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MSI320 Music Dissertation

To what extend was the liveness of the DJ as instrumentalist discarded in deference to a technological "revolution" ?

This dissertation is submitted in accordance with the requirements of the award of BA (Hons) Creative Music Technology.

I Michael Freeman confirm that, except where other sources are acknowledged, the work contained herein is my own. I am aware of Falmouth University's regulations concerning academic integrity, and submit this work in good faith.

7752 words

Sunday, 2nd February 2025

Using GenAI in Music Dissertation – Student Declaration: I used GenAI in the process of researching for the Dissertation. GenAI was used to produce the image at Figure 2.

Abstract

The liveness of the DJ turntable as a musical instrument has been misunderstood and undervalued in the music technology industry. The emphasis on auto beat and pitch matching has led to a devaluation of the DJ's performance skills, despite the turntable being accepted as a legitimate instrument. This misunderstanding stems from a lack of understanding of the balance between technology and human creativity in DJ'ing. The vinyl turntable, initially designed for audio reproduction, has been transformed into a unique musical instrument through DJ techniques like scratching. This transformation, which challenges traditional musical conventions, highlights the turntable's ability to create a live performance from recorded material. While digital technology offers benefits, it's crucial to preserve the physical functionality and gesture range of the turntable to maintain its unique musical qualities. The Technics 1210 turntable, a staple in DJ'ing, allows for creative manipulation of audio through its controls, rooted in Newton's Laws of Motion. Contemporary DJ software, however, often fails to accurately replicate the physical properties of the turntable, neglecting the importance of its rotating platter. This oversight overlooks the profound connection between the turntable's physicality and the dance floor, a connection that is fundamental to the art of DJ'ing.

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Acknowledgements

With thanks to all the staff at Falmouth Uni as well thanks to the Lord Jesus Christ.

Introduction

> *"Whenever I interview someone for a job, I like to ask this question: "What important truth do very few people agree with you on?"*
>
> (Thiel 2014)

The important truth here is that the liveness of the DJ as instrumentalist has been discarded in deference to a technological "revolution". People are hypnotised by the supposed benefits of auto beat matching and auto pitch shifting. Despite the DJ turntable being an accepted musical instrument, the raw performance skills and liveness of DJ'ing have been rejected by worship of some digital nirvana.

This dissertation will examine why these misunderstandings developed and to what extent the music technology industry has failed to implement serious approaches to providing hardware and software that implements the DJ's instrument of choice, the turntable.

A range of academic and non-academic sources will be used that cover the technology as well as documented understandings of the practice of DJ'ing.

Chapter 1

Liveness

> "*It is also generally accepted that a turntablist is a musician and that the turntable is to be considered an instrument*."
>
> (Hansen 2004)

"Liveness" in this context was defined by Butler …

> *"[…] liveness is a well-established value within EDM culture. A night in a club, and the musical performances that are central to that experience, is expected to be a unique and irreproducible event characterized by a collective energy […]"*
>
> (Butler 2014)

Yet liveness becomes misunderstood when technology becomes involved.

> *"Live performance now often incorporates mediatization such that the live event itself is a product of media technologies. This has been the case to some degree for a long time, of course: as soon as electric amplification is used, one might say that an event is mediatized. What we actually hear is the vibration of a speaker, a reproduction by technological means of a sound picked up by a microphone, not the original (live) acoustic event."*
>
> (Auslander 2023)

The liveness of the DJ turntable was crippled when it was transferred to hardware and software technological implementations. This confusion of not seeing the turntable as a true instrument came about because the turntable involves electrical currents produced by a stylus

or digitised physical movements of the turntable sent to software that plays digital audio files. This appears absurd when one considers that the technology should simply be a transparent transportation medium. The grooves of a vinyl record may be a fossilised recording of an originally live sound. But the gestures of a creative turntablist DJ transform the turntable into something remarkably close to an electric guitar. It would be seen as odd today to call an electric guitar performance as “not liveness”. No other musical arena would tolerate discarding the virtuosity of the DJ performer and their instrument.

> *“Part of the vinyl DJ's virtuosity lies in the way that s/he negotiates the risk of "trainwrecking"—of failing to match beats accurately and destroying the energy on the dance floor. But a lot of the computer software available to DJs today eliminates this negotiation.”*
>
> (Attias 2011)

If it were the case that guitars were automated, or live drums were automated, the rock audience would be up in arms. Yet this is exactly the onslaught that the DJ virtuoso has been subjected to when it comes to the over emphasis on auto beat and pitch matching.

Kill the DJ

Drum machines have taken their place in the lexicon of *House*, *Drum and Bass* and *Hip Hop* however the drum machine never replaced the human drummer in music where a human drummer is expected. There is a certain use of appropriate technology in electronica that is offset by humanising elements such as voice and manually played synth lines. A production style which is still prevalent today. However, curiously, the instruments of the DJ, the turntable and mixer, seem to have been singled out for destruction. Chris Csikszentmihalyi, a technologist producing a DJ robot, is quoted in *DJ Skills - The essential guide to Mixing and Scratching* (Weber 2008).

> *"We're trying to make human DJs obsolete, as far as possible. They're expensive, they're unreliable. If we can make this machine work, we'll give club owners an easy time".*

If that wasn't alarming enough, Webber continues.

> *"At the lab, they refer to the robot as the "DJ killer app." A program designed to record, store, and recreate the movements of DJs who scratch into its sensors is known as the "Soul Stealer"."*
>
> (Weber 2008)

This all might be amusing enough as part of an academic exploration of DJ technology, as well possibly being some sardonic humour by Csikszentmihalyi. However the DJ technology industry has almost been overcome by an avalanche of professional DJ "solutions" to "problems". "*Now we can solve the problem of you having to match*

beats together !" says the marketing blurb. No mention is made of the complete absence of this kind of hyperbole when it comes to guitars. Can you imagine it ? "*We can solve the problem of you having to manually play guitar strings !*". The rock band guitar virtuoso would be laughing all the way to their next gig, where punters would be transfixed as his hands danced across the frets.

There's an echo here of the sensitivities surrounding the singer Bob Dylan, formerly a purely folk musician, using an electric guitar for the first time at his Manchester performance. The audience shouted "Judas!" in reaction to Dylan breaking with a purely folk based approach to his music (No Direction Home 2005). Equally passionate reactions can be found in the reaction to DJ's using auto beat matching rather than manually blending rhythms together **(**Veen 2012). Electronic dance music and DJ'ing have been subjected to the assumption that "*more technology is better*" based on the disingenuous observation that "*they're already using drum machines and sequencers so they want more automation*". This misunderstands the balance between the technology and the skills of the DJ that has been developed over decades. The technology of the recorded music on the vinyl itself was offset by vocals that were a counterpoint to the machine based drum machine rhythms. DJ's then imperfectly blended those recordings. The music, often *Techno* music, is often misunderstood as a "worship of technology". This emerged from the assumed meaning of the term "*Techno*". In fact the term has its origins in the work of Juan Atkins, one of the originators of so called Techno music.

> *“We talked lots about [science-fiction novelist] Alvin Toffler's idea of the 'third wave’”*
>
> (Ferguson 2010)

A strong theme in Toffler's book “*The Third Wave*” is the responsible use of technology, which is now called appropriate technology, a term that Ernst Friedrich Schumacher originated (Schumacher 2010). Techno music is a statement of human and artistic control of technological processes, *not* some worship of technology as it is so often misunderstood to be.

> *“The techno-rebels argue that either we control technology or it controls us.”*
>
> (Toffler 1981: 168)

Techno makes this statement. Standing in defiance of a technocratic society that seemed to be careering towards increasingly resembling an “optimised” machine. This has also been overtly stated in the rock arena by such bands as “*Rage Against The Machine*”**.**

Yet DJ’s and musicians often prostrate themselves before these technological developments, giving in to their “inevitable” destruction of human skills. As the tech entrepreneur Marc Andreessen said …

> *“We believe that we are, have been, and will always be the masters of technology, not mastered by technology. Victim mentality is a curse in every domain of life, including our relationship with technology — both unnecessary and self-defeating.”*
>
> (Andreessen 2023)

Scratching

> *"So I was playing two records, and she bangs on the door, and told me: 'Listen, either you turn the music down, or you turn the music off.' While she was in the doorway screaming at me, I was playing one record on my right-hand side, and I was holding the other record with my left hand. I wanted to keep the groove going, so I was moving the record back and forth while the record on the right-hand side was playing. When she left, I realized what I was doing."*
>
> (Weber 2008: 52)

Grand Wizard Theodore explains how he accidentally misused the vinyl turntable when interrupted by his mother and invented "scratching". But what is scratching ? One of the earliest definitions was given to us by David Toop in his book about African Rap.

> *"Scratching in its early form arose out of the normal technique of cueing a record: you move the record manually with the needle in the groove and listen for the right starting point on a headphone. […] use[ing] a record percussively by quickly moving it back and forth over the same chord or beat."*
>
> (Toop 1991)

Scratching subverted the medium of pre-recorded sound by interfering with its predictable linear progression. Scratching alters the pitch (or speed) of the sound as well as reversing it. The original purpose of the purely audio reproduction mode of the vinyl recording is discarded. The sound is thrown around, sent forward and reversed, with the pitch going up and down "scratching" the audio backwards and forwards. Scratching treats the DJ turntable much more like a digital sampler that has been used by musicians to create as equally

chaotic cut ups and manipulations of vocals and rhythms. This was a sort of audio insurrection that contrasted with the much more purist audiophile setups that were often exclusively devoted to well behaved classical music recordings. Where a classical music collection is a static museum of recordings, the “misuse” of the DJ turntable turns a the recorded sound on its head, returning it to a wild, ever present, now. The vinyl record is reified with the abstraction of the grooves of the recorded music being mistaken for some concrete “vinylism”. Vinyl grooves are only a map of some original recorded audio not the audio itself. The DJ’s manipulation of the stylus in the grooves as well as the speed and direction of the turntable and vinyl record itself transmutes from recording to live instrument. Thus the creative turntable DJs’ manipulation of the playback device returns the audio to the present, creating a live performance from a technology originally intended to preserve the recording of a live performance for posterity.

I personally had an incident that bought these issues into stark contrast and echoed the experience of one of the inventors of scratching, Theodore Livingstone (as is quoted above). I can remember instinctively perceiving this “misuse” of the turntable when I was five years old. My Father had put on a classical vinyl record and then had left the room. I went over and looked at the turntable. “*What if I …”*. I turned off the deck and the turntable slowly wound down to a stop, and to my amazement, taking the audio with it. What a revelation ! The sound slowly reduced in speed/pitch, creating an extraordinary elongation of orchestral sounds. I’d made my first

creative act as a DJ. However my Father overheard this and burst into the room and accused me of trying to break the turntable, even of damaging his recording. Even at such a young age I realised this was unlikely. His reaction, to this day, seems to reflect the rebellious nature of DJ'ing and the cultures that surround it.

"*Graffiti was the first urban art form to gain popularity among New York City youth. As a method of individual expression and rebellion, it would eventually join the musical elements of DJing, b-boying, and rapping to become the basis of hip hop culture.*"
(Storhoff 2009)

This is why the turntable is such a unique instrument. In what is one of the earliest forms of sampling, the use by the DJ of the playback device of the vinyl turntable takes various musical genres and throws them in the face of predictability and convention. However the vinyl turntable, transformed into an unusual musical instrument, is not unique in this respect. It was the guitar that started off as a "polite" instrument, until someone decided to electrify it. Heavy metal, and other types of rebellious music, were created. In fact the guitar string itself was very likely to have been developed from the bow and arrow. Maybe all instruments started off as something that was never intended to be musical.

"For many, the concept of using the turntable as a musical instrument seems farfetched. It's difficult to accept that a device invented for one specific purpose, in this case carefully playing fragile records, has been reborn in such a radical fashion. It may help to consider that, if you go back far enough, every instrument in the symphony orchestra

has origins as something else. Musicologists trace the birth of instruments using vibrating strings back to the bow and arrow."

(Webber 2008)

The Wheels of Steel

But what about when it comes to carrying over these discoveries into the digital age ? This is where the "*wheels of steel*" (Grandmaster Flash and The Furious Five 1981) seem to have slipped back from their former glories and victories into the vagaries of de-humanising technology.

> *"Wheel up the wax on that Technics turntable, making sure not to knock the needle, as we step back into the past. To a time before smart phones and even smarter DJ controllers"*
>
> (Soundware 2022)
>
> *"Mechanical, acoustical, or electrical vibrations are the sources of sound in musical instruments. Some familiar examples are the vibrations of strings (violin, guitar, piano, etc)."*
>
> (Fletcher 1991)

There is presumption that new technology is always "smart". Developments in the digital realm have certainly bought benefits for musicians and DJ's. However along the way something has been left behind.

> *"As an engineer and an avid DJ enthusiast, I believed there was a way for technology to reflect the needs of the DJing culture rather than succumb to the technology driving the*

> *“innovations” and imposing their technological “advancements” on the culture.”*
>
> (Trotman 2018)

There is a physical functionality and behaviour of the DJ turntable that makes it a unique instrument in its own right. From scratching to beat matching. To accidental slow downs and reverses. The turntable has a freeform quality all of its own.

An interesting example of this is the *Technics Digital Turntable SL-DZ-1200* which is an early example of how, initially, the music technology industry got the approach correct to blending DJ turntables with the digital realm.

> *“DZ1200 is a tool that enables musical performances out of a large variety of digital materials in an analog style without odd feeling. The product, which was created from the image of SL1200 but intends to eliminate the barrier between the digital and analog worlds, is the digital turntable DZ1200.”*
>
> (Panasonic 2025)

This digital turntable was an attempt to retain the physical aspects of vinyl turntables and to not throw out those important functions in deference to digital advances. The physical aspects of an instrument are very important. Yet later developments in the music technology industry seemed to discard this approach.

Chapter 2

Gesture

One examination of the turntable, that I found, observes.

> *"Gesture Modification [...] This causes an exactly repeated scratching gesture to sound differently depending on the tone arm position."*
>
> (Bryan 2011)

This was expanded by using this following graphic.

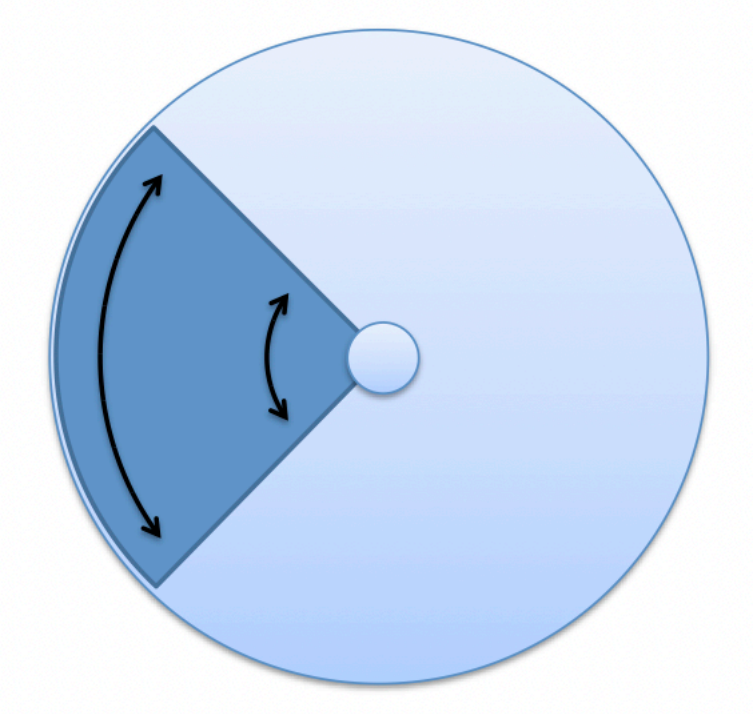

Figure 1

Bryan & Wang are referring to changes in sound as the artist moves the tone arm and needle across the entire expression of the platter surface. I've never seen this simple insight into the functionality of a

DJ turntable implemented in any software or hardware apart from the one Bryan & Wang discuss in their paper which implements as much a possible the full gesture range of the turntable.

The DJ turntable has developed over the years to have a number of expected functions that facilitate this full gesture range. Less expensive turntables have a belt driven platter that leads to slow startup times and lack of motor response. Modern professional turntables are expected to have a direct drive motor that can be manipulated by the DJ to have a powerful effect over the rotating turntable platter. The track can be started quickly with a very noticeable spin up time. The direct drive is expected to have a "brake" feature which is often adjustable. This comes into action when the DJ presses the stop button which leads to a satisfying and brief ramp down of the rotating platter which happens much faster than it would on a belt drive turntable (Fig. 2) This provides an added effect in the DJ's repertoire that is preferable to suddenly cutting off the track.

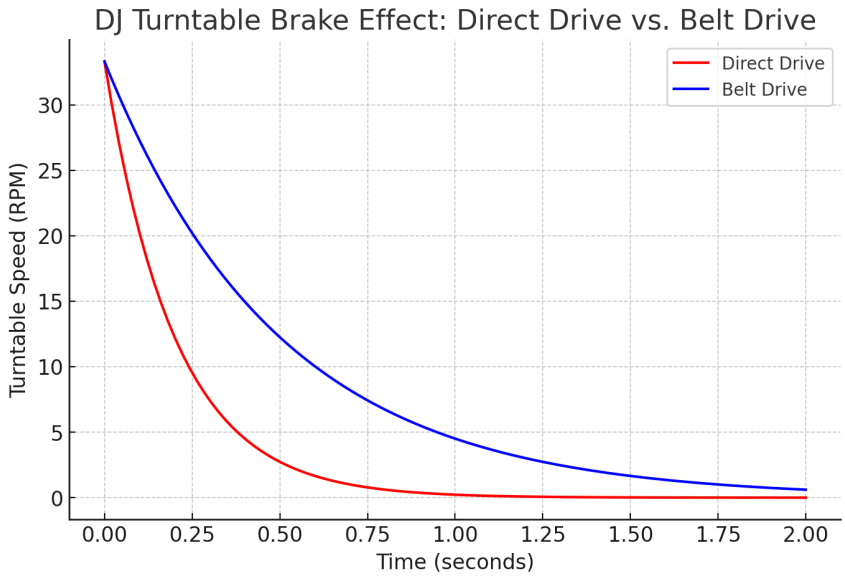

Figure 2

A further feature is the slip mat that is placed between the vinyl record and the turntable platter. This decouples the record from the platter and is especially important when scratching or beat juggling. However it’s often used by DJ’s when blending tracks in sequence together to hold the record at an exact cue position so that it will suddenly play once the DJ releases hold of the record. This is usually much faster than relying on the platter starting up from a standstill when it's propelled by the direct drive motor.

The DJ also expects there to be a sliding pitch control “fader” as well as an “on/off” switch, start/stop button, as well as 33rpm and 45rpm switches. Although originally designed for only playback of a record without any manipulations. These controls have become important to the creative DJ even if their function might not be immediately apparent to the uninitiated.

The “on/off” rotary switch on a Technics 1210 turntable has a simple “hidden” function. As a record is playing, if the DJ turns “off” the turntable, something interesting happens. Even though power appears to be completely shut off to the deck, indeed the platter stops spinning and slowly comes to a standstill, the actual audio phono output still operates. Hence a satisfying slow down of the tracks audio can be used to mix out a track as the new one is mixed in on the other deck. Some DJ’s add an extra flourish by manually reversing the platter with the deck turned off to initiate a reverse slow down.

33rpm and 45rpm buttons can also be manipulated to play tracks at the wrong speed or provide slows downs and speed up’s while scratching.

Underlying these control methods, and at the heart of turntable, is the heavy platter, which is of course subject to the laws of physics as the controls are manipulated. The slip mat, although having much less mass, is also subject to the laws physics.

The laws of motion governing the movement of objects with large mass on the surface of the Earth are typically referred to as Newton's Laws of Motion and Classical Mechanics (Newton 1726).

In particular:

Newton’s First Law (Law of Inertia) – An object remains at rest or in uniform motion unless acted upon by an external force.

Newton’s Second Law (F = ma) – The acceleration of an object is directly proportional to the net force acting on it and inversely proportional to its mass.

Newton’s Third Law (Action-Reaction) – For every action, there is an equal and opposite reaction.

Yet contemporary hardware and software recreations of the instrument of the DJ fail to take into account these fundamental laws.

DJ as Movie Director

The use of the term "*gesture*" in the paper (Bryan 2011) is also interesting, as the origin of the word roots back to semiotics and language. We "*gesture*" when we are speaking to emphasise a word or communicate meaning not accessible through language alone. DJ's who use turntables have developed an entire language of their own that the audience has become familiar with. This has some comparison to the development of film where the techniques of cutting, editing and dubbing encapsulate an entire language beyond simply what is coming out of the mouths of actors on the screen. This communication is prevalent between DJ's manipulating the turntable instrument and the dance floor. The participants are not passive observers.

> *[…] those who are listening to a performer play in dance music settings are engaged in the performance with their whole bodies, and this is not a distraction but an expectation; if the participants in a dance music night do not dance this reflects negatively upon the DJ […]*
>
> (Gadir 2014: 13)

The DJ, much like a film editor, controls pacing, continuity, and rhythm, while dancers respond in a dynamic, ever-evolving dialogue. At the heart of this dance are the "*wheels of steel*". I don't think it's a coincidence that these spinning disks have a power all of their own. For example Beth Hagens points out the profound context of spinning instruments in her work "SPIN as CREATIVE CONSCIOUSNESS".

> *"The spinning of Earth on its polar axis, visualized as circling stars, planets, sun, and moon. Hamlet's Mill (Santillana and Von Dechend) extensively argues for ancient cross-cultural transmission through myth of daily polar spin and the 26,000-year gyroscopic wobble of earth's axial pole using explicitly sexual, generative imagery of a grinding mill: Pole (power, penis) grinding Earth in spin. The fish-shaped bullroarer of the Dogon of Mali, for one example, is Po."*
>
> (Hagens 2009)

The *Bullroarer* is spun around on the end of a string to create a sacred sound. The spinning disk of the turntable creates unusual sounds in the "sacred space" of the dance floor and reflects the inherent spinning nature of reality itself right up from spinning atoms, to spinning planets and galaxies.

The *gestures* produced by the turntable, both physically, and in the musical and audio forms produced, also give us a clue to the importance of the physics driving this unique instrument. The physical gestures of turntable rotation is a language that is intertwined with the gestures and physical movement of the audience. The dancers.

> *"We should never forget that every gesture and action of our body is a deeply rooted mystery and not a mere outward function or trick, as many people regard it in modern times. It was thus that tumbling or standing on the head could once have been a sacred play."*
>
> (Laban 1974)

A description Laban uses to describe a dance movement reminded me of the stance and movement of a DJ when they gesture to exercise a scratch technique.

> *"Determined move in preparation for a gesture of proud defiance."*
>
> (Op Cit)

Scratch DJ's often "battle" in tournaments with their gesture and stance strongly evidencing Laban's insight.

In the context of *musique concrète*, the term "gesture" refers to the perceived actions or physical movements implied by sounds, even when no visible performer is present (Schaeffer 1966). This concept was developed primarily by Pierre Schaeffer, the pioneer of musique concrète, as he explored how recorded sounds could suggest movement, intent, or action independent of their source. Schaeffer's *Treatise on Musical Objects* (1966) provides one of the foundational discussions of gesture in *musique concrète*, detailing how sounds could represent "sonorous objects" that listeners could interpret as gestures based on their dynamic, spatial, or timbral qualities. The DJ turntable feeds back this process creating biofeedback loops. The sounds created by the musician who originally created the recording are already intended to suggest motion, dancing and expansive moving emotion ("E Motion"). The DJ uses his instrument to further enhance and feedback those motions and sound objects, all reflected in the physically spinning turntable reflecting the spinning motions of the dancers. Here we see how the art of the DJ has many fundamental

features that are not implemented in the purely digital and software paradigm of modern laptop mixing of music (Cascone 2002).

The link between the fundamental underlying physical functions of the DJ turntable and the dancers is so inherent and self-evident that it's not questioned. The relationship between “gesture” in *musique concrète* on the one hand and “gesture” in dancing is obvious once perceived. The physically rotating heavy turntable platter is endowed with a force much like a dancer.

This is provided by a fast reacting motor (a “direct drive” motor provides very fast responses) which appears remarkably similar to the spinning and gyrating dancers on the dance floor. The effects of the rotational velocity of the turntable inhabits a whole language of music, movement and dance hinted at by *Laban* and *Schaeffer*. So the gesture of the turntable in the hands of the DJ is paramount, yet is lost in badly done (in the author’s opinion) “*vinyl mode*” simulations in many of the most prevalent of DJ software such as *Virtual DJ*, *DJay* by Algoriddim and *Cross DJ* that implement inauthentic renditions of a “turntable” that fail to fully recognise and connect the importance of a physically rotating turntable platter as I have identified above. I examine these software applications in more detail in the following chapter.

Physically Modelling the DJ Turntable

Software engineers have not taken the time to understand the instrumental nature of the DJ turntable. Yet time has been taken to understand the nature of guitars and drums that have been physically modelled since the rise of digital audio from the early 1980's.

But what exactly is physical modelling ? Curtis Roads in *The Computer Music Tutorial* defines a physical model in the following way.

> *"Physical modeling (PhM) synthesis starts from mathematical models of the physical acoustics of instrumental sound production. That is, the equations of PhM describe the mechanical and acoustic behavior of an instrument being played."*
>
> (Roads 1996)

Physical models can be seen in their modern incarnations in Ableton Live instruments such as the following (Ableton 2025).

1. *Tension*

   Tension is a physically modelled synthesiser that simulates stringed instruments like violins, cellos, guitars, and harps. It allows users to control parameters like string stiffness, material, pick or bow position, and body resonance to craft realistic or experimental sounds.

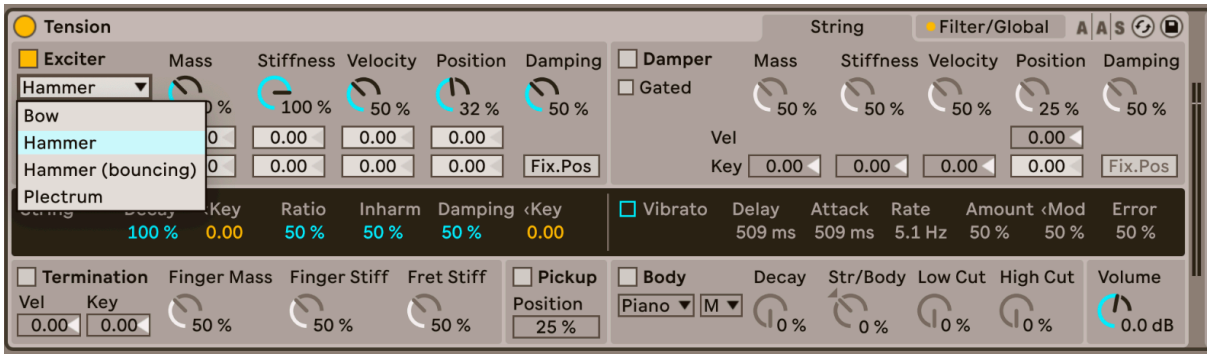

Figure 3

2. *Electric*

Electric is modelled after classic electric pianos, such as the Fender Rhodes and Wurlitzer. Using physical modelling, it simulates the behaviour of electric piano components like tines, hammers, and pickups, enabling users to modify aspects of the instrument's physicality.

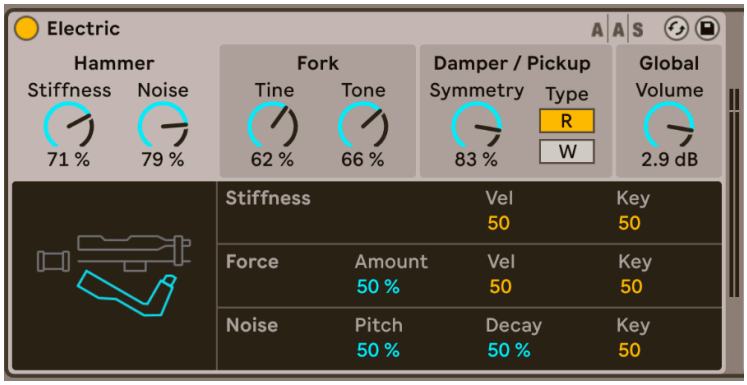

Figure 4

3. *Collision*

Collision focuses on simulating percussion instruments, specifically mallet-based ones like marimbas, vibraphones, and xylophones. It models how mallets interact with resonant objects, with customisable parameters for the resonators and the materials being struck.

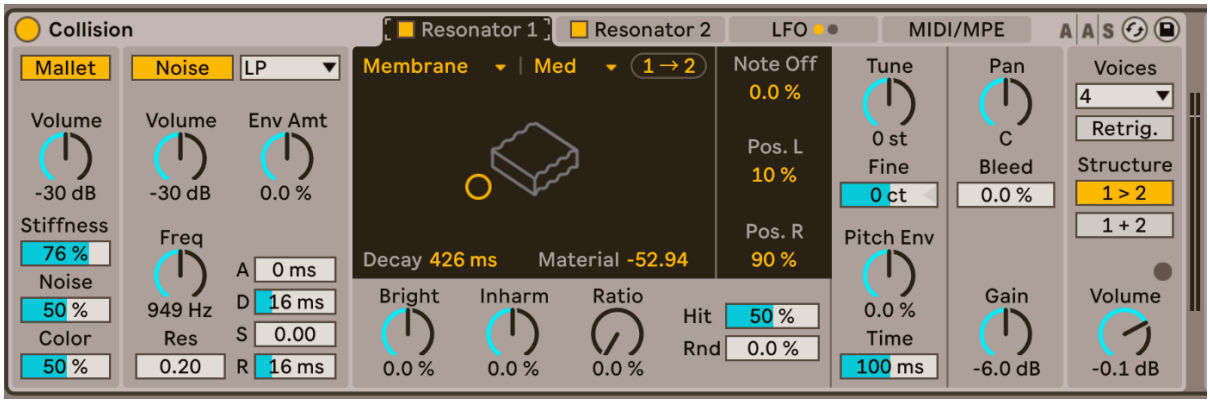

Figure 5

Yet such a device in Ableton Live that physically models a DJ turntable is absent. Is this because the instrument has not been taken seriously as a subject for physical modelling ?

> *"With the increasing use of CDs, mp3s and computer programs such as Ableton Live, the notion that vinyl and turntables represent the authentic technology of DJ culture seems somewhat redundant."*
>
> (Montano 2010)

Here the underlying science of what a DJ turntable does is missed in deference to treating the device purely as an outmoded technology, without examining the features that make it an instrument. It's treated simply as an audio playback device that is "*redundant*". This ignores the underlying physical mechanism that makes the DJ turntable sounds of the spin back, scratching, slow downs, braking and a plethora of other techniques. A mechanism that has never been physically modelled, as has been done with the Ableton Live instruments and, for example, *Karplus Strong Physical Modelling* (Karplus 1983).

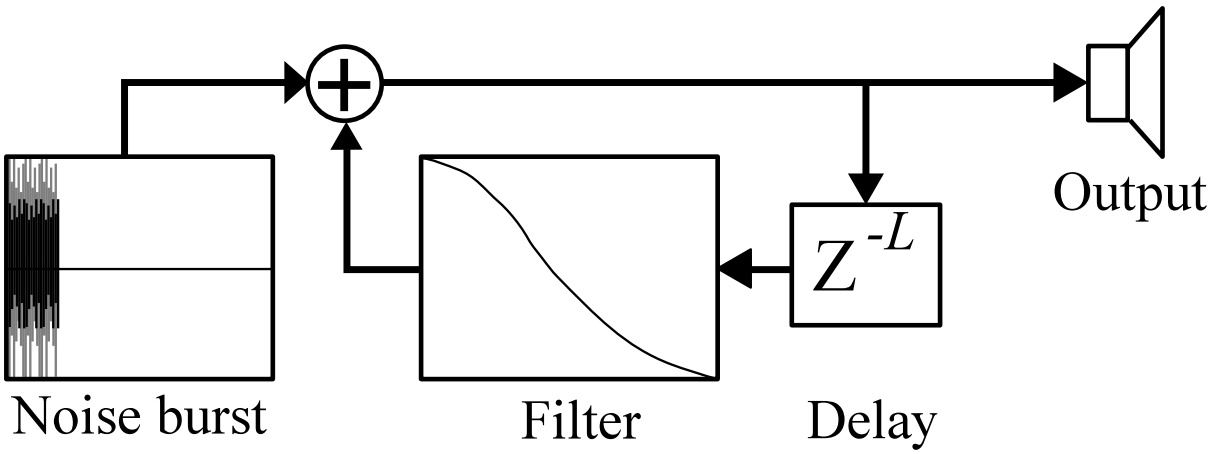

Figure 6

Here the vibrating string of the guitar is modelled by looping a waveform through a filtered delay line to simulate the sound of a plucked string. Interestingly there is a comparison between DJ turntables and strings. The “string like” nature of the turntable was noted by a performer …

> *“D.ST toured in Herbie's Rockit Band, playing the turntable (or as he dubbed it, the “turn fiddle”) like a musical instrument, employing effects and breaking new ground.”*
>
> (Webber 2008)

The DJ when scratching drags the needle up and down a groove much like a bow is drawn over the string of a violin. This shows how close the DJ turntable is to a more traditional instrument.

The following is a physical model that models bowed strings (Stanford University 2025).

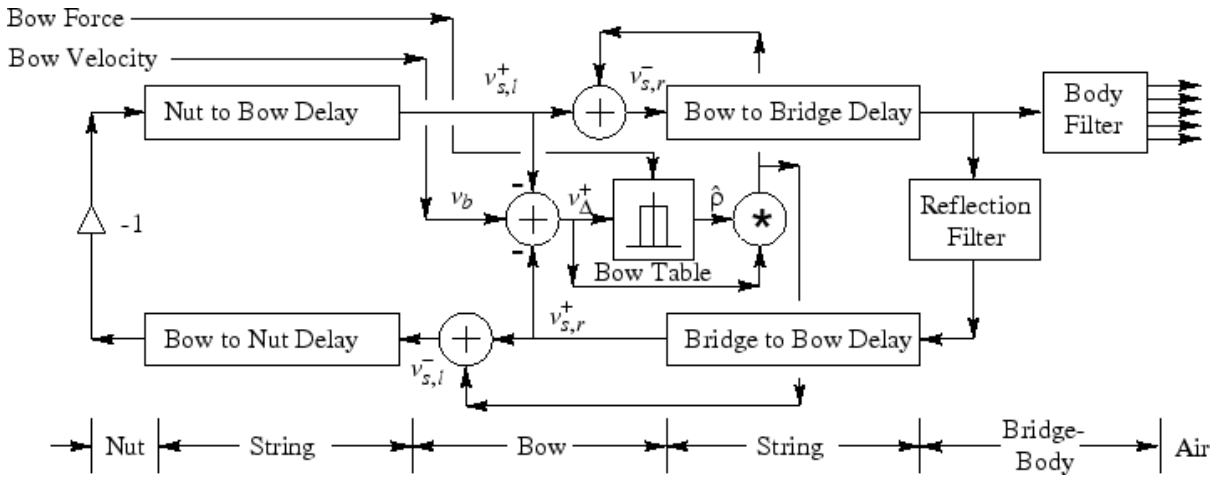

Figure 7

Examination of the diagram shows that the designer has taken the time to examine the fundamental physical features of a bowed instrument. A process that has been lacking when it comes to the development of DJ technology in the music technology industry.

The Roland 808, 909 and 303 musical devices have historically often been closely related to the DJ turntable. Techno, House, Hip Hop and Rap incorporated these devices in their works which were then mixed by the DJ. In their wisdom, Roland never fully re-released these hardware devices onto the market in their original form, resulting in a second hand market valuing these devices in the thousands of pounds. Roland eventually developed their *Analogue Circuit Behaviour* technology (Steel 2016) which is a physical model of the analogue circuits of the Roland 808, 909 as well as other devices. Previous to Roland's breakthrough these drum machines were often reproduced in software by using *samples* of the original hardware devices. These were prerecorded audio samples of each instrument of the drum machine. There were also hundreds arbitrary recreations of the 303

bass synth that all sound slightly different (Werner 2014). Yet the legendary status of these devices eventually led to a serious physical modelling of them by Roland. With engineers often working for years on the original hardware electronics to recreate the entire electronic signal flow in software. Yet here we have an anomaly. Another legendary device, the "*wheels of steel*", still has not had a professionally produced and seriously studied *physical model* released into the market (at least the author could not find one).

Physical modelling has a long history going back to Lord Rayleigh's volume *The Theory of Sound* (Strutt 1877) where the physical properties of various instruments are described. The publics first exposure to physical modelling was when the film *2001: A space Odyssey* was released (2001 1968). In the film *HAL*, the ship's AI, is having his memory modules removed. He regresses to singing the song *A Bicycle Built for Two.* This is a reference to the first pioneering work on physically modelling of the human vocal tract in 1962. The software Max (by Cycling 74) is named after Max Mathews, a pioneer in computer music. In 1961 Max arranged a demonstration of technology that included a rendition of the song sung by a computer model of the vocal tract (Kelly 1962). The author *Arthur C Clarke* was present, and was so impressed that he included the song in the film 2001 to honour this achievement.

As we have seen many instruments have been extensively physically modelled. However the DJ turntable still lacks such implementations, although there are suggestions in the literature.

> *"To replace the turntable, all its aspects should be simulated, for instance built on physics-based modeling techniques, to give an acceptable result."*
>
> (Hansen 2004)

The turntable may not ever have been subjected to an actual physical mathematical model. The authors research discovered a single project in an old Visual Basic forum that implements a physics based model of the turntable (Roman 2006). His model mathematically simulates the physics of the rotating turntable platter. However, in terms of the DJ turntable, what exactly are we talking about when we refer to a "*physical model*" of it ? Take the guitar string. We know that vibrations move up and down that string. The musicians places his hand on it at various places in order to play it. As we have seen, mathematical models have been produced that model that behaviour and there are various software instruments that use this approach (such as *Tension* in *Ableton Live* as noted above). A true physical model would model the central moving part of the turntable instrument. The rotating platter and direct drive. If one were to model a Hurdy-gurdy then the developer would not be expected to leave out the rotating part of its mechanism, yet, as I show below, models of the turntable do not properly implement this.

DJ Turntable as Instrument

What is a turntable actually *doing* when it behaves as an instrument ?

Roads notes that …

> *"A fundamental principle of physical modelling synthesis is the interaction between an exciter and a resonator. An excitation is an action that causes vibration, such as the stroke of a bow […] A resonance is the response of the body of an instrument to the excitation vibration. From a signal-processing point of view, the body acts as a time-varying filter applied to the excitation."*
>
> (Roads 1996)

In the case of a turntable, the exciter is the rotating turntable platter. Just like the bow, *the platter* is causing the excitation vibration. However, in this case, the body of the instrument or "string" is the rotating turntable and its effect on the recorded audio, if that is through the stylus, or control of digital tracks by sensors that detect the motion of the turntable. In digital DJ'ing systems that's where the forward or reversed speed (angular momentum) of the platter is translated directly to the speed (pitch) of a vinyl record or digital audio sample. This is effectively a virtual needle or pointer.

What seems to create the confusion with defining DJ turntables as an "instrument" is the fact that they play pre-recorded audio. The audio played is often pre-recorded audio of other instruments like drums, drum machines, synthesisers, vocals and so forth. The turntable has a long history of being treated purely as a play back device. The crucial difference that transforms the turntable into an instrument is when a performer is manipulating the platter and the controls such as *on/off*

switch, play/start, 45 and *33rpm* switches. When this happens the pre-recorded sound that is being played effectively becomes the string that we see in a violin or guitar. But the string is made of the linear recording of whatever prerecorded audio material. This is most obvious in the "*scratching*" of vocal audio samples when the singing or rapping takes on a completely new form in the hands of the DJ. This produces unusual sounding audio forms.

> *" [...] speech prosody and musical prosody from traditional instrumental music can be compared* [to scratching]. *Similarities with the singing voice can be found for example in the humorous improvisation of scat singing, and naturally, in the vocal elements of hip-hop culture, rapping and beatboxing."*
>
> (Hansen 2011)

Yet modern DJ controllers and DJ software, that claim to replace a physical turntable, have an incomplete set of this functionality. The only time that functionality is fully there is if the DJ uses a *Digital Vinyl System* (DVS). DVS sends a timecode, recorded onto the vinyl record, to software that controls digital audio playback. Because DVS still uses physical decks all the functionality explained above is retained. Some would argue that DVS lacks properly informed information to allow the DJ to jump to a place in the track because DVS does not show the original grooves of the track playing on the vinyl record. There have been some attempts to remedy this (Burger 2016). Otherwise systems that do not include the physical mechanisms of the turntable fail to fully reproduce it.

Modern DJ controllers and software have a heavy emphasis on providing automatic beat matching and pitch matching. This may have its advantages for, for example, radio stations that want to provide automatic mixing. However, to begin with, this misses the point of the DJ turntable as instrument, as well as the role of the DJ. Just as with any live performance the skills of the DJ are valued. DJ skills savvy audience members would be aware of the beat matching going on. However even if, most of the time, the audience are not consciously aware of it, the manual virtuosity of the DJ performer provides liveness and risk. The author, who is a trained DJ, can hear small corrections in mixes by DJ Sasha, one of the most respected and experienced DJ's in the world. The subtle **"**mistakes" are clearly part of his performance and add the liveness and risk. The dancers unconscious awareness of the manual beat matching highlights *risk* in so much as the performer may fail to match the beats. This is part of what creates a dynamic community space free of the staid and unchanging nature of purely technological performances (Cascone 2002). The aura of "*liveness*" is lost with modern DJ controllers and software where the DJ has handed over important functions to the technology. The same is true with pitch matching. Over the years DJ's have become skilled at finding chains of records that work together because their pitches don't clash. This was not a perfect process. A slightly off pitch record would, by adding slight discord, add *risk*, novelty and improved "liveness" with the concomitant audience response. The "chaos" of track pitch clashes can lead to interesting results just as it can when manually matching the beat.

"[…] beatmatching is the art of imperfection that faces the temporal unfolding of what exceeds mathematical precision or certainty: the wavering of what is-to-come through the clash of two rhythmic assemblages."

(Veen 2012)

Chapter 3

Resistance is Futile: The Borg Assimilate the DJ

Yet all the creative chaos is lost in the rush to "optimise" and "improve" everything with technology. The author was struck by the way Rick West samples the Borg Queen from the film *Star Trek: First Contact* in his track *Metamorphose*.

> *"Don't be frightened. We too are on a quest. I bring order to chaos. You are in chaos. I am the beginning. The end. The one who is many"*
>
> (West 2001)

The Borg kidnap humanoid species and turn them into half human robots that are obsessed with efficiency and optimisation. Therefore, as the Queen states, bringing "order to chaos". In this respect DJ controllers and software have colonised the "chaos" of the individuals

“imperfections” when it comes to beat and pitch matching. However this obsession with “optimisation” is not exclusive to the DJ world.

> *“An obsession with “optimization” is already making all advertising and music sound the same. Alex Murrell, strategy director at the British brand agency Epoch, also recently published an essay entitled The Age of Average in which he shows how everything from apartment interiors to coffee houses to architecture to people to media to brands all look the same.”*
>
> (Scott, 2023)

> *“According to the research in the video, lyrical intelligence, harmonic complexity, and timbral diversity have decreased while dynamic range compression has been used to make music louder and louder. In short, songs are becoming stupider – especially since every hit now includes the “millennial whoop” as well.”*
>
> (Scott 2018)

Each new piece of DJ software, as well as each new EDM release, has been subjected to this “optimisation”. The “optimisation” tells the marketeers and designers that the audience “*value a perfectly mixed DJ mix with no mistakes or pitch clashes*”. This of course misses all the nuances and important functions of the DJ, as described above, and of the DJ turntable and its relationship to the listener and dancers.

> *“As a rule, businesses do not like risk. The video states that record companies today must spend anywhere from $500,000 to $3m to sign and market a new artist. That is a lot of money to spend on a band without being fully confident of success.”*
>
> (Scott 2018)

In the world of DJ’ing this “optimisation” of auto beat and pitch matching is described as “freeing” the DJ from the “tedious” tasks of

beat matching and pitch matching. The author is yet to hear any new techniques that have resulted from the DJ being “freed” from beat matching or pitch matching. Is this not like “freeing” a guitarist from plucking the strings ? An audience at a rock concert would not be expected to witness the guitarist directing the playing of a guitar with a robot translating his commands into string plucking. Yet this is effectively what new DJ controllers and software do with the DJ. If controllers or software do promise features of a “DJ turntable” or “vinyl” effects, these are almost exclusively arbitrarily produced individual effects like “turntable slow downs” or “brakes” (at least the author could not find any examples of proper physical modelling). When scratching is implemented, a passably authentic type of scratching can be produced. But this lacks the complete gestural control and non-linear responses from an actual turntable. For example when a DJ stops a scratch, sometimes the turntable continues to spin for a while slowing down to the end of the scratched sample, adding an extra gesture to the performance.

The Corporate Colonisation of the Consciousness of DJ'ing

This colonisation and sanitising of musical and instrumental techniques into a monoculture of technologies is destroying epistemological diversity. Creating a monoculture of DJ software and controllers that have been stripped of the DJ turntables rich cultural context and instrumental functions.

> *"[...] attempts to destroy epistemological diversity through a monist framework – a single story – that claims to be universal: a form of epistemicide (Santos, 2014). This constitutes a colonization of the imaginary, of our capacities to imagine alternatives."*
>
> (China 2017)

A good example of this kind of failed approach is "*Live Scratcher*". An Ableton Live Max for Live device published by Isotonik Studios (Norris 2025).

Figure 8

The device allows the scratching of a sample by moving the play head backwards and forwards facilitated by using various internal and

external control methods such as an app on a mobile phone to send movements to the device. Even though the scratching can produce many interesting effects and sounds, Live Scratcher does not implement any of the core features that make a turntable an instrument. There is no *physical modelling* of the turntable platter movement. Neither is the slip-mat modelled which is such a crucial part of scratching. The slip-mat is placed between the record and turntable platter. The slip-mat allows the performer to hold, or move backwards and forwards the record, without needing to fight the motor rotating the platter underneath the slip-mat. Only the "*backwards and forwards*" is emulated here, therefore missing out on the complex and sophisticated dance of the various interacting elements of an actual turntable.

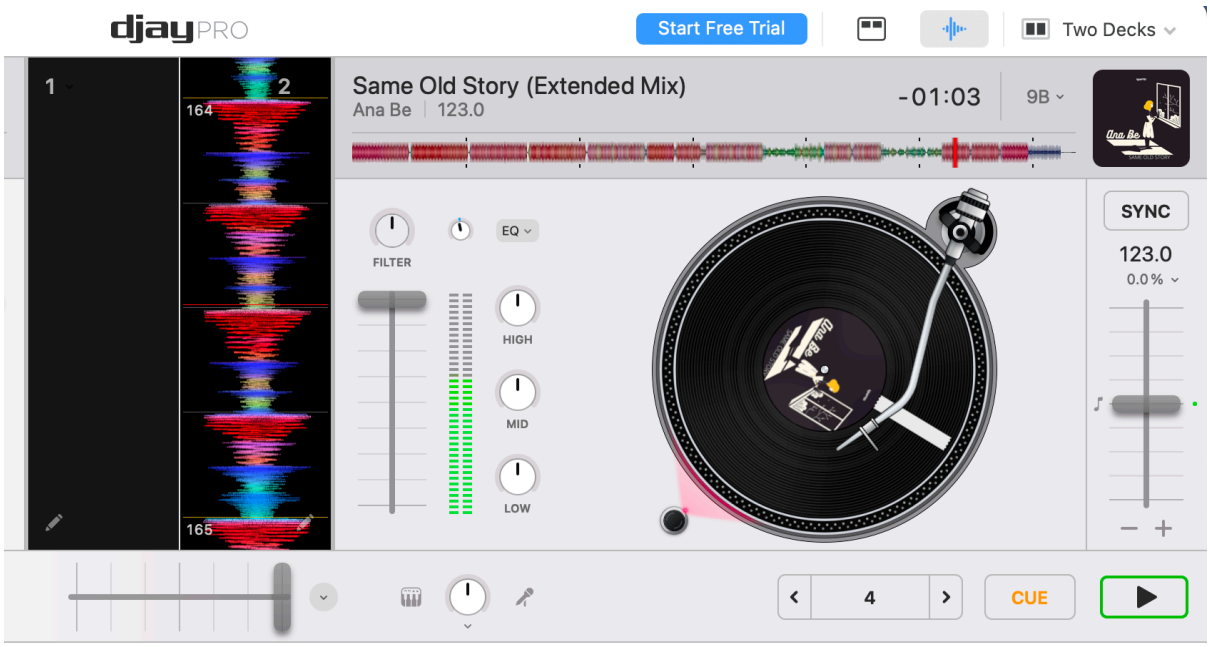

Figure 9

Another good example is DJay by Algoriddim (Algoriddim 2025). This piece of software has a "*Vinyl mode*" that has a recreation of a

vinyl DJ turntable. Moving the arm jumps to the appropriate place in the track. The power button, once turned off, does set the audio track into an extended slow down. However the time it takes to slow down is not long enough. I'm familiar with DJ turntables and know how long it takes for them to come to a stop. It takes even longer if the record is playing at 45 rpm but that is not simulated here. More so, even though the software has a barely passable scratch functionality, it does not sound right. Throwing the platter backwards and forward and playing with the transport functionality proves to me that there is no underlying physics simulation of the (in the real world) heavy turntable platter.

Why is this important ? In a video game when you punch a box you expect it to fly away convincingly, reflecting the power of your super hero punch, as the heavy box flies through the air and then satisfyingly shatters into pieces. But here it's as if the designer could not really be bothered to do justice to the mighty "*wheels of steel*". This is with "A.I." prominently displayed in the product description which implies that this is a clever product. However DJay fails the test of being a *physically modelled* turntable emulation.

Serato DJ Pro (Serato 2025) and Native Instruments Traktor (Native Instruments 2025) also don't have any kind of true virtual turntable emulation. These two products rely on a DVS (Digital Vinyl System) using time coded records to interface physical turntables with the software. As covered previously, this is still the most reliable way of using turntables with digital software as, of course, the real authentic

physical turntable instrument is used with its full range of gesture control.

Figure 10

Cross DJ, on iOS and Android devices, is DJ mixing software produced my MixVibes (Mixvibes 2025). The product has an interesting scratching emulation which is probably much enhanced by being able to use the touch screen. However, that's it. There is no underlying physics emulation of the turntable platter, or the

interaction between that various controls, the platter, slip-matt and vinyl record. As much as the implementation is functional, and it's likely that forms of creative mixes could be made with it, the product is not an authentic recreation of the actual turntable instrument with all the deep gesture control and interacting elements.

Conclusion

As I have established, creative DJ'ing has important elements of liveness, risk and gesture control that emerge from the blending of the playback of pre-recorded music material and the use of the turntable as an instrument. The performer *D.ST* encapsulated the nature of the DJ turntable as an instrument in his phrase "*turn fiddle*". With this understanding we have found that the music technology industry has implemented DJ turntable functions in a superficial way, to the extent that the practice of DJ'ing has been damaged when using purely technological (DJ controllers) and software solutions. This is reflected in the fact that there are a large number of DJ's that still play real vinyl records or use timecode vinyl records to control software. The industry needs to attend to these concerns as their customer base is comprised of people who are looking for the emotional experience produced by DJ's. A performance that can effectively produce authentic liveness and risk of the kind that their customers would expect to find at a live gig by musicians playing drums and guitars

without inappropriate technical assists. Much of what can be academically proved and evidenced to be important in the practice of DJ'ing has been discarded by the music technology industry, and needs to be restored.

I'd like to see further research in this area, as well as a more assertive approach by various music and DJ'ing organisations to advocate for authentic approaches to DJ'ing by the music software and technology industry. There is a need to combat ignorance surrounding why the DJ turntable is an important instrument just like a guitar.

I am not the only DJ who has these concerns, which is evidenced by the rise of vinyl sales in recent years. Also there was a predicted upcoming phasing out of vinyl and turntables that were to be replaced by laptops and controllers. However this never transpired, likely due to the audience and dancers themselves, who seek not only the valuable experiences provided by the musicians that DJ's play, but also the virtuosity of the DJ.

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Figures

Fig. 1: Explanatory diagram showing gesture control range (Bryan 2011).

Fig. 2: CHATGPT. 2023. Prompt by the author: ‘Could you provide me a diagram of the DJ turntable brake effect direct drive versus belt drive’ [AI generated image]. Available at: https://chat-gpt.org/ [accessed 18th January 2025].

Fig. 3: Screen shot of Ableton Live instrument by the author.

Fig. 4: Screen shot of Ableton Live instrument by the author.

Fig. 5: Screen shot of Ableton Live instrument by the author.

Fig 6: POROCYON. 2015. *English: SVG Version of Https://Commons.Wikimedia.Org/Wiki/File:Karplus-Strong-Schematic.Png*. Available at: https://commons.wikimedia.org/wiki/File:Karplus-strong-schematic.svg [accessed 2 Feb 2025].

Fig. 7: (Stanford University 2025)

Fig. 8: Screen shot of Ableton Live instrument by the author.

Fig 9: Screen shot of DJ Pro by the author.

Fig 10: Screen shot of Cross DJ by the author.