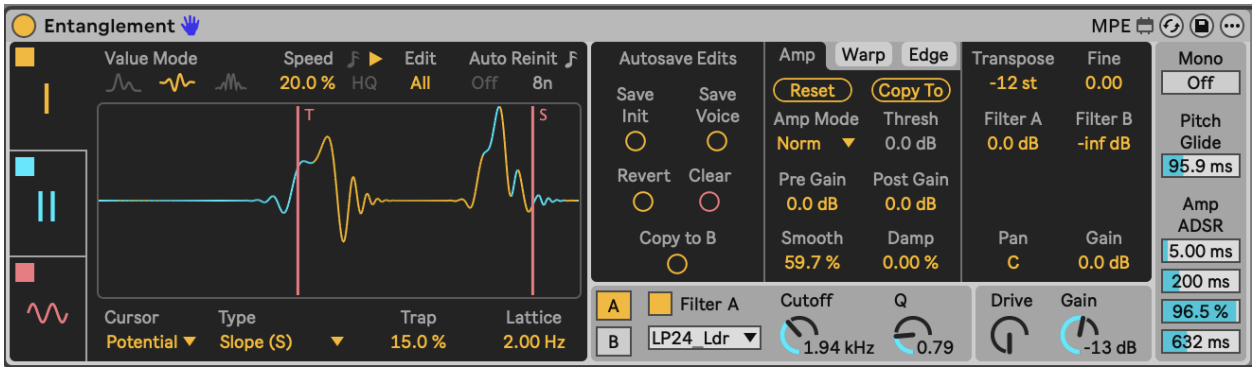
Entanglement User Manual



To install:

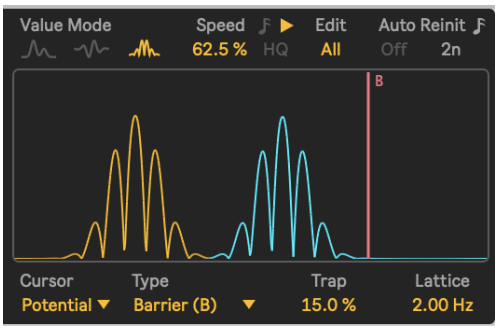
Unzip the folder and drop the folder called “Entanglement” in this exact location in order for presets to load correctly: *ableton/user library/presets/instruments/max instrument*

If you are having issues, make sure you are using the latest version of max/msp (usually bundled version is fine however Live 10 users may need to install the latest version of Max8). You do not need to have a license if you are using Live suite. Download the newest version here: https://cycling74.com/downloads and once downloaded go to the ableton Preferences > Library and set the newly downloaded version of max to the one ableton should use.

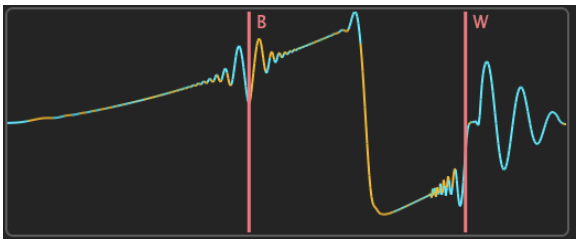
Synopsis

Entanglement uses a 1D quantum wavefunction (Schrödinger equation) to produce waveforms for use in a dual polyphonic wavetable synthesizer. You can add energy (wave packets/quantum particles) to the simulation in various different ways and those waveforms will evolve and transform based on the equation and your settings. You can also add environmental factors (potentials) to transform the energy (waveforms) in different ways. Additionally you are able to manipulate the resulting waveform in different ways (stretching, warping, quantizing, smoothing, FM etc). You can derive your waveform from the wavefunction as either probabilities (using the real and imaginary planes), the real values alone, or the absolute of the real values which all give you different waveform types and thus different sounds. Each oscillator (I and II) has its own independent wavefunction, energies, potentials and settings. That coupled with an internal modulation system makes this device a powerhouse for insane sound design from basic synth sounds, to complex evolving sounds, to crazy mind blowing sounds. The evolving nature and very compelling transformations of the waveforms through the quantum wavefunction stands this synth apart from the many other wavetable synthesizers out there.

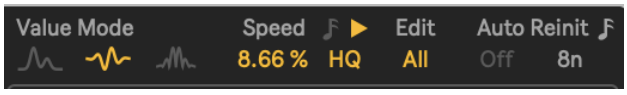
The Quantum Wavefunction



Here is the main visual display of the waveform derived from the wavefunction. There are also various settings in this section for adding/removing energies and environmental factors and core functions.



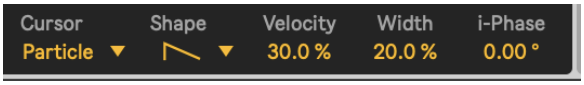
The visual shows the waveform AFTER it is derived from the wavefunction and all the manipulations, etc are applied to it. The colors represent which direction of the velocity for each part of the wavefunction energies/particles are heading (yellow goes to the right and blue to the left). If you are in the “Real” *Value Mode* (more about that below). The higher frequency of a wave particle, the faster it moves (higher velocity). The red lines represent the environmental factors (Potentials) and the letter next to them tells you which type (more below). Clicking on this visual can add or remove energy/potentials depending on the Cursor mode (more below). You can design the initial quantum wavefunction state and then each time a voice is created it starts at that initial state and progresses from there. This visual may display the latest active voices’ waveform or the initial waveform state depending on the settings (more below).



At the top are a few core functions. *Value Mode* selects which type of values of the wavefunction are used to make our waveform. The left option is “probability” which is the square of the magnitude of the real and imaginary values. These are the types of values one is used to seeing when seeing the quantum wavefunction. Because of their mathematical nature, they are generally more rounded than the other options and are polar values. The middle option are the real values themselves which make up one plane of the function values. These values usually have more frequency content and are bipolar. The right option is the absolute value of the real values, which have the same dynamics as the real except they are polar values and thus have a much different waveform/sound. To the right of this are values for controlling the *Speed* of the simulation. The percentage of speed scales the “dt” variable of the simulation and thus changing speed doesn’t just alter the simulation rate but also at higher values may affect the resulting values and even introduce artifacts depending on the other settings. The note symbol next to speed allows you to *Sync* the speed scaling to the BPM of Live (120BPM is center 1:1 scaling). The arrow next to that changes the simulation *Direction* to run forward or in reverse. The *HQ* button if **disabled** runs the simulation at a slower framerate and scales the “dt” (speed) up to compensate and appear to run at the same rate. This can save **A LOT** of cpu, however depending of the speed and settings it may produce a different sound that might be less smooth. The *Edit* setting can be set to “All” or “Init”. If “Init” then the waveform visual only ever displays the initial state of the wavefunction that each new voice starts at. Additionally editing the wavefunction only applies to the initial state and not active voices. If set to “All” then if there are active voices the display shows the latest active voices’ current state, and if there are no active voices it displays the initial state. If you do any editing of the waveform when an active voices’ state is displayed, it does NOT edit the initial state at all but applies those changes to all active voices. *Auto Reinit* is a function that automatically reinitializes an active voice to the initial quantum state at a regular interval set in either synced note divisions or free milliseconds.

Cursor Modes
There are several modes for changing the cursor behavior (clicking/dragging) on the waveform visual.

Particle

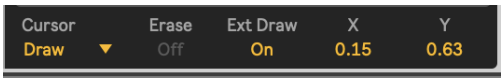


In this mode clicking on the visual adds quantum particles (wave packets) of energy to the wavefunction. The X position of your click is the center of the wave packet and the Y position is the amplitude. You can choose from basic *Shapes*. The only realistic one is the “Sine” wave option which mimics an actual gaussian free quantum particle. There are other basic shapes (square, ramp, triangle, noise, chirped) which give more experimental results. Sine and Chirped options give beautiful cascading harmonic series of different flavors. *Velocity* sets the frequency and thus speed of the wave packet in the real/imaginary values (rounded off in the “Probability” *Value Mode*). It is bipolar with negative velocities going to the left and positive to the right. *Width* sets the width of the wave packet. *i-Phase* offsets/rotates the phase of the imaginary plane from the real plane of the added particle. This will change the shape and dynamics/movements of the added particle (for example a value of 90 degrees will cause the particle to split in half and go two opposing directions).

Potential

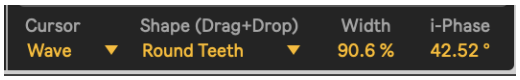
Here you can add/remove different environmental factors which will transform and affect the particles/energies differently. The speed of the simulation (dt scaling) will dramatically affect their behavior for most potentials. *Barrier* adds a high value barrier potential. At low simulation speeds this will block much of the particles with very little quantum tunneling, but higher speeds will pass through it more. *Trap* option adds a harmonic oscillator that models spring-like confinement. Energies will oscillate around it and there is a parameter called *Trap* next to the *Type* that scales the speed and power of the trap potentials. The *Lattice* option simulates a crystal lattice that can also modulate the energies for different effects. There is a *Lattice* frequency parameter as well to control its strength, higher frequencies can even “freeze” energies in place as they are modulated (truthfully I don’t fully understand the affects but recommend for all potentials seeing their effects on the “Real” values at a slow simulation speed to get an intuitive understanding for how they affect the waveforms). *Slope* adds a linear potential that can accelerate a particle like a gravitational force. It also can cause interesting oscillations depending where you place it. *Well* adds a double-well which can model tunneling and also cause barrier-like effects. *Random* injects noise.

Draw



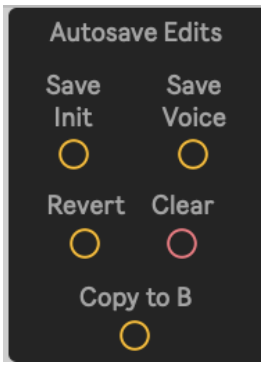
In this mode clicking and dragging free draws energy. If *Erase* is on it removes energy. *Ext Draw* allows for drawing using the *X* and *Y* values if enabled. This way you can map drawing to a controller or automate it for echaskech like drawing

Wave



In this mode you can add other single cycle waveform shapes directly into the wavefunction. There are many built in waveform options in the *Shape* parameter from simple to complex. But you can also drag and drop your own .wav/.aif files here for use (ideally drop single cycle waveforms as they are downsampled to 512 values)! *Width* changes the width of the waveforms when adding them. *i-Phase* does the exact same thing as in the Particle mode where it offsets the phase of the values in the imaginary plane from the real plane which (depending on your waveform shape) may change the direction/dynamics of the waveform transformation in the wavefunction. If you have the simulation speed at 0% and in the “Real” *Value Mode*, then you can play these waveforms back just as a normal wavetable oscillator (note put the *Edge* value to 0% to avoid buzzy artifacts if you do this, more in a later section below). However if you turn the simulation speed up your waveforms will transform as energies in the wavefunction!

Initial Quantum State Editing

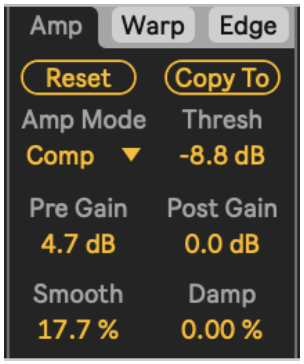


Saving the initial quantum state has some nuanced options. If *Autosave Edits* is enabled then every change of energy you make to the initial quantum state is saved for later recollection (ie in a saved Live set or device preset). If *Autosave* is disabled then you must press either *Save Init* or *save Voice* to save a state of energy for later recollection. *Save Init* simply saves the current initial quantum state to memory for later recollection. *Save Voice* (which you can press whether *Autosave* is enabled or not) will save the current energy state of the latest currently active voice (which is visualized). This is useful if you like where the energy has progressed to and want to have the voice start initially at that state. If *Autosave* is disabled, you also have the ability to *Revert* to the last saved state. So you can make edits freely but if you desire to you can revert back (NOTE: if *Autosave* is enabled you cannot do this as each changed is saved to memory, and you must then rely on edit-undo to undo changes). *Clear* clears all energy in the initial state (NOTE: not in active voices). *Copy to A/B* copies the energy values to the other source oscillator. NOTE: this does not copy other settings such as manipulations etc.

Waveform Manipulations

There are three parameter menus for waveform manipulations and additional wavefunction settings. Most of these do not affect the wavefunction simulation itself and are applied afterwards, but some do. At the top of each menu the is a function to *Reset* all of these parameters to their defaults and to *Copy* them to the other source oscillator (NOTE: these functions apply to parameters of all three menus).

Amp



These parameters affect the amplitude values of the waveform. The *Amp Mode* sets how amplitude values are handled, particularly when they go over the ceiling value (of “1.”, and “-1.” as well for Real value mode). “Clip” hard clips values. “Soft” soft clips values. “Fold” reflects values back (and if they reach the floor they are reflected back up). “Norm” normalizes values which is very useful for many settings and keeping the volume loud. Also there are some settings that make the values explode and normalization is very useful/necessary for getting interesting results in those settings. “Comp” does a compression of the values using the *Thresh* value to the right. *Pre Gain* scales the amplitudes BEFORE they enter the amplitude mode, while *Post Gain* scales them afterwards. *Smooth* applies a smooth function to the values to round them off. *Damp* dampens the values over time which could be useful for many effects (NOTE: dampening amount is linked with the simulation speed).

Warp

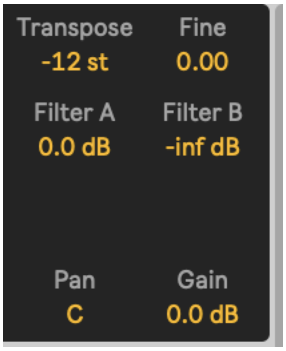
Stretch stretches/compresses the values to the left (in negative percentages) or right (in positive ones). *Warp* compresses/stretches values to and from the center. *FM Depth* is an fm amount/index applied to the waveform values and *FM Ratio* sets the ratio frequency of the frequency modulation. NOTE: this is not an active oscillator but a shaping of the waveform itself so the results are different. *Width* affects the width of the peaks in the waveforms, lower values make them narrower and higher make them wider. *Steps* adds a quantization to the amplitude of the wavevalues set in a number of steps.

Edge

This sets the behavior that happens to values as they reach the left/right edge of the screen. These settings DO affect the wavefunction simulation. *Mode* sets the edge mode. The left option wraps values around, this is the cleanest option and one that is standard in the simulation. The middle option mirrors/reflects the values at the edges. At low simulation speeds this works as stated but at higher speeds this

causes explosions of values so using normalization amp mode is recommended here (you will get some interesting effects with that!). The far right option is scrolling which dampens the values as they reach an edge. *Fade* sets the amount of amplitude fading that occurs at the edges (this setting does not affect the simulation). This is to prevent clicky sounds that may or may not happen as values reach the edges. Additionally, this can introduce a strong fundamental especially at higher values. However, for certain situations (for example using a pure sine tone in Real value mode with no simulation running) it can introduce some slight buzziness so you can set it to 0% if desired in those situations. *Flip* assigns the real values to the imaginary values and vice versa at the edges. At slow speeds with certain edge modes this will cause the values to erupt at the edges. So i'd recommend either using this with higher speeds or to use an amp mode other than normalization. *Noisy* does a dirtier algorithm of the edge modes and adds noise to the values as they reach the edges.

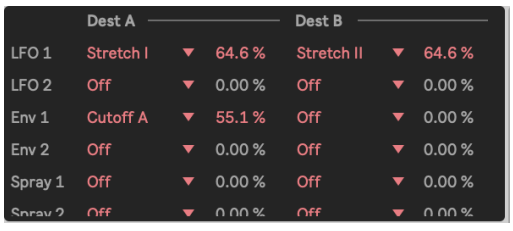
Output/Other Source Settings



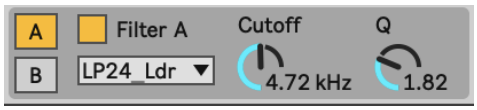
In this section you can transpose and fine tune the oscillator. *Filter A* and *Filter B* are the amount of gain sent to either filter. Additionally you have a final *Panning* and *Gain* for the source oscillator.

Modulations

There are two mappable LFOs and ADSR Envelopes per voice. They are quite standard except for a couple things. The LFOs have a perlin noise option. Below the perlin noise option are a number of unique shapes as well. You can also drag and drop your own LFO shapes (as wav or aif files) onto the dropdown shape menu to use your own custom LFO shapes! The envelopes are standard except they have a # of repetitions option to repeat the envelope. The highest value of this is infinite repetitions for a looping envelope. The modulators can be applied to 2 destinations each and there are also 2 random spray values, MIDI and MPE mod options!

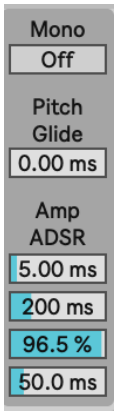


Post Source Parameters



There is an A and B filter routed in parallel. They have standard filter shapes as well as ladder (_Ldr) filter shapes.

There is a very basic *Drive* setting for overdrive. *Gain* here is the main gain of the device at the end of the signal chain.



Lastly there are a few global parameters. Activating *Mono* mode reduces the usual 8 voices to a single one and handles pitches differently to work like a monophonic synth. *Pitch Glide* adds portamento pitch gliding. And at the bottom is the *Amplitude ADSR* envelope for the voices. NOTE: if you want to have individual envelopes for each source I and II, you can map the assignable envelopes in the modulation section tot he gains of each source.

I hope you enjoy this device! Please email me if you have bugs or other issues:
dillonbastan@gmail.com
More: http://dillonbastan.com