

SYNTHARP

Daniel Miller

211507

Development

Essay

Wordcount: 3609



Introduction:

This essay will detail the research, discussion, work and feedback conducted in the creation of my sample-based virtual instrument. The first half will focus on the research undertaken, with the second half looking at the design and building processes. I will follow this with a discussion over potential improvements, before concluding with my overall experience of the project.

My objective for this assignment was to build a sample-based software device, blending the charms and possibilities of both acoustic and electronic instrument design through the emulation of an unfamiliar acoustic instrument and additional experimental synthesis capabilities. An area of music technology that has fascinated me for years, I feel passionate about building this into my career and excitedly anticipated learning the recording, library processing and design processes involved.

Along with instrument creation, I also have a keen interest in synthesis and experimental sound design. I regularly enjoy experimenting with the intricate editing capabilities of my Elektron Digitakt digital sampler, often incorporating the results into my own productions. The destructive capability of analogue technology also fascinates me, on which I based a past project involving the use of self-built cassette-loops and Impulse Responses.

Combining these passions, I wanted to incorporate both acoustic irregularities and digital control into my project. Therefore, I decided it would be interesting to use an unfamiliar acoustic instrument as my sound source, opting for the autoharp. I planned to design an instrument allowing ease of use whilst providing in-depth sound design capabilities, adding my own 'space' through the inclusion of a self-recorded Convolution Reverb.

This project allowed me to indulge in my interests around acoustic and digital audio production, whilst making use of my technical recording and processing skills. Allowing me to experiment and learn software design has given me crucial coding and design skills, which I feel excited about making use of in future projects, as well as hopefully benefitting my future career path.

Introduction to Syntharp:

Syntharp is a polyphonic software instrument based on samples taken from the strings of an autoharp and processed through user-definable audio synthesis methods. Triggered by a MIDI input, the relevant velocity-mapped sampled note of the instrument is played back, with a variety of sound design features available to on the interface.

Featuring several adjustable parameters, Syntharp allows the user control over the envelope functions: Attack and Release, as well as the Cut-off and Resonance of a low-pass filter. There are three algorithms to choose from, 'Warp', 'Bright' and 'Toy', each offering a pre-defined effect chain to add colour the instrument, selectable through buttons on the interface. Finally, a truly original Convolution reverb provides a user-definable 'space', of which I will detail the process in the 'Work' section of this essay.

Taking influence from the colourway of the original instrument, the Graphical User Interface (GUI) depicts a sketchy drawing of the autoharp, designed with the help from a good friend, Jessie Campbell. The Filter, Envelope and Space functions are adjustable through rotary knobs, whilst the 'Warp' 'Bright' and 'Toy' effects chains are initiated using individual buttons, positioned horizontally along the lower part of the interface.

Research

With the availability of affordable technology and ability to share creations easily through dedicated websites and social media platforms, sampler instrument creation is a popular and fast-growing area of the music industry. Personally, I have discovered many creatives and devices using platforms such as Instagram and YouTube, both of which bolster a strong community of likeminded experimental musicians and developers.

I have a huge admiration for composer, Christian Henson, who founded Spitfire Audio alongside Paul Thompson in 2007 (Wikipedia, 2021). Producing high-quality virtual instruments and sample libraries, Spitfire Audio products range from vast, orchestral packs, such as the 'BBC Symphony Orchestra' (2019), to the wildly experimental 'Pool Project' (2021): a collaboration with artist, Oliver Patrice Weder, involving the recording of a variety of instruments within a highly reverberant pool house. I have also found great inspiration in the Spitfire LABS sample packs, with the meticulously detailed audio quality, and creative thought behind instrument choice largely inspiring me into taking this venture into software instrument design.

Furthermore, Henson set up Pianobook, "a peer-to-peer community of composers, producers and sound smiths sharing their sounds for all to use for free" (Pianobook, 2022), in 2018. With hundreds of creative sample packs available for free download, many of which are authored by independent developers, Pianobook is a wonderful resource for browsing the creations of independent and small-team Developers. I feel enthused by what is defined as a "community", with the aim to:

promote the notion that the best sounds for music are made by people who make it!
(Pianobook, 2022)

I also found great inspiration from sound designer and composer, Matt Bowdler's creative electronic project, 'The Unfinished' (2022). Collaborating with Hans Zimmer and Spitfire Audio to name just a few, Bowdler creates cinematic sound and synth design, offering a

range of creative sound sets through his website. I particularly resonated with the persona Bowdler appears to add to his creations, almost presenting each device as if present in their own unique world:

Sound design is about listening. Good sound design is not about what you create, but about what you choose to leave out (Bowdler, 2022)

I aimed to build this philosophy into the creation of my own instrument, aiming to present it in its own space, brought to realism through the inclusion of an original convolution reverb and through intricate recording techniques, highlighting the unique acoustic tendencies of this single instrument.

There are a variety of different Sampler formats available, with the current most popular being: Kontakt, EXS24, Decent Sampler, SFZ and Ableton Sampler. However, it is important to recognise some of the formats, such as EXS24 and Ableton sampler, are only available in their native Digital Audio Workstation (DAW)¹. As a result, I have chosen to make my instrument in Kontakt, due to it being available as a free plugin for any DAW, as well as its own standalone Application. Ensuring my instrument is widely compatible will give it the best opportunity for user interaction, and therefore potential commercial success.

¹ EXS24 is only available for Logic Pro, whilst Ableton Sampler is restricted to Ableton Live

Work

My aim was to create a sampler instrument that both highlighted the aurally pleasing individual resonances of the autoharp, whilst also providing a starting point for experimental sound design.

In this section I will be describing the processes involved in creating Syntharp, detailing the recording, processing, software-building and interface design methods undertaken for this project.

Instrument creation

Recording

In order to capture a faithful emulation of the autoharp, I chose to record the instrument using condenser microphones, as they would be sensitive to even the quietest resonant nuances, and provide a flat frequency response, ideal for capturing an accurate recording, in line with my aims.

I used a stereo microphone attachment on a Zoom H5 recorder, with the 90-degree XY positioning allowing for the natural panning of the instrument, as well as capturing resonances throughout the instrument in each sample, giving a thorough and realistic recording. I ensured the microphones were set to a desirable level, without peaking, before proceeding to record five velocity layers of each string, as suggested by experimental audio programmer and composer, David Hillowitz (2020).

XY mic

This has two crossing directional mics.



Features

- Shock mount structure minimizes external vibration noise.
- Mic can handle sound pressure input of up to 140 dB SPL, allowing it to capture sounds that previous recorders could not.
- Three-dimensional sound with natural depth and width.

Figure 1: 90° angle XY microphones (Zoom, 2014)

As my aim was to produce samples with a clean timbre, I remained mindful of hiss, hum and interference from other sound sources whilst recording. I positioned the microphones a few inches from the sound hole, in the centre of the instrument and ensured of correct phase correlation with each string through test recordings. I chose not to record 'round robins', the process of taking multiple recordings of the same source to give a more human-like variety when triggered (Spitfire Audio, 2019), as I felt the unpredictability introduced by this would damage the impact of the included synthesis controls, such as the filter cut-off, which would behave in a far more stable manner when fed a constant input signal.



Figure 2: Stereo microphone placement for recording

Processing

Though not often hugely noticeable when recording, the noise floor from hardware, such as microphones and preamps, can build into an audible issue, becoming increasingly apparent as the levels of polyphony build. In order to control this, I used the 'voice denoise' function of the Izotope RX noise reduction software. Using a short recording of the room as my noise profile, I imported the samples as one audio file into RX and applied the denoise plugin, setting the threshold and reduction levels to sufficiently reduce the noise floor without drastically colouring the important aural characteristics of the instrument. When satisfied, I exported back into the Logic session for further processing.

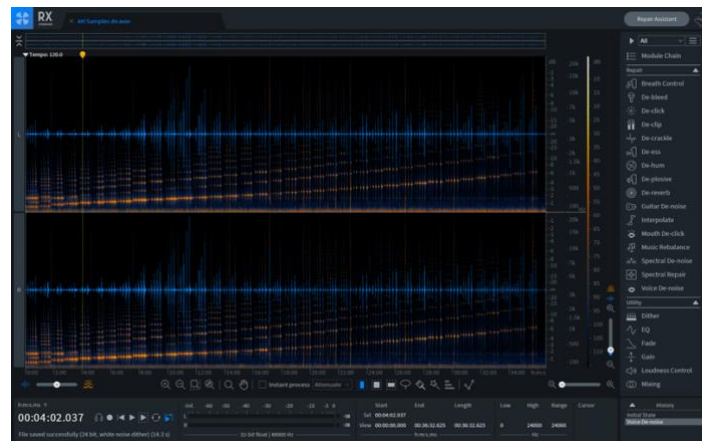


Figure 3: Denoising using Izotope RX

With 36 notes and 5 velocity layers, I was working with 180 individual audio files. With many files, it is crucial to remain well organised, reducing the opportunity for confusion and improving workflow. To achieve this, I created tracks for each string of the instrument, grouping these together to allow processing to all tracks collectively. I made use of the key command 'tap to transient' to speed up the process of cutting silence from the start of each audio file, before adding fadeouts to each sample and naming them based on note and velocity, for example, 'AH_C2_2' (UNSW, 2005). As well as presenting neat and logical, this would aid the Auto-map function of Kontakt when importing into a new instrument. Finally, I exported as high-quality 48kHz, 24-bit files and organized my files into folders, based on velocity.

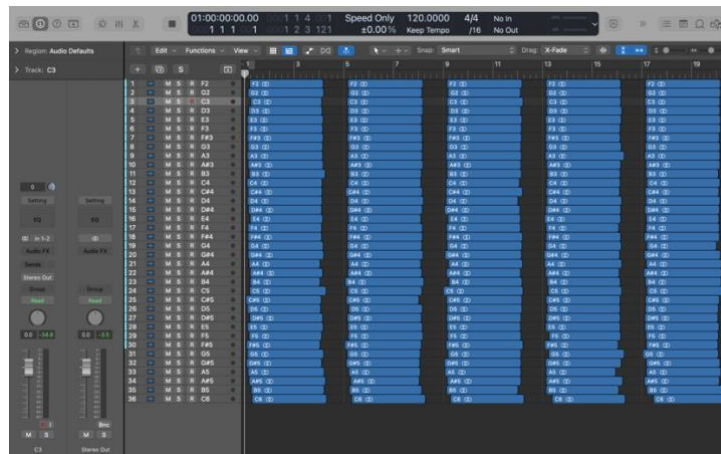


Figure 4: Samples in Logic Project

Building in Kontakt

The next step was to import my samples into a new Kontakt instrument. I created five groups, for each velocity layer recorded, before importing the relative audio files into the Mapping Editor of each group. As my samples were uniform in name structure, I was able to make best use of the Auto-map function, automatically assigning each file to their correct position on the keyboard. Best utilizing the Auto-map function saved me a lot of time, hugely important when working to a strict deadline. I fine-tuned and ensured a uniform level for all notes, before setting the velocity boundaries for each group. I then adjusted the built-in envelope to match that of the instrument: a fast attack and long, 8000ms release.

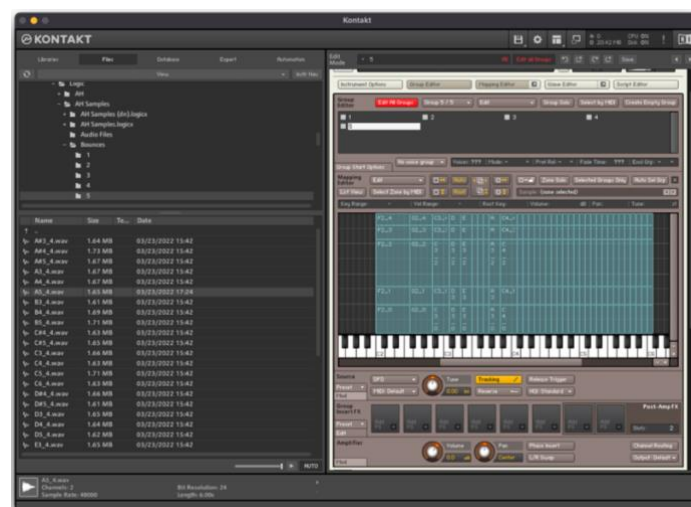


Figure 5: Automapping in Kontakt 6

Following on, I wanted to make use of the Insert Effects to add subtle glue and warmth to the instrument. I used the Compressor and TransLimiter to slightly tame the transients, with the Tape effect adding a little warmth. I also wanted to give the user an option to modulate the instrument with selectable, predefined effects. I liked the EQ 3, Chorus and Lo-Fi inserts, selecting these with the view of mapping them to named buttons on the interface. I experimented with different low-pass filters, eventually choosing the Ldr L4, as the four-pole slope provided the steep, 24dB attenuation I desired (Frequency Devices Inc., 2014).



Figure 6: Insert Effects chain

Building in Kontakt: Convolution Reverb

Aligning with my desire to create a truly unique 'space' for Syntharp to sonically reside in, I felt the inclusion of an original convolution reverb would be an exciting addition, whilst also offering a unique selling point for my device, a narrative I could build into my brand identity and implement into further releases.

I decided to include an Impulse Response I had recorded when given access to the Meeting House Chapel in Sussex. The reflections of the space are incredible, with the dome-like shape providing a rich, 10-second reverb tail and the distinctive window array adding a subtle fluttering effect. Using the 'Virtual Echo Chamber' method, involving two speakers positioned either corner of the room and two measurement microphones in the opposite corners, I played a frequency sweep through each speaker in turn, to capture the space.

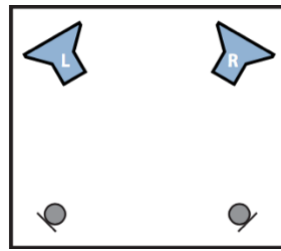


Figure 7: 'Virtual Echo Chamber' method (Apple, 2022)



Figure 8: Meeting House Impulse Response set up

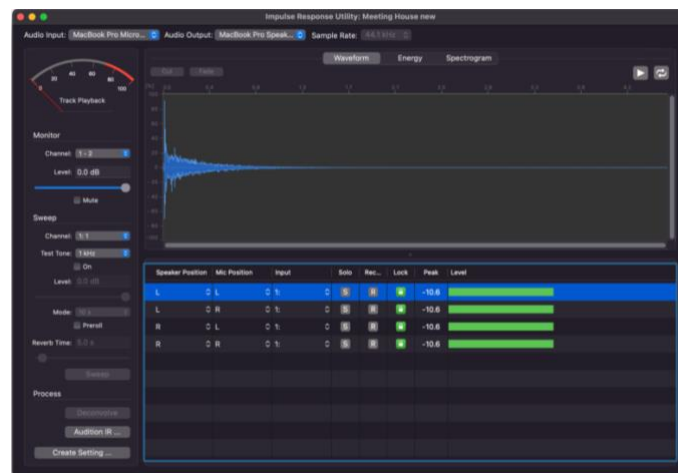


Figure 9: Impulse Response Utility file

As I used Apple's Impulse Response Utility software (Apple, 2022), the convolution process creates a .SDIR file, for use in the Logic Pro Space Designer reverb plugin. I converted this into to .wav file, recognisable by the convolution engine inside Kontakt.

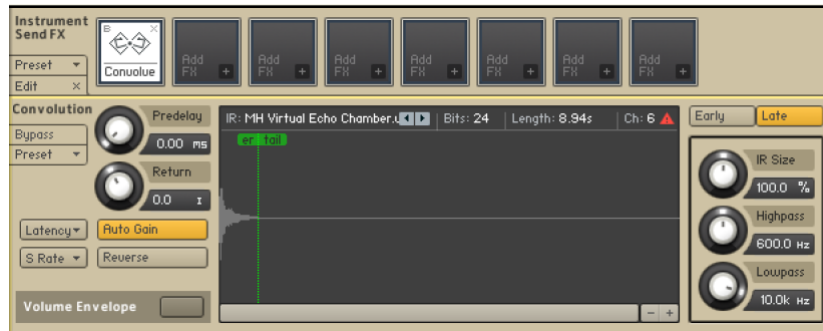


Figure 10: Convolution reverb in Kontakt

Building in Kontakt: Scripting

The next task was to add a GUI to my instrument. Though I have coding experience, working with JavaScript to develop an interactive software instrument, as well as HTML and CSS for website design, using the Kontakt Script Processor was the aspect of the project I felt least comfortable with. Making extensive use of tutorials, as well as referring to the KSP Reference Manual throughout, was crucial to the process.

Kontakt Script Processor (KSP) is a procedural scripting language (YummyBeats, 2020), meaning it is not object oriented like C# and JavaScript (Doherty, 2020). Everything is organised into call backs: small blocks of code that get executed when different events happen, in reference to previously defined variables (David Hilowitz Music, 2018). An example of this could be the instrument starting up or a note getting played.

In order to create a visual interface for the instrument, it is first necessary to define 'make_perfview', executing the script using 'On init' at the beginning and 'end on' to end each block. The height of the interface is defined using the 'set_ui_height()' command, which I made relative to pixels using the '_px' extension to match the dimensions to that of the designed artwork. To add the desired knobs, I used 'declare_ui_knob()', moving these to their correct location using the 'move_control()' command. I was able to find snippets of code and names of devices using the KSP Reference manual, helping me discover the location of the send level for my convolution reverb: 'ENGINE_PAR_SENLEVEL', for use in my script.

Much of my learning process was done through trial and error, such as my discovery of the 'make_persistent()' function, which keeps knobs at the same value when not used, of course pivotal in any fully functioning instrument. At points, getting familiar with the Kontakt software felt like a steep learning curve. I feel there are frustrating parts of the software, such as the lack of key commands or intuitive scrolling.



Figure 11: An example of my code, showing the function of two declared variables

Design

The importance of visual aesthetics in audio software is huge. Many of the leading plugin manufacturers have one thing in common: their products are pleasing on the eye. Whether it be the smooth, warm colour palette of Valhalla's VintageVerb (2012), or the ultra-realistic Waves J37 Tape (2013), visual design plays a huge part in selling the device before it is even heard (Apple, 2022). Visual presence can also be an important cue in the function of the plugin, as demonstrated well by J37 tape.



Figure 12: (Waves, 2013)

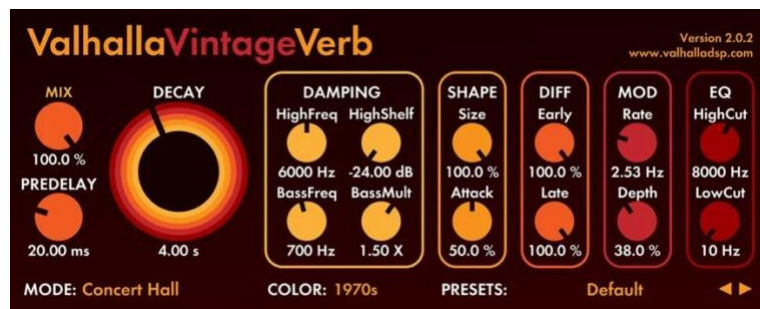


Figure 13: (ValhallaDSP, 2012)

Users often grow frustrated with DAW stock plugins, as they rarely possess the quality and descriptive visual interface of their third-party counterparts.

Shifting focus away from artwork, layout is another hugely important factor. A GUI with logically positioned elements can drastically increase workflow, whereas an overcomplicated interface can confuse the user, and even scare them away from using the device. Referring to the FabFilter Pro-Q 3 EQ plugin (2018), Producer Chris Selim talks of the importance of interface in terms of process:

it doesn't sound better...but the workflow within the plugin itself is superior (Chris Selim - Mixdown Online, 2020)

I also constantly referred to German designer Dieter Rams' 'Ten Principles for Good Design' (2017) throughout the process:

1. Is innovative
2. Makes a product useful
3. Is aesthetic
4. Makes a product understandable
5. Is unobtrusive
6. Is honest
7. Is long-lasting
8. Is thorough down to the last detail
9. Is environmentally friendly
10. Involves as little design as possible

Taking all the above information on board, I wanted to emulate the instrument in a visually enticing, yet original manner within my GUI. I feel I was most inspired by the warm colour palette of ValhallaDSP's VintageVerb, as well as the hand-drawn aesthetic presented by Aberrant dsp in the SketchCassette II plugin (2020). I enjoy the playful element of this design, whilst it importantly adheres to Rams' principles: retaining an innovate style whilst remaining understandable and unobtrusive.

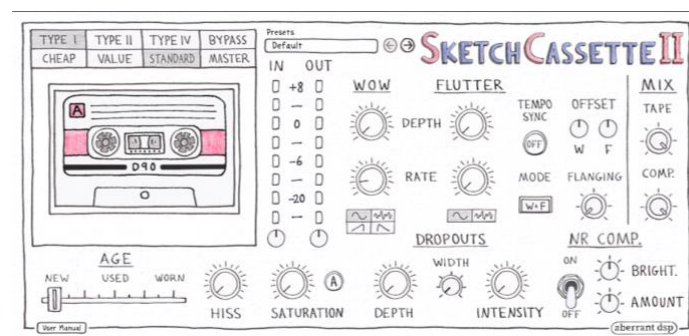


Figure 14: Aberrant SketchCassette II

In my design, I ensured all knobs controls were of a size that felt comfortable to use, whilst spaced and formatted in a logical way. I tried to keep my design original and uncluttered, whilst retaining the key visual features of the autoharp instrument I was emulating.

In future, I would very much like to make the interface visually reactive, such as replacing the Kontakt-native knobs with my own drawn versions, and movement in the strings when initiated.

I placed a high level of importance on the design process, as I would like to use the style as a template for future projects, giving my brand its own recognisable aesthetic.

Discussion

Issues encountered

Initially, I aimed to add further synthesis elements to Syntharp, including an envelope shaper to affect the filter section and a rate-adjustable Low-Frequency Oscillator (LFO). I also planned to include a 'loop' function, to allow further focus on sound design through the ability to create anything from 'freeze'-like drones to long repeating samples.

Due to the limitations of the Kontakt software, it is only possible to add modulation to effects present in the 'Group Insert FX' section, an area of the software notoriously difficult to call into a script. After successfully sculpting the effects and desired parameters, I was unfortunately unable to figure out how to present these in my GUI, and due to time constraints for the project, had to remove these functionalities for this early version of Syntharp.



Figure 15: Group Insert FX

How I overcame and adapted to these issues

Though at first disappointing, I decided to overcome this issue by placing emphasis on pairing the instrument with MIDI controllers to initiate filter envelope modulation through the automation of the 'Cut-off' knob on the GUI. Though providing a satisfactory short-term fix, I would like to properly address the problem, ultimately adding the feature in for a future version of the instrument.

Once I am comfortable with the scripting for this section, I feel the synthesis modulation capabilities will increase the potential of using Syntharp as a deeper tool for sound design, which remains a key focus of the instrument.

Conclusion

Referring to the planning stage of my instrument, my initial objective was to blend acoustic and experimental electronic elements into an easy to navigate and visually enticing sample-based software instrument. I wanted to produce high-quality samples presented through a user-friendly and unique GUI.

Considering these objectives, I feel I was able to achieve my goals and produce an instrument I feel very proud of. I believe I have created a unique concept with the addition of an exclusive Convolution reverb, while the GUI provides a visually pleasing and recognisable element. The inclusion of a logo gives clarity to the use for the device, with inspiration taken from the typeface on the original instrument adding a delicate yet individual touch.

Furthermore, I feel I have developed valuable skills in sampler instrument creation. The ability to use Kontakt and the Script Processor will provide invaluable for me as I pursue a career in the field of instrument development. Understanding Izotope RX is also a very respectable skill to have, as the programme is extensively used in a huge variety of creative media settings, including film audio and music production.

In addition, I have found the presence of communities with likeminded aims, such as Pianobook, hugely helpful. Developing an understanding of Kontakt allowed me to explore many open-source instruments, opening my eyes to the generosity of many of these developers, who inspired me throughout the process.

Though unable to implement all the features I set out in the planning stage, I feel confident that as my scripting ability grows, I will be able to add these in future versions of the

software. Aiding my desire for the instrument to be easily understood by users at all ability levels, I feel it would be beneficial to add a 'pre-sets' folder, providing a diverse selection of stating points to demonstrate the capabilities of the instrument.

An important part of the process was in user feedback and beta testing. I sent test versions of the instrument to friends and colleagues, asking them to respond with what they liked and what they think could be improved. James Burns suggested the addition of the 'Bright' switch, to give a different tonal option to the instrument, whilst complimenting the artwork. I am grateful for this suggestion as I feel its inclusion gives an additional timbre to the instrument, particularly useful when used to create lead melody lines.

I thoroughly enjoyed this process and am already looking to develop another sampler instruments using the concept I designed for this project. I would like to create more impulse responses to use with future devices, perhaps looking more creatively and capturing profiles of the resonances of instruments and less familiar locations. I feel confident in growing this as a brand, as I believe the sonic aims and GUI possess an identity that would resonate with the experimental audio community present on social media. Making use of these streams would help build the profile of my designs, as well as listing these for download, along with user manuals, on my website. I am hugely excited to begin work on further devices soon.

Bibliography

- Aberrantdsp, 2020. *sketchcassette*. [Online]
Available at: <https://aberrantdsp.com/plugins/sketchcassette>
[Accessed 15 3 2022].
- Apple, 2022. *Impulse Response Utility Manual*. [Online]
Available at:
[https://help.apple.com/impulseresponseutility/mac/1.0.3/en/impulseresponseutility/usermanual/Impulse%20Response%20Utility%20User%20Manual%20\(en\).pdf](https://help.apple.com/impulseresponseutility/mac/1.0.3/en/impulseresponseutility/usermanual/Impulse%20Response%20Utility%20User%20Manual%20(en).pdf)
[Accessed 3 3 2022].
- Bowdler, M., 2022. *The Unfinished*. [Online]
Available at: <https://www.theunfinished.co.uk/about/>
[Accessed 12 3 2022].
- Chris Selim - Mixdown Online, 2020. *Stock Plugins vs Third Party Plugins - What YOU NEED to Produce a PRO MIX*. [Online]
Available at: https://www.youtube.com/watch?v=Hzs1yWaKBH4&ab_channel=ChrisSelim-MixdownOnline
[Accessed 14 3 2022].
- David Hilowitz Music, 2018. *Intro to Kontakt Scripting: Adding your First Knob + FREE KONTAKT INSTRUMENT*. [Online]
Available at:
https://www.youtube.com/watch?v=uYghRBv1piE&list=PLUlzDbia61baXhHgGfsZsSwDKME1N3apg&index=12&t=771s&ab_channel=DavidHilowitzMusic
[Accessed 1 3 2022].
- David Hilowitz Music, 2020. *How I make sample libraries - 2020 Edition (Kontakt, SFZ, Decent Sampler, REAPER)*. [Online]
Available at: <https://youtu.be/N6wprMToxSg>
[Accessed 12 3 2022].
- Doherty, E., 2020. *What is object-oriented programming? OOP explained in depth*. [Online]
Available at: <https://www.educative.io/blog/object-oriented-programming>
[Accessed 4 3 2022].
- FabFilter, 2018. *Pro-Q 3*. [Online]
Available at: <https://www.fabfilter.com/products/pro-q-3-equalizer-plugin-in>
[Accessed 15 3 2022].
- Frequency Devices Inc., 2014. *Low Pass Filters*. [Online]
Available at: <http://www.freqdev.com/Low%20Pass%20Filters.html>
[Accessed 14 3 2022].
- Moore, A. D., 1963. The Autoharp: Its Origin and Development from a Popular to a Folk Instrument. *New York Folklore Quarterly*, 19(4), pp. 261-265.
- Pianobook, 2022. *What is this all about then?*. [Online]
Available at: <https://www.pianobook.co.uk/about/>
[Accessed 10 3 2022].
- Rams, D., 2017. *Ten Principles for Good Design*. 1 ed. Munich: Prestel.
- Spitfire Audio, 2019. *BBC Symphonic Orchestra*. [Online]
Available at: <https://www.spitfireaudio.com/bbcso/>
[Accessed 14 3 2022].

- Spitfire Audio, 2019. *What is a Round Robin?*. [Online]
Available at: <https://spitfireaudio.zendesk.com/hc/en-us/articles/360025864833-What-is-a-Round-Robin->
[Accessed 14 3 2022].
- Spitfire Audio, 2021. *Oliver Patrice Weder - The Pool Project*. [Online]
Available at: <https://www.spitfireaudio.com/shop/a-z/oliver-patrice-weder-the-pool-project/>
[Accessed 14 3 2022].
- UNSW, 2005. *Note names, MIDI numbers and frequencies*. [Online]
Available at: <http://newt.phys.unsw.edu.au/jw/notes.html>
[Accessed 15 3 2022].
- ValhallaDSP, 2012. *Valhalla VintageVerb*. [Online]
Available at: <https://valhalladsp.com/shop/reverb/valhalla-vintage-verb/>
[Accessed 12 3 2022].
- Waves Audio, 2013. *J37 Tape*. [Online]
Available at: https://www.waves.com/plugins/j37-tape#butch-vig-billy-bush-j37XxoCr7MQAvD_BwE#tab-gallery
[Accessed 15 3 2022].
- Wikipedia, 2021. *Christian Henson*. [Online]
Available at: https://en.wikipedia.org/wiki/Christian_Henson#Spitfire_Audio
[Accessed 12 3 2022].
- YummyBeats, 2020. *KSP Kontakt Scripting*. [Online]
Available at: [https://blog.yummybeats.com/ksp-kontakt-scripting/ksp-scripting-ni-kontakt-basics-ksp-is-it-easy-to-learn/#:~:text=Kontakt%20Script%20Processor%20\(KSP\)%20is,most%20of%20our%20code%20into.](https://blog.yummybeats.com/ksp-kontakt-scripting/ksp-scripting-ni-kontakt-basics-ksp-is-it-easy-to-learn/#:~:text=Kontakt%20Script%20Processor%20(KSP)%20is,most%20of%20our%20code%20into.)
[Accessed 4 3 2022].
- Zoom, 2014. *H5 Handy Recorder Operation Manual*, s.l.: Zoom Corporation.