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Using DAWs as modelling tools for learning design sound-based applications in education

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Using DAWs as Modelling Tools for Learning Design Sound Based Applications In Education

Abstract

This article discusses a proposed design and sound tool teaching and learning approach, with interesting solutions based challenges not immediately associated with traditional DAW instruction. By stepping outside of the usual boundaries of DAW use, music production teaching is presented with a number of novel learning challenges. There is potential for DAWs, especially in educational settings, to be used to enhance the discipline, encourage experimentation and stimulate design based ideas that promote DAW use beyond the mixing and engineering type contexts. By shifting DAWs into areas of sound based music, as proposed by Landy, this innovative approach, facilitates deeper, experiential learning where sound is treated as the basic musical unit, therefore allowing for a potentially greater range of designed outputs.

1. Introduction

As a guitarist, in my early formative stages I used established guitarists as models and exemplars for my own development by learning their material and playing style mainly by using vinyl recordings, cassette and radio. This was no easy task given my lack of musical training, learning to play the music in a piecemeal fashion, listening as closely as possible, attempting to identify notes or chords and copying the recorded performance in what was a slow and often times painstaking process. Some issues I faced at this stage included trying to copy parts that were the result of multitracking, which I naïvely assumed to be the work of a single guitarist. Whilst this was frustrating it also enabled, through patient practice, to develop a composite part that featured most of the significant parts. Once this stage was reached then could start a process– what I refer to as 'tinkering' - of playing with its inner workings to make something similar but ideally with some differences. During this stage my observations and reflections would be 'still sounds like Hendrix' or 'the Sex Pistols' or 'Bob Marley', which would mean the work was still too derivative to really be considered anything other than a testing ground of growing competency in making 'soundalikes'. However, occasionally there would be moments where an idea, even if not fully realised, could stand on its own merits and was potentially a viable proposition. However, given my limited means, how could I advance beyond this stage? Certainly in the mid-70s, in my home learning context, the best that could be hoped for was to use a cassette recorder and develop an archive of ideas, potentially for future use.

From my youthful and inexperienced perspective at that time, the recording studio represented, at least as myth, a site of experimentation. Whilst I had not yet learned the harsh economic realities and costs involved in studio-based recording, which Théberge refers to 'both in practical and iconic terms' (Théberge 2012: 80), this 'primary model' became encapsulated in the term ''the studio'' (*ibid.*). I was entranced by the romantic allure that surrounded these spaces and the producers who used the studio for their personal and 'wild' experiments including Lee 'Scratch' Perry at Black Ark, Jimi Hendrix at Electric Ladyland and Todd Rundgren at Bearsville. 10 CC's 'I'm Not In Love' and their use of mixing desk and tape loops to create the voice parts (Stewart & Goldman Fan Page 2017), is a good example of this sort of endeavour. These types of activity fall under what de Carvalho

describes as 'the main discourse' (de Carvalho 2012), with the goal of achieving 'a "good sound"' (*ibid*.). However, contrasted with home recording, two potential discourses are identified, one of resistance to the imposition of rules and the counter discourse as being 'less prescriptive than the one of "pros"' (*ibid*.), adopting a "recording with what you have" (*ibid*.), approach. However it should be noted that producers such as Perry, due to circumstances, and Eno (2004), by choice, also operate within these paradigms.

Théberge, argues for the 'cottage industry' as a way to understand the recording studio, once decentralised from its original corporate setting to one of standalone facility (Théberge 2012: 79). Given these sorts of operations and the costs involved, either by hiring a studio or trying to purchase equipment[1], the question of when you would have an opportunity to experiment and develop in this area of practice becomes highly relevant, especially where access to a studio might be limited not just by location but also by a lack of available funds. Given the self taught, home learning musician situation, I could arrive at a 'rough' approximation by using two cassette machines deployed as a makeshift bedroom studio. This process was quite straightforward, play the first part on to tape player 1; put tape 2 into record, play tape 1 and overdub the second part in real time. Fast forward tape 1 to a clear section of tape. Press record on tape 1, play tape 2 and overdub the third part and so on. Shuttling between decks built something of a multitracked part but, with successive bounces, tape quality deteriorated, which is now identified as the 'lo-fi' aesthetic (de Carvalho 2012; Theberge 2012: 81).

Without track separation or a mixer, this was a crude example that enabled me to develop some experience in playing and recording in a self managed, multitracking situation, devising parts that Eno refers to as the 'additive approach to recording' (Eno 2004). This approach was not too dissimilar to one advocated by Howard Roberts - a member of legendary studio session musicians The Wrecking Crew[2] - in his book Superchops (Roberts 1978). If mistakes were made during the recording process there were a number of available choices. These were redoing the part or learn to accept the 'flaws', locating this activity as part of the discourses identified by de Carvalho (2012). However, both options were also a part of the learning although less obvious to me at that time. As development of practice over time, this activity contained something of tacit knowledge building in respect of 'know how' and 'know what'. It was not enough just to have an aural memory, achieved by listening to recordings, and a physical memory by learning the parts, this also needed to be developed into an operational knowledge and execution, however rudimentary, in the moment to commit to a recording. To this could also be added the experimental 'what if', even as embryonic practice. This type of approach is somewhat similar to ideas of potential where the process is described more as 'the sense of not yet being this or that, here nor there'(Manning et al. 2014: 41).

In a more contemporary setting, DAWs, by contrast, offer a myriad of opportunities as an experimental playground. However, even here there can be a tendency towards 'correctness' policing that leans more towards the 'main discourse' (de Carvalho 2012). Advertised and promoted as professional tools, DAWs come with an expectation to deliver professional results. To solve some of these more professional, labour intensive issues, DAWs have fallen foul of the templated approach for recording, mixing and mastering. By templating production environments, users forsake the everyday repetition that builds familiarity, knowledge, expertise and, ultimately, confidence. DAW FX Chains and channel strips can be easily exchanged with no requirement for repatching, even between projects. Arrangements become regimented into ordered, colourful blocks, similar to Wishart's 'lattice oriented'

(Wishart 1996: 11) systems, even though these blocks ultimately have no effect on how the music sounds nor its appreciation.

In addition to available DAWs, there are also a number of other software and hardware DAW-type tools available for experimentation. These include Live Coding, using environments such as Supercollider, TidalCycles and Sonic Pi (Toplap no date), as well as more established software such as Max/MSP and Pure Data (PD). Modular synthesizers with DAW and/or DSP processing capabilities such as Orthogonal Devices ER-301, Monome Teletype, Rebel Technologies Salt, OWL and hardware Magus platforms. Hardware standalone units with coding capabilities such as Monome Norns - also available as a DIY project - as well as those with DSP programming such as Empress ZOIA and MOD Devices. Native Instruments' Reaktor platform has both standalone and VST versions available with a large number of options of commercial and community implementations available. This briefly enumerated range of tools offer users a variety of approaches to select from and combine in their practice.

The advantage of Live coding and, to a certain extent modular synthesizers and some hardware units, is the capability to produce new outputs in realtime that can be performed with, which Collins refers to as a 'code and run aesthetic' (Collins 2003: 321). Writing from an earlier perspective, Collins indicates the potential issues driving laptop musicians towards Live Coding 'suspicious of the fixed interfaces and design decisions' (*ibid*.: 322), however it could be argued that commercial software such as Ableton Live with its integration of Max/MSP (Manning 2014: 423), now allows for more customisation than would have been available in 2003.

Live coding facilitates real time manipulation which Collins identifies as an 'essential difference' (Collins 2003: 327) as these 'interpreted languages allow programs to be written while they run' (*ibid*.)[3]. I associate this idea with one of a continuously, uninterrupted running play head or timeline. Live coding programs allow new code to be added to or code to be amended without having to stop to recompile the software and it is in this sense that they are performative. In many ways this is a similar issue, albeit with a different focus, that the Controllerism movement (Moldover 2015) attempted to resolve, by exploring and developing new interfaces and controllers to facilitate a more performative interaction between humans and their DAWs, in particular Ableton Live. What all of these briefly discussed approaches offer is for '… improvisational and compositional elements with a balance of directed and automated music-making' (Brown et al. 2009: 28), and the purpose of this article is to draw attention to where these types of ideas could be applied to the more fixed interfaces of DAWs as they are now and perhaps less fixed than they were in the early 2000's.

This brief introduction is by way to propose some oblique teaching applications using a DAW. The main focus will be a process I refer to as Sonic Recursion (Boon 2020a), a method of making compositions or designing sound by the explicit use of feedback. A broader discussion around modelling strategies argues the importance of articulating a design aesthetic in order to 'stimulate' additional levels of enquiry for teaching and learning, to raise this beyond mere technique. This approach is a useful learning vehicle bridging the development of difficult to acquire knowledge, unusual solutions based approaches that demonstrates how a disambiguated approach can encourage experimentation, within the more conservative aspects of DAW usage and the fixed interface.

Ableton will be used for the majority of this discussion, techniques such as Audio Rate Modulation (AM) will be discussed along with a short discussion of Cage's Williams Mix (Strange 1972: 91), which provides an opportunity for DAW users to make simulated 'tape edits' applied to clip based parameter automation. This method allows for an alternative, creative and compositional approach to be incorporated into the DAW, that builds technical skills applied in a creative pursuit. By implementing the approach outlined in this article, students will be able to design processes that, even if not approaching bespoke design, ensure that the maker will have a more comprehensive understanding of the available modular capabilities within their DAW and develop the confidence to explore, design and enjoy, self made and self directed 'solutions'.

2. Model Based Approaches

A model based approach is one where something that already exists is modelled in another environment either for learning or to make something similar to it. The environment can be software, hardware or a hybrid. Typical examples can include synthesizers considered to be prohibitively expensive or software that might offer an interesting approach but not available on the user's platform of choice. Modelling can also involve recreating an already existing piece of music, such as Reich's Piano Phase, but purposing it for a different environment from the original context. Reich's Piano Phase implemented in a DAW will differ to that in a Live Coding context (Aaron no date). The act of modelling allows the user to problem solve within their chosen domain and whilst difficulties will almost certainly be encountered, they will also arrive at a point where '"you adjust to what you have"' (Kaloterakis 2013). This is very similar to the novice guitar learning attempts described at the start of this article where the end result might not be perfect but that the activity leads the user to a more informed understanding.

As an example, consider the classic, monophonic subtractive synthesizer. VST instruments exist in large number that already model this, usually as a complete, monolithic solution, so what could be learned by undertaking this sort of modelling activity? The goal here would be for the student to gain design experience and therefore build a better understanding of synthesizer topography, the functioning and relationship of units combined to make the whole, ideally using, generally but not exclusively, the DAWs stock plugins. In this respect, each part can be thought of as a layer for instructional design:

> A layer is a concept: the idea of an independent functional element of a design. A designer specifies components that will be used to carry out the function and how they will be connected. The layer itself is an empty container: it's an abstract idea—"support the building", or "provide a protective outer surface". The designer fills this placeholder with actual components and structure that can perform the function. The layer is, in effect, a design variable waiting to be given a value by the designer. It is a functional part of a system that needs to be defined by the designer. (Gibbons 2013: 24)

By not using a single all encompassing VST instrument but instead to split the parts of the this synth using a suite of plugin modules, with each acting as a container, opens the doorway for experimental exploration and design within a controlled and familiar environment, that might lead to these ideas being applied within more traditional production contexts:

> '[a] designer who "sees" a better set of layers has an advantage because layers are chosen on the basis of their utility.' (Gibbons 2013: 29)

Examples of synthesizers to model can be found in a number of available sources (Strange 1972; Chamberlin 1987; Papen 2012), but also from the manuals of synthesizer manufacturers such as ARP, Roland, Digisound 80 and Nord Modular. All have schematic representations and can lead to interesting implementations and as starting points for in class discussion. Strange's outline of the self playing Dream Machine (Strange 1972: 85-86) and subsequent discussion of his Rapout approach (Reasonable Analytical Procedure for Observing Usable Techniques) are well worth spending some time considering within such a problem space. What this also achieves is potentially a sense of community that goes beyond the idea of presets. Much like the modular synthesizer implementations of Reich's Clapping Music or Live coding implementations of Piano Phase, there will be differences and variations between users and systems. Rather than viewing any single expression as 'correct', instead these can be viewed as expressions of the 'what-if' (Manning et al. 2014: 41), that Cocker identifies as a sort of:

> dynamic model of both 'performing thinking' in action and the performing of 'thinking-in-action', a practice based on the principles of timing and timeliness, of invention and intervention. (Cocker 2016: 102)

2.1 Audio Rate Modulation

Low Frequency Oscillator (LFO) plugins are available in Logic with its Modulator plugin (White 2019) and Ableton's Max for Live LFOs available as audio and MIDI devices. There are a number of uses for the LFO such as to modulate filter cutoff or wave shaping. A second potential use for the LFO is as a source of Audio Rate Modulation. This is where LFO speed is at a sufficiently fast enough rate as to move into the audio spectrum. LFO's with rates above 20hz or higher will produce useful results in this area.

Audio Rate Modulation is a blanket term for a number of approaches using an LFO operating at audio rates. One modulation technique, Amplitude Modulation (Strange 1972: 112-118; Wishart 1996: 235), affects volume by operating on the VCA.

> … we have not considered oscillating motions which are so fast as to produce amplitude modulation of the signal (the timbral effects of spatial motion);… (Wishart, 1996: 235)

With the LFO operating at audio rates on the VCA the effect of Amplitude Modulation (AM), rapidly opening and closing the VCA, will generate new harmonics and overtones, especially if operating at extremely high rates. To simulate a crude VCA, either the output level of the synth can be modulated or, as an alternative, a utility plugin can be used. Varying the LFO's modulation rate and depth, wave shapes and any available internal modulation characteristics including phase, depth and offset should be explored in the context of this process.

A second LFO can be introduced, possibly also operating at Audio Rate, that is used to control and modulate elements of the first LFO, which can also be used to introduce Cross Modulation – where the varying strength signal outputs of two Oscillators or two LFOs modulate each other[4] – and brings us to a point where new knowledge and territory can be explored as part of the 'what-if', as a result of the 'know-what' and 'know-how'. The DAW can offer the user an almost limitless supply of plugins to develop this approach.

2.2 Decoupling Pitch and Gate Events

One of the reasons for discussing this method is, in a sense, to decouple the monolithic instrument which arrives pre-configured with waveforms, envelopes, filters, modulation LFOs, routing matrices, FX, along with a comprehensive library of presets, and, instead, to encourage a more elemental and exploratory approach. The decoupled approach, whilst it can also appear laborious in a DAW, does allow for a large amount of customisation and modification without going beneath the 'hood'.

In a software synthesizer it is difficult, though not impossible, to decouple pitch from gate events, a task that is more easily accomplished within a semi or fully modular system or Live Coding context. In a DAW this decoupling of note from event can be achieved by using a gate plugin triggered by an external MIDI or audio source and is a variation on Sidechaning (White 2006). This sort of decoupling allows for new rhythmic variations to be superimposed whilst retaining some or all of the melodic information (Boon 2020c). This idea can also be extended by the use of an additional LFO plugin such as using a Sample and Hold (S&H) function (Strange 1972: 80, Chamberlin 1987: 327, Waltari et al., 2003: 19), which will bring additional randomisation to the opening and closing of the gate, that can be synchronised or free running.

Whilst this is a very simplistic and sufficiently descriptive approach, it does offer the student a stable model to experiment with so as to 'deliberately' facilitate a somewhat experimental design approach using the DAWs building blocks as a sort of LEGO™. LFOs operating at audio rate allow the student to explore Audio Rate Modulation (AM) within the host environment and perhaps graduating to other implementations in software and hardware. Once confidence is achieved, AM techniques can be applied to any number of parts of the composition, performance and production process. Multiple LFOs can run at different rates, phase relationships can be adjusted, encouraging exploring cross and inter modulation techniques.

2.2 Cage and Williams Mix

John Cage's piece Williams Mix (Strange 1972: 91), directs the performer to make a number of recordings, some with processing, to which a set of tape splices determined by iChing[5] chance operations to structure the compositional output. Cage's approach is more complex than this simple summary, but the key aspect here is the use of these tape splice shapes used to transform material, essentially functioning as some sort of VCA. In a more contemporary setting, these splices can easily be applied as automation envelopes in a DAW, making automation somewhat performative. Due to these prepared splices with decision making managed using the iChing, students can explore the effect of these different shapes on source material, transforming how source material, such as samples or field recordings, are heard. It is worth exploring the instructions for Williams Mix in full as the piece combines tasks of gathering and processing recordings, using a system of randomisation to generate the final piece.

Confidence in simulating tape splices in a DAW will offer students additional opportunities to deploy creative techniques using tape based methods (BBC 2015). These sorts of exercises, whilst they follow a path that is well worn (Manning 2014: 23), does allow the student experience of the historical development of tape based processes even without access to tape. As an aspect of community of practice (Lave and Wenger 1991), even if all students

were given the same brief, samples and field recording sources, the outputs would all be somewhat unique and different. This is a difference that is not necessarily predicated upon the note based approach, even though there is a score based set of instructions, but something that moves closer to that of sound based music rather than 'based on the traditional note-based paradigm' Landy (2019: 20).

2.3 A Partial Conclusion

The purpose of this section has been to introduce a different use of the DAW in a taught context, to stimulate and develop skills and knowledge in modelling within this environment using a 'what-if' framework. There are some shortcomings to this approach, such as the lack of convenience when compared to a fully featured VST instrument. However, it does have an advantage by challenging assumptions around traditional DAW use. A description has been outlined that is closer to a system of quasi-independent control of all elements. This decoupling approach also challenges the user in respect of 'ritualistic knowledge' (Perkins 1999: 8), that DAWs, but also music in general, are susceptible within 'the main discourse' (de Carvalho 2012). In addition to this, independent control of these elements could facilitate alternative composition, arranging and mixing approaches due to this disaggregation and combination:

> Finally they can be considered as a pure combinational structure that only takes the form of electric signals by chance, an interplay of empty positions and mutual oppositions. (Eco 1976: 36)

In closing this section, it is perhaps worth reflecting upon implementing a TB303 type synth using Sonic Pi in a live coding scenario, randomly selecting between two pitches with randomised release and cutoff, how few lines are required to do so and to consider how this could be modelled in a DAW with this sort of economy:

```
use_synth :tb303

loop do
  play [48, 46].choose, release: rrand(0.1, 0.4), cutoff:
rrand(45, 90)
  sleep 0.125
end
```

3. Sonic Recursion - An Example Model

Sonic Recursion (Boon 2020), is a process that explores sound with the deliberate use of feedback to shape and 'mangle' sound sources, directed under the influence of designer and modulation sources. In this suggested model sound sources are referred to as exciters, in that they are used to introduce some sort of audio into the feedback system but do not necessarily need to be looped or repeating. This is just one sort of approach and is modelled loosely upon two ideas. The first is dub reggae mixing approach where a channels' signal is looped back into itself and controlled via pot or fader and the second is based on the feedback circuits found on some synthesizers that can only be 'tapped' at specific points within the signal flow and circuit design.

The general signal flow in Sonic Recursion is that audio is directed around the system using a number FX channels, a central buss I term the Nexus Buss (sub group), before being sent to

the Master outputs. The Exciter channel is set to sends only, so that its sound can only be heard once directed through the FX sends, so that none of the original program material can be heard dry.
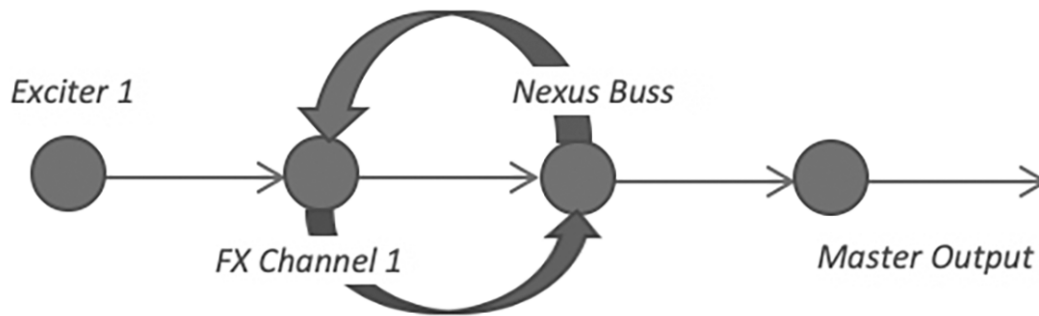

Figure 1a Illustration of signal flow

Figure 1a illustrates a straightforward implementation where Exciter 1's audio is sent to FX Channel 1, which is then directed to the Nexus Buss. At this point, some of the signal from FX Send 1 on the Nexus Buss is directed back to FX Channel 1 as indicated by the circular loop and that audio returns to the Nexus Buss and is also directed on to the Master outputs.

To this example can be added a number of other 'rules' of operation. Firstly, that a single FX Channel is identified as the initial receiver of signal audio from Exciter 1. What this means is that other FX channels have sound sources routed to them via the Nexus Buss. This is partly to simplify the management and direction of audio around the system but also to create a purpose for using and exploring recursive elements of feedback.
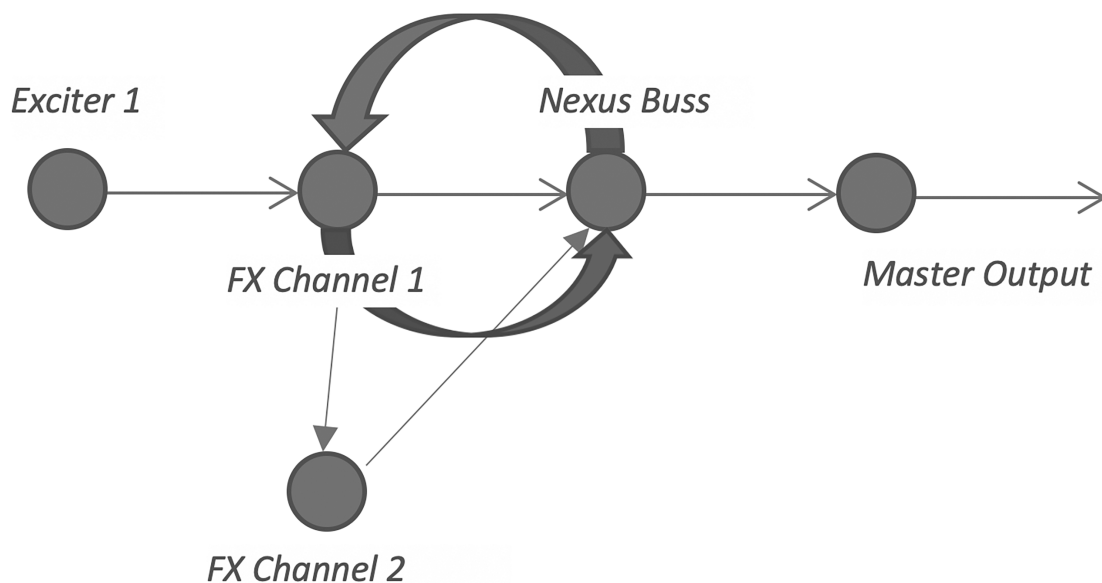

Figure 1b Illustration of FX Channel Exclusivity

Figure 1b demonstrates a variation in that FX Channel 2 can only have audio routed to it from FX Channel 1. Whilst its output is directed to the Nexus Buss, FX Channel 2 cannot receive any audio from any source other than FX Channel 1. This is an attribute to be exploited within this system and allows for a more designed approach with some sense of exclusive relationships between some channels and not others.

As with both previous examples, sources can be easily switched out, there should not be any requirement to play pitches unless one wants to and that there should be an aesthetic principle as part of the technical (Landy 2013: 461), and creative challenge. From my perspective Ableton Live is the one of the ideal DAWs to explore and design processes with. The ease of swapping elements in and out, reordering chains, creating sub chains, automating parameters, use of almost any external device such as a tablet or phone as a controller with minimal setup requirements. The integration with Max for Live means that this DAW can be extended almost infinitely and, more importantly, that this extensibility is driven as much by users as by third party developers.

3.1 Basic Parameters for a Recursive Machine

The recursive machine need only operate on a single sound source. In my example video (Boon 2020a), I refer to these as exciters, and these can range from pitched data, one shot samples, to field recordings and stretched audio using software such as Paul's Extreme Sound Stretch. However, there can be any number of exciters and in this the user has sole decision making responsibility. What is required is that users should take an enquiry based approach and identify a range of sources to 'test' inside their design leading to a developmental area of practice discussed by Manning and Schaeffer's macro and micro level exercises (Manning 2014: 23). At this stage using the same exciter source but with variations prepared in advance along the lines of Williams Mix (Cage 2010), provides the end user with a wealth of creative approaches and adaptations on how an audio file or sample can be treated and transformed.

Creating between three to five FX Channels is generally advisable. In respect of enquiry, it's probably best to use one effect per channel but there is nothing stopping the user from exploring multistage effects. The choice of effects is entirely up to the user however in my example (Boon 2020a), uses delay, sometimes using two different types, one per channel, reverb, distortion and for the final effect I like to use either a resonator or frequency shifter, sometimes in combination. The frequency Shifter plugin can be used to introduce synthesis techniques such as Ring Modulation (RM) and the Resonator can be used to assert pitch information on non-pitched source material if required. To each FX channel, especially as we are dealing with feedback, it is recommended to place a limiter as the last plugin on each FX channel and the Nexus Buss, set nominally at -3db, and to also place a limiter on the master channel, set anywhere between -3 to -6db. The limiters are a precautionary measure and protection against any spikes especially when using headphones.

3.2 Directing Sound

As has been discussed, the designer should nominate an FX channel as the initial source of audio to be routed to the Nexus Buss. The implication here is that all other channels have audio routed to them either from the Nexus Buss or in an exclusive relationship between FX

Channels as shown in figure 2. However, as figure 2 also shows, channels can have their audio looped back to them as well.
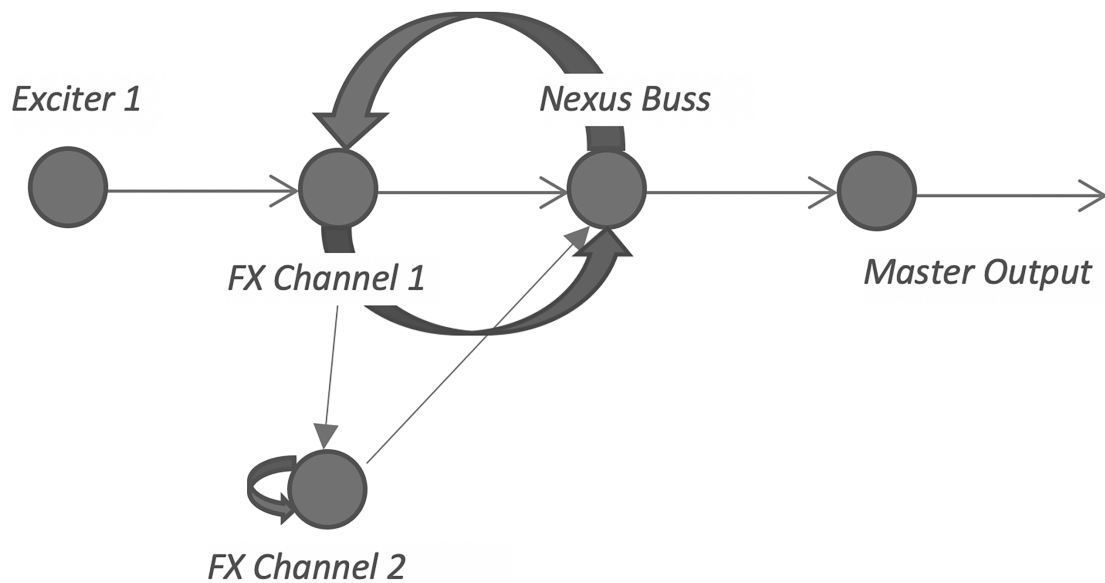

Figure 2 Illustrating Loopback on FX Channel 2

Ableton Live allows for sends on FX channels to be self routed. Initially this facility is disabled but can be easily activated and forms another layer of recursion within this system, local to the channel. Figure 3 shows a more developed implementation using five FX Channels with a clear indication of feedback relationships established between all FX Channels and the Nexus Buss; a mutual signal relationship between FX Channels 1 and 2, and 1 and 5; and an exclusive bi-directional signal relationship between FX Channels 4 and 3. Note that FX Channel 3 has a uni-directional relationship with FX Channel 4 before its audio is routed to the Nexus Buss. In all of these models it is quite possible for a number of unpredictable situations to arise between learners, their sources, models, software and outputs.
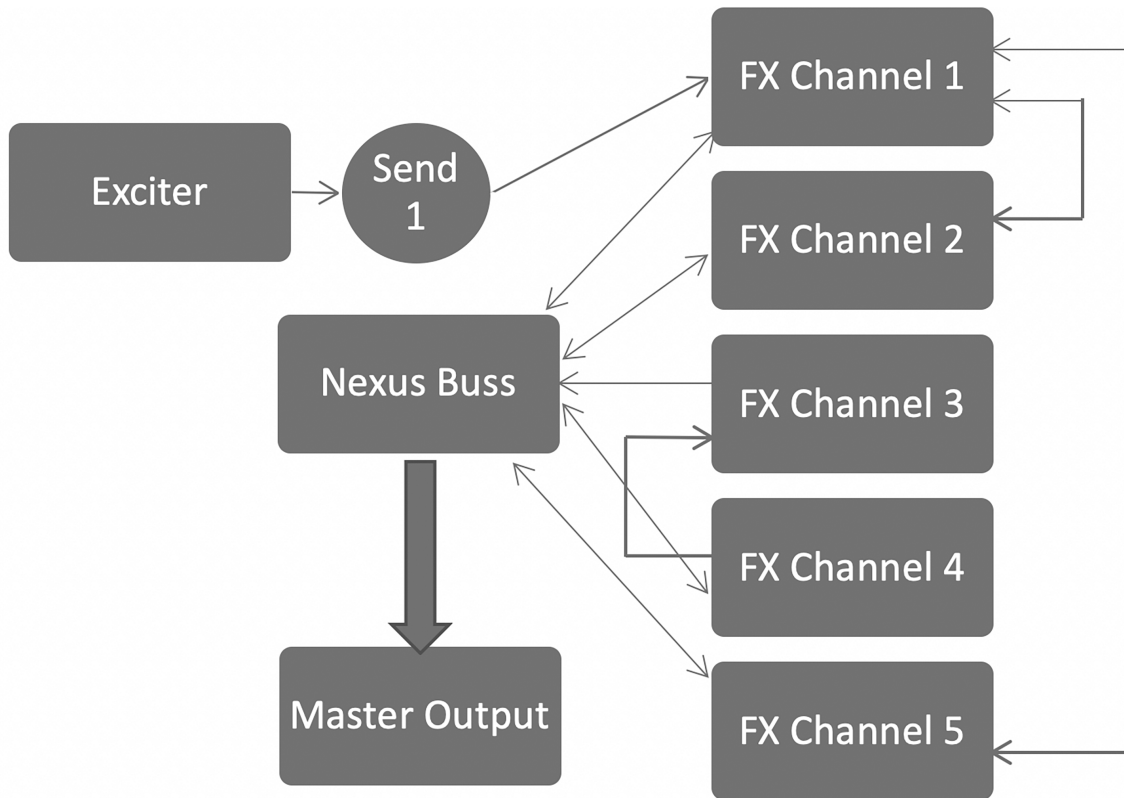
Figure 3 Sonic Recursion signal flow

3.3 Enhancement 1 – Max for Live LFO

Modulation sources such as LFOs are essential to animate parameters. The Max for Live LFO is capable of modulating up to eight parameters simultaneously. Whilst there is a limitation in that all eight parameters are 'locked' to a single LFO source, each channel offers some customisation of its operating range. The advantage here is that eight parameters need not be assigned to a single plugin but instead a variety of plugin parameters across the system can be adjusted together which potentially establishes more of a relationship between a various components. LFO rate, for example, can be 'performed' by the designer in real time or modulated by another modulating source such as an additional LFO, an envelope or the result of a logic based function. It is quite possible to bring any number of modulators into any project once one what is available.

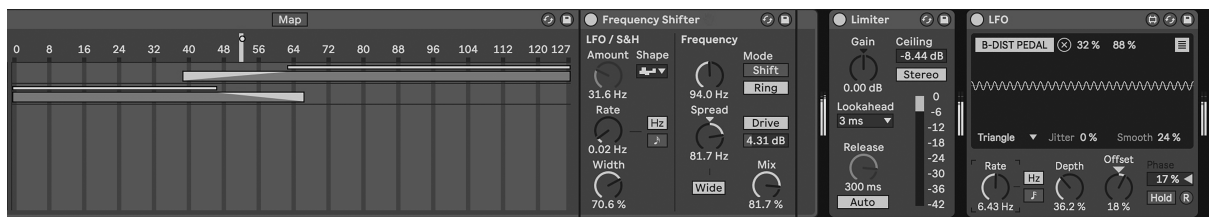*Figure 4a – Front Section of an Ableton Channel Strip*

Figure 4b – Rear Section of an Ableton Channel Strip

The channel strip shown in figures 4a and 4b are of an Ableton Audio Rack that has two channels labelled 'FREQ SHIFT' and 'DRY'. In figure 4b the Chain Selector, narrow block between numbers 48-56, is under the control of an LFO positioned at the end of the channel strip. Both channels have had cross fades applied to them that modulate between the 'wet' signal of the frequency shifter and the dry signal. This enhancement demonstrates a shift away from a static based effect into one that has a bit more animation. If the LFO operates at audio rates then the cross fades will cycle in sync with a variety of modulated parameters across a number of devices and channels.

Techniques borrowed from modular synthesis, such as using a triggered envelope to open a VCA momentarily to allow a new modulating source to pass through influencing the design output is a sort of 'injection' technique achieved using a variety of modulating sources including bursts of noise and chaos. Whilst these are relatively straightforward to execute in a modular environment, they will take a little bit more thought to accomplish in the DAW. Making use of gate plugins, triggered by an external trigger or rhythmic pattern is one possible solution. The incorporation of modular VST environments such as Native Instruments Reaktor or VCV Rack offer access to modular components where their signal outputs can be directed back to the DAW.

3.4 Enhancement 2 – Performance Controllers

One final enhancement to consider is the use of an external controller. These will come in a variety of forms including those on keyboards where alongside the traditional modulation and pitch bend wheels, some may also have collections of pads, sliders and knobs. These can be assigned to a number of operations and designers should consider them. Added to these are the MPE (Midi Polyphonic Expression) keyboards made by Roli. The inclusion of MPE in most DAWs means that MIDI automation can be applied at a more micro level on a per note basis. Added to this are grid based controllers which offer a dedicated control surface such as those by Ableton, Akai and Novation to name a few. There are also control surfaces available for phones and tablets which include Logic Remote and various implementations of the Novation Launchpad type interface as well as Liine's Lemur app (*see figure 5*). Lemur started life as a hardware interface and migrated into a virtual interface a number of years ago. The interface is essentially a blank page within which you design your own control interface based upon your immediate requirements. I find this the most preferable sort of interface and tend to use it for most projects, even if at the expense of foregoing touch sensitivity. Interfaces can be as simple as one big fader controlling an LFO or a more complex interactive performance surface (Boon 2020b).
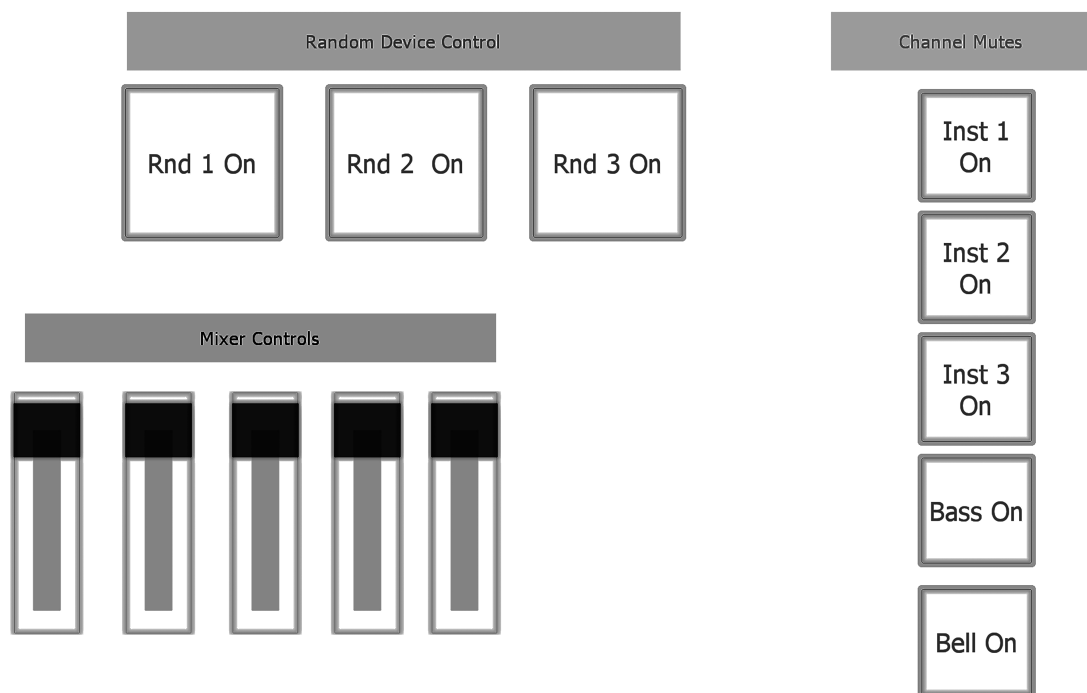
Figure 5 Example Lemur Interface

Again, this allows designers an opportunity to really consider performability within their work, to extend it beyond the technical. Explorations as part of the process can result in highly satisfying results especially when making decisions as to what sorts of parameters or processes to expose for interaction.

4. Discussion

A DAW is a multipurpose tool and, in this respect, can be viewed as similar to 'Computer as instructional medium' (Gibbons 2013: 17). A DAW is both the tool of the professions and also a site for learning and teaching. The environment is sufficient that self-starters and seasoned professionals alike are able to use it for the realisation of their works and learning. In this respect DAWs are capable of operating in a 'traditional' role as a recorder for MIDI and audio but also as an arrangement tool, as a mixing engine, as a scoring and sound design environment, as a remixing tool and as a mastering studio. Whilst there has always been something of a hybrid working practice in studio work, using a DAW as an environment for modelling i.e., not just concerned with realising recordings or pieces as a part of teaching and learning, has 'lagged' somewhat.

As teachers and instructors, and hopefully also as users, we should be able to teach classic tape and recording based approaches as well as encourage the use of the DAW as a site for design, experimentation and for the formulation and devising of pieces that embody more of a sound based approach (Landy 2019: 17). Extending the DAW as a place of design, whether emulating an already existing model such as a subtractive synthesizer or designing a sound tool that uses less familiar techniques, enables the student to develop skills within a number of areas, as well as the confidence to step outside of normal and expected mode(s) of

production, operating within the variety of recording discourses identified by de Carvalho (2012).

It is quite possible to encourage a spirit of adventure, set a number of starting parameters, share audio sources amongst a group and task our students to design, organise and facilitate a sound piece. When listening back to these pieces, commonalities and differences can be discussed and evaluated amongst the student practitioner group, ideas. It is here where the broader goals of a community of practice (Lave and Wenger 1991), can also be realised and that students can be engaged in a common task, a looser reference to Joint Enterprise, and participating legitimately, albeit on the periphery of music practice, via their DAW. It is peripheral because this is a generally uncommon application in terms of how DAWs are primarily used and taught, but is by no means unusual. All of the pieces could be collated into a playlist or album and released on Bandcamp. Further adaptations are also possible if students exchange their sound machines with other students for further adaptation. By doing so a sort of collaboration in response is possible, where each can develop skills in extending or paring back the sonic capabilities of different projects, allowing for some interesting reflective discussions on outputs, choices and decision making.

Meyer and Land's examination of Threshold Concepts is perhaps instructive here. Where the process of using a DAW in an uncommon fashion can be used as a '… portal, opening up a new and previously inaccessible way of thinking about something' (Meyer and Land 2003: 1), and that in the puzzling out of these sorts of procedures that this could lead to a 'transformed internal view of subject matter, subject landscape, or even world view.' (*ibid*.). Whilst a transformed world view is a possibility, both subject matter and landscape will be very much within the grasp of most students. The challenge with this approach is to encourage and facilitate DAW usage that is not predicated upon writing a 'hit' song, or even arriving at something that resembles a traditional recording. By doing this, and exploring less familiar applications whilst using familiar tools differently, students will experience their DAW as a site for making something that does not conform to the more usual song or track based models.

5. Conclusion

The ambition of this article is to demonstrate some viable methods and approaches to expand upon the dominant paradigm of DAW usage. There is nothing intrinsically wrong with a traditional track based approach and I am not suggesting that we replace it. What I am suggesting is that through our teaching we are very much able to introduce other modes of working to our students, that have an express goal to extend their understanding, using a mixed methods approach incorporating elements of both the familiar and the unfamiliar in their DAW of choice. In its basic formulation, rather than being radical, I view this as more 'emancipatory' by offering users a number of teaching and learning approaches. The first is that at any point a user can 'adopt' a position that switches the operational paradigm. This cannot be over stated enough in terms of its potential for empowerment.

The second is that users will encounter 'tricky' design aspects that will emancipate them, at will, from the 'ritual knowledge' (Perkins 1999: 8), of DAW use to perhaps experiencing more 'foreign knowledge' (*ibid*.), between which there will be a certain amount of conflict. This potential conflict can be identified in the different recording discourses (de Carvalho 2012; Kaloterakis 2013) and ideas of correctness, highlighted by Eno concerning potential differences in approach when dealing with hiss:

> … Lee Perry, a producer who's always been very intelligent as far as using the constraints of the situation goes, might find there's hiss building up on tracks he's used over and over. A Western engineer might get frightened by this, and use all sorts of noise reduction and filtration. Perry says, "Okay, that's part of the sound, so we'll just add something else to it and use it' " This adds an ambiance of weirdness behind what was straightforward reggae. (Eno 2004)

So, in this sense, the knowledge and experience of using and uses of a DAW can be extended by using modelling approaches such as Sonic Recursion along with many others such as Live Coding, but also by locating the work within the various recording discourses and activities based upon constraints. Williams Mix (Cage 2010) is an example that functions within this space where the recorded sound is subjected to a number of tape edits that change our relationship to how we hear the sound and further that these choices are organised using a randomised system that removes human reliance upon comfortable logics. It is at each stage that new connections can be made or broken apart to create new meaning (Eco 1977: 36). Students following this discipline approach will be able to explore different principles of design employed by manufacturers via their schematics and, whilst DAW operators might not be able to reproduce an exact facsimile, they will, by exploring these conceptual spaces, find unique solutions to difficult problems. The contrasting of DAW practice with that of Live Coding indicates where perhaps the two areas could also be used to create a hybrid practice.

Overall, the sorts of activities discussed here assist students in developing their competencies in a number of areas, hopefully with some balance between technical and aesthetic requirements. Ideally, work should be 'tipped' in favour of the latter, as students will almost always require an antidote to an overly techno-rational discourse. By doing so, this process allows students to participate in a design based activity, that encourages experimentation using familiar elements whilst stimulating divergent practices. These sorts of tasks provide students with opportunities to integrate a variety of flexible approaches into their more straightforward (*my assumption*) productions, expand their body of both conceptual and experiential knowledge, with a transformed thinking of their own discipline practices.

Notes

1. See discussions in Kaloterakis (2013) for varied opinions on this subject - https://www.arpjournal.com/asarpwp/creativity-and-home-studios-an-in-depth-study-of-recording-artists-in-greece/
2. See The Wrecking Crew Film - https://www.wreckingcrewfilm.com/
3. This approach is similar to one implemented by Macromedia's Director and their interpretive multimedia language Lingo with a command line interface that allowed real time input. The Director environment also hosted third party Xtra's (similar to VST plugins) and the Sequence Xtra (finally purchased by Sibelius) enabled real time input from a command line interface: http://www.sibelius.com/products/sequencextra/features.html
4. For examples see complex oscillators such as Make Noise DPO and chaotic oscillators such as Rob Hordjik's Benjolin.
5. iChing is a system of symbols used to identify order in chance. Cage used this in his Music for Changes (1951), to make composing decisions in what is described as indeterminate music i.e. left to chance or free choice, allowing substantial variations in performance. See also Eno's Oblique Strategies as a variation of this approach (Burgess 2013:18; McNamee 2009).

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