating system.

b) Startup

When Kepler’s Harmonies first launches, you should hear on your computer audio a clarinet ensemble playing a never-ending and ever-changing sequence of chords. A little blue circle representing the Earth should be moving around, on a grid which represents musical space - a Tonnetz (“tone-net”) - in a large jiggly circle.

To speed up the moves, drag to the right the slider next to the red dot at the top; to make larger moves each time, drag to the right the slider opposite the blue dot, and to change the sense of rotation of the jiggly orbit, click once on the blue dot. In the vignette, with the black background, on the top right you will see the history of where the Earth has been. Click on the REWIND button at top right to reset that display and start a new orbit. Clicking on the colourful triangle will change the balance of the harmonies played, with the shares shown in a footnote to the window. If this all works, you have a functioning application. There are many more features and possibilities...

2) The standard Kepler’s Harmonies screen

To explore the parts of this application without distraction from a moving orbit, first press STOP, the red button on the top right. You can do this at any time and it will stop the movement of the blue ‘Earth’ musical cursor, and the sound. Pressing the green GO-ON button will start things moving and playing again if you are operating an orbit or harmonic cycle.

With motion stopped, you can click with the mouse, or press a touch screen anywhere in the central area, and on releasing the pressure a chord will play. The grid that looks like a shoe rack is called the Tonnetz. The colourful triangle to its right is called a Discordiser. On either side of it are the Playing Prompts, on the left for concert pitch, and on the right for a transposing instrument. Immediately below those are the Music Controls, and below that again two information lines, the first giving quite technical information on the last action, and right at the bottom (the Window Status Bar), a footnote that tries to give further information or a hint on what you did or might do next.

Looking at the top of the Window:

- there are a number of menus, and then
- below that the Orbit Dynamic controls to manage speed of update and rotation,
- to their right two Orbit Geometry sliders and a spinner (which start greyed out) to manage the geometry of a ‘launch’,
- to the right of that a Vignette which records the history of your moves on the Tonnetz since the last rewind, and then
- on the right of that the Stop/Rewind/Go-on buttons you already used.

You can close down the application at any time by clicking on the x sign in the top right corner.
The - symbol will minimise it, leaving any sound playing.

There is no useful way to resize the window, so to make it larger on your screen you would need to reduce the screen resolution with the Windows display settings. There is no built-in volume control, so again, use the operating system for that: all sounds are made by the MIDI system (though you are able to select an external MIDI synth if you have one).

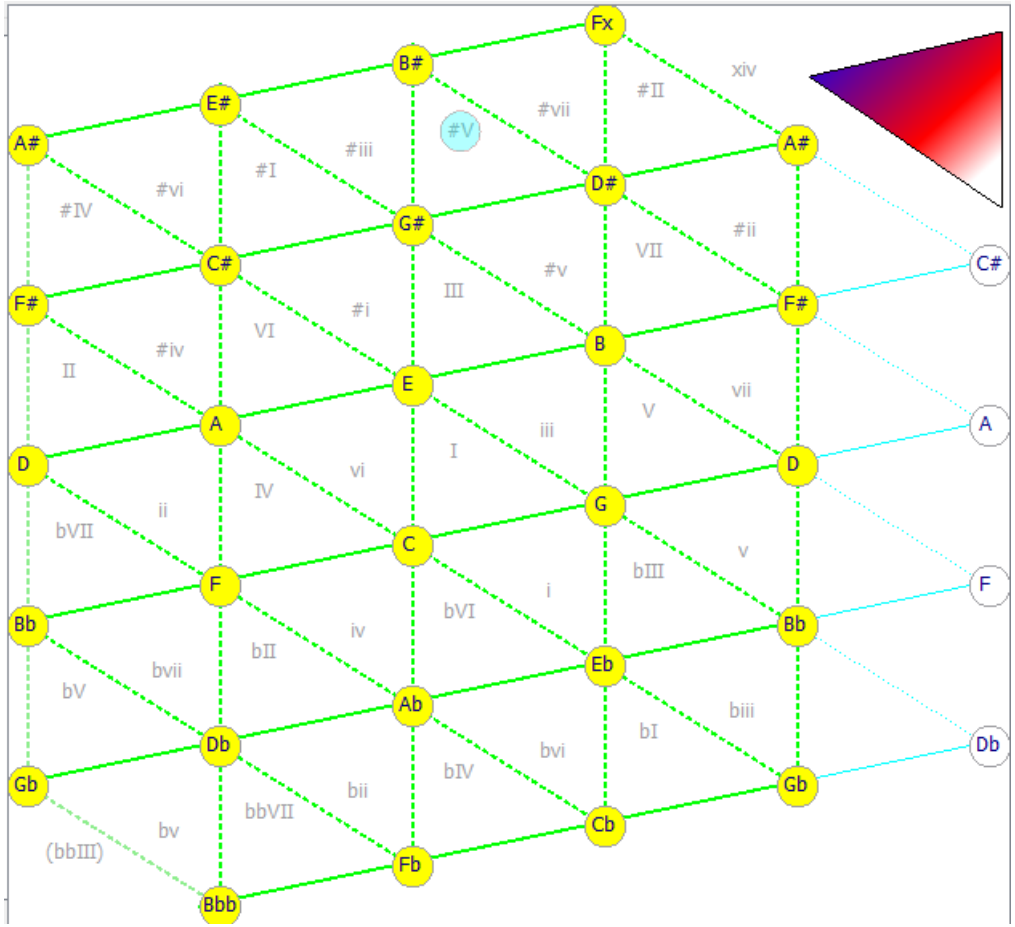
Now to explain the parts of the screen in more detail, using a few of the controls as we go along. If you are happy to experiment, which can do no damage, then the following section (3) might be your next reading, to take a high level view of how this can be used. If in your experiments a new window opens up - 'Hugo the musical fabric designer' - you can just close it for now: section 4 explains its function in detail.

a) The Tonnetz in 12 and in 19 steps to the octave

The Tonnetz displays a grid of notes in yellow circles, and optionally chord symbols in the white spaces between them for triads. There may be a separate video demonstrating this application, from E Mids CoMA, on the history and detailed layout of the Tonnetz. However, the important points for using Kepler's Harmonies are:

- the notes are just for orientation; clicking will always play a chord and move the Earth symbol to the chord location
- there are four types of chord available for orbits and manually clicking: major triads with triangles pointing up, minor triads with triangles pointing down, major seventh (M3M7) chords on the sloping dotted lines, and minor seventh (m3m7) chords on the vertical dotted lines. If you click on a chord symbol expecting a triad, and instead get a tetrad, try clicking closer to the middle of the solid boundary line of that triangle: by using the Discordiser you must have extended the 'capture zone' of one of the dotted line seventh chords over the chord label.

The Tonnetz wraps around from left to right, so if you click on an m3m7 all the way to the left of the grid, the chord position that will be shown is the one to the right opposite. For example, clicking on the dotted line between Bb and D will take you to a position where the root of the minor seventh chord, G can also be seen, and the seventh of the chord F appears as a ghost to the right. Triads that include ghost notes can't be selected as that would duplicate a triad on the left. You may notice that, as on a standard piano, in 12-tone equal temperament there is no difference between the sound of a G# and an Ab. Compare, for example, the sounds of the chord G#B#D# (labelled #V) and AbCEb (labelled bVI) - identical.

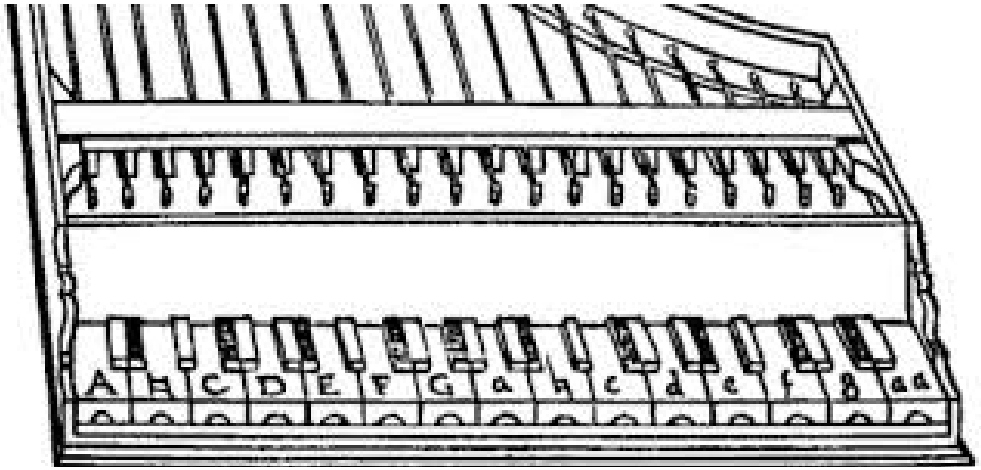


Picture of Tonnetz here with Earth on #V

Now for the exciting bit! When the application starts up it will be using a conventional scale with twelve notes to the octave, equally spaced - ET12 (12-note equal temperament). If you click on the Temperament menu at the top, and then select '19-ET' (ET19 in this manual), a little fanfare will announce that we are now using 19 notes to the octave. That will then fully use this five-row Tonnetz. The chord #V is slightly flatter (in fact, a third of a tone) than bVI. Every chord on the Tonnetz will now be distinct. Only if you go just outside, to the top right, and click on xiv (which would be FxA#Cx), do you find a chord which sounds the same as one already on the Tonnetz: bv at the bottom left, sounding GbBbbDb. Those are 'enharmonic' in ET19. If you haven't changed selections from any other menus at this point, clicking GO-ON

will restart a jittery orbit that takes you on a journey round the sounds of ET19 (known since at least the time of Vicentino around 1600 and also known as ‘third-comma meantone’). Conventional notation works perfectly for ET19; you just have to remember (as even Mozart, and indeed Mahler, would have expected) that Db is a sharper note than C#. The sound of a minor third C to Eb is acoustically purer in ET19, and the major third C to E no worse.

String players are still taught to play their C# in tune with their open E, and their Db in tune with a wind Bb and hence as a slightly higher note. Major thirds on an equally tempered keyboard are perceptibly too wide, relative to the acoustically pure frequency ratio of 5:4. In ET19 there is only a third of a tone between an Eb and an E - use a full semitone, and one of those intervals with the note C is bound to sound out of tune; we just get used to it, or use lots of vibrato. The book ‘How equal temperament ruined harmony, and why you should care’ by Ross W Duffin (W. W Norton, 2007) makes this case with passion!



Vicentino’s keyboard with split keys e.g. A#, Bb and additional B#/Cb and E#/Fb
Woodcut showing a ‘Cimbalo cromatico’ from Zarlino

The computer keyboard shortcuts for temperament, when the menus are in focus, are <Alt p> then either <Alt 2> for ET12 or <Alt 9> for ET19. If menu text is showing grey then first click or press in the top Menu region of the screen. After pressing the Alt key, you will see the available shortcut symbols on the menu, at the current level of indent, as underlined characters.

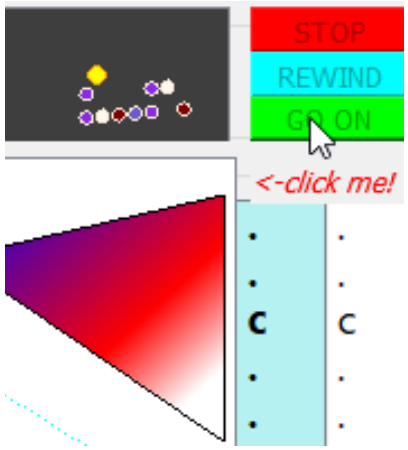
The Tonnetz also wraps around from top to bottom in ET19, with a kink so that E# is the same as Fb - one of the extra black keys on Vicentino’s keyboard. If you happen to see the ‘shoe-rack’ in 3 dimensions, then this is just a step from front to back. In ET12, only the middle three rows are strictly needed since (for example) G# is enharmonic with Ab, three rows directly below. The reason for this is that three major thirds (each four semitones) make an octave of 12 semitones; while in ET19, each major third is six one-third tones, so three in sequence make 18 steps, one step less than a ET19 octave: C E G# B#==Cb. To hear the difference of one third of a tone between D# and Eb, while in ET19 click first on chord #vii on the top row and bI on the bottom row. As B#=Cb and Fx=Gb, you hear only a minor third moving to a major one (the ‘Parallel’ transition from minor to major, or Tierce de Picardie, in the key of Cb).

b) Vignette

This is a secondary information display to show the history of your movements on the Tonnetz. In test modes, it will show in different colours the type of chords that the orbit movement, or manual clicks, snapped to. In the Launch mode it will show the exact calculated orbits of the Earth and the Sputnik before that magnetic snapping. However, in Launch mode it will not show the history of any manual clicks while you have the orbit stopped. The Vignette clears when switching between Test and Launch modes, and also when you Rewind.

c) Discordiser

The colourful triangle offers an approximate way to vary the fractions of triads/ m3m7/M3M7 chords by changing the relative sizes of the invisible ‘hot zones’ - if you like, ‘magnetic strips’ - that attract a randomly selected point on the Tonnetz towards one of the dotted lines or the centre of a triad triangle. You can click anywhere on the Discordiser triangle and the information display footnote will show the relative areas of those strips. Towards white increases share of triads up to about three-quarters, towards blue favours m3m7 chords, and towards red favours M3M7 chords; but there is always a contribution from each type of chord, for orbit variety.



Vignette showing Discordiser below

d) Playing Prompts

These differ between temperaments so if you are currently playing in ET19, use the Temperament menu to return to ET12. STOP any continuing orbits. Then explore how the playing prompts to left and right of the Tonnetz appear, for different manual chord selections (click or press inside the Tonnetz).

The left side displays the note names to be played, or improvised around, for the instruments tuned in C, within an ensemble using this as an electronic cue. In ET12 the notes cover a range of two octaves, with pitch increasing upwards and dots on the semitones that are not being played. In ET19 they cover only one octave, You have to play a new chord before the playing prompts will re-appear, after a change of temperament.

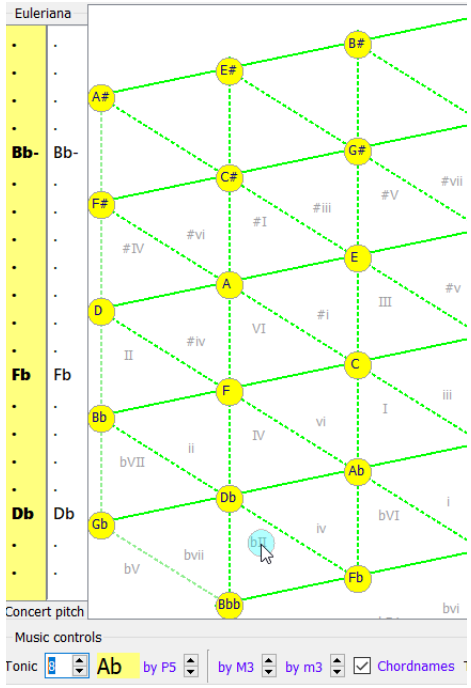
The right side displays the note names used by a transposing instrument, by default in Bb. Use the little spinner to the left of 'Bb', that starts on 10, to change this if you transpose by a different amount. That immediately changes the name of the tonic note, with a blue background, to its right. The note names will be different, the next time you click on a chord.

The white regions on either side will show the notes that are coming up next - we will see this when we set up orbits (section 3 below) or sequences of transitions between chords (section 4).

When you are using ET19 (chosen from the Temperament menu) you will see one dot every third-tone. There is room to display only one octave (which may then require a transposed chord to appear), even though notes chosen from two octaves will actually sound (in root position). The font will be slightly larger.

In C major the ET19 scale is represented most simply as:
C C# Db D D# Eb E E# F F# Gb G G# Ab A A# Bb B B# C'
and each successive note is higher by a third of an ET12 tone, with the intervals E to F and B to C consisting of two one-third tone steps. This makes the intervals C to E, and G to B, narrower even than in just intonation, close to Joachim's playing and a lot narrower than the 'expressive' (sharp) leading tones that Sarasate introduced. Generally, familiar intervals from the ET12 scale sound more restful when played in ET19. (NB for technical reasons and to reduce surprises, in this implementation limited by the relatively coarse pitch shifts of the Microsoft GM synth, the pitch of E in ET19 is set slightly higher than it should strictly be; you will certainly hear the unexpectedly low B in the G major chord, however).

In ET19, for chords in the lower part of the Tonnetz, especially when the tonic is in a 'flat key', you will see E# notated as Fb, the same pitch in ET19, and Bb- instead of A#. Double flats and double sharps take you only two-thirds of the way to the next whole tone.



ET19 playing prompt for Bbbmaj chord

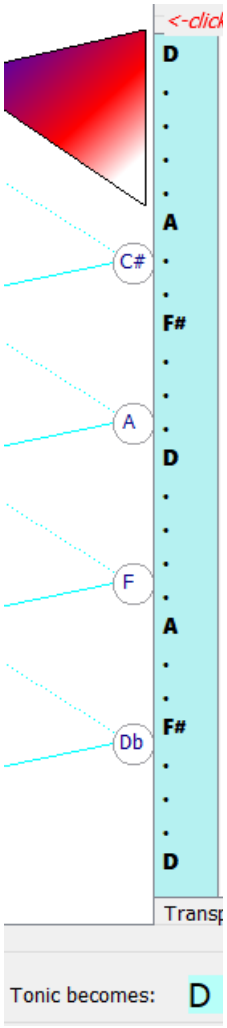
There are a couple of compromises in the display for ET19 and very flat notated keys to fit the column:
- instead of Bbb, which has wide characters, the name Bb- will appear instead
- the more unusual Abb on the transposing note display appears Ab- (if you pick an already 'flat' chord including Fb, which has to be spelt Abb for an instrument in A).

e) Music Controls

Still while on STOP, in temperament ET12 and clicking on one chord at a time, we explore the music controls below the Tonnetz:

The transposing spinner affects only the playing prompts. If you prefer to type a number rather than use the spinner then this control (also the tonic spinner on the left) accepts only the number 0 to 11, representing the different chromatic levels up from C, a semitone at a time. Generally, with a tonic shown as for a sharp key, the display of individual notes will favour sharps over flats where there is a choice - but this is not precise, nor is there any distinction between minor and major keys. The choices of chord notes on the Tonnetz are independent of any key signature. Remember that the Playing Prompts display only updates when you play, or re-sound, a chord. Here as an example, for an instrument transposing to Bb the chord of C major will be displayed as a D major chord. This will allow a full two octaves appear above the D, as it does above the C in concert pitch:

Chord of C major shown as D major on blue playing prompt, for an instrument in Bb



A tick in the middle of the music controls shows that chord (triad) names are shown in the centre of triangles. You can untick that to remove all the chord names. We will need them shown to explore the other controls, however. Reticking will display the chord symbols in the last place you put them. They are movable...
If you already changed the tonic, now move back to C. Then to see the working of the other music controls, first spin the P5 control: the arrow up moves the key up a perfect fifth at a time in the cycle of fifths (up to a limit of C#); conversely the arrow down moves you down, with a limit (on the flat side) of Ab. As you change this, keeping your eye on the tonic chord I in the centre of the Tonnetz, you will see the chord labelling move bodily from side to side, and then stepping up or down the rows rather like an old-fashioned typewriter with a row advance (ding!). Not all the triangles will then be labelled, but even in remoter keys such as C# and Ab you will see the I in the middle of the major triad above the tonic. The label for the chord CEG becomes whatever harmony this becomes in the new key - the chord III in Ab, for example, bIII in A, and so on. This might be a useful way for jazz players to learn the relationships between chord symbols, keys and the notes to be played. These labels are, however, always for concert pitch, not what the transposing instrument is playing from (unless you set the 'Transposing to' control to 0, C, of course, when both yellow and blue playing prompts will show the same notes).

Just the same chord symbol movements, but in a different order, are available by setting the tonic level number, using its spinner, or typing in, directly. For example, tonic level 2 is D, two semitones up from C, and will show the same chords as moving P5 by two steps from C to G to D. You can mix and match use of those two controls, remembering only that spinning P5 up from C# (level 1 on the Tonic spinner) or down from Ab (level 8) will not be able to change anything. We only have twelve tonic levels to play with and have in these Music Controls to assign each a notation letter, to keep things as simple as possible.

The tonic and P5 controls work in exactly the same way in ET19; exotic keys such as D# major that would be needed in ET19 for a complete closed cycle of key changes by fifths (think: 'the 76 Preludes and Fugues'!) are not available in these music controls, but the tonic chord of that key is available on the Tonnetz at the top right. Any higher in the cycle of fifths and you use enharmonic equivalents on the Tonnetz itself, so instead of sounding the Fx minor chord, which would be off the Tonnetz boundary at the top right, you can use the Gb minor chord at the bottom left of the Tonnetz which sounds exactly the same in ET19. Even at the extremes of the Tonnetz where triangles are cropped, if you click on the dotted line for a major seventh tetrad, at extreme top right of the Tonnetz, the D# major seventh chord D#FxA#Cx is sounded, the same as, D#FxA#Db, or as EbbGbBbbDb the bbIIImaj7 chord in the key of C (if it does not sound the same, you might still be performing in ET12 - look at the Temperament menu!). That is at the extreme lower left of the Tonnetz, and these two oblique edges are therefore the 'wallpaper joins' in ET19. In ET19 a 'major seventh' is by convention 17, not 18, third-tone steps above the root (ie. C to B, not C to Cb=B#), so that the major third above the dominant (fifth of the chord) is acoustically acceptable.

The spinner 'by M3' moves chord labels directly up or down. In ET12 it will continue indefinitely because B# = C in pitch and so C E G# C' is a closed cycle (as are C# F A C#', D F# Bb D' and Eb G B D#'). In ET19 we are limited in this version of the application to one step up or down from tonic C, because G# and Ab are not the same note.

The spinner 'by m3' moves the chord labels by minor thirds, obliquely parallel to the dotted line. In ET12 it will continue indefinitely because C Eb F# A C' and the circuits starting on C# and D are each a closed cycle. Hence you can translate diagonally on the Tonnetz; the ET12 'wallpaper' has no kinks. In ET19 this spinner is limited at present to a choice of C upwards to Eb, or downwards to A and then F# , because a minor third down from F# in ET19 is the note D#, and upwards from Eb is Gb: remember that in ET19, apart from E#=Fb and B#=Cb, there are no enharmonic equivalents within the single flats and sharps. In fact the different note names we are so used to for the same keyboard 'black key' actually make sense when you remember that before the Bachs and even in their time, black keys were often split...

The fastest way to reset the chord symbols to CEG = I is to type the number 0 when the Tonic level is selected (click and drag over the existing number). Keyboard up and down arrows will also then be able

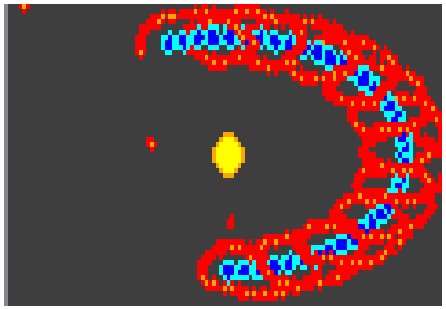
to change the level, and the <Page Down> key returns you to 0. When the Transposing to spinner is focussed, the <Page Up> key takes you to level 10, Bb, which might be a useful short-cut for Bb transposing instruments needing to adjust their 'Transposing to' level quickly (e.g. for a brace of clarinets).

f) Orbit Controls

The inspiration for "Kepler's Harmonies" was a suggestion from Joe Davies, the director of the Contemporary Music for All (CoMA) ensemble in the East Midlands, that during the lockdown period of the Covid-19 pandemic, we write and play music, in one of our sessions (October 2020), that commemorates the 63rd anniversary of the launch of the Sputnik satellite - which was Red.

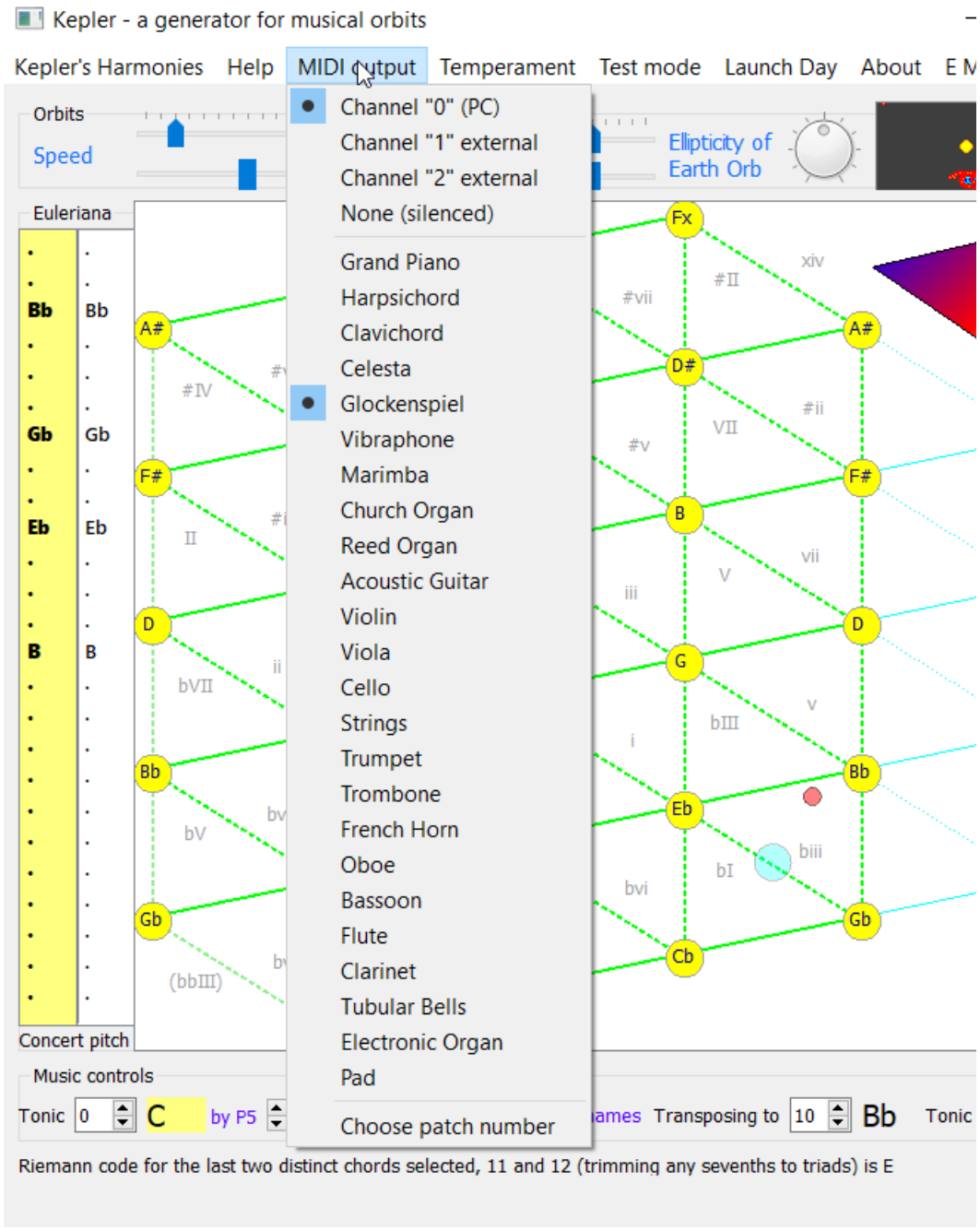
So to go straight to 'Launch' day and see how all the Orbit Controls work, first select on the top menu 'Launch Day' and then the submenu 'Launch!'. You can do that by clicking, pressing, or, with the Menu zone focussed (showing menus in black, not grey text) using the keyboard shortcut <Alt L> twice in succession.

Now you will see the blue Earth moving slowly around anticlockwise, magnetically attracted to chords in proportions set by the Discordiser, while the Sputnik orbits it (also anticlockwise). To change the sense of rotation of either object, click on its symbol in the Orbit Controls area. You might want to REWIND so as to see the Vignette display refresh. It has a yellow Sun symbol at its centre, and the combination of circular orbits of the Earth, and the Sputnik round the Earth, makes a spiral 'garland'. The Vignette shows the exact positions before action of the 'magnetic zones' on the Tonnetz. The Sputnik orbits round a point that is the weighted average of the chord presently sounding and the previous and next chords.



The Vignette snail (caterpillar?) trails

While the orbit is going quite slowly round most of the Tonnetz extent is a good time to look at the 'delayed action' of the Playing Prompts. The Earth will sit on the chord that is sounding and the yellow or blue note prompts are the notes to be played now. But the white areas show the note to be played next, and that is the chord that the Earth will jump to next.



The MIDI options, showing also the red Sputnik in orbit round the Earth on Cbmaj7

For small movements on the Tonnetz, only one or two notes will change at a time, and for sustaining instruments the application will tie-over notes that are the same from one chord to the next.

To explore the effect of changing speed controls, it may be clearer to change the MIDI instrument to one that is not sustaining. To do this, click on the MIDI output menu, or if menus are in focus, use the keyboard shortcut <Alt M>. A choice of instruments will appear. Click on 'Celesta' for a gentle introduction... now every calculated movement of the Earth will sound all the notes of a chord, even if the precise movement is not enough to change the chord, or would only change some of the notes. If the orbit takes the Earth outside the Tonnetz region, but still inside the Tonnetz window boundary, the application will continue playing the last chord that was within the Tonnetz until the Earth is back inside its boundary (strictly, inside a 'magnetic' zone that extends a little to the right of the dotted lines bounding the playable Tonnetz).

To change the rate of sampling of Sputnik position, and indirectly the calculation of Earth movements, move rightwards the horizontal slider that is to the left of the red Sputnik symbol. This has a wide range from 1 to 12 so means a slow update rate when at its left extreme. Return it to a faster rate to see easily the effect of the slider to left of the Earth symbol. This changes the angular velocity of the Earth orbit, so increasing it moves round the Tonnetz faster even at a constant setting on the Sputnik slider. The green dots on the Vignette will become further apart.

Moving both sliders to their lowest setting makes the chord sounded by Earth change only once every 10s or so, and then for a sustaining instrument, the evolution of the harmony is positively Brucknerian.

Using speed sliders on the faster side, and remembering to REWIND so the Vignette acts as a guide, let's explore next the remaining orbit geometry controls. These are 'live' only after a Launch. Maybe select a different, sustaining MIDI instrument.'Pad' is rather ethereal, nice for space travel. Why not Temperament ET19 too?! If you want to just watch the movement with sound off, one possible action is to set MIDI output <Alt M> to <Alt s> , silenced, the fourth row down. To get back to playing the instrument last selected, click 'Channel 0' (or 'Channel 1' or even '2' if you have one or more external synths connected). The selections of channel and instrument are independent, on this menu. You are likely to hear a quick fanfare on successfully changing channel, up the entire MIDI range by minor thirds. This has the function of resetting the pitch shifts across MIDI voices in ET19.

The two Orbit Radii controls do the expected things to the orbit radii of Earth (to right of its blue icon) and Sputnik (to right of its red icon). Since we don't want to lose the playing chord for too long at a time, if the Earth position would be outside the screen area (before any magnetic attraction to a chord on the Tonnetz), then the position is simply reflected off the rectangular boundaries of the screen. The Sputnik then tries to rotate in a circular orbit around the weighted Earth position. With the Earth radius at its maximum (12th notch right on the slider) quite pretty border patterns will appear on the Vignette. When the Earth moves close to or just beyond the Tonnetz edge, however, you will hear fermata in the music, especially in the empty wedges to top left or bottom right of the skewed Tonnetz.

For the earth radius at its extreme left setting, a given rate of angular rotation (set with the speed slider on the other side of the Blue Earth icon), will seem to play music slower on a sustaining instrument, simply because it will take longer to move round to the next chord boundary. That is at its most extreme with a symmetrical circular orbit and with the white part of the Discordiser clicked to reduce the size of the magnetic zones next to the dotted lines for seventh chords, so that you are forced to move to triads for most positions. The chord may not change for some minutes, but it will eventually. The moving Sputnik proves that the application has not frozen, and just before the Earth plays a new chord, you should see its notes appear in the white part of the Playing Prompts.

The final Orbits control is the dial to control ellipticity. Unlike Kepler's great discovery, in our application the ellipses remain symmetrical about the centre of the Tonnetz, the centre of the line between C and E. So that the orbits stay generally within the Tonnetz boundary, it is best before using this control to reduce the radius of the Earth orbit to somewhere on the left hand side of that slider. You can REWIND to clear the Vignette at any time to refresh its snail trails of the motion. Moving the dial to the left of centre will make a more horizontal ellipse (perhaps playing a stepwise cycle of fifths), or the right a vertical one which takes the tonality of the chords played (especially perceptible in ET19) much further and faster through the cycle of fifths. Return it to its centre position to make the Earth orbit circular again. When the mouse is over that dial, <Home> and <End> keys rotate it to either end and <Page Up> or <Page Down> move it by half its range, so the combination can always return you to a central setting. Adjust to taste!

In this version of the application the Sputnik is purely a visual decoration and amusement. In a future one, it might play the notes that it hits!

On the Vignette, however, by adjusting the relative Earth motion, it is possible to see ‘resonances’ in the two orbits as repeats in the spiral pattern An observation about the ratios of periodicity of Jupiter’s moons was the source of Kepler’s scientific insight about constant angular momentum of planetary motion, and his astrological theories about the harmony of the spheres, when that insight is applied to note frequency ratios.

In scenarios reached under the Test mode menu, only the Speed sliders are active, any Earth orbit is circular, the Sputnik has fallen into the ocean, and the Earth Orbit Radius is fixed: acting a third of the way up its range (notch 4 of 12, but the slider is greyed out at its last position, and inactive). When changing from Launch, to Test, back to Launch, that slider will remember its previous setting.

g) Menus

Most of the common menu controls will have been tried out by now, if you followed this guide in sequence, but for quick reference the menu hierarchy, with keyboard shortcuts and purpose is:

<Alt K> **K**epler’s harmonies (no need to press the shift key to get K as upper and lower case are treated the same)
    <Alt d> Loa**d** a sequence of neo-Riemannian transitions (“Rie symbols”) from file into the edit row of the Hugo form
    <Alt v> Sa**v**e to file from the Hugo form the currently committed sequence of Rie symbols.

<Alt H> Help
    <Alt h> Where to find help - currently existing only in the form of this User Guide

<Alt M> MIDI output
    <Alt 0> Channel “0” (PC) Use the Microsoft GM Wavetable synth, only 27 years old and still the only one with Windows!
    <Alt 1> Channel “1” external. The secondary synth detected by the operating system, e.g. Yamaha. It is assumed to silence all voices for a given note, so for a sustaining instrument repeated notes are tied over (“Legato”).
    <Alt 2> Channel “2” external. Use whatever is your secondary synth detected by the operating system, e.g. Pianobox. This does not silence all voices for a given note, so all notes ae silenced and then resounded (“Portato”)
    <Alt s> None (**s**ilenced)
    [no shortcut] Grand piano, Harpsichord, etc (defaulting to Clarinet) - see section 5 for comments on choice
    <Alt C> **C**hoose patch number - applicable to an external synth and may use any instrument or arpeggiator. Makes the articulation legato and removes octave boosts.

<Alt p> Tem**p**erament
    <Alt 2> 12-ET 12 notes to the octave, equally spaced (called ET12 in application code; variables start with a letter)
    <Alt 9> 19-ET 19 notes to the octave, equally spaced
    (only visible after re-entry to the Temperament menu, after selection of 19-ET and that will not apply to ET12:
    <Alt - > (minus sign) For sustaining instruments, always hold over tied notes despite side effects on some external synths. Overrides the initial synth setting on Channel “2”.
    <Alt . > (full stop) Even for sustaining instruments, re-sound ‘tied’ notes to avoid side effects on some external synths. Overrides the initial synth setting Channels “0” and “1”, or the effect of choosing a patch by its number.

<Alt T> **T**est mode (see section 3 for details)
    <Alt S> **S**etup start and click
    <Alt J> **J**ittery orbit with snail trail
    <Alt C> **C**eltic knots choose weave below
    <Alt w> Open form to choose the **w**arp and weft explained in section 4 below.

<Alt L> **L**aunch Day
    <Alt L> (again) **L**aunch! Start full operation of deterministic orbits, with no jitter, and fully adjustable geometry

<Alt A> **A**bout
        <Alt a> This **a**pplication: Credits to scientist musicans of the past, and also to a couple of the key people who helped steer this.
        <Alt s> Licen**s**ing. Since this used freeware (from GitHub) and a non-commercial Qt installation, it must be free to use. Code is controlled by LGPLv3: https://www.gnu.org/licenses/lgpl-3.0.txt. No warranty whatsoever is provided or implied. These license terms must be passed on to any further users.

<Alt E> **E** Mids CoMA
    <Alt u> About **u**s - a dropdown with standard text on our group that trialled this, taken from its website.

3) The main uses of this application

The Launch Day orbits described fully above (section 1f) were the initial goal of development, but various intermediate staging points in development have been preserved and can be used as part of the ‘Test mode’ menu. One of these has enjoyed an independent line of development into a fully-fledged system for experimentation with triad sequences using neo-Riemannian theory. Under the Test mode menu, you choose between three main options, the further choice ‘Open form’ offering support to the third of these:

(a) Setup start and click;
(b) Jittery orbit with snail trial;
(c) ‘Celtic knots’ to choose and weave on the Tonnetz a neo-Riemannian transition sequence.

a) Setup start and click

This will stop any timers driving orbits or cycles of chord transition, and allows free choice of single chords anywhere on the Tonnetz (tetrads - seventh chords - as well as triads). The instructions are sent to the Playing Prompts twice in quick succession so that the notes on a white background are the same as those on the coloured ones. The information bar will show a chord number, which was helpful during system development. These count up from zero rightwards and then upwards on the Tonnetz, starting from the silent off-Tonnetz chord labelled bbIII when C is the tonic, which is numbered -1, up to #II which is numbered 75. The two chords to the right of this have numbers reported only in ET19: 76 and 77 whose sounds duplicate numbers 0 and 1.

So with 19 notes to the octave in ET19, and four types of chord on each root, we would expect to see and hear 4 x 19 = 76 distinct sounds, in line with this numbering.

Only minor third, minor seventh and major third, major seventh tetrads are obtainable, while staying with lozenges in 2D - 3D is harder to see!

A message about a Riemann code will appear in small text every time two different-sounding chords have been clicked. This could be a shift or a 'toggle'. To see simple shifts, click on chord I then V to see the letter 'F' represent a Fifth upwards, then back on I to see '-F' for a Fifth down, then III for a Major third up ('M'), then chord I again shows '-M. Chord I to chord VI is a sIxth up. The simplest toggle is probably from chord I to chord i and back again, each time showing 'P' which stands for Parallel (major or minor keys). From I to vi or back gives the letter 'R'; this moves between Relative minor and major. The last of the three toggles to neighbouring triads that share two notes, such as between I (CEG) and iii (EGB), is termed 'L' as B is the Leading note in the key of C. 'T' is a tone up and '-T' a tone down.

Every possible move between triads on the Tonnetz has been given a code letter, and for that purpose the available seventh chords are truncated to the triad that starts with the same root.

This spreadsheet is an index to the codes, which also appears within the Hugo form:

https://docs.google.com/spreadsheets/d/1E3I8XOx_XoBVGmeL3MWw2HszKUsjQwOLoneAKNCAD0/edit?usp=sharing

b) Jittery orbit with snail trail

You will need to press the green GO-ON button to start movement on this orbit. Click on the blue Earth icon at the top of the screen if you want to change the sense of rotation. This immediately reflects the Earth position about the Tonnetz centre. Rate of update is controlled by the slider against the red icon, and distance of movement on the Tonnetz at each step (as a change of angle about the Tonnetz centre) by the slider above it. To give variety, a random amount of jitter is applied to both the x and y screen coordinates each step, so that even for a sustaining instrument there is usually a change of sound at each step.

Move the size of the orbit rotation to its minimum (slider at left of blue icon to position 1) to see this jitter clearly, which can include some apparent 'backwards' steps against the primary sense of orbit rotation.

REWIND will restart from a position directly below the note C, and clears the Vignette so that it will show the 'snapped' positions of Earth and the history of the chords played.

The Discordiser can also be used in this test scenario, as in the full Launch Day operation, to change the share of triads and each tetrad chord type. That share, and also the sense of Earth rotation about the Sun, will persist through switches either way between this test mode and the Launch Day operation, since they share many operations at the detailed implementation level. You can transition seamlessly from a Jittery orbit into Launch Day, adding a Sputnik to the view and removing the jitter from the movement of the Earth. Coming back from that to the Jittered test case would remove any eccentricity from the orbit and fix the radius of the Earth orbit, and of course lose track of the Sputnik.

c) 'Celtic knots'

Changing the test mode to 'Celtic knots' and then pressing GO-ON starts a cycle of movements from the position the earth has reached. That is determined by a series of Rie ("neo-Riemannian") codes, each standing for a transition between chords, which at set-up are R L P R L. Start by clicking REWIND, which moves the Earth to chord CEG (labelled I with concert pitch tonic set at C), to see these clearly. Then GO-ON sets the transitions in motion, strictly in accordance with the moves dictated by the Rie codes - no orbits, Sputnik or jitter here. In this scenario, the speed slider opposite the Earth controls the speed of update between triads, and seventh chords are never played.

A toggle moves from a minor chord to a major one, or vice versa. A shift keeps the mode (minor or major) of the chord but can apply either rightwards/upwards (to sharper regions) or leftwards/downwards (to flatter regions) on the Tonnetz. The shifts moving flatter are prefaced with a minus sign.

Over two cycles of operation the default moves, sharing two notes between each chord are all toggles, easiest to understand while looking at a Tonnetz with tonic C at concert pitch (or see picture overpage):
(cycle 1)
I relative minor (R) to vi (A minor, assuming the starting chord is C major)
vi leading note (L) to IV (as note E is the leading note for a tonic of F)
IV parallel minor (P) to iv
iv relative major (R) to bVI (as Ab is the relative major for F minor)
bVI leading note (L) to i (as G is the leading note for Ab)
(cycle 2)
i relative major (R) to bIII (Eb the relative major for C minor)
vi leading note (L) to v (D the leading note for Eb)
v parallel major (P) to V
V relative minor (R) to iii (as E is the relative minor for G major)
iii leading note (L) to I (taking us back; B leading to CEG, chord I)

The Earth has woven its way around a figure of eight. Playing continues over further cycles. The cycles can be made much longer.

To make the start and end of each cycle clearer, the letter codes will always be supplemented with two ‘E’ symbols at the start, standing for Extend. Each pauses, for a beat, the sound that was being made before the cycle starts - useful for getting an ensemble, or a video recording, under way, and knowing when to stop at the end of a cycle.

To start from any chord, first rewind (to start from the beginning of a cycle, then click on the starting chord, then GO-ON. For example, start on vi and see what happens.

The same sounds, but different chord designations, are made if the tonic is shifted. For example, use the M3 spinner to shift up a major third in key, so that the tonic is E and CEG becomes the major chord bVI. The neo-Riemannian idea is to get away from harmony that is fixed to keys, and instead to see chordal relative relationships as the main driver. This removes the burden, in the analysis of Romantic period and later music (for example, Debussy’s), of always having to say, when labelling specific chords, ‘what key is this in’? The key insight is that a motion on the Tonnetz of a given direction, and distance, from a major and also from a minor chord, will always sound the same, whatever the starting location.

The Earth will follow the folding rules in the Tonnetz for whatever temperament is in use, rather than disappearing off either side, top or bottom. It never goes outside the three middle rows when in ET12. This limits to 25 the number of Rie codes that are necessary within ET12: 13 toggles with ‘H’ and ‘A’ redundant, plus 12 shifts (including ‘E’ for no move; excluding ‘-X’ which is the same as ‘X’ in ET12, half an octave).

This functionality operates in a very similar way in ET19 as in ET12. The only difference is where a cycle takes the Earth off the top or the bottom of the Tonnetz. In ET12, the wallpaper joins up or down are straight, while in ET19, they are staggered by one column.

With the help of the Hugo form (details in section 4 below), you could visualise this by tailoring a new weaving pattern that consists of just the code ‘M’, a major third shift upwards, after the standard (Yorkshire) ‘EE’. Delete any letter after ‘EE’, using the Del button on that form. Then tick the box againt Rie code ‘M’ and click on the right-hand pad labelled M to add it to the list of codes at the foot of the form. Next, with motion on the Tonnetz stopped, click the long button with the yellow background to implement the new transitions list, that has just the one upwards shift. Finally, click GO-ON on the main window, starting from any chord you like, to see the effect of that minimal cycle. In ET12 the major thirds upwards moves will stay in a fixed column, constrained to the central three rows, while in ET19 they move one pair (Maj+min) of columns to the right in each vertical fold, finally moving all the way from the rightmost to the leftmost column, while staying Maj or min. The sounds you hear are limited to a two-octave span so sometimes a shift up of a third will be heard as a shift down of a sixth.

4) Hugo, the musical fabric designer

This section gives full information on how to work with Rie codes and ‘weave’ interesting patterns; the topics are:

a) saving and loading code patterns;
b) the tabs on the Hugo form and how to enter the codes
c) auditioning and previewing the effect of single codes.

a) Saving and loading code pattern files, and reverting to previous

To design your own musical ‘weaving patterns’ for the third Test mode in the menus, click on ‘open form to choose the warp and weft’. A complete new modeless, movable window entitled ‘Hugo the musical fabric designer’ (after Hugo Riemann) will appear and can be moved around your screen, whilst using the Kepler’s Harmonies application in any other way that you want. This lets you create a draft ‘weaving’ pattern. To implement this, stop any orbits or transition sequences with the STOP button, and then click on the button ‘Implement the current list as the weaving pattern and save it’. Closing the form with the Save button at the top does the same thing.

For a more permanent way of storing a sequence that has been implemented in either of these ways, create a Rie file (suffix .rie) on your local storage using the ‘Save sequence’ file option under the Kepler’s Harmonies heading of the main window <Alt K>, <Alt v>. To load a file previously saved in that way, use ‘Load sequence’ from the same menu <v>, which will display only files that have the suffix .rie . You could set their description within your operating system as a ‘Rie symbol list’ or similar, as a memory-jogger. They are text files, but it is recommended to edit them only through the Hugo form. Corrupted files or files of the wrong type will throw up the error box “Unknown Element(s): no Separable Rie Strings on File.” If the loaded file is missing the symbols EE at its start then Hugo will add them to the working copy, and will save them to the start of Rie files that are output. Loading only puts the codes into the editing area of Hugo (in case they are not what you want, so you can still revert to what you last had in draft).

There is an example, HAPPYNEWYEAR.rie in the Deploy folder which spells out the cycle (returning to its starting chord, for ET12 and either a major or minor chord start) :
EE H A P P Y N E W Y E A R T O P M U S I C I A N S W E R E S U R E C O M A

Interestingly, the weaving pattern looks different between a start from major or from minor, but has the same overall translation. This sequence uses only Rie codes in the ET12 subset. When played in ET19 this is not a closed cycle, and the relative destination is different when starting from major, or minor.

You cannot edit the Draft Pattern with the keyboard editor. Use the Del key to remove one of the existing codes at a time, from the end of the sequence. You can safely delete quickly as far back as EE, which is permanently displayed. Section (b) below gives full details on choosing and adding symbols. Basically, you click on the selection pad to the right of a ticked box.

The Draft Pattern editor will expand onto a second row if necessary and, if you really want to go well beyond 100 chords in sequence, will continue to edit in new symbols, which you can audition and delete, but you will not be able to see the rightmost Rie symbols in the editor. The small information display under the Tonnetz will tell you what they were, when playing back. The ultimate length limit has not been tested. Let the writer know if you find it!

You can hear the effect of the string of codes currently in the Draft Pattern editor using the ‘Hear them first’ option on the Hugo form. If you have a draft sequence in the editor, then the button ‘Hear them first’ will play it (starting with EE, from the current Earth position) as fully separate chords (portato), with the triangles behind the triad lighting up, as crotchets at a temp of about 120 bpm - so you can keep a moderately long sequence ‘in the ear’. This works in either ET12 or ET19 - in ET19 using the full Tonnetz grid, in ET12 just using the three middle rows in which Riemann transitions are defined from the chord CEG. The playback speed for this cannot be altered; you would need to ‘Implement the current list’ to be able to play back the sequence at a different speed. MIDI output channel and instrument settings can also be changed and apply to this audition (possibly useful over earphones if you want to try something out privately during a streamed demonstration that is using the main computer audio)

To implement these ready to play normally on the Tonnetz, STOP any orbits or cycles currently using the Tonnetz, click on ‘Implement ...’ in the Hugo form and then click GO-ON. This seems slightly laborious but avoids crashes through lack of synchronisation between the movements in the player and edits in the separate form window. The effect is likely to be different starting from a major chord, so you can set any starting point on the Tonnetz by clicking on a chord after you STOP movement and REWIND, or after just pressing REWIND. Setting the weave in operation with GO-ON, or auditioning it with ‘Hear them first’, will start from that chosen chord.

Closing the Hugo window with the top-right x, or with the Close button, do the same thing - they leave any symbols in memory ready to show in the Draft Pattern editor and continue editing on re-opening that form, so long as you have not terminated the whole application. The little question mark to the left of x is a mystery to this programmer, too. It’s called a ‘What’s this’ button, but will not help you.

The Revert button at the form top will abandon any editing, including a Load retrieved from file, and restore a sequence previously saved to memory in that application session, or if you have not saved anything yet, will put up the initial display EE R L P R L (as used in the demonstration in 3c). The gaps between letters are for clarity, since there are two-letter codes such as '-F' (down a fifth).

So next, let's assume you want to add new transitions to a sequence. There are a number of convenience features to choose the one you want and preview or prehear its effect, and also the whole sequence.

b) The tabs on the form

There are four tabs on the Hugo form, displaying different orderings or subsets of the 'Rie' symbols - the extended set of neo-Riemannian transition codes:

- Sorted ET12: first the form shows all the toggles, then the wholesale shifts (e.g. 'M': I to III or i to iii) that lie within the three Tonnetz rows of ET12
- Sorted All: a comprehensive list of the toggles or shifts required to move in one step anywhere around the complete 5-row Tonnetz
- Alphabetic ET12: the ET12 list sorted alphabetically
- Alphabetic All: the total list, sorted alphabetically

For the two 'Sorted' tabs, six transitions forming a hexagon around any given chord (including joins at the vertices, preserving one note) - are shown in bold. The subset of original German and neo-Riemannian codes 'R', 'P', 'L', 'S', 'N' and 'H' ('Hexatonic') are shown ticked, when first opening the Hugo form.

Ticking in the box on a row of any of the tabs will copy across to that symbol on all other tabs. Ticking primes the neighbouring 'Pick next' pad for code selection, and the new Rie code letters that are available for selection will appear in black on those pads. Clicking on one of those primed pads will add its Rie code to the end of the Draft Pattern at the foot of the form. If you pick the wrong code, just delete it with the pink Del button. You can prime all pads on a given form using the Tick All button at top of that form. After Tick All on a ET12 tab, only the codes needed for ET12 will show as ticked if you move to a ET19 tab. However, clicking 'Untick All' will remove all ticks from all tabs, not just the current one.

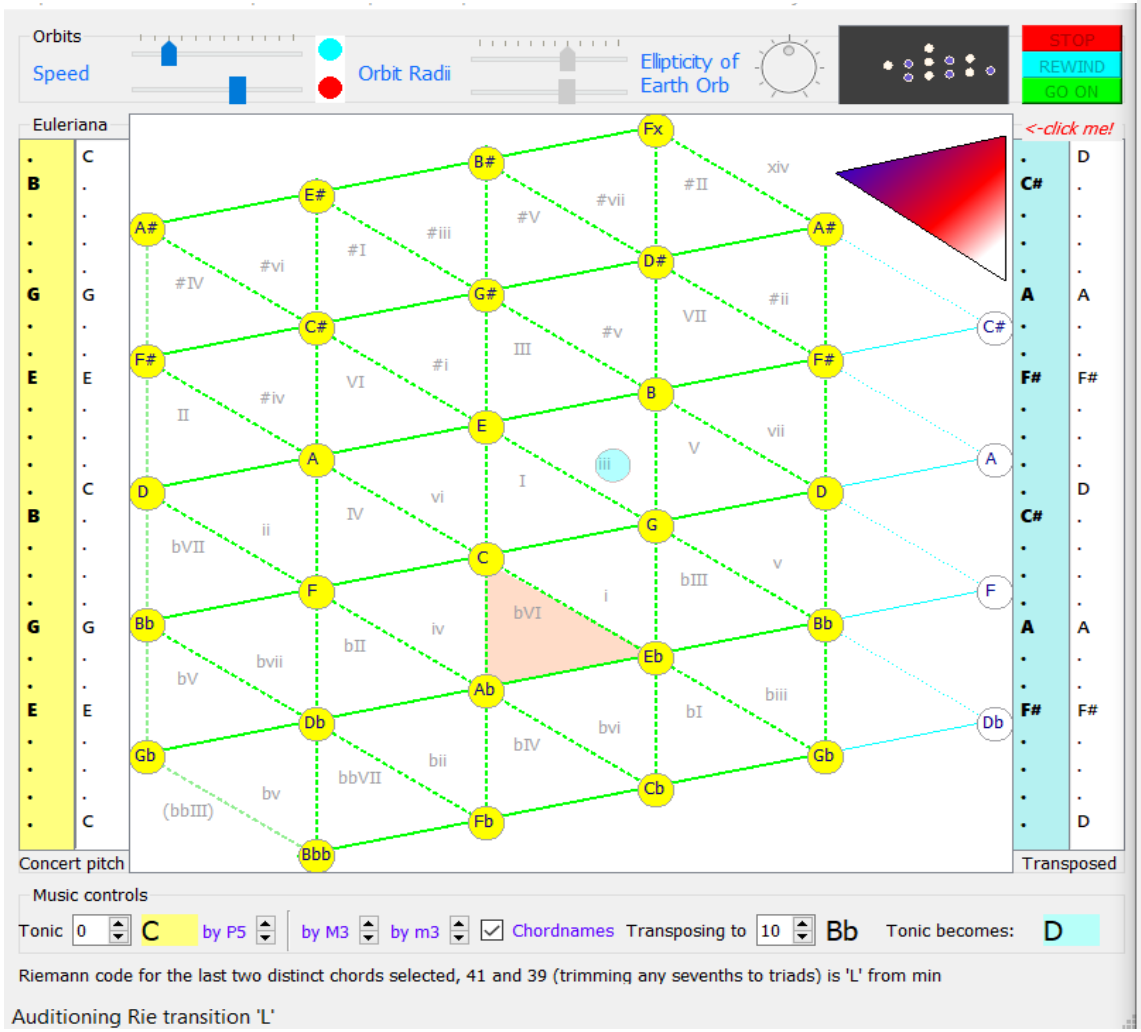
The main reason for restricting the number of 'live pads' is to make it easier to audition the ones you might want to apply, without setting off sounds from other pads while moving a mouse cursor around the form. Also, even working in ET19, you might want to start with a subset of the transitions familiar from ET12 and add further ones judiciously to a harmonic sequence. Too much spice can spoil a dish!

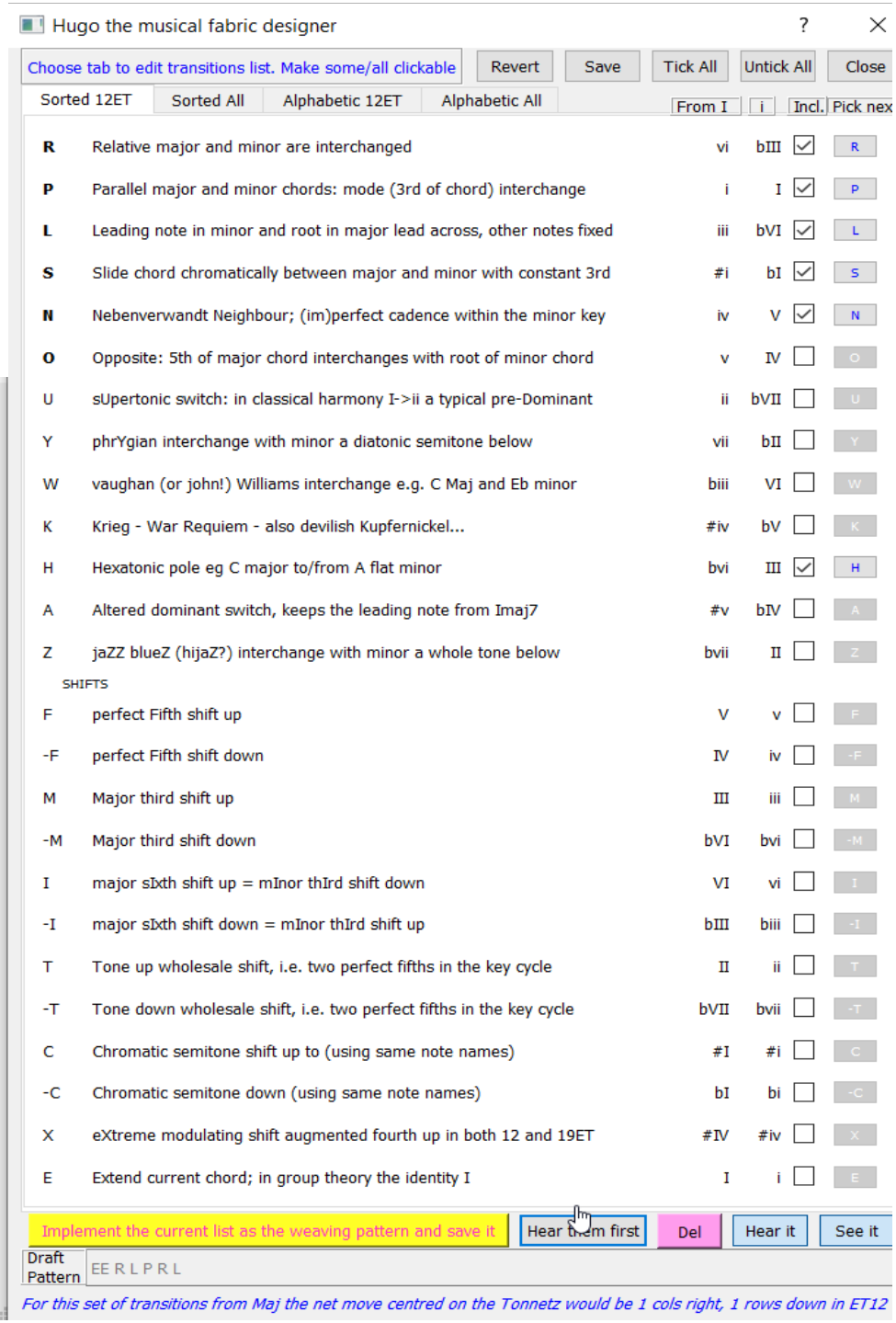
In the sorted tabs, under shifts, each shift Rie code is followed by its inverse, e.g. 'C' for a chromatic shift up is followed by '-C' for a chromatic shift down. That code means a semitone in ET12 but a third of a tone in ET19 (for which a diatonic semitone 'D' or '-D' is two-thirds of a tone e.g. C to Db). There are two exceptions: 'E' for 'Extend', effectively a 'zero shift', and 'X' within ET12, since an augmented fourth divides an octave exactly in half so only one pitch class is required to represent its target. In ET19, however that augmented fourth, (symbol X) moves C to F#, 9 third-tone steps upwards, i.e. three whole tones, and the wider interval C to Gb upwards (10 third-tone steps, a diminished fifth) is distinct: the move '-X' from any note thus reaches a pitch class one-third of a tone higher than the move 'X'. The two would sound the same in ET12. (To make coded messages we might need to use *any* letter, yet play the sequence in ET12; so we need to somehow define the behaviour of the longer ET19 moves on the Tonnetz even when their ET12 destination is folded back to the three middle rows.)

The ET19 gamut of 19 toggles and 19 shifts (on the Sorted All and Alphabetic All tabs) includes some unfamiliar intervals, overflowing the set of capitals in the alphabet. My naming for these, eg. 'u' for "ugh", reflects some personal prejudices - In ET12 this simplifies to the harmless 'N' transition. Others might like the discomfort of such large shifts across the Tonnetz. Two that are easy to get used to are the toggles 'd' - the ET19 equivalent of the over-familiar ET12 'S' 'slide' move - and the mellifluous 'J', 'Joe's Jump' in honour of our local CoMA director.

All of the extended Rie codes developed for ET19 will play something in ET12, usually based on reading the chord symbol as if for ET12. For example, 'J', moving from I to #vii, has its root stay at the same note in ET12, while moving down from C major to B# minor, one third of a tone lower, in ET19. From the minor chord i, CEbG this goes to #I, C#E#G# in ET19. To make this a symmetrical toggle when applied to ET12, that target chord has to be read in ET19 as the equivalent chord Dbb Fb Abb (which does not appear on the Tonnetz, or we could simply make this a toggle from i to bbII). Then in ET12 this is enharmonic with the major chord CEG, and so the Jump 'J' can just be played in ET12, in either sense, as the Parallel transition 'P'. The 'Gross' transition I to #vi, 'G' in ET19 plays in ET12 as the interesting toggle 'Z'.

The Hugo form shown alongside a snapshot of a 'Hear them first' audition starting from CEG. Over two cycles the default moves, sharing two notes between each chord are all toggles,
(cycle 1)
I relative minor (R) to vi (A minor, assuming the starting chord is C major)
vi leading note (L) to IV (as note E is the leading note for a tonic of F)
IV parallel minor (P) to iv
iv relative major (R) to bVI (as Ab is the relative major for F minor)
bVI leading note (L) to i (as G is the leading note for Ab) - as pictured below
(cycle 2)
i relative major (R) to bIII (Eb the relative major for C minor)
vi leading note (L) to v (D the leading note for Eb)
v parallel major (P) to V
V relative minor (R) to iii (as E is the relative minor for G major)
iii leading note (L) to I (taking us back; B leading to CEG, chord I)





The codes ‘A’ and ‘H’ are both available in ET12 and make the same pitch toggle. ‘H’ was the original Riemann code moving from chord I to bvi, but since that target lies outside the middle three rows of the Tonnetz, you may see it moving upwards, instead. The transition ‘H’ has space to move down from III to i (C minor is bvi of E), but from chord I it will move to the enharmonic equivalent #v (G sharp minor) rather than bvi (Ab minor). Sound both chords manually while in ET12: they sound the same. Once again in ET19 those shifts are different; #v is a lower pitch then bvi, so the transition codes ‘A’, moving up the Tonnetz from chord I, and ‘H’, moving down, hit different-sounding targets.

Similarly, the toggle ‘G’ in ET19 is treated as ‘Z’ in ET12 by reading the transition from minor as i to bbIII (rather than #II, which does lie on the 5-row Tonnetz). Another way to think about converting ET19 transitions to ET12 destinations is to calculate them in ET19, from a location in the three middle rows, and then if the destination is outside the middle three rows, to move up or down three rows so that it is. That is how the ET19 transition will be read in ET12, through a ‘centring’ routine.

As you dig into these problems of the ET12 notation, it becomes helpful to remember that the original applications of the Tonnetz did not assume equal temperament, nor ‘folding’ vertically: in a Pythagorean, just intonation or even a meantone system the pitch relationships and chord transitions are much more like those we can encode here with ET19. A circulating ET31 temperament would however require even more rows and an F triple sharp, Fx# (!) and if the temperament is not circulating then the Tonnetz extends up and down potentially forever.

c) Auditioning: predicting the effect of appending new codes

As these codes take some time to learn, it is useful to be able to audition them before implementation. To be able to hear the effect of any of the primed (ticked) transitions, depress the ‘Hear it’ button to bottom right of the Hugo form. To prepare to see the move on the Tonnetz using a red background for a major triad and a blue one for a minor one, press ‘See it’. Either option stays in place while this form is open.

Select on the Tonnetz, if the Earth is not already sitting on the chord, the first chord from which the entire draft sequence will begin. Then hover the mouse over the pad of a Rie code on any tab (there is no equivalent on a touch screen for this). If no sequence has been implemented, then for demonstration purposes the audition will be directly from the currently selected chord.

However, immediately a sequence has been implemented, or whenever you have made a change to the draft sequence, on auditioning a Rie code, you will see and hear a move from the *end chord* of the existing draft sequence to the next chord after the transition being considered. If you like that sound, pressing on the pad will add that code to the sequence and immediately the next ‘audition’ will start from that new extended endpoint. You can press that pad straight away for a double dose of that transition, or any other primed pad. This makes it very fast and convenient when composing to try out and extend, or backtrack on, a series of Riemann transitions.

For the preview, starting from a manually selected chord, to end up in the same place, when used in the ‘Celtic knots’ test mode on the Tonnetz, as the sequence in the Hugo editor, then consider this: after a STOP, you may need to REWIND so that the pattern starts at its beginning, not immediately GO-ON at the point where you last stopped (i.e. paused within the sequence). After that REWIND sets CEG as the start chord, you are free to sound a new starting chord manually. The information in text at the foot of Tonnetz will show you how far you have played through the ‘weaving pattern’. It displays the transition that just loaded the notes of the next chord into the ‘white zones’ of the Player Prompt ready for playing next. The Earth follows the chord when, on the next beat, it moves into the yellow zone. Hence the transition code will show a little ahead of the required interval actually sounding - preparing the ear rather than testing it!

In blue italics at the foot of the Hugo form, underneath the draft pattern, every change, including a change of temperament, or the mode of starting chord on the main application window, will lead to a new prediction of the relative distance that the complete sequence will move on the Tonnetz. Here one ‘column’ is counted as the distance between a major and a minor chord on the same row, so there are eight columns to a row. Five columns to the right is the same as one row up and three to the left.

This feature has two main uses; one is to try and design a sequence of transition codes (meaning something when read, such as SANTACLAUS) which returns on the Tonnetz to its starting point, giving musical ‘closure’. The second is simply a check on correct implementation of the various moves, including excursions during the sequence outside the Tonnetz, and folding back (through five rows in ET19, three in ET12). Please report any reproducible discrepancies to Andrew Chadwick, saying exactly what you did and saw. This is version 1...

5) A more comprehensive guide to the sound playback

MIDI implementations are inconsistent and buggy. This functionality has only been tested thoroughly on the Microsoft GS Wavetable MIDI synthesiser available under MIDI output/ Channel “0”, where we supply a fixed list of instruments that sound reasonable and remap their pitch to an appropriate octave, eg 2 up for celesta, 1 down for ‘cello. However a wider range and better sounds are likely to be available on an external MIDI engine and after some testing on an old Yamaha PSR-540 driven through a Presonus Audiobox (this combination responding to General Midi messages up to 127, a gunshot), and a StudioLogic Black Sledge,the following set of compromises and advice was arrived at. There were nice surprises; picking an instrument that was an arpeggiator was very effective, and any specialised MIDI synth sounds better than the one built into Windows.

Therefore the MIDI output setting gives you freedom to pick any external synth (and also crash your system...) and at the foot of the instrument menu there is an option to pick any output MIDI patch number in the range 1 to 999. The number shown on opening that entry popup is the instrument number last used in this session. That patch selection also removes any octave overload and makes the assumption that the instrument is a sustaining one, so that notes which are constant between two chords will be tied over. If you need to, or just want to, override that in ET19, use the ‘Portato’ menu option that appears when already playing in ET19 and you re-enter the Temperament menu.

Channel “1” will be the second MIDI engine detected by the operating system before Kepler’s Harmonies is launched, so make any external synth connections in advance. Sometimes you have to switch the synth off and on again, or temporarily disconnect its MIDI DIN or USB connection, before the operating system will recognise it. If you are having trouble diagnosing problems with MIDI connections, MIDI-Ox is a useful tool.

Channel “2” allows for a third MIDI engine and is specialised for the assumption that voices are not correctly silenced, so would persist for the wrong instrument or notes in ET19 unless all notes were reset. Therefore in ET19 this channel will start by treating all instruments as not sustaining, effectively starting with ‘portato’.

For the preselected instruments, octave boosts and sustain assumptions are as follows. For a piano especially, which is assumed to sustain, a slow tempo may mean that in fact only new notes in a chord are heard, and not old ones, by the time the new ones sound. At very slow tempi the (default) clarinet instrument is a good sustaining choice, that does not distort intonation too much nor weary the ear quickly.

For the recommended instruments on Channel “0”

Instrument name	Patch number	Octave boost	Treated initially as sustaining?
Grand Piano	1	0	Yes
Harpsichord	7	1	No
Clavichord	8	1	No
Celesta	9	2	No
Glockenspiel	10	1	No
Vibraphone	12	0	No
Marimba	13	1	No
Church Organ	20	0	Yes
Reed Organ	21	0	Yes
AcousticGtr	25	0	No
Violin	41	1	Yes
Viola	42	0	Yes
Cello	43	-1	Yes
Strings	48	0	Yes (may possibly sound as timpani!)
Trumpet	57	1	Yes
Trombone	58	-1	Yes
French Horn	61	0	Yes
Oboe	69	1	Yes
Bassoon	71	0	Yes (Windows quality poor for low range)
Flute	74	2	Yes
Clarinet	72	0	Yes
Tubular Bells !	15	-1	No
Electronic Organ	19	0	Yes
Pad	95	0	Yes

At present the logic for making an instrument sustain or not, across different output channels and means of patch selection, is a little quirky, but reduces surprises for new users and gives full choice for experienced ones:

When Channel “0” is first selected, sustaining for any instrument follows the table above, and you are blocked from selecting an instrument through its patch number.

When changing to Channel “1” or “2” the instrument selection is retained. Making a selection of the same instrument by patch number means it will be treated as sustaining in ET12, and within Channel “1” in ET19 as well. It will lose any octave boost preset (since some synths you may want to use will not be using General MIDI, but instead their own scheme for allocating timbre or ‘preset’ to instrument number).

If you select a patch number higher than 127 (try higher than 254), it may well be supported by Extended Midi (which varies between manufacturers). Switching back to Channel “0” will retain that patch number, but you may hear nothing - in which case you can click against one of the ‘safe bet’ standard instruments.

In any case, to restore the original sustaining character and any octave boost of an instrument, select it against its name, even if already checked. That will override the manual patch selection.

There is a direct way, on any output channel, of managing the choice within ET19 between tying over notes (‘legato’) and re-sounding them (‘portato’). This appears under the temperament menu when it is re-entered after ET19 has already been chosen. The keyboard shortcuts for legato, after < p > for Temperament, are < Alt - > and for portato < Alt . >. In some synths, within ET19 (in which this application uses different polyphonic ‘voices’ for different pitch shifts) treating sustaining instruments with legato can mean that certain of the old notes are not cleared until another note needs that same voice. This is either a bug, or a feature so long as discords are tolerated!

Treat Channel “0” as a safe haven, and any external synth as experimental at first. The implementation of pitch bends uses all 15 of the MIDI channels, setting a different pitch bend for each, so there is plenty of scope for implementation bugs in ET19 - e.g. different instruments (timbres) being applied for different pitch classes, or notes failing to be silenced. The current code works around that latter bug found with miditech PianoBox II if used on channel “2”, but other synths may share the same problem.

If you hear a percussion instrument that is different for each note, then the synth is not using the MIDI specification of channel 9 as the percussion instrument channel. That would be a very ‘off-beat’ use of this application.

The manual selection of patches for unfamiliar synths is something of an adventure. No guarantee, nor indeed warranty, is offered on what may result. But exciting new results can be obtained, where Kepler’s Harmonies are the framework for something more rhythmically, timbrally or melodically exotic. In particular, using a keyboard split with an arpeggiator near the bottom of the range for the current MIDI instrument can arrange that lower notes pulse as held pedal notes, which in ET19 and on the legato setting may be dissonant with the chords currently being sounded. Patch number 127 is often a gunshot - be careful with that one when holding a hot drink, especially with a slow-moving Earth that may take a random time to move to a new, sounding ‘note’.

A final word of warning - if Windows cannot find Channel “1” or “2” after it has been enabled (for example you disconnected an instrument while this application was playing) you will probably just get silence, but it is quite possible to encounter the dreaded BSOD (Blue Screen of Death). MIDI drivers are ancient as well as low-level. So best save any other work you were doing on the computer - like writing this documentation :-(- before going off the beaten track with sound outputs.

Good luck, have fun and if you see wider potential for this in contemporary music or indeed musical education, please let me know

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