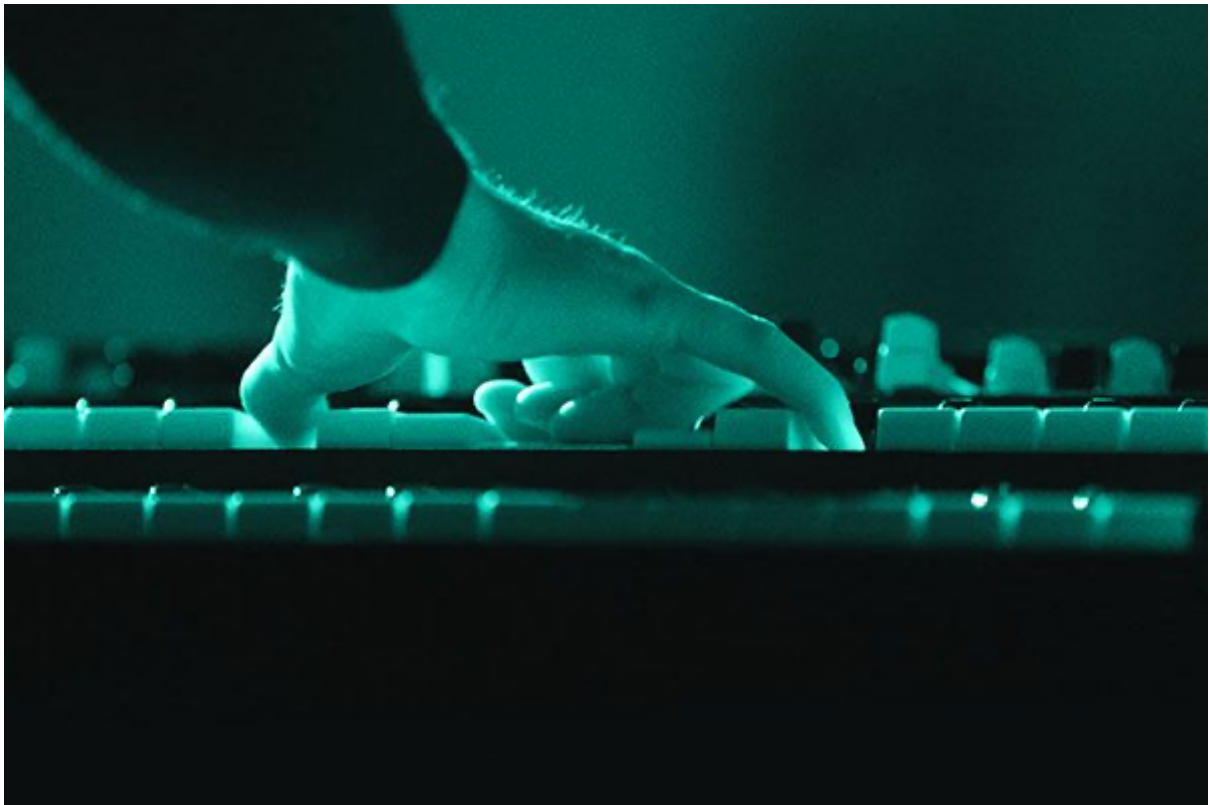


Tim Corfield

Element D2b

Instrument Essay



Word Count: 3970

Introduction

This essay is to reflect on the John Cage, percussive piano, a VST instrument that has been developed by myself. Some things that I will be discussing are the defining characteristics of the instrument, what has led me to some of the design choices in the creation process and I shall be reflecting on the development process and how it could be improved upon.

To create a virtual instrument to something that I've never done before in my life and certainly not within my musical career. As a challenge it's something that I have found difficult in this process. Creating a virtual instrument is no easy task, particularly when you look at the market of hundreds virtual instruments; to see what is out there really is quite daunting to come up with something purely original that has his own unique selling point.

Creating an instrument is no small task, and certainly when you look at the likes of native instruments or Spitfire Audio it's very difficult to envisage an original piece of work that could appeal to end users. Some of the questions that arise in developing this are:

1. What instrument I have created.
2. An overview of the principle's behind how my instrument works.
3. Issues that were encountered during the created and how they were overcome.
4. Reflection of the results of the instrument.

5. Improvements that could be made to the instrument and how these can be applied.
6. Comparison of my instrument to other commercial providers of VST instruments.
7. User feedback and beta testing of the instrument with the focus group.
8. Discussions of my approach to creating the instrument.

What instrument I have created?

In order to understand what a virtual instrument is, you would need to look back into the history of music production and to understand what an electronic instrument is. Surely a virtual instrument is an electronic instrument like a synthesizer or original piano?

The difference is that it is a program that has been installed onto a computer whether this be an Apple Mac or a Windows system. So, an electronic instrument is a musical instrument that produces sound using circuitry, instead of a mechanical instrument, such as a piano, where we have length of prepared wire, which has struck by hammers.

These electronic adjustments rely on the manipulation of electrical signals to generate modify and control sound and has used production went on through our history synthesizers developed a musical protocol called midi which stands for musical instrument digital interface “MIDI is an acronym that stands for Musical Instrument Digital Interface. It’s a way to connect devices that make and control sound — such as synthesizers, samplers, and computers — so that they can communicate with each other, using MIDI messages” (Indiana University). It was

this protocol that enabled computers to control the sounds of these electronic instruments, so that they could be recorded, manipulated and used to perform, live to an audience. When do you think of synthesizers do you think of brands such as Roland, Korg, and of course Yamaha.

But again, this is not far enough in the history, to understand what an electronic instrument is, and how it developed into a virtual instrument.

What was the first electronic instrument created? The Telharmonium, also known as the Dynamophone, was an early electronic musical instrument invented by Thaddeus Cahill in the late 19th century. It is considered one of the earliest examples of electronic music technology “The Telharmonium (also known as the Dynamophone) was an early electrical organ, developed by Thaddeus Cahill c. 1896 and patented in 1897.” (Wikipedia)

So since the 19th century we already have examples of an electronic instrument and thus started a whole series of brands and inventors of electronic instruments that we see today such as:

- Roland
- Yamaha
- Korg
- Behringer
- Moog
- Nord and many more (Gear4music)

It was only till the 1980 did we see a company called Steinberg Media Technologies who saw that these physical instruments could be created and manipulated on a computer. Karl Steinberg is one of the key names in music production history one might say he was a key pioneer of music production that we see today and certainly he runs the most successful music software in Europe

“Karl Steinberg now runs one of Europe's most successful software houses.” (White, P). It was from his Company that brought use the VST instrument a revolutionary tool that would be used in the world of music production today “1996 This year sees a development that can only be described as revolutionary” (Steinberg). The VST (Virtual Studio Technology) plugins generally run as a standalone virtual instrument or can be used as a plugin with a DAW (digital audio workstation) such as Cubase, Logic Pro, Pro tools and many more. Most VST's are either instruments, effects or processors which are vital tools to a musician or producer. Some VST's are emulations of historic synthesizers such as the Roland Juno which can be bought directly from Roland's cloud VST library “Sounds of past, present and future. Yours in minutes” (Roland Cloud). Neon was the first of a series of VST instruments that would follow over the coming years and it was included with Steinbergs Cubase VST 3.7. It was a oscillator which could be played with human expression but also was able to interpret midi data. In later years other developers realized the potential of Steinberg VST plugins and soon a whole world of instruments where made available. Early VST were just emulations of real world instruments but as technology advanced, VST instruments became more sophisticated and diverse. The market saw an influx of virtual instruments offering realistic emulations of acoustic instruments, drum machines, and more. The availability and affordability of VST instruments made them popular among musicians and producers. Thus making music creation affordable vs shelling out mega bucks for Yamaha Grand Piano! Popular commercial vendors of VST plugs are:

- Native Instruments
- Roland
- Spitfire Audio

- Propellerhead Software

The John Cage Percussive Piano

Creating a virtual instrument is no easy task, particularly when you look at the market of virtual instruments to see what is out there really is quite daunting to come up with something purely original that has his own unique selling point.

As I work in the education sector as a Music Teacher teaching secondary students I wanted to develop a plugin that would compliment a students learning practically that taught at A-level. Part of the A-level course there is a study into a very influential and renowned composer called John Cage. Like with many composers Cage was exploring new ways of creating and organizing sound and had a significant impact on the development of avant-garde and experimental music in the 20th century. Also known for his most controversial and musical works which was a piece called 4'33" (Schwarm, B). It was a composition to represent a musical element silence but it also reflects his interest in Indian philosophy and his exploration of silence. "4'33", musical composition by John Cage created in 1952 and first performed on August 29 of that year. It quickly became one of the most controversial musical works of the 20th century because it consisted of silence or, more precisely, ambient sound—what Cage called "the absence of intended sounds." (Schwarm, B)

Like other composers before him such as Debussy Cage was drawn to unique sounds or Eastern music such as Gamelan (Appendix A) where the instrument is percussive. Cage wanted to transfer these types of sound into different western world instruments such as the Piano. In the late 1930s, Cage began experimenting with the prepared piano technique. He would carefully place objects on the

strings, strategically positioning them to achieve desired sounds. Each object produced a unique timbre and altered the pitch and resonance of the strings when struck by the piano hammers “Cage experimented with inserting various everyday items between the strings of the notes” (Pearson). The resulting sounds ranged from muted, bell-like tones to metallic rattles and buzzing noises (Appendix B). Cage's prepared piano compositions opened new avenues for exploration and experimentation in music. They challenged traditional notions of melody, harmony, and rhythm, embracing chance operations and indeterminacy. The prepared piano technique influenced subsequent generations of composers and expanded the possibilities for extended techniques on the piano and other instruments.

It was this sound that I wanted to create so that I could aid students in there learning of this controversial composer and perhaps inspire their creativity.

In order to create a VST of this caliber I needed to start with the composer himself and study how he came up with the concept of putting nuts and bolts into a piano. John Cage produce a table (appendix D) which detailed the size and shape of the bolt. Cage was also particular to detail which string it would go into and the distance from the bridge of the piano to the dampers (appendix C).

As this was to be my first foray into the world of VST instrument I did not want to over complicate the creation process thus my instrument would be based on one octave (12 semi tones).

I started with a Baby Grand Piano located where I work Reepham High school in Norfolk (appendix E). The materials I would be using where generic stainless steel bolts which I intended to wedge into the strings of the Piano. Using John Cage’s guide I would choose a octave from middle C and measuring the

distances which could be anything from 1 inch to 6 inches would place the bolt into the one of the set of three strings of the note C (appendix F).

In order to capture the sound I would need to decide on a suitable microphone, position and number of different mic positions. This I would be limited on due to the equipment afforded to me at the time. Currently for my setup I use a Behringer UMC204HD USB audio interface which only has two inputs; so this would be my first limitation and if I had access to more funds would certainly be the first improvement and purchase a more suitable interface however, I would be able to capture my audio through the 24bit/192kHz converters “studio-grade 24-Bit/192 kHz converters for the best possible sound quality” (Behringer). For the microphones I was grateful that my school possesses the AKG C1000’s (appendix G) which gives good results on a wide range of instruments “Gives usable results on a wide range of instruments including acoustic guitar.” (White. P).

The C1000’s were placed forty centimeters apart and thirty centimeters above the treble strings of the piano (appendix H). They were then connected into my audio interface close so that I could easily play each note and record (appendix I). As I stated earlier I did not want overcomplicate the development of this instrument and so I decided that I would record each note at three different velocities soft, medium and strong. In addition to these velocities to get a continuity each note would be recorded 3 times. This was done so that the software that I would design would be able to cycle through them when the note is played through a DAW.

For the design of the instrument again would be kept simple but it would be done with the Phobospear branding which I have already established,

furthermore I would be limited to the feasibility of this project and resources available to me at the time.

The controls would be a simple design of a dial, fader and a switch graphic (appendix J). If more funds were available to me I would commission a company that specializes in GUI (graphic user interface) design to develop a series of controls to match my brand.

To create the software I would be using two different programs Hise which is a open source framework for sample based instruments. There are a number of resources which are available to me some of which are:

- Video tutorials
- Github which is a central website for developers with shared resources and help guides.
- Microsoft Visual Studios which is a IDE (Intergrated Development Enviroment) which helps programmers to develop their apps.

In Hise I was able to create a program that contained a sampler however, for it to understand my samples they needed to be edited and labelled in a certain way. This sampler which I was able to add on using Hise did have a very clearn function that would be key to the sound quality of the JCPP (John Cage Percussive Piano), in that it was able to cycle through multiple samples and recognized different velocities. Again this would depend on how the samples were edited and labelled.

Each sample needed to be of the exact length otherwise Hise would not be able to play them in a coherent manner so I needed to use Cubase and ensure each sample was sufficiently edited. The tuning standard for Midi was agreed by the Midi Manufactures Association in the Midi protocol “precise musical pitch

agreed to by the MIDI Manufacturers Association in the MIDI protocol”
(Wikipedia).

Each sample would also need to be exactly labelled so that the sampler in Hise could understand what they were. This also included an understanding of Midi note referencing something that I was not familiar with.

The MIDI note numbers range from 0 to 127, covering a total of 128 possible notes. Note number 0 represents the lowest note (typically C-1 or C₀ depending on the conventions used), and note number 127 represents the highest note (typically G₉). The middle C (C₄) on a piano keyboard is usually assigned note number 60. For example, if you want to play the note A₄, you can send a MIDI message with the corresponding note number 69 to any MIDI-compatible device, and it will produce the correct pitch, regardless of the specific instrument or synthesizer being used.

Hise would also need to understand which velocity the note is so the word dynamic is used and the file is labelled accordingly:

- Dynamic 1 – soft
- Dynamic 2 – Medium
- Dynamic 3 – Strong

As I said earlier Hise is able to cycle through the samples to create a more realistic sound this process is called round robin and the file has the following included:

- rr1
- rr2
- rr3

So the files are labelled in a very specific way as follows:

Piano_close_60_dynamic1_rr1

Piano is the instrument, close is the mic position, 60 is this midi note number, dynamic 1 is the velocity and finally rr1 is the round robin feature which Hise uses.

Because this instrument is going to be aimed at schools and education I wanted to keep the functionality simple and user friendly. So in the first iteration of the plugin the only controls available would be gain, pan, delay which is when the note would be triggered and width.

Gain and pan are fairly self-explainable. Gain is to increase the volume and Pan for sending the signal of the instrument left or right. Width is so the musician could change the stereo widening of the sound. The delay function is intended in a live aspect and this would be so the musician could delay the triggering of the key pressed depending on what style of music is being performed.

Details of issues encountered and how these where overcome

Thanks to the video tutorials learning how to use Hise was fairly straight forward task. What was also clear in direction was the design element as I would be using my existing branding.

The biggest issues I face was understanding how to compile and use my instrument with my DAW. If this was going to be a product to be marketed at schools then there would need to be a plugin file that teachers and students could install.

Hise does have an export feature which allows you to make a VST plugin or a standalone instrument. To my ignorance one assumed is was a simple case of

clicking the export function and when doing so to find how underestimated this process was!

I have mentioned earlier the resources that are available to help with using Hise. One of those resources is a website called Github which is also referenced on Microsoft webpages. Located are comprehensive instructions of how to compile Hise for various platforms such as MacOS and Windows. As the computer systems used at the school where I work are Windows base this would be the system I would be compiling to. This process also required a copy of Microsoft Visual Studios to be installed along with the latest version of the Hise source code which is located on the Github page.

To make the process easier to compile the instrument the samples needed to be consolidated into one file which would also add a level of compression to the overall file size. The original size of the samples is 80.9Mb but once compressed I ended up with one file with a size of 30.4Mb.

User feedback and focus group testing

Once the first iteration of the instrument was completed I wanted to gain valuable feedback to the overall quality, look and useability of the instrument. My focus group would consist of:

- Geoff Green Head of Music at Reepham High
- Sarah Ballard Music Teacher and Producer

(<https://sarahballardmusic.co.uk>)

First impressions were positive encourage that a VST plugin was develop with education in mind. The overall look of the instrument resembled the branding of Phobosphear Productions certainly with the addition of the logos and color

scheme of the brand. The comments made toward the simple approach to the controls was positive and is helpful to students who may not be ICT literate.

Sarah Ballard stated that - “the graphics of the controls could be more inkeeping of the Brand perhaps with a futuristic feel certainly would be more appealing with a younger generation”

Geoff Green stated that – “even though I like the look of the instrument and the simplicity of the functions I would prefer more control over the expression of the sounds produce. It would also be useful if there was an effect that could be added so that there was another level of expression when played as a standalone instrument.”

This feedback which was receive from the focus group was absolutely vital to the development of the JCPP.

Second Iteration of the JCPP

Armed with this new information from the focus group I was able to relearn some the additional functionality of Hise and add new features to my VST instrument.

Hise has a number of built in effects and processes that one can use in building a VST instrument but it is important that these are added in a certain way. This is called a process tree. A process tree also known as a process hierarchy or process tree diagram, represents the relationship and structure of processes in an program “Process trees allow us to model processes that comprise a control-flow hierarchy” (vanSelst, S.J and Leemans, S.J.J).

So in Hise the processes are the Sampler followed by effects which I am able to add which come with Hise.

So using the feedback that was given in the focus group I decided to add the following and compile into a VST plugin for Windows:

- Attack – is a parameter of the envelope when a sound's volume rises from zero to its maximum level after a note is played.
- Release - the time it takes for a sound to fade out after a key is released.
- Reverb – this creates a tail of reflections of the sounds as if it were to be bouncing off walls in a hall which then decays over time.
- Along with the Reverb I also added a bypass button so this effect can be turned off without having to adjust the dial (appendix K).

Improvements that could be made

Even though I was initially pleased with the results of the JCPP VST plugin there would be some improvements that I would make. As mentioned earlier if I had access to further monetary funds I would purchase a bigger interface so that I could have multiple mic positions. But to think on a more grander scale I would look to enlist the services of a professional studio and work on a more prestigious instrument such as the Yamaha CFX Concert Grand Piano (Yamaha).

In terms of a studio then there would be nothing compared with the worlds largest recording space, Abbey Road Studio One “The world's largest purpose-built recording studio, Studio One can comfortably accommodate a large symphony orchestra or chorus. It's played host to celebrated classical recordings from Elgar

and Prokofiev, as well as iconic film scores from The Lord Of The Rings Trilogy,” (Abbyroad).

Another point of improvement I would like to make is to improve the quality of the sounds the plugin produces. In order to get a better sound of the percussive piano is down to the number samples you have “The more samples you record, the better the result will be, but the longer the recording” (Titeux, N.) To ensure that you have enough realistic sound there is a simple formula to follow which can give you a total number of samples needed. The formula is as follows:

- $\text{number of notes} \times \text{number of velocity layers} \times \text{number of round robins}$

So in the case of the Percussive Piano if I were to use the full amount of keys 88, and I would like to have up-to 5 velocity layers and finally I would stick with 3 round robins.

- $\text{Number of Samples} = nvr$
 - $88 \times 5 \times 3 = 1320 \text{ samples}$

This simple equation represents a huge task that would be involved to make this improvement I would need to justify whether there is a immediate demand for this instrument and how much I could sell it for.

How does this compare to existing commercial instruments

Currently there is already a company that has already produce a similar instrument. The company is called Big Fish Audio which is based out in United States. Since 1986 the company has been producing virtual instruments based on orchestral sounds “Thirty-four years ago, we recorded and created the first commercially available virtual instrument, the Prosonus brand of orchestral libraries. Since 1986, Big Fish Audio has consistently produced the highest quality

sample libraries available” (Big Fish Audio). Their John Cage Prepared Piano which retails at \$99.95 features 1320 samples of various bolts and screws inserted into the strings of a Piano. Their instrument feature 45 different Pianos that have been prepared “Forty-five of the piano's eighty-eight keys were prepared, eleven with double preparations; three dynamic levels in five articulations comprise a total of 1,320 samples.” (Big Fish Audio).

However, in terms of the free market there is no such VST plugin that exists. There are various sample packs that can be found royalty free which you could use and drop into a sampler on a DAW. Would this limit the musician on freedom of expression? Without carrying out further testing it would be difficult to ascertain.

Did I achieve the goals I set out?

In a word, yes! The initial idea was to create a VST plugin that could be used in a secondary/college setting where students could experiment and understand the sounds the John Cage created through his passions and influences of eastern musical styles and instruments.

The JCPP plugin is simple and user friendly. With functionality that has been developed through feedback given by an industry lead focus group. Already through research and if more resources were made available there would be clear improvements that could be made perhaps even with the addition of making that improvement in schools with the aid of students to further their understanding not only of the composer but of the production techniques required.

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4'33", musical composition by John Cage created in 1952 and first performed on August 29 of that year. It quickly became one of the most controversial musical works of the 20th century because it consisted of silence or, more precisely, ambient sound—what Cage called “the absence of intended sounds.” Schwarm, Betsy. “4'33””. *Encyclopedia Britannica*, 11 Apr. 2023, <https://www.britannica.com/topic/433-by-Cage>. Accessed 15 July 2023.

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Cage experimented with inserting various everyday items between the strings of the notes

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Forty-five of the piano's eighty-eight keys were prepared, eleven with double preparations; three dynamic levels in five articulations comprise a total of 1,320 samples.

Appendix

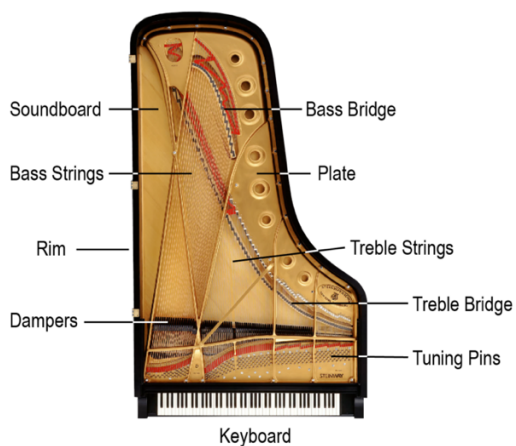
- Appendix A (image taken from <http://survivingmusictheory.weebly.com/section-b-world-music.html>)



- Appendix B (image taken from <https://www.newyorker.com/magazine/2010/10/04/searching-for-silence>)



- Appendix C (image taken from <https://www.musicalitynetwork.com>)



- Appendix D (Image taken from <https://www.seattlepianoteacher.com/a-performers-guide-to-the-sonatas-and-interludes-for-prepared-piano/>)

TONE	MATERIAL	SINGS LEFT 1-2	DONES RIGHT 2-3	MATERIAL	SINGS LEFT 2-3	DONES RIGHT 3-4	MATERIAL	SINGS LEFT 3-4	DONES RIGHT 4-5
16ms				SCREW	2-3	1%			A
				MED BOLT	2-3	1%			G
				SCREW	2-3	1%			F
				SCREW	2-3	1%			E
				SCREW	2-3	1%			D
				SM. BOLT	2-3	2%			C
				SCREW	2-3	1%			B
				FURNITURE BOLT	2-3	2%			B
				SCREW	2-3	2%			A
				SCREW	2-3	1%			A
8ms				MED BOLT	2-3	2%			G
				SCREW	2-3	2%			F
				SCREW	2-3	2%			E
				SCREW	2-3	2%			C
				MED BOLT	2-3	3%			B
				SCREW	2-3	4%			A
				FURNITURE BOLT	2-3	1%			G
				SCREW	2-3	1%			F
				SCREW	2-3	2%			E
				SCREW	2-3	2%			D
			SCREW	2-3	1%			C	
			SCREW	2-3	1%			B	
			SCREW	2-3	1%			B	
			SCREW	2-3	1%			A	
			SCREW	2-3	2%			F	
			SCREW	2-3	2%			E	
			SCREW	2-3	2%			D	
			SCREW	2-3	2%			C	
			SCREW	2-3	2%			B	
			SCREW	2-3	2%			B	
			SCREW	2-3	2%			A	
			SCREW	2-3	2%			F	
			SCREW	2-3	2%			E	
			SCREW	2-3	2%			D	
			SCREW	2-3	2%			C	
			SCREW	2-3	2%			B	
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			SCREW	2-3	2%			A	
			SCREW	2-3	2%			F	
			SCREW	2-3	2%			E	
			SCREW	2-3	2%			D	
			SCREW	2-3	2%			C	
			SCREW	2-3	2%			B	
			SCREW	2-3	2%			B	
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			SCREW	2-3	2%			F	
			SCREW	2-3	2%			E	
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			SCREW	2-3	2%			C	
			SCREW	2-3	2%			B	
			SCREW	2-3	2%			B	
			SCREW	2-3	2%			A	
			SCREW	2-3	2%			F	
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			SCREW	2-3	2%			B	
			SCREW	2-3	2%			A	
			SCREW	2-3	2%			F	
			SCREW	2-3	2%			E	
			SCREW	2-3	2%			D	
			SCREW	2-3	2%			C	
			SCREW	2-3	2%			B	
			SCREW	2-3	2%			B	
			SCREW	2-3	2%			A	
			SCREW	2-3	2%			F	
			SCREW	2-3	2%			E	
			SCREW	2-3	2%			D	
			SCREW	2-3	2%			C	
			SCREW	2-3	2%			B	
			SCREW	2-3	2%			B	
			SCREW	2-3	2%			A	
			SCREW	2-3	2%			F	
			SCREW	2-3	2%			E	
			SCREW	2-3	2%			D	
			SCREW	2-3	2%			C	
			SCREW	2-3	2%			B	
			SCREW	2-3	2%			B	
			SCREW	2-3	2%			A	
			SCREW	2-3	2%			F	
			SCREW	2-3	2%			E	
			SCREW	2-3	2%			D	
			SCREW	2-3	2%			C	
			SCREW	2-3	2%			B	
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			SCREW	2-3	2%			F	
			SCREW	2-3	2%			E	
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			SCREW	2-3	2%			C	
			SCREW	2-3	2%			B	
			SCREW	2-3	2%			B	
			SCREW	2-3	2%			A	
			SCREW	2-3	2%			F	
			SCREW	2-3	2%			E	
			SCREW	2-3	2%			D	
			SCREW	2-3	2%			C	
			SCREW	2-3	2%			B	
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			SCREW	2-3	2%			A	
			SCREW	2-3	2%			F	
			SCREW	2-3	2%			E	
			SCREW	2-3	2%			D	
			SCREW	2-3	2%			C	
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			SCREW	2-3	2%			A	
			SCREW	2-3	2%			F	
			SCREW	2-3	2%			E	
			SCREW	2-3	2%			D	
			SCREW	2-3	2%			C	
			SCREW	2-3	2%			B	
			SCREW	2-3	2%			B	
			SCREW	2-3	2%			A	
			SCREW	2-3	2%			F	
			SCREW	2-3	2%			E	
			SCREW	2-3	2%			D	
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			SCREW	2-3	2%			B	
			SCREW	2-3	2%			A	
			SCREW	2-3	2%			F	
			SCREW	2-3	2%			E	
			SCREW	2-3	2%			D	
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			SCREW	2-3	2%			D	
			SCREW	2-3	2%			C	
			SCREW	2-3	2%			B	
			SCREW	2-3	2%			B	
			SCREW	2-3	2%			A	
			SCREW	2-3	2%			F	
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			SCREW	2-3	2%			F	
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			SCREW	2-3	2%			A	
			SCREW	2-3	2%			F	
			SCREW	2-3	2%			E	
			SCREW	2-3	2%			D	
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			SCREW	2-3	2%			F	
			SCREW	2-3	2%			E	
			SCREW	2-3	2%			D	
			SCREW	2-3	2%			C	
			SCREW	2-3	2%			B	
			SCREW	2-3	2%			B	
			SCREW	2-3	2%			A	
			SCREW	2-3	2%			F	
			SCREW	2-3	2%			E	
			SCREW	2-3	2%			D	
			SCREW	2-3	2%			C	
			SCREW	2-3	2%			B	
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			SCREW	2-3	2%			A	
			SCREW	2-3	2%			F	
			SCREW	2-3	2%			E	
			SCREW	2-3	2%			D	
			SCREW	2-3	2%			C	
			SCREW	2-3	2%			B	
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			SCREW	2-3	2%			A	
			SCREW	2-3	2%			F	
			SCREW	2-3	2%			E	
			SCREW	2-3	2%			D	
			SCREW	2-3	2%				

- Appendix E (imagen captured at Reephram High)



- Appendix F (image captured at Reepham High)



- Appendix G (Image taken from <https://reverb.com/uk/p/akg-c1000-s-cardioid-condenser-microphone>)



- Appendix H (imagen captured at Reepham High)



- Appendix I (Image captured at Reepham High)



- Appendix J (Image created using Hise)



- Appendix K (Image taken from Cubase)

