

Blue Heaven - A polyphonic FM Synth

My approach to creating this VST instrument has been to first undertake research online by exploring the vast array of plug-ins that are readily available on the market today. My initial idea was to create an artefact based instrument but due to current circumstances in the UK decided that the best way to move forward would be to create a virtual synth. I thought that the best thing to do would be to create something that I could potentially use in upcoming performances and one that other artists/producers might also be able to use in a similar way. One element I want to incorporate in my live performances is sound modulation and live filtering techniques to make my shows unique and also give them a measure of improvisation. After viewing some artists who are already doing things like this, I decided on the creation of a polyphonic FM synth. Some of my influences are; Tropical house, afro beat and r@b so I wanted to give this plugin a summery, Caribbean type aesthetic, so I've called it, 'Blue Heaven.' The capabilities I am aiming for it to have will be, the ability to adjust the reverb, and modulate the delay and saturation via the Launchpad midi controller. Blue Heaven will be completely integratable with Ableton Live and all Ableton Midi controllers but will also work seamlessly with any midi controller that can effectively map the specific macro's. One of my first approaches to engaging in research for the creation of my instrument was to first, embark on some exploration into the history of the digital audio workstation, (DAW) and the in-fluctuation of VST plugins into the daily workflow of the average producer. First I will begin by summarising a brief history of what I have learnt about the VST plugin. *'Max for Live contains a number of helpful examples and tutorials that you can use as starting points for your own investigations or creations. Any time you open one of these devices and decide to modify its contents, you should save your work as a copy of the existing patches that come with Max for Live to avoid problems associated with overwriting the original devices.'* (SOS 2020).

The history of VST

'The history of VST began in 1996. At that time Steinberg just released Steinberg Cubase 3.02 that included the very of VST plugins, Espacial (a reverb), Choirus (a chorus effect), Stereo Echo, and Auto-Panner. Each and its type has a different role.' (Kaussa, 2020) The popularity of Digital Audio Workstations has risen greatly in the past twenty years, making music production easily accessible to the novice producer or anyone wanting to make music from home with the ability to achieve a clean, pristine and professional sound from many a bedroom, or basic home studio set up that in

the past would have had to be recorded in a professional studio, potentially costing thousands, if not hundreds of thousands of pounds to achieve similar results.

This approach has slowly become more widely acceptable and is now somewhat *expected* as many chart songs and official releases are being made in what some may consider to be 'fairly humble' surroundings. Now due to the development in processing power and affordable interface capabilities, VST plugins are becoming more and more essential and every producer has their favourite array of *go to* plugins for whichever effect they are trying to achieve in the mission of making their production more professional and polished in the 'Do It Yourself' age. The history of VST actually started in 1996 when Steinberg came forth into the world with Steinberg Cubase 3.02. This consisted of the epitome of VST plugins; Stereo Echo, Chorus, Espacial and of course, auto panner. There are a couple of types of VST plugins, three to be exact and they are as follows;

VST Instruments

A VST instrument has the ability to generate a sound by itself via the use of samples or an algorithmic function. Samples are sounds which have been gathered from the pre-recording of live instruments such as piano, bass, guitar and drums amongst many others, which can then be triggered by the virtual instrument. In contrast, an algorithmic based VST instrument is synthetically programmed using the computers inbuilt processor. They both have different pro's and con's and often come down to personal preference as the debate over the two kinds can be extensive and both sides have significant points for argument.

VST Effects

A VST effect differs from an instrument as it does not generate an actual sound by itself, but rather has an impact or effect on the sound via the use of altering, distortion, manipulating and warping techniques to achieve the desired result. Some examples of VST effects would be; Reverb, delay, EQ, compression, saturation, limiters and chorus just to name a few key ones. These kind of effects can be vital for cleaning up a vocal or instrument signal, removing unwanted frequencies and/or giving a previously dry signal a lovely warm and ambient feel. One other thing that some of these effects can assist with, is adding gain and perceived volume to a track and can also assist in altering the position of the sound in the stereo field.

VST MIDI Effects

Midi effects cannot manipulate audio and can only be placed on a midi based instrument where they can be used to arpeggiate, transpose or trigger chords routing the signal to the VST instrument. These plugins can be extremely helpful if a producer has limited musical or playing capabilities as these plugins can help create melody's and sequences by simply pressing one key on the computer keyboard on note on the midi piano.

One thing I've not yet mentioned is that VST plugins can also run within hardware completely independently from a DAW. This can be incredibly helpful in a live performance situation because even with the level of technology we are currently working with in 2020, computer crashes can still happen and using a VST inside a hardware based instrument can certainly help to avoid and prevent these situations, ensuring a smooth performance void of the fear of a CPU overload message appearing on screen mid performance. Each of these hardware instruments vary in price and have their own strengths and weaknesses which may be relevant depending on the kind of performance taking place. Here are some of the main hardware instruments capable to hosting VST plugins; Virtones Vped, Novation Bass Station, Novation MK3, Music Receptor, Novation Circuit, Seelake Audiostation, SM ProAudio V-Machine and many more.

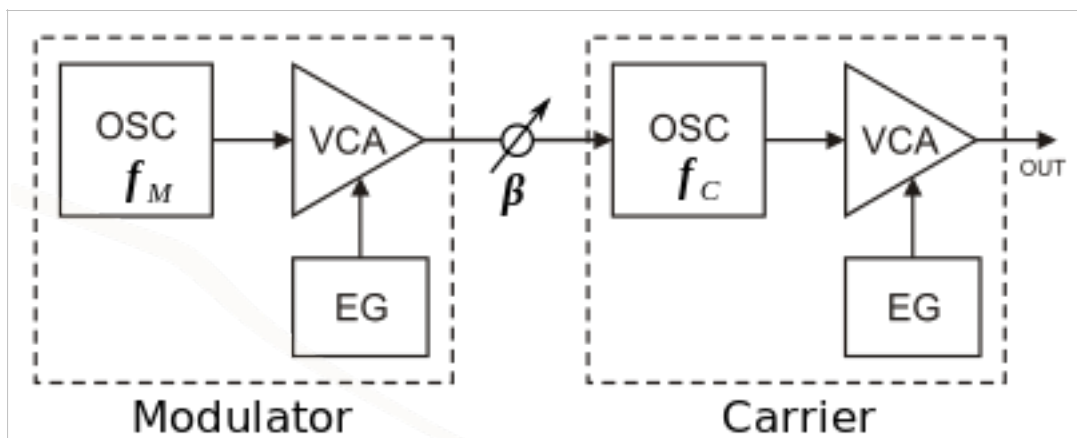
The biggest pro factor of VST may be that Steinberg made the technology completely free to use, making it accessible for any level of developer or up and coming sound designer to use. This has set the stage for thousands of free plugins to be created by absolutely anyone, anywhere in the world from the comfort of their home bedroom.

Frequency Modulation Synthesis

Frequency modulation synthesis (or FM synthesis) is a form of sound synthesis whereby the frequency of a waveform is changed by modulating its frequency with a modulator. The frequency of an oscillator is altered in accordance with the amplitude of a modulating signal.

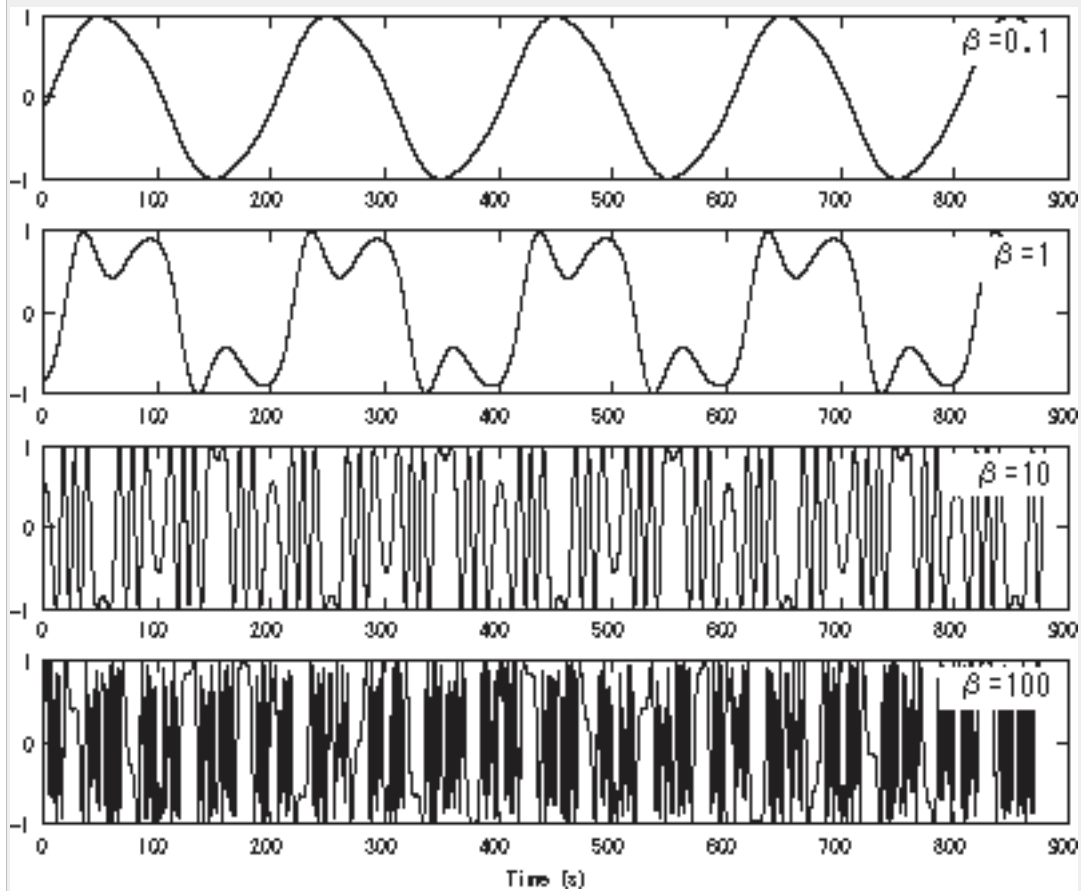
'How many people can claim to have discovered an entirely new form of sound synthesis? John Chowning can. He did so by accident while experimenting with different types of vibrato at Stanford University in the mid-'60s. Chowning found that when the frequency of the modulating signal increased beyond a certain point, the vibrato effect disappeared from the modulated tone, and a complex new tone replaced the original.' (Anon, 2020)

FM synthesis using 2 operators

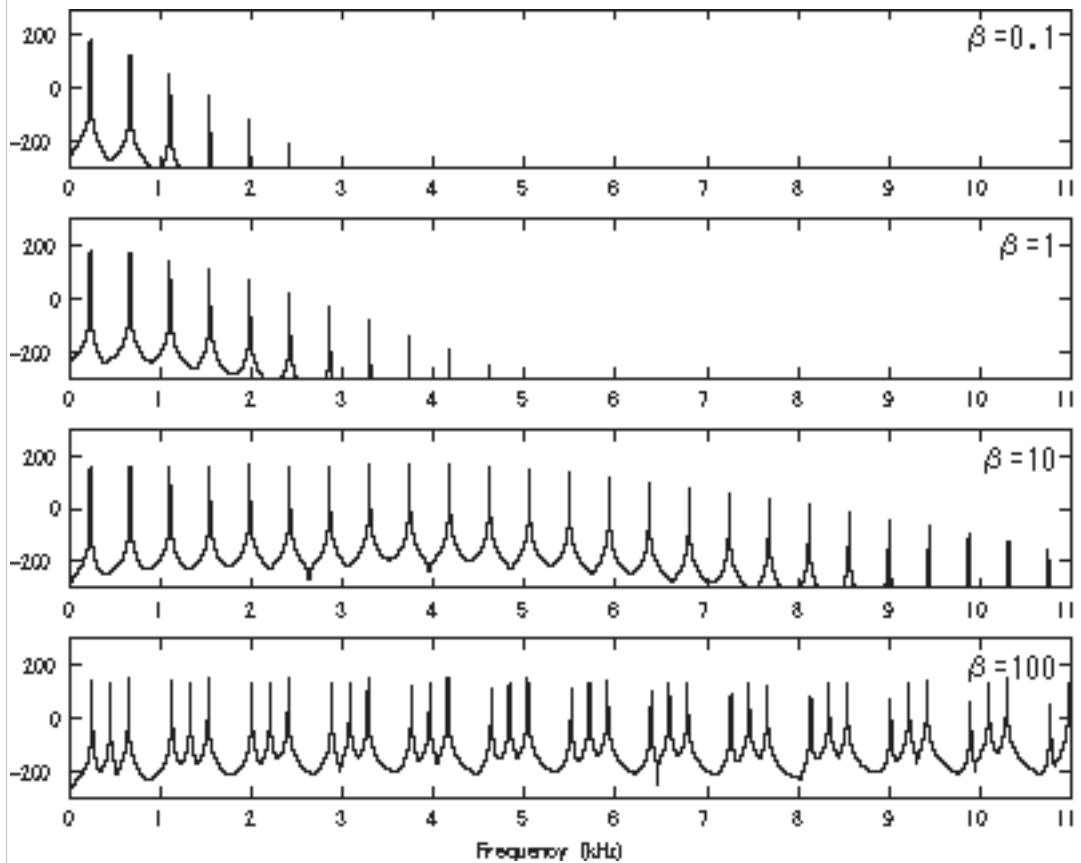


A 220 Hz carrier tone f_c modulated by a 440 Hz modulating tone f_m , with various choices of [frequency modulation index](#), β . The time domain signals are illustrated above, and the corresponding spectra are shown below (spectrum amplitudes in [dB](#)).

Waveforms for each β



Spectra for each β



FM synthesis can create many varying sounds ranging from harmonic and inharmonic. It is essential for the modulating signal to interact harmonically with the original carrier signal to enable effective synthesization of harmonic sounds. As the modulation increases the sounds intensify and diversify resulting in some complex and interesting frequencies. By modulating the frequencies of the original signal, unique sounds can be created. Digital FM synthesis has become common practice as it is more stable than using analog oscillators which may exhibit problems such as wavering pitch. Synthesiser, released in 1983, brought FM to the forefront of synthesis in the mid-1980s. In his article, *The Synthesis Of Complex Audio Spectra by Means of Frequency Modulation* by John Chowning, whom the concept was expounded from by Yamaha, who later on bought the patent thereby began the production of their digital synthesiser prototypes in the late seventies.

Frequency Modulation is based upon at least two oscillators and they are a carrier and a modulator. The carrier frequency is responsive to the original signal and pitch can then be controlled with a midi instrument or midi controller. The modulating frequency is what changes the carrier signal at the designated rate of modulation.

The purpose of my instrument is to alter the original carrier signal whilst in the midst of music production, which would be specifically focused on live, improvisational performance. The main idea is to create ambient effects on stage bringing uniqueness and creativity to the beginning and endings, intro's and outro's of songs and to engage the audience with interesting and captivating transitions via the manipulation of the original sound. This will be achieved by the movement and adjustment of dials which are mapped via my specific choice of DAW Ableton Live, via the choice of midi instrument or multiple midi instruments used for the specific performance.

In terms of the *user friendliness* of this VST plugin, it's plain to see that on first sight, FM synthesisers can be more than a little daunting. The idea of FM synthesis is more complicated than other sound design methods such as subtractive synthesis and does require some background knowledge and education on the theory of FM synthesis before starting to implement this plugin to full effect. However, I am aiming to create a very simple design on this occasion which I hope will not require too much depth of understanding to use and can actually be implemented in conjunction with Ableton Live by any user who has the basic knowledge of how to apply audio and midi effects in Ableton and preferably has considerable knowledge of the use of chains and racks. This modulator will represent a small segment of FM synthesis and should therefore be relatively easy to implement without extensive knowledge on the subject but rather, a lot can be achieved by trial and error and a person's ability to use their own ears and trust their instincts when it comes to what sounds good. Using this tool will enable producers and performers to create more

complicated and interesting sounds and frequency variations that would otherwise be more difficult and time consuming to achieve by other methods. Due to current world events I have chosen to create a virtual synthesiser as opposed to a hardware based synth and as per my research, I believe it is going to take me about two days to create the plugin itself. In terms of its look from an aesthetic perspective, this plugin will look similar to other plugins you might find in Ableton and will be simple and focused. The name, 'Blue Heaven' is reflective of the kind of sounds I am aiming to create in my own music which is a tropical house, Ambient type vibe.

The difficulties I have faced in completing this project have mainly been due to current world circumstances, specifically the governments implementation of a nation wide lockdown due to the Covid 19 virus. This has placed unexpected psychological barriers and presented mental health issues such as; dealing with working in isolation, the lack of community to ask questions from and or run ideas and concepts by, and advice or work on the project with. Summed up, it has largely been the sheer struggle of having to self motivate in such uncertain times. It has been extremely hard to focus on this project and a genuine challenge to muster up the usual kind of enthusiasm I would likely have had if circumstances had been more normal. I am personally striving to overcome the stated issues by doing my best to interact with my fellow students via social media platforms such as WhatsApp, Facebook and Instagram and by working from campus as much as is possible. By both supporting and being supported I have managed to complete this project which has, at times felt unachievable. The motivation issue has been overcome by me setting specific times to work on this project, changing my work environment and breaking down the assignment into relevant sections to tackle in small pieces. This has also helped to lessen the steepness of the learning curve on this subject which I have previously had very little technical knowledge on or experience in.

For this comparison I am going to set my synth 'Blue Heaven,' beside Arturia's legendary DX7 V. The DX7 V (FM) synthesis functions as it modulates one waveform with another to produce much more complex harmonic profiles than its analog family as with all FM synthesisers. With a plethora of sound choices running from acoustic and organic to the synthetic and highly processed sounds, you won't have to have an extensive knowledge of FM synthesis to use this plugin. It also has an extensive library of presets and endless sonic power of which you can tap into. 'Blue Heaven FM synth is a much simpler approach to things. The DX7 V arrives with a preset library packed to the brim with every 80's sound you could begin to imagine or remember and numerous instrument sounds to draw from including drums, piano, basses, marimba amidst numerous unique and quirky synth sounds which have been designed by the Arturia sound design team. So if you're looking for familiar sounds from the 80's or something new and unfamiliar to the ear, the DX7 V is a great synth to have in your plugin arsenal of virtual keyboards. Blue Heaven will follow the same FM concepts but as mentioned, in a much simpler fashion, focusing on one sound

signal that can be altered and manipulated by one or two modulating dials. Both synths can be used inside Ableton Live and many other DAWs and can both be used on stage for live improvised frequency manipulation and modulation. The DX7 V is extremely valuable when it comes to creating new sound effects and musical instruments for anyone who is wanting to focus more on creating their own sound.

The DX7 V has a host of new features which include multiple waveforms, a filter and feedback loop on each operator, new modulation sources, a monster unison mode, and more so is of course a very complex synthesiser made by professional sound designers.

In terms of aesthetics, the DX7 V is very visually pleasing whereas at this stage my design is a very basic, mechanical presentation which is grey and looks visually identical to the other plugins inside Ableton Live due to the fact that I have used Ableton's Max for Live to create the synth itself. In the future I would like to design a unique cover which would of course be a lovely sky blue and have a similar appearance to Kontakt's Analogue Dreams synthesiser.

In this instance I have decided to create a VST synth but there are many pro's and con's on both sides which I have also explored as part of my research for this project. Please find Pro's and Con's below.

The Pros of Hardware Synths

It will not be difficult to find a person who will argue that the sound of a hardware synthesiser will always be of better quality than a VST synth. The difference in sound is made most obvious when it comes to analog synths. The waveforms are a different shape, which result in a definitive sound difference. When it comes to digital hardware synths vs. soft-synths it's much harder to tell however, there are many people who will doggedly maintain that hardware does sound better and it is a fair argument because when it comes to analog, it's pretty hard to imitate the depth and warmth of tone.

One thing I haven't yet mentioned in great detail is the obvious point that the price of hardware synths is largely varied however, there are many more affordable options available today than in previous years. Also, hardware synths do hold their value and are often deemed to be a classic addition to a studio set up and when it comes to vintage equipment you could be paying a lot more than for a newer instrument on the market today. Many vintage units actually sell for more than

their original value.



(above — the Dave Smith Instruments / Sequential Prophet Rev2 and the Behringer Model D)

When it comes to live performance, there's the tactile element of having a tangible instrument in front of you, with dials and faders that can be tweaked and dialled in to enhance and effect the sound on stage which can be much more desirable to a performer than working off their laptop for example. Part of the beauty of making music is the interactive nature of the process and hardware synths represent this perfectly. There's also an element of improvisation when you are tweaking things and potentially creating live loops on stage. No one quite knows what will happen or what might possibly go wrong and will have to be adjusted on the fly.

The Cons of Hardware Synths

As mentioned earlier, the price of a hardware synth can vary massively. Brands such as Behringer, Korg, Arturia offer many lower priced options, however. Then there is the middle of the road range of digital and hybrid workstations from companies such as Roland and Sequential. On the higher end of the market are the premium analog or hybrid polysynths that offer extensive choice of sounds such as; Moog One, Waldorf Quantum, Yamaha Montage. For any of these synths you will be looking at a price range of anywhere from £1500 to £8000.

One Con of hardware synths however is that they take up physical space which obviously software does not so if you are working from a home studio set up then space may certainly be an issue to consider. When it comes to using hardware synths for live performance and gigs then portability also starts to become an issue. It's much easier to transport a laptop full of hundreds of sounds than it is to find a way to deliver three different hardware synths to a venue.

Lastly, there is the topic of versatility to discuss. Hardware most definitely has its shortcomings, particularly when it comes to analog equipment. Behringer's Neutron for example, has extensive parameters, 2 oscillators and a hefty patch bay, but when it comes down to the nitty gritty, you are looking at 5 waveforms and one signal exhibiting a distinctly analog tone. As much as many analog hardcore fans will defend the organic and un-challengeable sound of analog, when you compare circa-£300 worth of hardware to soft-synths of the same value, it remains undisputed that you will be guaranteed to get more choice and bang for your buck. So when it comes down to it, it really depends how you value sound quality over sound design choices and or presets.

Software synths

In the '90s, computers started to play an increasingly crucial role in music production — and the soft-synth market gradually grew in parallel. Innovations like MIDI and VST ([Steinberg's Virtual Studio Technology](#)) facilitated access to a broader range of sounds and a fluid workflow that proved irresistible for musicians and producers alike.

Nowadays, the software synth category is undeniably enormous. It ranges from emulations of classic hardware ([Native Instruments' Monark](#), [Arturia's Analog Lab](#)) to totally fresh architecture ([Omnisphere](#), [Native Instrument's Reaktor](#)).

The Pros of Software Synths

As I have mentioned previously in this essay, soft-synths offer an extensive amount of choice. Ranging from sampled emulations of classic hardware, to an artificial made wavetable-style synth, there are endless options and possibilities to help get you started. There are additional parameters to tweak, which will most likely emulate many of the things you would find on the actual original

hardware such as; cutoff, waveform, resonance, ADSR.



(above – Omnisphere 2, widely regarded as one of the most powerful soft-synths in the business)

The Cons of Software Synths

Sound – A debatable topic. Many people come from a somewhat, elitist perspective to put it kindly, when debating the sound quality of software synths in comparison to hardware and it is often subjective and to taste although there is a certain warmth in analogue that seems to be thus far unattainable in software synths. It is also very much dependant on a persons ears and experience in listening and having their attuned to what are sometimes, very fine differences. In terms of re-sale value soft synths just don't hold their weight whereas we know from what I've discussed above, hardware synths do.

The obvious point to mention is that software synths aren't tactile so the use of them requires a keyboard, mouse or midi instrument. They lack that pleasing aesthetic of being able to adjust knobs and move faders and such around at ease which can be a great limitation if you were to be using the software synth for live performance.

To conclude, once again this really does come down to personal preference and what the user is looking for and for which purposes. It also depends on what's important to the individual in terms of value for money, transportation and many other factors.

Reflection upon the results of your instrument. (500 words)

Conceptualising and visualising the instrument was definitely my strength in this project! When it came to the actual making of the instrument I found the task extremely difficult and my limited knowledge on the subject has limited my ability to bring this synth to fruition in a practical sense.

I decided to make my synth within Ableton's version of Max MSP and learnt most of how to do that via online tutorials, but also found that the tutorials had a lot of vital gaps that made it difficult for me to move on to next stages at times. In current conditions, it has been impossible to work with others as I might have otherwise which would definitely have made this a lot easier and made solving simple problems more doable.

As the synth currently stands, it is able to receive signal flow of which I have added parameters which allows for the adjustment of; velocity, attack, threshold, sustain and release. It works within Ableton flawlessly and will also work with live performance in conjunction with midi instruments such as Push, Launchpad and other midi controlled instruments.

I'm somewhat disappointed in the result but also trying to take the effect of current circumstances into consideration. I think that this task could have been better done as a group assignment or if people were to work as a pair. Obviously in the future that may be possible.

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