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# Research on the Making Technology of Virtual Orchestral Instrument

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## Abstract

In this paper, we propose an analysis of the sound source of virtual orchestral music in detail by using the production technology of sampling and playback, and technical experiments and verification for the most advanced Hollywood Library series of timbre and the timbre production and control technology of Vienna instrument Pro and other softwares, to find their solutions and come up with the best timbre production method for orchestral music from the perspective of the specific design ideas of the productions of virtual orchestral instruments. The so-called virtual orchestral instruments are non-real orchestral instruments, which are based on the imitation of timbre of real orchestral instruments, processed and synthesized through the scientific and technological means, and produced by the use of electronic equipments or computers. The study of virtual timbre production technology is very important, and it is like the study of composers' creative techniques. Not only scientific and advanced timbre production methods can be obtained from the study, but also new ways of future timbre production are expected to be explored.

▸ Keyword :virtual orchestral music ; computer music ; sampling ; timbre production

## I. The Introduction of Background

With the rapid development of computer technology, many software developers invent a software timbre that can be used in the computer, rather than hardware sound sources, so we generally call it “soft sound source”, that is, software sound source. Depending on the computer, it is convenient and quick to use, and its storage capacity will increase.[1] Today, there are a number of timbre production companies have made a lot of outstanding timbres in this way, such as the Symphonic Orchestra series of orchestral timbre developed by East West / Quantum Leap or the Vienna Special Edition series of orchestral timbre developed by Vienna Symphonic Library, Germany, etc. For the timbre production methods for virtual orchestral music, we should first mention the link of “sampling”. What is sampling? Sampling is to record and collect the sound sample and record the sound of real instruments, including different pitches, intensity and so on. While the edition and production and then playback of recorded instrument sound samples is called the sampling and playback. For example, the sampling of trumpet timbre is to record each pitch, different intensity of each pitch, and the sound of different playing methods in the studio to form multiple samples and combine them into a sound in accordance with the law of arrangement of scales, and then use the sound source or sampler to call these samples to make a sound in the production playback of MIDI. As the sampling of the sound of real instruments, so the imitation of traditional instruments by the sound source recorded in this way is often very realistic.[2]

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## II. Timbre production technology based on digital waveform sampling and playback

### 1. Recording technology

#### 1.1. Recording conditions

First of all, a better recording environment is the key. The recording of sound samples usually usually selects a recording studio with a better sound environment to carry out the recording, and many well-known timbre production companies will choose a famous orchestral recording studio.[3] EASTWEST has spent $ 5 million on the acquisition of Cello, the Hollywood well-known recording studio. Cello has five recording studios, three of which are very famous throughout the Hollywood. Cello was founded in the 1960s, among which one recording studio (Figure 1) can accommodate a symphony orchestra of 70 people.[3] The type and quantity of microphones used as pickups in the entire studio almost can be said is the top in all the recording studios, and a lot of Hollywood film soundtracks and TV soundtracks are done here. After buying the entire Cello studio, it becomes East West's studio, now called East West Studios, where all timbre sampling and post-processing work of East West will be done.[4]

Fig.1. EAST-WEST Studios

Second, for timbre sampling, the recording director is very important. Recording directors with rich experience can fully understand the performance and sound principle of various instruments, so as to record the best timbre samples to lay a good foundation for the late timbre production. Shawn Murphy, as a timbre recording director for Hollywood Brass, he has won the Oscar, C.A.S (Film Audio Association Award), Film and Television Arts Society Award and Emmy. Furthermore, the excellent player and the quality of instruments are the guarantee for recording quality, and players' techniques and timbre control ability are the keys to the quality of the timbre. The intonation, rhythm, timbre and control ability are important conditions for sample collection, and timbre sampling will always invite experienced and skilled players to record. Meanwhile, there will be a lot of differences among musical instruments with different qualities in the tone quality and timbre.[5] A good musical instrument sounds bright and transparent, with excellent texture, while with withered timbre and narrow frequency response, the sound of poor instruments is difficult to control.

#### 1.2. Recording mode

There are two types of sites that can be selected for the sampling recording of instruments: 1. Record in the recording studio. Recording in the recording studio only carries out the sampling in terms of the sound samples of instruments, which does not involve the effect of environment. Such result is that the sample sound is clean, with no environmental sound, leaving a lot of space for the late sound processing. Because of the limitation of conditions, the early virtual instrument sampling was carried out in this way. 2. Record in the real concert hall. The purpose of the environment selection of real concert halls is to record the real playing sound field of concert halls. The presentation is that the sound sample is accompanied by a sound of the playing environment, which can achieve the most authentic effect. But the recording mode with the sound field also has disadvantages, when you need dry sound, or do not like this sound field coming with together, and want to make timbre environment yourself, you cannot remove it, resulting in a limited production. With such a production mode, EASTW-EST's early Gold Edition series of orchestral timbre brought inconvenience to users. So the usual recording mode is to carry out in the recording studio.[6]

Now, the recording mode of EASTWEST's Hollywood Orchestra series of timbre is to record each timbre with five microphones simultaneously, including near-field microphone, mid-field microphone, medium microphone, aluminum surround sound microphone (the traditional Hollywood recording microphone positioning, so that not only the sound of instruments are recorded, but also the entire sound field environment is recorded. The producer can choose no environment sound to carry out the

production, can call the effect of different spatial sense at any time, and also can select all the sound fields to use together. Such approach is very flexible. There are CLOSE (near field), MID (midfield), MAIN (main monitor bit), SRND (surround) four option switches in figure 2, so that recording environment in different sound fields can be selected flexibly.


Fig.2. The recording mode with microphones

In order to achieve a more realistic effect, Hollywood String adopts a very detailed recording way to carry out recording. Its recording adopts the split microphone positioning way that highlights the leader, and configures two additional near-field microphones at the same time of each violin group's recording.[7] One of microphones is more directed to the leader, and the other is directed to others in the group. The volume of different microphones can be adjusted to emphasize the leader, which can give an impression that the voice of the leader is highlighted in the band.

There is also a more detailed recording mode, which is to locate the position of each player in the band or the stage. Various types of different positioning can also be collected, so that adequate preparation can be made for the post-mixing instrument space for the instrument space positioning in the late sound mixing.

## 2. Sample collection and planning

For the production aiming at a particular instrument, first we must understand the performance, voice mode and various playing methods of this instrument, and make a detailed statistics for all the sound effects it can produce to prepare for the recording sampling.

### 2.1 The number and collection time of samples

Due to the limitation of scientific and technological level and production technology, the sampling timbre produced in the early eighties and nineties of the last century sounds false and untrue. One of the reasons is because the storage space is not enough, so that a large number of timbre samples cannot be collected, not to mention the multiple potency dimension problem of timbre. Even some timbres only use a few samples of the same potency dimension to complete the timbre production, and then to carry out the automatic distribution through the intelligent computing based on the digital mode of basic samples, deriving other pitches to expand the sound area (Figure 3). However, the farther away from the base sample, the worse and less like the sound's texture is, and the speed and length of sound will also change, resulting in the decline of the overall timbre quality, which is the usual timbre making method of the hardware synthesizer produced in the eighties and nineties of the last century.

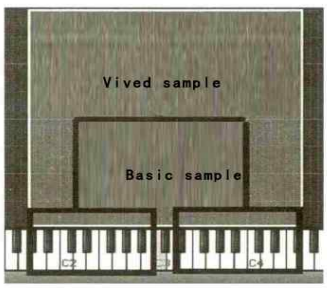


Fig.3. Derived Extended Range

There was a classic synthesizer Roland D50 in the 80s, and its storage capacity was only 1 megabyte, but also 100 timbres needed to be placed in this 1 megabyte space. Such situation is very extreme, but it is only to make timbre in this way under the limitation of conditions then, so the timbre quality must be poor. As the rapid development of computer technology and the increase of memory capacity, producers can finally no longer worry about the capacity problem and can record timbre samples as possible. Because each instrument has its own range, in order to make the timbre more realistic, it is necessary to carry out a sampling for all the pitches of instruments, and the pitch and multi-layer potency dimensions that their playing methods can play.[8]

In 2012, Vienna Library introduced the sampling timbre of Dimension String (s multi-dimensional string) timbre with a sophisticated production technology, and its sampling quantity has reached1 million. Due to the pitch and sound quality of the same tune on different strings must be different, so this sound source captures all the tunes that each string of stringed instruments can emit, resulting in a very large number of samples, which is a very comprehensive sampling method. The number of

sampling samples is only one factor, and the length of recording time of samples will have an impact on the sound texture. The longer the sampling time is, the more it can demonstrate the natural changes in performance. Some musical instruments are able to sustain a long time playing a single tone, such as the stringed instrument playing a long tone, and as long as the ne, such as the stringed instrument playing a long tone, and as long as player's physical strength allows, he can keep the playing on.[9] There are also long tunes played by stringed instruments for a long time in many works, but this unlimited recording needs the support of mass storage devices. In the early virtual instruments, due to the limitations of technology and equipments, the sampling time cannot be very long, or even a pitch can only be recorded for half a second or less, which has brought a lot of technical problems for post-production, and the post-production only can rely on the technology for loop playback of sound samples to make up. However, for the sample of such a short time, the effect produced by a regular loop playback will be very mechanical and unnatural. Therefore, it is necessary to record long-time samples as possible, without loop processing.

Fig.4. The Tone Sample of Violin Solo

As you can see from figure 4, in this timbre sample of this violin solo, a long tune is recorded for 17.45 seconds, and no loop production method is used. Some musical instruments cannot be played for a long time, and even need special playing skills to complete, such as the loop breathing method of wind instruments, but such recording method is usually not recommended, although such method can complete a long-time playing, but obviously, its sound quality is not very good. In order to achieve the performance effect of long tune, for this type of instruments, the production method of sample loop playback will also be adopted, to extend the sound infinitely through this technology.

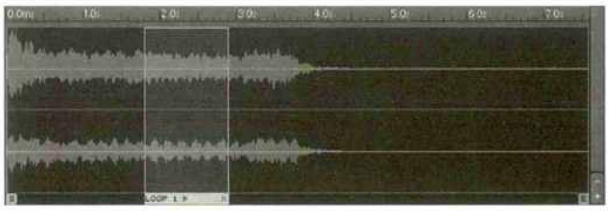

Fig.5. Circulation Processing of stringed instrument music

Figure 5 introduces the timbre of stringed instruments makes a loop processing within the range of1.9 seconds and 2.9 seconds, so that the timbre can carry out the loop playback in this range after entering the yellow area.

### 2.2 Sample types

From the left grid of figure 6, we can see all the instruments included in the timbre of Hollywood Brass, including the group play and solo of all the brass instruments. The number in front of the name of instruments indicates the number of instruments, such as: 2French Horns means the timbre of two French horns, 3Trumpets means three trumpets, and those begins with Solo mean the timbre of solo.

In the middle grid we can see each instrument has five kinds of playing effects, among which Long represents long tune, Short represents short tune, Effects represents some other playing methods, such as vibrato, gradually strong tune and so on. Legato represents the playing method with legato, Mutes represents the timbre of con sordino, and Keyswitch represents to switch playing method with the key. In the right grid we can see a variety of playing skills of instruments and several different timbres of long tune, such as: Exp Vibrato represents the expressive playing method with vibrato, SusVib represents a long tone with vibrato, and Sus NV represents a long tune without vibrato.

Fig.6. Hollywood Brass Tone Menu

From figure 7 we can see a variety of playing skills of the timbre of French horns, which also includes some expression-class performance timbres, such as the gradual strength of different speeds, decorative sound,

fast passing sound and other playing methods of French horns. In order to truly restore various sounds of instruments, it is necessary to strive to record all the playing methods and playing skills, resulting in a large number of samples, thus the timbre capacity will be expanded therewith.


Fig.7. The Different Performance Skills of Horn Tone

In order to make the virtual orchestra sound more realistic, the sampling collection of timbre is not limited to a single timbre, but also is to record the group timbre. The timbre in Hollywood String contains the individual recording of each group of stringed instruments, including the first violin prepared by 16 people, the second violin prepared by 14 people, the viola prepared by 10 people, the cello prepared by 10 people and the double bass prepared by 7 people. As you can see from figure 8-1, it also carries out the sampling recording for the ensemble of each string of each group of stringed instruments, resulting in a timbre with more elaborate small compilation combination. Such approach allows music creators to quickly get more real sound effects. Figure 8-2 shows the timbre preparation of Hollywood String and the distribution of the number of people in divisions.


Fig.8-1. Sample Recording

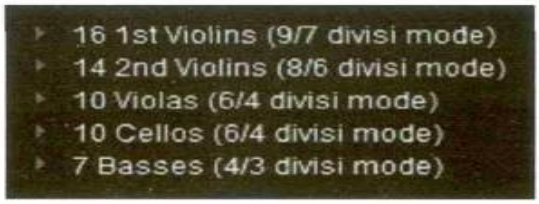


Fig.8-2. Tone Organization and the Allocation of the People's number

In the Hollywood brass timbre, EASTWEST also makes a separate sampling for combination of commonly used instruments of the same kind, such as the timbre of solo, and playing in unison of two, three, or even six French horns. From figure 9 we can see that the collection of timbre samples is very comprehensive, and commonly used combinations and playing methods are all included, so as to bring great convenience of music production.

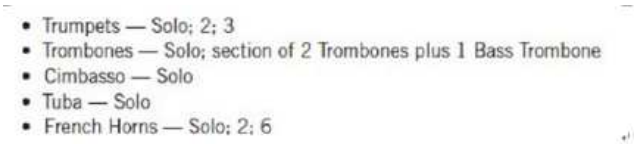


Fig. 9. Sample Gathering and Statistical Analysis

### 2.3 Sampling potency dimension layer

A musical instrument will have different color effects through the concert with different potency dimensions, and its sound quality will also change. It is not the zoom in or out on loudness of a trimbre, such as the sound of French horns is warm and soft when playing with light potency dimension, becomes full when playing with middle potency dimension, and can have a blasting effect when playing with great potency dimension. Therefore, in order to restore the true performance timbre, it is also necessary to carry out samplings of different potency dimensions for the sound of different potency dimensions that the player can play. Usually, the potency dimension layer of a good sampling is above four layers, and a good pianist can even play more than ten kinds of potency dimensions, and the timbre production of multi-layer potency dimensions will make the timbre be more delicate and realistic. The following figure is the distribution of potency dimension of timbre of the platinum edition percussion timpani produced by East West, a total of 13 layers of potency dimension.

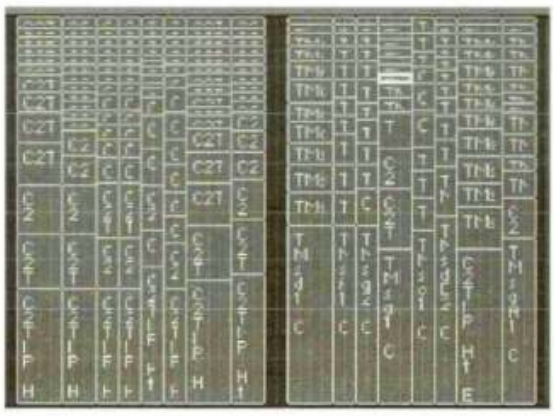

Fig.10. Intensity Distribution Map of Timpani

It can be seen from figure 10 that above the figure is heavy potency dimension, and the below is light potency dimension. The greater the potency dimension is, the more dense the sample distributed is; the less the potency dimension is, the less the sample distributed is. From this figure, we can also see that not every pitch is assigned the corresponding pitch sample, and some tones are extended out.

Although the collection of different potency dimensions, length and various different samples of playing methods can be described as comprehensive, but in order to make the timbre be more realistic, more detailed sample collection is also required. For example, when the instrument is played at different speeds, the resulting tone changes are very different, thus, in order to fully improve timbre sampling, the sound sample resulting from of instruments at the different playing speed also needs to be collected.

## 3. Sampling late synthesis technology

Timbre late synthesis technology is the key link to the production of timbre, and each link of timbre is needed to be adjusted or repaired, the step of which is related to the ultimate quality of timbre.

### 3.1 Amendment to samples

Due to the recording environment or the player and other factors, there is a difference in volume on loudness of many samples after the collection, which will make the volume between tunes be different when playing with the same potency dimension, resulting in trouble for the production, so it is necessary to adjust the loudness of all samples to prevent the occurrence of volume difference. When carrying out the recording sampling, there are also some flaws in the intonation, especially the intonation of wind instruments, which is difficult to control, so the intonation should be corrected. If the deviation is very large, the best solution is to re-sampling, which also shows the importance of pre-recording sampling link. If the sampling quality is not high, the difficulty of late synthesis will increase directly.

### 3.2 Adjustment to envelopes

Usually, an important part of the synthesis of timbre is to adjust the sound envelope of timbre. The envelope of timbre refers to the entire vocal process of a sound from the beginning to the end. That includes three kinds: amplifier envelope, pitch envelope and filter envelope. The process of envelopes is usually divided into four stages: At-tack, Decay, Sustain and Release (hereinafter referred to as A, D, S and R). Sound can change in different stages through the adjustment of value of those four stages, which is an indispensable function of any synthesizer and is an essential link of timbre post-production. It can be seen from figure 11 that by adjusting these four processes, the loudness, pitch and its filtering of timbre can be changed. Setting the envelope to adjust the continuation process of timbre.

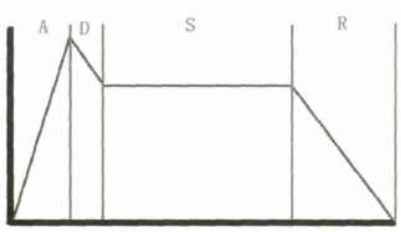


Fig.11. The Process of Package Route

# II. Control technology corresponding to real band playing

How to make music producers can easily play and control the timbre is a problem that sound producers must consider. Using the computer to create is not like the traditional way of composition, just consider the music itself is enough, but music producers also need to have some MIDI related knowledge and control technology, so as to create the music with abundant emotion and full of humane.

## 1. Tautophony technology

The early use of the timbre of virtual orchestral music in the hardware synthesizers to create music always make people feel mechanical and rigid, lacking changes. One of the reasons is the number of samples of the same pitch and the same playing method is small, thus at the time of repetition, the sample is only one, with no change. When playing the tautophony, although players play the same pitch with the same playing method, there is a subtle change of the sound made each time. As the number of sampling samples increases, for the technology of tautophony, it is possible to use samples alternately, thereby avoiding the effect of "machine-gun" (continuous repetition of the sound of the same texture) which was generated when the early timbre was carries out the tautophony. There are 9 samples triggered randomly when the Hollywood brass timbre repeats the same short tune, which can make the sound achieve a more natural effect. The Vienna Orchestra's virtual orchestral timbre creates more detailed settings in the tautophony, including Repetition Slow and Repetition Fast, each of which produces a corresponding timbre and each repeated timbre has four sound samples for the random trigger.

The author has recorded two different timbre samples of the flute with different sound source for comparison (see Figure 12). The upper figure is the Xpand sound source, and the lower figure is the Vienna Library sound source. With the same pitch of small character group 2 a, using MIDI to trigger the two sound sources, from the four same repetitions of potency dimension, loudness and length, we can see the flute timbre of the Xpand sound source obviously in the upper figure, and the four waveforms of the same sample all do not have any change and their shapes are the same after the continuous four repeated playing; while in the lower figure, the four repeated sample shapes of the flute timbre of Vienna Library sound source are different. This clearly shows that XPAND's flute timbre is repeated with the same sample, while Vienna Li-brary's flute timbre is four different sampling samples. Such mode makes each repeated sound have a subtle change, and such production method is more humane.

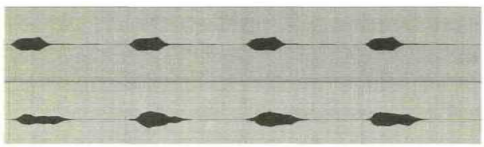

Fig.12. Different Sound Source of Two Flutes Sample

As we can see from figure 13, sometimes it is possible to trigger samples of different potency dimensions by switching different keys. Vienna Library orchestra offers nine samples of different potency dimensions for the producer to switch and use randomly.

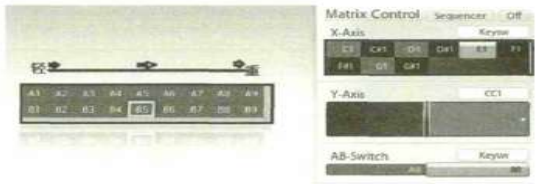


Fig.13. Corresponding Keys of Intensity

## 2. Legato transition control technology

When conducting the performance of real instruments, the transition between tunes is natural and coherent, while virtual instruments are conducted by the procedure of continuous playback after the collection of a single sample, so they lack the characteristic of the part of sound connected between sound and sound. Early timbre producers ignored this part of sound production for various reasons, so sometimes the connection between sounds will appear stiff, not natural. And with the improvement of production technology, producers gradually also put this very important link into the production.

When the stringed instrument is playing the melody, the sense of coherence between tunes is very important. The timbre of bow playing method is unique and charming, which is one of the characteristics of the timbre of stringed instruments. In order to make virtual stringed instrument music be more realistic, the producer presets three most frequent legato modes: 1. Continuous legato, 2. Swith-bow legato (to change the direction of bows in the process of connecting bows), 3. Glissando legato (the glissando effect produced by the finger wiping the string when the transition between tunes). However, Holly wood String can control the speed of glissando legato through potency dimension. The lighter the potency dimension is, the lower the speed of glissando is. It can also automatically call legato samples at different speeds according to the speed of playing, and the automatic call can change by coordinating with the actual playing speed. A variety of legato samples triggered by different speeds are preset in the software, so the effect is naturally different from the previous mechanical legato timbre of stringed instruments.

## 3. Playing method switching technology

### 3.1Key switching

Each instrument has a lot of playing methods. Such as violin's playing, pizzicato and tremolo, brass's legato, staccato and so on. When using the MIDI way to produce music, each playing method represents a timbre, and each timbre is to be chosen in the different timbre channels. Under such circumstances, the production of music produces a lot of trouble, such as your 1-3th section is playing, and the 4th section is pizzicato. When you want to play the 4th section, you have to stop the playing, and re-switch another track of the corresponding pizzicato channel, which will make your playing be incoherent, and also need to set a variety of timbre channels resulting from different playing methods, causing a certain extent of trouble to the production. And when the producer can make the timbre preparation with the method of Keyswitch, you can arrange different playing methods by using the way of triggering keys to the corresponding key, and open different playing methods by triggering different keys.


Fig.14. Tone of cinematic Strings

Figure 14 shows the timbre of stringed instrument music of the software Cinematic Strings. The pitch position on the keyboard corresponds to the eight commonly used playing methods of stringed instrument music, from top to bottom are respective the play the music, tremolo, minor second tremolo, minor second tremolo, fast legato mode, staccato, accented staccato and pizzicato, and such setting is clear. In figure 15, the white keys represent the parts with pitch that can be played and the blue keys represent the parts that can be switched by corresponding playing methods.

Fig.15. Keyboard Display

Today, most virtual instruments all use this timbre-switching mode for timbre production, and such mode can be set in more complex way, for example, to switch more keys in the vertical and horizontal coordinates. It can be seen from figure 16 that X and Y represent vertical and horizontal coordinates, and the switching key in the bass area can be changed by switching X and Y, thereby increasing more playing methods or playing modes. However, this design is too cumbersome, and the requirement for producers is high. It is necessary to master the control and change methods skillfully to carry out the production freely.

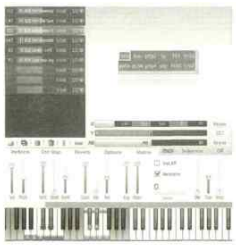

Fig.16. Tone Switch Menu

### 3.2 Controller switching

Some timbres have a wide range and many keys, even the timbre of full keys (88 keys). The switching of using keys to control playing methods is not convenient enough in the playing, so it can be switched by the controller, as well as some knobs or faders of the external equipment or on the MIDI keyboard. Today, what is more advanced is the use of Tablet PC as the controller of Vienna Instruments pro software produced by VSL Company to operate. Tablet PC is connected to the computer through the wireless network, which then triggers the change of some parameters inside Vienna Instruments pro or the switching of playing methods, so that it is more convenient to operate.

Usually, the switching mode of playing methods of some virtual orchestral timbre is preset, and the producer cannot be free to change, but this software Vienna Instruments pro can customize the switching mode. Whether the position arrangement of keys or the use of other controllers to operate, you can set according to your own needs or habits. Music producers can break free of constraints and create flexibly.

As we all know, playing a long tune of a trumpet, from light to heavy blow, the timbre will gradually change. From weak to strong, there is a significant change in sound quality from the soft timbre to metallic timbre. In order to achieve such a real change, it is also possible to make linear control change on different sampling samples,

and the gradual speed can also be changed according to the requirements of the producer. The seamless operation between several sampling samples can be carried out through controllers.

The vibrato effect produced by the String of stringed instruments is also very common. Real String is also divided into fast and slow, or from slow to fast with a change. Hollywood String can control the speed of the String through the modulation wheel to make the sound played be more natural.

### 3.3 Playing speed switching

When players play, due to different playing speeds, the coherence produced between tunes and the sound texture will be different. In order to achieve this natural and humanized effect, first, it is necessary to collect the samples of timbre comprehensively, including the samples played at different speeds, and then to trigger different sampling samples intelligently by tapping the speed of keyboards, so the effect thus produced is as the real playing. As we can see from figure 17, the slow-speed sample response area is shown in the X-Axis diagram on the left hand, and the fast-speed legato sample response area is the right one.

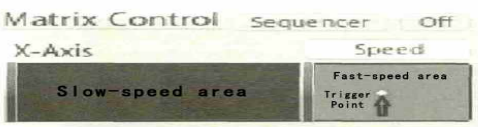


Fig.17. Performance Speed Switch

## 4. Playing procedure presetting

For composers, perhaps what they most hope is to play a comprehensive, wonderful and most realistic sound on the keyboard freely, and directly show the best playing effect. From this, we can see that how to make the composer be more convenient when making music and make playing be more handy, the presetting of convenient procedures is extremely critical.

### 4.1 Pitch presetting

In addition to the humanized processing on the tautophony technology, the neutrality of the pitch also need the technical processing. It is often said: “The sound of machine is too accurate, and it will be more like real if is less accurate”, in fact, it is the case. Samples sampled early all conduct the pitch correction in the later stage, and the sample pitch triggered each time is fixed, which will have a certain sense of mechanics. In order to achieve a high degree of simulation, virtual instruments have to do a humanized processing for some details. Usually, the grasp of pitch of players in their playing will not be as accurate as the machine, which is embodied a very important aspect of human nature. Vienna Instruments pro can conduct the pitch change processing of microtone for each tune’s beginning of virtual instruments or anywhere in the continuous process, and can set up twelve kinds of pitch changes and make them appear in turn, and coordinate with different samples triggered by different playing speeds at the same time.

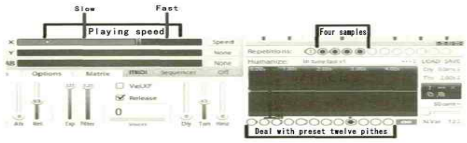


Fig.18. Pitch Processing Preset

As is shown in figure 18, three different presetting modify the change process of timbre in the pitch continuation, and twelve kinds of presetting can be set according to your own needs, so as to achieve the effect of continuous changes.

Fig.19. Processing of Intonation fluctuations

As is shown in figure 19, by adjusting the beginnings and ends of each tune, the sound made has slight changes in the change of pitch, so no rigid, immutable and extremely accurate pitch will occur, but the random subtle intonation floating processing. Thus, such all-round and intelligent processing way can get rid of the sense of mechanics, and make the presentation of sound be more natural.

### 4.2 String and bowing presetting

The timbre of Vienna’s Dimension Strings also has a quite humanized production method. The producer can set the string from which the sound is played, or can also play with the preset conventional position. Since the number of sampling is comprehensive, the producer can also control whether each tune of the string is played with the upper or lower bow, which is a realistic simulation.

## III. Effector use technology

A sound entity is often larger than the largest instrument (the playing place is a sound entity, so we call it "room" for the time being). We cannot "play" a room, but this is just what the best room desires - like other instruments, they want to be played by players, conductors and composers. The so-called "playing room" means that we can freely control the space of the sound. Only the reality of instruments' sound is far from enough, and the playing environment also needs reality. In order to simulate the real orchestral sound in all directions, in addition to the real simulation of timbre itself, the playing environment of timbre also needs real simulation. Due to different audition environment, such as different concert hall environment, cinema environment and space of different sizes, etc., the final result thus produced are different, so the limitation production for real orchestral music's playing sound field is also very important. In addition to the collection of instrumental sound samples, reverberation samples are also required, that is, it is necessary to take sample the acoustical characteristics of reverberation in the room where instruments are played. Vienna Company has developed reverberation effect software Vienna MIR PRO. This software belongs to the "convolution reverberation", which stores a lot of famous reverberation presetting in the concert hall. MIR software has conducted sampling for the several classical halls in the Musikverein, such as Vienna Golden Music Hall, Mozart Hall and Schubert hall and so on, which is like the sampling of impulse response convolution reverberation.

Fig.20. Concert Hall

MIR engine adopts a very real concept of "cyclotron reverberation". This application has more than 1000 individual impulse responses per room. For example, placing the French horn in the Vienna MIR virtual concert hall, the position on the stage will trigger one or more settings of eight pulses (six horizontal directions and two up and down directions). The character direction of each instrument is already provided before the cyclotron pulse, and the result is the need to reflect to different directions depending on the frequency distribution and instrument's volume. For example, when the French horn points to the rear, it will have different spatial frequency with the trumpet in front. MIR engine will calculate all this in real time, and what listeners get is what they heard at that time - it seems that the French horn sounds like it is playing at the specific location on the stage, and it will not be limited by the location where is first used for a pulse recording. The impulse response of MIR has a high-fidelity stereo sound format that can make each point of the room's available area achieve seamlessly inserts. MIR space simulation technology is adjusted through the three-dimensional chart, namely, the so-called "What you see is what you get". At different locations, the instrument can simulate the space where the instrument locates through the sampling operation of such locations, so that the listener can listen to the direction changes of instruments. You can also choose the direction of instruments, or even let them play back to the listener. Listeners can also choose to collect sound at the command's location, or have an audition at any location in the concert hall's auditorium.

Figure 21 shows the occurrence point is in left, middle and right different azimuths. As you can see from the figure, the player is randomly placed anywhere on the stage, and the sound heard from the speaker by the listener is the same as in the concert hall. The Vienna MIR PRO provides the designer with a well-designed control icon that can give people an overview of the sound at the first glance and can allow the producer to quickly and intuitively control all aspects of instruments' sound. This preset reverberation method is almost used universally in all sound sources, but like Vienna's MIR PRO, a advanced reverberation space control technology with a larger controllable range is still relatively rare, but such design idea has been also slowly adopted by other companies.

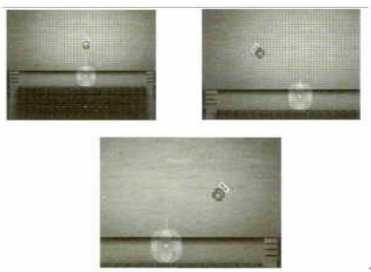

Fig.21. The Musical Feelings of Different Directions

## IV. Conclusion

From the analysis of the above production technology, we can see that virtual orchestral production technology by means of sampling and playback has been quite comprehensive and mature. The timbre made through the use of these technical means can carry out a high degree of simulation of real instruments, but in the future, there will be more new technology to make timbre production means be more perfect and convenient.

In a word, Virtual Orchestra will be mostly widely and popularly used with the rapid development of computer technology, which imperceptibly indicates a revolutionary in patterns and techniques of stringed instruments performance in future music in a traditional sense. The revolutionary will be a breakthrough in performance and space and environmental constraints. Without doubt, compared with conventional Orchestra performance, the making and control technology of virtual Orchestra instruments still need to go through further correction and improvement.

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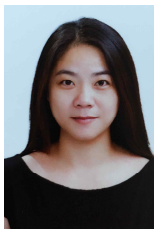

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