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MECHANICAL TECHNO: EXTENDED TURNTABLE AS LIVE ASSEMBLAGE

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Abstract

This practice-as-research thesis uses Mechanical Techno, an automated musical instrument-system and kinetic sounding sculpture, to analyse liveness in electronic music, framed by the concept of the assemblage.

As a project Mechanical Techno uniquely bridges several fields of research: experimental turntable practice, electronic dance music, sound art, and new musical instrument design. The research project shows a new body of work developed across these areas. A portfolio comprises documentation of a live performance, studio recordings, musical instrument designs, and new collaborations. Led by the practical work, the exegesis discusses the way the instrument-system works and what it can do, framing the work at different scales of assemblage.

Mechanical Techno is presented as a system which embodies a high degree of action-sound-coupling and machine liveness, enabled by the particular performance approach and set of affordances which are built into its design. Through live work in the studio, the project is considered as a physical audio workstation, enabling a discussion of the resulting mechanical and human signatures which define its aesthetic. Mechanical Techno sits between an automatic playback system and a playable musical instrument, and uses various interfaces for live inscription developed during the research project. This enables an investigation of the role of the setter in contemporary music practice. By combining Mechanical Techno with other artists' projects, new collaborations are considered as live assemblages.

The thesis argues that the use of the extended turntable as a mechanical musical instrument is a category of turntable practice distinct from both dance music DJing and instrumental turntablism. The several strands of creative practice contribute to an overarching discussion of liveness and its relationship to assemblage theory within experimental and electronic musicking.

Acknowledgements

This project would not have been possible without the help and support of a host of people. First, I want to express my gratitude to Professor Hillegonda Rietveld and Dr. Adam Parkinson for going above and beyond as my supervisors, patiently providing advice and reassurance throughout, particularly when faced with the difficulties of the current crisis in higher education. My collaborators deserve special thanks for their contributions, without whom I would have not been able to finish the project, so thank you to Cath Roberts, Sam Underwood, Kev Foakes and Lucy Cheesman. Additionally I'd like to thank Leon Trimble and Laura Murphy for the live visuals, and Sascha Brosamer for the work we did together early on in the project which didn't make it into the final thesis. I also really appreciate all the promoters and venues who booked me to play over the past three years, the labels who've released material and the people I had to say 'no' to for lack of time—thanks for the invitations anyway. Many kind people helped with technical support, advice and info. Thanks to Jack Driscoll for the expert studio work, Justin Paton for letting me record his synths, Darren Adcock for the electronics help, Nik Clifford for the dubplate cutting, Tony Hope from the LSBU fab lab for his infinite patience, Dylan Beattie for his knowledge on lathe cutting, Peter Craig for showing me his fairground organ setting room, and Lia Mice for the helpful advice before I began the PhD. Finally, huge thanks to my family for the continued support throughout my unusual and meandering career, and to Laura for always being brilliant, supportive and patient.

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Chapter 1. Introduction

This research project uses and considers Mechanical Techno, a kinetic sounding sculpture and automated musical instrument-system, as a live assemblage, generating insights into performance practice, studio composition, instrument design and collaboration. As a practice-as-research project, the thesis comprises a body of new work and documentation leading each chapter of the exegesis, which details the resultant findings.

The Mechanical Techno project is a configuration of the extended turntable made to function as a multi-mode sequencer, used to make rhythmic electronic music. The basic principle is that, given the turntable is rotating at 33 1/3 RPM, a four-beat cycle will produce a tempo of 133.333 BPM, ideal for dance music. Several ways of generating four-four rhythms and loops are played at the same time by stacking them together as a tower: an idea taken from Danish turntable duo Vinyl -terror & -horror. I began the project in 2014 and have since performed live with it over 170 times and released multiple albums of recordings.

In a Mechanical Techno live performance I begin with an empty turntable, adding one layer of modified vinyl at a time, making visible the sound each introduces into the mix. Physically building the tower results in sonically building the music (Image 1.1). Musical breakdowns result from dismantling the tower. During a performance I build the tower in different configurations to generate different musical outcomes. As each addition acts as a demonstration of the way the technology works, the whole performance acts both as the creation of a piece of music and a visual illustration of the working of the machine. The principal function of the Mechanical Techno system is to physically make electronic music in real-time. Based on a single-cycle-loop, the music is driven by rhythm and repetition with a focus on optimisation towards a groove. The musical aesthetic draws primarily on techno and related genres including house, UK garage and rave. There is also influence from more experimental fields including free improvisation, dub production, noise music and drone. Through this research project I developed new instrumental components, performance approaches and collaborations with Mechanical Techno. The project draws on techno's electronic aesthetic and production

methods as well as its future focus and conceptual links to the technoculture (Rietveld 2018), but produces music using techniques, roles and practices connected to the world of physical mechanisms and mechanical musical instruments. In this thesis, Mechanical Techno is explicitly positioned as a live assemblage, and the affordances of such a conceptual understanding are analysed. To further define these underpinnings, the discussion now turns to the key concepts: Mechanical Techno and live assemblage.

Image 1.1: Mechanical Techno performance at Rhythm Sticks, Centrala, Birmingham, 31May 2024. Photo By Irena Mackie.

Mechanical Techno

Techno is a broad concept which has been interpreted differently in various contexts. Developing through the 1980s as a global phenomenon with epicentres in Detroit and other cities including London, Manchester, Frankfurt and Berlin, techno became a 'transnational, yet locally definable, electronic dance music culture' (Rietveld 2018:113). Two interrelated concepts of techno are outlined here: techno as a cultural-historical phenomenon and techno as a musical genre. Such categories inevitably overlap in genre studies, as Smith describes: 'genres are social constructs, which are only partially based on formal musical characteristics. Cultural-historical analysis and

musical analysis are both necessary in genre studies…' (2024:98) The distinction is useful in understanding the term in relation to Mechanical Techno, as conceptually the project draws on both techno's capacity to contain complex ideas relating to technology and the future, and its musical aesthetic.

The narrative and future-focused elements of techno are considered here first. In Detroit, techno developed in black underground club culture through the 1980s, evolving in parallel with Chicago and New York's house music. Detroit techno crystallised as a genre following the release of the 1988 compilation *Techno! The New Dance Sound of Detroit*, released in the UK (Rietveld 2018:116). In Sicko's analysis of the scene and its sound, the conceptual aspects are identified as most important: 'Rather than any one particular sound, techno is more of a mind-set, having to do with the fantasizing and philosophizing of Derrick May and Juan Atkins as kids. This is where techno will always find its strength.' (2010:143) Future focus and science fiction resonate throughout techno, placing it in a broader Afrofuturist tradition. Themes of robotics, space travel and unknown worlds permeate techno releases. Eshun describes techno's alternative futurist narratives as Sonic Fiction: 'Sonic Fiction is the manual for your own offworld break-out, reentry program, for entering Earth's orbit and touching down on the landing strip of your senses.' (1998:103) These themes are not as straightforwardly futurist as they may at first seem, in part due to the context of post-industrial decline in Detroit at the time of their emergence. According to Sicko, techno had 'antiquated notions of the future,' (2010:11) and the high technological prowess espoused in the titles and occasional lyrics was often brought to life musically by outdated or cheap synthesizers and drum machines. 'Atkins appropriated the term "techno" from Toffler's 1980 publication *The Third Wave*, which suggests that the "techno-rebel" takes control of technology rather than being controlled by it, by making it part of frontline culture.' (Rietveld 2018:116) Sicko quotes Toffler emphasising the specific facet of the term which got carried forward: 'As he [Toffler] asserts, "The techno-rebels contend that technology need not be big, costly or complex in order to be 'sophisticated.'" (Sicko 2010:11) Though Sicko acknowledges the difference in context between Toffler's imagined techno-rebels and the Detroit musicians using synthesizers to make music, he points out the fundamental similarity: 'the common ground is a

simplification of technology and an emphasis on maximising the potential of the individual.' (ibid:12) This is the particular aspect of techno-futurism which informs Mechanical Techno: that forward-looking themes, science fiction concepts and utopianism can be embedded within musical works, without the technologies that produce them necessarily being from the future or even the bleeding edge of technological development.

Two concepts which I have previously explored with Mechanical Techno are the self-replicating machine and post-apocalyptic or apocalypse-proof technologies. The project acts as a self-replicating machine in that some of the components are recycled from discarded vinyl records. By recycling other unwanted dance music to create new electronic music, Mechanical Techno acts as an engine of self-replication. My 2016 album *Auxon* embeds these themes. Recycling components, consumer technology or repurposed science equipment also feeds into ideas of sustainability in a post-apocalypse future. This is in part influenced by the record groove as a robust and long-lasting storage medium: that a gramophone disc created a century ago can still be played back today, with only the most rudimentary equipment required. These themes resonate with some of techno's science fiction and futurist concerns, particularly in the way they are embedded in both the music and the non-musical components such as titles and packaging. They also present a point of departure, as Mechanical Techno's future focus is ramshackle, clanking and imprecise.

Themes focusing on technology and the future run through techno's history, and the way that these are most clearly expressed is through the sonic character of the music itself. 'Existing uniquely in a studio-generated soundscape, synthesized bleeping and modulating sounds dominate techno's surreal dance recordings, allowing an exploration of the experience of a cyber-future in which information and communication technologies play a central role.' (Rietveld 2018:115) The musical and sonic signifiers of techno as a genre also inform Mechanical Techno. In its broadest musical use, 'techno' as a genre descriptor often works interchangeably with terms like 'dance music' or 'EDM (electronic dance music)' to encompass any and all electronic music with the intended function as use by DJs for people to dance to. '… in the study of electronic dance music, techno is often regarded as the main musical form without specifying (sub)genres.'

(Rietveld 2018:114) This usage ignores both the nuanced musical identifiers of the genre and its sociocultural context. Nevertheless, it sometimes gets deployed as shorthand for whole scenes and collected (sub)genres. Narrowing down the focus by a degree, techno is an umbrella term encompassing almost endless subgenres including acid techno, minimal techno, industrial techno, tekno, hardgroove, dub techno, and deep techno. 'As much as techno is a sum of musical influences, it has also divided into an infinite number of substrata, which are nearly impossible to trace.' (Sicko 2010:134) Various related terms hint at the sociocultural connections and interactions the music offers: underground techno, big-room techno, business techno. The diversity of subgenres and overlap with other established genres (particularly house, but also many other club music forms) makes stylistic parameters one of the less reliable indicators of the form. As a genre well into its fifth decade, common understanding of definitions has changed over time too. Classic late 1980s Detroit techno and modern mainstream techno may share few recognisable characteristics.

No genre is straightforward to define in stylistic or aesthetic terms, and to do so is necessarily reductive. Nevertheless, certain broad similarities and tendencies can signify the genre. Typical tempo for techno is between 120 and 150 bpm, though some subgenres may fall outside this range. Some signifiers often (but not always) present include: a wholly electronic sound palate, four-four bass-drum, off-beat hi-hats, significant emphasis of bass and sub-bass, looping cycles of two or four beats, sixteenth note percussion, fluid parameter changes of multiple instruments. In an article on the sonic signatures of distinct electronic music genres, Smith writes that 'Techno is characterized by its mechanistic aesthetic, with clearly electronic timbres. The texture emphasizes percussion, short repetitive bass riffs and sound effects, with no clear melodies.' (Smith 2024:107) In addition to the specific sounds, the way they interact is also important: 'It is rhythmically complex with the various parts interlocking like an industrial machine.' (ibid) The speed range of the turntable as it is used in Mechanical Techno puts it right in the band of tempos typically used in techno. The project references techno's electronic sound palate, including specific sounds such as the TR-909 hi-hat sound and a filter based on the TB-303 bassline synthesizer. Typically, Mechanical Techno uses a four-four rhythm and layers of percussion. Smith's

description of the sonic character of techno is quite broad, but it sets the general palate of sounds and attributes that are used in Mechanical Techno. Specifically, the notion of 'various parts interlocking like an industrial machine' (Smith 2024:107) can be applied both metaphorically and directly.

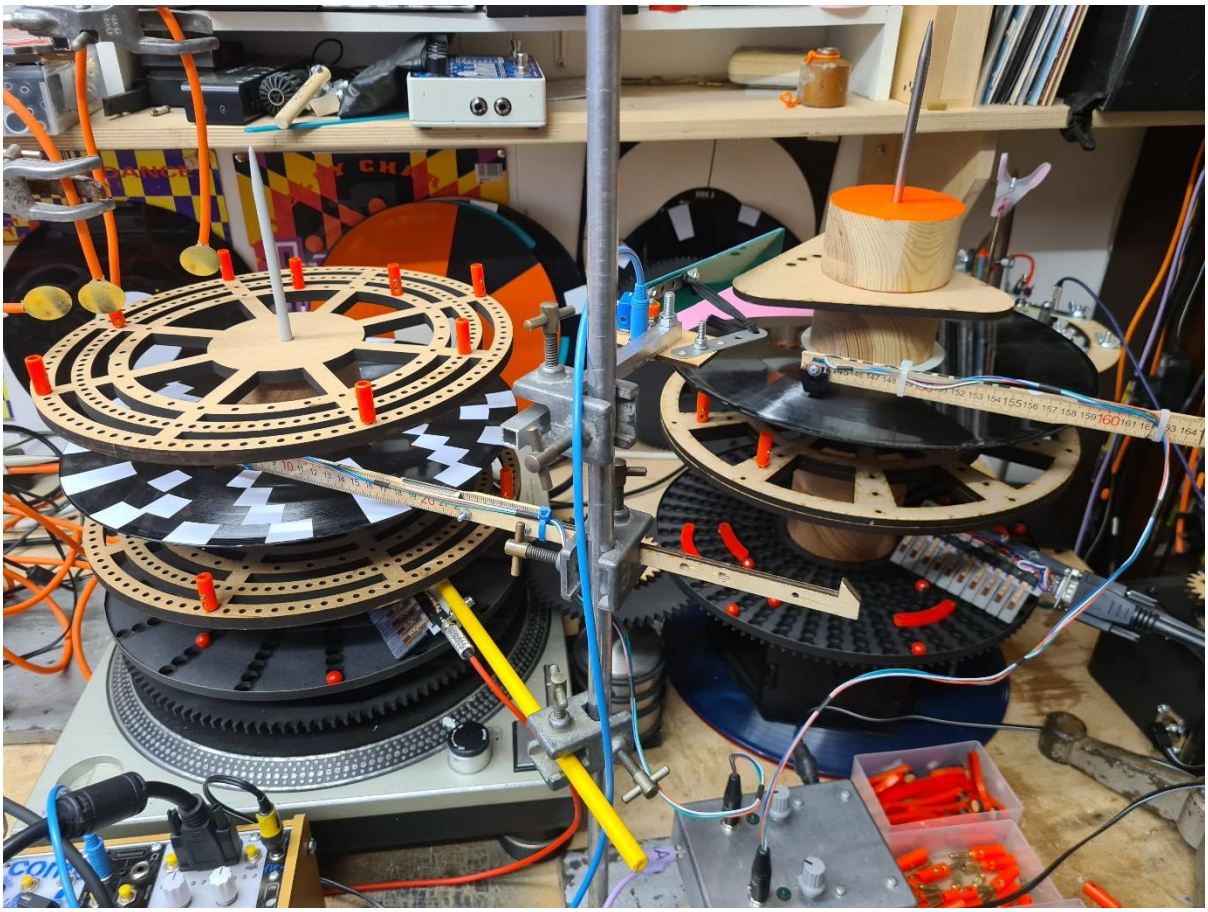

Image 1.2: Example of a Mechanical Techno studio setup as a physical machine.

Mechanical Techno draws both on techno's sonic palate and musical tropes, and, less explicitly, aspects of its embedded notions of the cyber-future. A defining feature of techno is its 'machine aesthetic' (Rietveld 2018:114) and this is also true of Mechanical Techno. The point of departure is the nature of this machine. Where techno's sounds, production and performance are exclusively electronic (analogue, digital and, increasingly, virtual), Mechanical Techno foregrounds the physical-mechanical (Image 1.2): mechanical sequencing, physical automation and hands-on human operation. Techno, like most forms of electronic dance music, is a type of functional music: its function is to get people to dance and keep them dancing. 'The principle means of experiencing styles such as techno and house—as encapsulated in the etymologically transparent term *discotheque*—is through dancing to recorded music.' (Butler 2014:67)

This approach influences Mechanical Techno's aesthetics in its regular pulse, foregrounding of rhythm and repetition, and continuity between sections. This also distinguishes it from some more abstract and sound art focused turntable projects, which typically do not prioritise dancing. As well as in gallery spaces and experimental music venues I have performed with Mechanical Techno at electronic music festivals, night clubs and squat raves. In this regard the project connects with a lineage of live techno and electronic dance music. Having identified the ways in which techno influences the project, the following section clarifies the relevance of the term 'mechanical.'

The Mechanical Techno system is a type of automated or self-playing musical instrument, and is influenced by music boxes, barrel organs and fairground organs as much as by DJ performance, electronic music production and experimental turntable practice. Use of the term 'mechanical' for such instruments infers the method of automation, but can also cause the category to be too narrow and therefore exclude certain devices. Ord-Hume considers the terms 'self-acting' and 'automatic' as alternatives, finally preferring 'mechanical' as it 'appropriately implies a system of playing by the agency of a mechanism of some sort' (1983:168). The second potential issue he identifies is that, often, mechanical musical instruments are not only mechanical but also use pneumatics, electromagnetic devices or electronics in their function. He concludes that 'mechanical' is general enough to encompass these methods of automation in most cases (ibid). Though discussing classic mechanical musical instruments such as music boxes, player-pianos and fairground organs, Ord-Hume's defence of the term 'mechanical' is also appropriate to Mechanical Techno. Once built, the machine will continuously play music by itself (as long as it has power to run). The physical motion of the turntable is necessary for any sound to be produced: mechanical movement is fundamental. Nevertheless, use of piezo triggers and electronic switches sets the system in the electromechanical domain, and many of the sound sources are mechanically triggered but electronically produced, both analogue and digital. As Ord-Hume identifies, it is not inappropriate to designate such electromagnetic processes as fundamentally mechanical. Use of the term 'mechanical' in regard to musical instruments, then, typically implies physicality, and automation of

both sequencing and sound generation. Mechanical music as a descriptor also often carries negative connotations, such as implying monotony and expressionlessness: ‘even during the late eighteenth century, critics viewed automata as “soulless” and therefore as incapable of expression.’ (Kemper & Cypress 2019:453) Common understanding of these distinctions is discussed in more detail in the section on musical instrument design in the literature review (Chapter 2).

The mechanical aspect of Mechanical Techno is its point of departure from techno as a genre and way of creating music. Physicality is fundamental to the project: the rotary motion of the platter powers all processes; without movement there is no sound. Whilst some sounds and effects are electronically produced or modulated, every sound source has some element of physicality in its production: a vibrating needle, a physical mechanism, or electromechanical switching or triggering. The system is fundamentally automatic. Once built, as long as it has power to drive the motor, the system will produce music indefinitely. The project consciously draws on older mechanical musical instruments for its technical functioning. Elements of the system use different automated playback techniques: physical, acoustic, analogue, digital. The arrangement, construction and alteration over time are the aspects which are hand-played. A focus of my research with the project is disruption of the dichotomy between mechanical music (as it has often been characterised), ‘time perfect, repetitious, logical, perfect, normative,’ and human-played music, ‘flexible, fallible, instinctive, emotional, individual’ (Magnusson 2019:53-54). The Mechanical Techno system is fallible by design, and emphasises difference within repetition. As Kemper & Cypress write, ‘Automated instruments are capable of producing and applying their own language of mechatronic expression’ (2019: 449). The physicality of the machine and the inclusion of improvisation within performance both contribute to this aim. The persistence of the negative connotations of the label ‘mechanical’ is one of the main catalysts for the project. Aside from aesthetic concerns, it carries with it an implication of laziness, avoidance of the hard work of genuine instrumental playing, or a short-cut to music making without the hard-earned skillset of an accomplished instrumentalist. Mechanical Techno blurs the distinctions between the attributes associated with

mechanical music—automatic, self-acting, precise, perfect, monotonous, repetitive—reframing them in positive terms, as a system which can even circumvent them.

Mechanical Techno is influenced by the technological aesthetics, primarily electronic sound sources and modes of production of techno, and its narratives of future focus and the technoculture. The project also draws on understandings of the term 'mechanical', which is its point of departure from the genre. Previously I have stated my aim aesthetically as to produce 'music that sounds a bit wrong,' (Dunning 2024:232) aiming to disrupt both genre boundaries (of electronic dance music) and expectations for a performance installation. The main concern is to make music which is unusual and interesting by breaking from expectations, as Demers explains in her discussion on the aesthetics of experimental electronic music: 'The interesting moments in any genre occur, of course, when expectations are in some way thwarted, when a work does something it is not "supposed" to do according to the rules of its genre.' (2010:10) Mechanical Techno disrupts the rules and expectations of techno as a strict genre through several means. The new 'machine aesthetic' (Rietveld 2018:114) it produces makes previously hidden electronic processes into visible physical-mechanical ones, introducing all kinds of flaws, glitches and unreliability. Identical repetition is disrupted through microtiming variation and indeterminate processes. The narrative focus departs from futurist science fictions to imply a more chaotic worldview, something less controllable and more prone to breakdown. With a definition of the project now stated, the following section addresses how the instrument can be understood as unique live assemblage that is activated during performance.

Live assemblage

In order to consider the concept of a live assemblage it is first necessary to define assemblage itself. Assemblage here is a term drawn from Deleuze and Guattari, primarily from *A thousand plateaus: capitalism and schizophrenia* (2013). Throughout that text the term is applied to many different combinations of components including: the 'feudal assemblage' consisting of the earth, people, horses, weapons and tools, heraldic law, statements and expressions (ibid:103); 'the territorial assemblage of a bird species' (ibid:388); 'the "war machine" assemblage' and 'the "work machine"

assemblage' (ibid:464); a nomadic rider described as a 'man-horse-bow assemblage' (ibid:470-1); a 'farmer-gatherer group' and a 'manufacturing group' (ibid:509). Assemblages comprise an array of heterogeneous components, that is, things of different kinds. They can also exist at different scales, from the very large-scale feudal assemblage down to an individual with a weapon astride a horse. Indeed, at the very start of the text, the book itself is defined as an assemblage, elaboration on which begins to give substance to the term:

> 'In a book, as in all things, there are lines of articulation or segmentarity, strata and territories; but also lines of flight, movements of deterritorialization and destratification. Comparative rates of flow on these lines produce phenomena of relative slowness and viscosity, or, on the contrary, of acceleration and rupture. All this, lines and measurable speeds, constitutes an assemblage.' (ibid:2)

Here we learn that an assemblage has tendencies towards both stasis and change, and that these occur at different speeds. The significance of this statement is in Deleuze and Guattari's conception of the assemblage as 'an answer to the venerable philosophical question, What is a thing?' (Adkins 2015:10)

This research project is one of musical instrument design, performance and composition, not one of philosophical discourse. As such the way in which I have interpreted the assemblage is to suit the framework and direction of the practice. Deleuze and Guattari's definitions of the term are sometimes illusive and generally multifaceted, open to multiple complex interpretations and adaptable to different contexts. It is in this spirit that the concept is applied in this research project. For each of the sections dealing with creative practice (Chapters 4 to 7), aspects of the work have been grouped according to the divisions proposed by Nail in his interpretation of the assemblage in relation to political theory (2017). Where Deleuze and Guattari use the terms concrete assemblage, abstract machine, and persona, Nail refers to these three aspects as elements, conditions, and agents. The concrete assemblage encompasses the elements: constituent parts or components of the assemblage. The abstract machine is the conditions: a set of relations, or conceptual structure, which provides rules and foundations to organise the assemblage, its layout and the connections between the elements. The personae are 'the mobile operators that connect the

concrete elements together according to their abstract relations' (Nail 2017:27). These categorisations are used throughout this thesis, and some more detail given in Chapter 4, which analyses how the concept informed a performance event.

In *Assemblage Theory* DeLanda acknowledges that 'the concept is given half a dozen *different interpretations* by its creators Delueze and Guattari,' [original emphasis] and sets out to bring them together (2016:1). In doing so, DeLanda's own interpretation diverges from the original in several respects, one of which I have brought into use within this research. DeLanda's 'modification to the original concept is that the parts matched together to form an ensemble are themselves treated as assemblages, equipped with their own parameters, so that at all times we are dealing with assemblages of assemblages' (ibid:3). DeLanda argues that his fine-grained view of a 'nested set of assemblages' (ibid:5) allows for a nuanced understanding of the ontology of the systems in question (ibid:7). Understanding a system as an assemblage is dependent on the scale under consideration. By considering all assemblages as nested assemblages, and defining the scale for the specific study, a clearer understanding of the system and the forces which animate it can be gained.

Koestler's concept the 'holon' relates very closely to the assemblage. A holon is something which is simultaneously a part (of something larger) and a whole (made up of smaller parts).

> 'A "part," as we generally use the word, means something fragmentary and incomplete, which by itself would have no legitimate existence. On the other hand, a "whole" is considered as something complete in itself which needs no further explanation. But *"wholes" and "parts" in this absolute sense just do not exist anywhere*, either in the domain of living organisms or of social organisations. What we find are intermediary structures on a series of levels in ascending order of complexity: sub-wholes which display, according to the way you look at them, some of the characteristics attributed commonly attributed to wholes and some of the characteristics attributed commonly attributed to parts.' [original emphasis] (Koestler 1976:48)

Like Deleuze and Guattari, Koestler applies his theory to hierarchical structure in language, to social structures, and to biological organisms. Where Koestler goes further even than DeLanda is in the almost fractal nature of the holon, whereby any layer (or scale) can be further subdivided, or magnified, to the next scale of complexity. This granularity need not break down altogether, as he explains the contingency of the scales under consideration: The holon is not only the sum of its parts but also dependent on the forces which bind them. 'We can "dissect" a complex whole into its composite holons of the second and third order, and so on, but we cannot "reduce" it to a sum of its parts, nor predict its properties from those of its parts.' (ibid:54) Koestler provides a diagram of an alternate view of the hierarchy of a military battalion (contrasting it to the usual branching tree visualisation) in order to illustrate how each level is contained within the one above it (ibid:60).

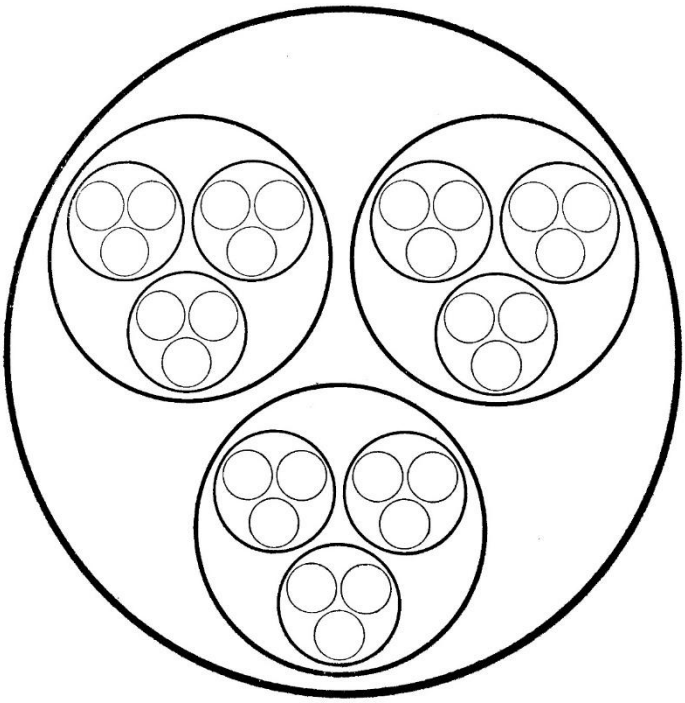

Figure 1.3: Koestler's diagram of the structural aspect of an army

The nested aspect of Koestler's concept, congruous to the assemblage, is of direct relevance to this research project. It is DeLanda's modified version of the assemblage, seen as comparable to Koestler's holon, which informs the understanding presented here. Mechanical Techno works as an assemblage at several distinct levels, and this

concept is used to structure the thesis itself. Having defined the relevant features of the assemblage, the next section outlines the importance of liveness in the work.

Liveness is the main concern of this research project, relevant not only in the performances themselves but also the studio recordings, and the design and development of instrumental components. My work incorporates mediatised elements in numerous ways, from the use of cameras and visuals in performance to the presentation of work as pieces of recorded music. Auslander's discussion of liveness in relation to our increasingly mediatised culture covers some of these cases and is central to my understanding: 'Live performance now often incorporates mediatization to the degree that the live event itself is a product of media technologies.' (2008:25) As he notes, this is not a new phenomenon, as any event which uses electric amplification can be considered mediatized to a degree. '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.' (ibid) Two specific aspects of liveness which Auslander identifies are important to the project throughout, taken from his description of the ways in which live TV broadcasts bring the performance space into the private realm of the viewer's home: 'Television's key characteristics, linked to its liveness, are immediacy and intimacy.' (ibid:14) Similarly Butler discusses liveness in relation to artists using preexisting musical recordings as source material in their work, foregrounding the importance of immediacy: '…performance built around recordings and recording technologies can become live and immediate. This immediacy is negotiated between a performer and the sounds he or she creates as well as with the audience members who hear and respond to those sounds.' (Butler 2014:22) The kinds of performances Butler refers to here are typically hybrid, using playback media as sound sources equal to or instead of played musical instruments. Importantly, the audience participate in the production on an equal level. 'Both performer and audience are active co-producers of "liveness" and hence of "performance" experienced consciously as an event.' (ibid) My research links the concept of immediacy to Jensenius' concept of action-sound-coupling, whereby causal relationships between source and sound are exposed in the act of production. As he writes, 'The interaction feels immediate if the action-sound separation is low' (Jensenius 2022:159). Intimacy

has been considered both in sonic terms—as the 'aural intimacy that can be obtained only from the reproduction of sound' (Auslander 2008:39), achieved by such techniques as close microphone placement—and in social terms as closeness to the performance space (that is, physical proximity) or the closeness of the collaborative relationship. Liveness, defined by immediacy and intimacy as is core components, is fundamental to Mechanical Techno, the performance approaches it enables and its aesthetic outcomes. The specific way this is brought about is through use of the system as a live assemblage.

Assemblage as a concept is both a noun and a verb. Mechanical Techno is a collection of components which are composed together to form *an assemblage*. The way that those components are brought together is through an active *process of assemblage*. In typical English language usage, the term is most used as a noun. This differs from its intended use by Deleuze and Guattari, to the extent that many authors explicitly disambiguate the term as commonly understood in English. Translations from Deleuze and Guattari's writing, which was originally in French, fail to take into account the nuance of the word.

> 'The word in English fails to capture the meaning of the original ***agencement***, a term that refers to the action of matching or fitting together a set of components (***agencer***), as well as to the result of such an action: an ensemble of parts that mesh together well.' (Delanda, 2016:1)
>
> 'The difference between these two definitions [*agencement* and *assemblage*] is perhaps subtle, but by no means inconsequential: we might say the former is a process of composition whereas the latter is one of compilation; the difference being that one works with a pre-existing set of entities and gives it a different order, whereas the latter starts from scratch and builds up to something that may or may not have order.' (Buchanan 2017:458)

Buchanan's reference to assemblage as a 'process of composition' particularly resonates with the project. Chapter 4 specifically considers a live performance in terms of a live assemblage, with the real-time composition of the music and the assemblage of the machine occurring as one activity. Considering the active aspect of the concept,

assemblage as a verb as opposed to a description of an arrangement of components, is a main concern. In contrast to the in-person live performance, Chapter 5 considers how liveness might be imbued into recorded works, through audible signatures and other contextual information, affording a different kind of live experience. Mechanical Techno works as a live assemblage as it is animated, automated, interactive and can be seen to contribute to the aesthetic outcomes through its actions. It also exists through a process of live assemblage, as it is built up and dismantled in real-time, and changes over time at different rates.

The main concepts of this research project, then, are techno, the various definitions of the term 'mechanical', assemblage, and liveness. Techno is a genre of music with primarily electronic sounds and methods of production and performance, which embeds references to human relationships with the technoculture. 'Mechanical' implies physicality, automation and non-human agency, and has historically had negative contexts of repetition, monotony and mindless precision. The Mechanical Techno project draws on techno's concepts and aesthetics, but replaces the electronic methods of production with mechanical ones. Assemblage refers both to a combination of heterogeneous components, identifiable at different scales, and the process of drawing the components together. Liveness depends on both immediacy and intimacy, happens during performance, and can also be embedded into recorded compositions. The research project conceptualises musical instrument-systems, instrumental components and collaborations as nested sets assemblages, and the process of assemblage itself as an active set of actions and forces. With these concepts and processes forming the foundation of the project, the following discussion opens the questions that the project sets out to answer.

Questions, aims and objectives

Because Mechanical Techno is both a performance-installation and a live electronic music project it has the capacity contribute knowledge to both fields, and to provide analysis of the ways in which these fields can overlap. Mechanical Techno crosses several areas of practice, each with its own scenes and fields of research, and thus aims to contribute knowledge in several areas. Broadly, these areas are:

- Discourse relating to the turntable and its use in creative contexts
- Electronic dance music production and live performance
- Sound art, especially relating to sounding kinetic sculpture, performance-installation and improvised experimental music practice
- New musical instrument design

There are two sets of research questions which this project aims to address. First, what are the affordances of Mechanical Techno? What can it do? And how does the mechanical approach to performance and production of electronic music differ from the electronic modes of techno? Second, how can assemblage as a process be used in musicking contexts? Can an instrument be considered a live assemblage? And how does that affect its creative outcomes?

These two sets of questions lead to two sets of aims which the project addresses. First, the project aims to investigate Mechanical Techno through practice, testing its existing capacities for performance and recording, and seeking out new affordances. Machine music and automation is deployed as a distinct mode of performance and composition practice, interrogating the processes at play. Second, the project specifically aims to consider the extended turntable as a live assemblage, and foregrounds assemblage as a process.

The objectives of the project, in order to meet these aims are:

- to design and develop new instrumental components for use within the extended turntable system
- to use Mechanical Techno in a number of different live contexts, documenting use and reflecting on outcomes
- to develop ways of using assemblage theory to structure or inform performance practice
- to create new recorded compositions using Mechanical Techno in order to interrogate the processes involved
- to plug Mechanical Techno into new collaborations, creating performances and recordings as part of larger assemblages.

Having outlined the subjects which the research aims to address, and the means by which the questions will be answered, the following section sets out the reasons the project is necessary and the fields to which it will contribute.

Rationale

Mechanical Techno is a longstanding project, which began almost ten years before this research project. As a unique approach to performance, instrument design and electronic music production it has the capacity to contribute insights into numerous fields of study. One of the reasons this research project is necessary, then, is to capitalise on the opportunities Mechanical Techno presents to contribute knowledge. Automatic music machine performance has been popular for some time and within both underground music scenes and on more mainstream platforms like YouTube where such projects are increasingly common. Despite this, formal documentation and academic research in the field is limited. There is overlap with fields like live coding and modular synthesis, but physical automation is less commonly covered. This research project offers a response to this lack of material. The research offers insights in several related fields, and as such it could be valuable to both scholars of those fields and practitioners such as instrument makers, improvisers, and electronic musicians.

The research project began at a point in time of artificial intelligence and large language models defining the zeitgeist. Such technologies are archetypical examples of black boxes, as interpreted by Latour. In a black box process, there is an input and an output, but the device works so seamlessly and efficiently that its workings and internal components become invisible, unknowable. Black box technologies become tools used without critical interrogation or understanding: ‘paradoxically, the more science and technology succeed, the more opaque and obscure they become’ (Latour 2000:304). Mechanical Techno challenges this way of using and interpreting technology in two ways. First, by exposing the physical-mechanical processes at play, making visible the components of the assemblage and the ways in which they interact. And second, by encouraging and prioritising failure, glitches and breakdown so that the system cannot function so efficiently as to render itself invisible. Investigating Mechanical Techno at

such a time contributes to a broader discourse of attitudes towards uses of technology in creative contexts.

Portfolio structure

Considering the research project in terms of nested assemblages affords the capacity to view the work at different scales. The portfolio of work is organised through conceptualisation of assemblages at three scales: instrumental components, instrument-system, and collaboration. Figure 1.4 shows how the assemblage scales are understood, following Koestler's top-down diagram of the structure of a hierarchy. Not shown here are the smaller and larger scales of assemblage which continue off each end of the scale (that is, the smaller units which make up each instrumental component; and the broader fields within which collaborations are situated).

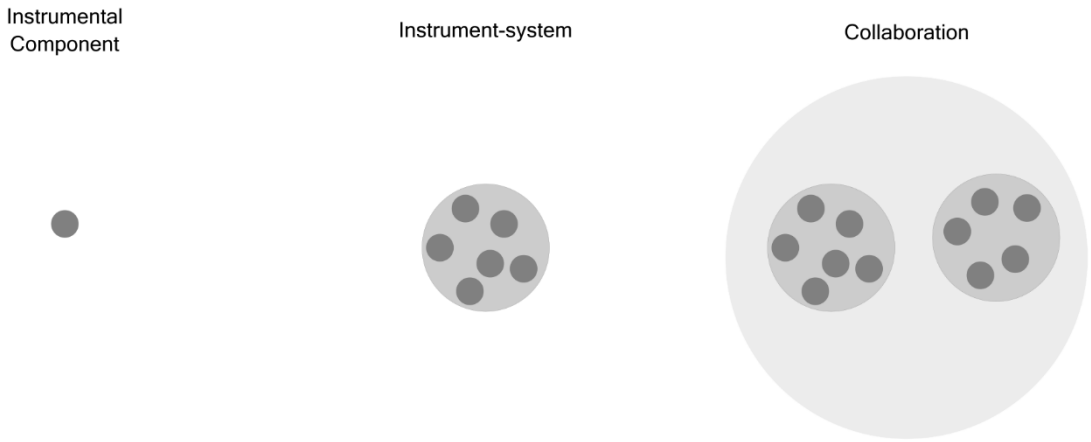

Figure 1.4: Scales of assemblage analysed in the thesis

At the instrument-system scale, a performance with the complete system demonstrates the application of nested assemblage organisation in a live context (Chapter 4), and recorded compositions are included to illustrate the capacity for the system in a studio context (Chapter 5). At the scale of the instrumental component, the technical aspects of the system are explained and examples given of their affordances (Chapter 6). Use of the extended turntable system in four duos makes up the collaboration scale analysis (Chapter 7).

The functioning of each scale of assemblage affects those above and below it. For example, inclusion of a specific instrumental component within an instrument-system prioritises certain affordances of that component and changes the way in which it is used; and the decisions made in building the particular arrangement of the instrument-system will have knock-on effects in the potential for collaboration. For the purpose of this research project, the scales at which assemblages can be considered expands downwards to include the constituent parts and materials of each instrumental component, and also upwards to include 'performance ecosystems' (Waters 2007), and beyond that 'planes of social mediation' (Born 2011:376). Unlike Koestler's strict hierarchy of scales of holons (1976:61), the choice of the scale at which to view an assemblage is fluid and somewhat arbitrary. Ontologically, all assemblages exist on the same plane. To consider an assemblage at a specific scale is really to decide upon the boundaries of the thing under discussion.

Chapter outline

Following the introductory overview of the project, which sets out the key terms used throughout, the literature review (Chapter 2) offers a discussion of existing research in the broader fields to which this research project contributes. It refers to artists and researchers in four areas: turntable practice, electronic dance music, sound art, and organology. The literature review also identifies the gaps in knowledge that this project addresses. The research design section (Chapter 3) next outlines how this framework is applied in practice. As a practice-as-research project, the core activities of making, reading and reflecting are broken down and the approaches to each are identified. Specific approaches are explained and the practice as a whole defined as a maelstrom of activities from which outcomes are flung. The main approaches are identified as cycles and improvisation, concerns which inform all aspects of the project, and the sources from which these themes are drawn are discussed.

The practice outcomes are presented in the portfolio and their insights are addressed in Chapters 4 to 7. Each chapter is led by documentation of creative practice and followed by analysis and critical discussion of the work. My suggestion to the reader is to review the audio and video for each chapter first before reading on. A complete solo

performance in Sheffield in November 2024 introduces Chapter 4, where Mechanical Techno is discussed at the scale of instrument-system and defined as a live assemblage. Application of the concept in the development of the performance is discussed, considering elements of the project as concrete assemblage, abstract machine and personae. Consideration of external forces, self-imposed rules, and performance approach feed into discussion of other aspects of the assemblage. Mechanical Techno is distinguished as an uncommon form of turntable practice focusing on the single-cycle-loop, followed by a discussion of the concept of machine liveness.

Mechanical Techno as an instrument-system for creating recorded compositions in the home studio is the basis of Chapter 5. Four recorded pieces lead the chapter. Recording with Mechanical Techno is defined as a two-stage process analogous to work with a digital audio workstation, but with significant differences which lead to unique outcomes. The project is discussed with regards to its effectiveness without the presence of any visual component. Communicating liveness is considered through the concept of physical signatures, relating to the machine itself, the by-hand quality of the performance, and the extra-musical contextual information.

The scale of assemblage is zoomed into in Chapter 6, which focuses on the individual instrumental components which make up Mechanical Techno, considering a diagram of the device and extending the turntable. The discussion is led by a video that explains the technical developments produced during the research project. Discussion of the components draws out new affordances produced, deployed in work from the previous two chapters. Two main themes are of importance here: the forgotten role of the mechanical music setter, and real-time algorithmic programming with physical objects.

Collaborations are considered in the final section of the portfolio, Chapter 7. Larger assemblages containing Mechanical Techno are considered, with the project plugging into other musician-system assemblages. Video excerpts from live performances with each of four collaborations lead the chapter, with discussion of each. The collaborators were Cath Roberts (electronics); Sam Underwood (acoustic modular system); DJ Food (Quadraphon extended turntable); and Heavy Lifting (live coding). Discussion of each of the collaborations draws from recorded conversations with each artist and my own

reflective journal entries. Common themes from the diverse projects are identified: collage music as a process, getting lost in complex systems, and sculpting a sound together. The discussion that follows, in the literature review, delineates the field to which the project contributes new knowledge, drawing together the main sources that inform the work and relevant artists.

Chapter 2. Literature review

Introduction

This chapter positions the research project in relation to existing written and artistic work in the various fields to which it relates. Key pieces of research and practitioners are identified, and significant differences between that work and this research project are highlighted. Gaps in current knowledge which this project aims to address are established.

This research project draws from and aims to contribute knowledge and insights to four broad areas:

- Discourse relating to the turntable and its use in creative contexts
- Electronic dance music production and live performance
- Sound art, especially relating to sounding kinetic sculpture, performance-installation and improvised experimental music practice
- New musical instrument design

Two key concepts cut across all of these areas and are examined throughout the research in order to draw insights from the practice: assemblage, both as a noun and a verb, and particularly assemblages at different scales; and liveness, as a consideration in instrument design and as a desirable attribute in performance and recording.

Turntable practice

One way to consider the extended turntable project is by a focus on the turntable itself as the fundamental element of the assemblage. Doing so sets the project in a lineage with artists from many different disciplines who use the turntable in their work. Extensive historical research into experimental and instrumental turntable use has been conducted by Kelly (2009), Feaster (2011), Katz (2012), Weissenbrunner (2013), Silpayamanant (2023) and others. This research project contributes to the same field with analysis of my approach as a specific example of creative turntable use.

Dependent on how the context is interpreted, the turntable is usually either considered an instrument or a playback device. Within the context of hip-hop turntable practice, Katz sets out specific uses which he considers qualify a device as an instrument and apply to the turntable as used by hip-hop DJs. These include real-time sound manipulation, specific techniques developed for the device, a unique and individual sound, and either some intention by the maker of the device that it should be used as an instrument, or adaptation by the user for such a purpose. By this definition, a pair of turntables used for mixing house music might not be considered an instrument, but a scratch turntablist use case would be. Katz acknowledges this duality as a potential problem in considering a device an instrument, describing the turntable as a 'complex case' (2012:63). To put a record on at home and listen to it makes the turntable into a 'playback device' (ibid), but when a scratch DJ (such as early hip-hop pioneer GrandWizzard Theodore, in Katz' hypothetical example) 'feels inspired to scratch the record for a few bars before sitting down again' (ibid), that is, performs instrumental gestures with the device, it turns into an instrument. Katz notes a duality in the turntable here, between playback device and playable instrument, which can be seen through most writing on turntable practice: 'If the turntable suffers from an identity crisis, it's because it actually has two different identities' (ibid).

Use of turntables for mixing music has been foundational to the development of club culture and electronic music (Rietveld 2007). Even as turntables decline in popularity in favour of CDJs with USB support or other digital technologies, DJs who play vinyl are still common across various scenes. Furthermore, techniques of turntablism inform the design of devices like CDJs, which still include a rotating platter as a tactile interface for pitch adjust, spinbacks and other effects. Various genres of dance music tend to favour different approaches, though beatmatching to maintain a steady tempo throughout is the norm. Deep house or techno DJing tends to use long, seamless mixes whereas a UK garage or jungle mixing style might favour quicker cuts between tracks. Scratching is most commonly used by hip-hop DJs, and turntablist virtuosity has played a crucial role in the development of the genre. Though rarer amongst house and techno DJs, scratching does sometimes feature in these DJs sets, often when coupled with breakbeat and rave elements.

Running parallel to their use in dance music contexts, turntables have been used extensively in experimental music, sound art and the contemporary art worlds. In *Cracked Media: The Sound of Malfunction* (2009), Kelly gives an overview of these practices, centring the destructive nature of much of the work: "'Cracked media" are the tools of media playback expanded beyond their original function as a simple playback device for prerecorded sound or image.' (Kelly 2009:4) He goes on to define 'the crack' as 'a point of rupture or a place of chance occurrence, where unique events take place that are ripe for exploitation toward new creative possibilities' (ibid). Pursuing the approach can lead to breakdown of the equipment, but not without potentially fruitful artistic outcomes: 'Experimentation with readily available tools and resources is central to contemporary artistic practice and is at the heart of the crack.' (Kelly 2009:6) Importantly for Kelly, there is a distinction between 'cracked' and 'broken', and one often leads to the other. 'Here we encounter the experimentalist who is prepared to extend his or her instrument to the point at which it breaks, perhaps never again to be used in the manner in which it was intended.' (ibid) The phrase 'extended turntable' used throughout this research project is taken from Kelly's writing: 'The use of modified, cracked, or broken technologies originally intended for the mediation of sound is a key element in the expansion of musical sound, and such devices can be understood as extended and expanded instruments.' (Kelly 2009:17-18) A key difference in my work, and one reason for focusing on the concept of the 'extended turntable' over cracked and broken media, is that the turntable itself remains constant. Despite mechanical or sculptural additions, changes in function and purpose, and recontextualisation of the turntable, the device itself remains unaltered, and can be plugged back into its normal functioning at any time. An example of such an extension is an additional tone arm. The turntable functions as normal but with the addition of a second, independent sensor which can play back from different parts of the record. The capacity to create sound has changed but the turntable itself is unaffected.

A focus on the appropriation of pre-used equipment is central to the PhD thesis of Weissenbrunner, which includes an analysis of an early iteration of Mechanical Techno. *Experimental turntablism - live performances with second hand technology: Analysis and methodological considerations* (2017) also examines the work of sound art duo

Vinyl -terror & -horror and solo noise DJ Joke Lanz. Weissenbrunner's thesis provides a snapshot of my extended turntable practice in its early development, specifically analysing a performance from 19 September 2014—'one of the first performances where Dunning played with the vertical turntable construction' (2017:208)—so provides a useful contrast to the developments made during this research project a decade later.

A number of practice-research projects have investigated the turntable in its instrumental use, including by Bell (2010), Chávez (2012), Baldry (2016), Rezaei (2017), Kelly (2019) and Feshareki (2019). My own work focuses specifically on the use of the turntable as a sequencer, with a rejection of the priority of technique and dextrous interaction, and the extension of the turntable with other self-built interfaces. A smaller subset of practice-research has covered the development of turntable modifications. One example is from musician and instrument designer Tom Richards, whose voltage-controlled turntables (Richards 2015) informed the oscillator turntable described in Chapter 6. Likewise, Janek Schaefer's multi-armed *Tri-phonic Turntable* (Schaefer 1997) is a precursor to some of my work, and indeed the concept of the extended turntable. Another key practitioner whose work encompasses live experimental music performance, installation, instrument design and practice-research, is Takuro Mizuta Lippit, also known as DJ Sniff. His PhD thesis, *Listening with Hands: The Instrumental Impulse and Invisible Transformation in Turntablism* (2020) documents several instrumental builds, performances and installations as well as detailed research into hip-hop turntablism and experimental practice. Technical developments include self-built cartridges, new tone-arm designs, modified portable turntables, crossfader innovations and digital devices controlled through the turntable and mixer as interface. Aesthetically, music made as DJ Sniff tends to be abstract, improvised and technique-focused, embracing both the hip-hop turntablist tradition and art-music experimental sound. Here the work differs from my approach in several respects. As will be discussed in further detail, my practice involves eschewing technique in favour of automation and perceived machine agency. Lippit's notion of the 'invisible transformation' (Lippit 2020:33), describing the incremental development of the DJ mixer into an increasingly specialised instrumental tool, is a fundamentally different focus to my approach of visibly extending the turntable setup into a recognisably new assemblage.

Electronic dance music

The primary use of the Mechanical Techno system is for creating electronic music in real-time. Generally there is a focus on rhythm and groove, and aesthetically the sound draws on dance music genres such techno, house, and UK garage as well as more avant-garde influences including dub, free improvisation, noise music and drone. Danielsen's writing on groove music (2018) has been invaluable in conceptualising the musical focus of the project, particularly in enabling me to draw parallels between live-played funk music and the way my music is generated. This research project interrogates both technical innovations and creative processes in the production of electronic music, and develops a musical outcome destabilising certain genre assumptions and aesthetics. Butler's research foregrounds interviews with live electronic music practitioners and DJs, and analysis of some of their creative processes. His term 'playing with something that runs' (2014) is helpful in defining the kind of approach that Mechanical Techno facilitates: combinations of pre-programmed sequences, automated systems and intervention by the musician at an arrangement level rather than as a direct sound-making instrumentalist. My research develops Butler's concept through investigation of this type of instrument-system (comprising pre-recorded elements and prepared sequences) as a separate category of instrument.

Mechanical Techno repurposes a turntable as a sequencer, and as such its usage shares functionality with both drum machines and DAWs. LeRoy's *Dancing to the Drum Machine: How Electronic Percussion Conquered the World* (2023) gives a good contextual overview both of drum machines' history and their creative usage. Other work has covered certain technical and creative aspects, including by Bilmes (1993), Arar and Kapur (2013), Püst, Gieseke, and Brennecke (2021), and Warren and Çamcı (2022). This project broadens this area of research by covering the turntable as sequencer specifically. Rotational motion has been used throughout automated music history to produce musical patterns. Some music boxes of the nineteenth century used disks with pegs to pluck combs of tuned tines to play complex polyphonic melodies (Long et al 2017:200). Theremin's *Rhythmicon* produced polymetric patterns of tones from a rotating barrel. The first electronic drum machine, the *Wurlitzer Sideman*, used a

rotating disc of electrical contacts to swich patterns of drum sounds (LeRoy 2022:8). Use of a turntable as a sequencer follows this rotary principle.

Numerous implementations of turntable sequencer have been developed by other practitioners. Christian Marclay's early turntable instrument the *Phonodrum* was a 'rhythm machine' (Kelly 2009:156) made using a record fitted with nails and a guitar string attached to the tone arm. The *Quintron Drum Buddy* is a playable instrument which uses optical sensors and a tin can with perforated holes (Quintron 2010). Muneteru Ujino's installation and performance project *Ujino and the Rotators* uses pegs on a turntable and physical switching via relays to power various household devices and instruments sequentially (Munteru 2017). Numerous turntable sequencers are demonstrated in online videos including by OhioFi (2008), So Kanno (2009), Lomond Campbell (2019), Phonopollution (2019), Love Hultén (2022) and JO Kazuhiro (2025). Two new commercial turntable sequencer devices have recently been introduced to market called *Malista System* (SonicState 2023) and Playtronica *Orbita* (Pas 2022) which use Hall effect sensors and optical sensors respectively to detect rotating patterns. Uniquely to Mechanical Techno, the assemblage functions as several interconnected sequencers running concurrently, a modular approach using multiple types of interface and modes of interaction. As such, it breaks new ground both in the development of the individual interfaces used (discussed in Chapter 6) and their combination as an assemblage (in focus in Chapters 4 and 5).

Mechanical Techno occupies a reasonably small niche in using modifications to the turntable to repurpose it as a looping device primarily for creating dancefloor focused electronic music. Three projects which could be categorised in the same way are Thomas Brinkmann's *Klick* (1999), Institut für Feinmotorik's *Octogrammoticum* (2009) and DJ Food's *Quadraphon* turntable (Foakes 2025). For the album *Klick*, Thomas Brinkmann used the turntable as a rudimentary sequencer by cutting marks into the run-out grooves of records, creating clicks and pops in a rhythmical pattern. The liner notes explain how the album was made: 'About 15 endless grooves, cut with a knife in the last groove of vinyl records, some voices from records as well, and feedbacks are the sound sources.' (Brinkmann 1999) Musically the album focuses on texture and repetitive rhythm, producing a minimal techno aesthetic. The experimental process

leading to a broadly dance music aesthetic outcome is a similar approach to that I take with the Mechanical Techno project. Isolating the inherent rhythm cycle of the turntable is the fundamental principle at play. Whilst sharing the same basic principle, the project develops it in multiple directions: Where Brinkmann's project sticks to a minimal aesthetic palate through restricted use of techniques and equipment, Mechanical Techno's modularity and inclusion of multiple outboard components opens up a multitude of creative options. These techniques are discussed throughout, and specific technical developments are covered in Chapter 6. In their use of multiple prepared turntables without records, Institut für Feinmotorik's *Octogrammoticum* (2009) is a performance practice which creates rhythmic and textural collages of sound. The use of modified equipment and focus on the single-cycle-loop to create rhythmic pieces share similarities with Mechanical Techno though ultimately the performance approach—that of working as a machine operator, within a live assemblage—differs in kind. The instrumental setup of DJ Food's *Quadraphon* is a turntable with four tone arms, combined with a multichannel DJ mixer and auxiliary delay unit (Foakes 2025). The records used in the project are almost exclusively locked-groove disks, each groove playing one cycle of audio. Live sets are improvised audio collages, blending drum breaks, whole track sections, samples and techno loops. I worked with DJ Food and his *Quadraphon* in one of the collaborations discussed in Chapter 7 of this exegesis.

Demers' study *Listening through the noise: the aesthetics of experimental electronic music* (2010) has informed my research throughout. Demers discusses the use of noise in creative choices and production techniques, across genres including electroacoustic music, dub techno, drone music, noise, and ambient music in the sound art and soundscape fields. As such, the discussions are relevant to various aspects of my creative project. As Demers writes, 'the ways in which we listen to unmusical sounds hinge on whether we believe that sounds signify or possess meaning,' and that the concern which differentiates electronic music from other media is 'a concern with the meaningfulness of sound' (2010:13). This research project investigates musical meaning in media and machine noise, player action and sound as texture. The aesthetics of the Mechanical Techno project and its outcomes are a primary driver to its development, as outlined in Chapter 4.

Relating to the aesthetic outcomes of electronic music practice, liveness in electronic music is another seam of research to which this project aims to contribute. Rietveld's writing on *Authenticity and Liveness in DJ performance* (2016) is a touchstone here, along with work by Parkinson and Bell on *Deadmau5, Derek Bailey, and the Laptop Instrument — Improvisation, Composition, and Liveness in Live Coding* (2015). More general concerns relating to liveness are outlined below.

The approaches to studio composition outlined by Eno in *The Studio as Compositional Tool* inform the discussion of studio-based work in Chapter 5 (Eno 2004), as does Reich's approach to process music (Reich 2004). More specific practice-research such as by Strachan (2017) on the use of the DAW in the creative process and Randell and Rietveld on *Modular Synthesis as Compositional Performance* (2024) provide specific examples to contrast to my own electronic music production practice: Use of Mechanical Techno as an assemblage, built and developed through a series of self-imposed rules (as discussed in Chapter 4 and into Chapter 5) imposes restrictions which lead to an aesthetic of weirdness, risk and the possibility of breakdown.

The ways in which the technological and creative direction affects the aesthetic outcome are discussed in relation to Brøvig-Hansen's concepts transparent and opaque mediation (2017), as developed with Danielsen into a broader discussion of digital signatures (2016). Digital signatures are present through the tools of music production, the mediation of the recorded sounds into their final form presented as music. Doing so can leave clues to the listener as to the means of production, and indeed saturate the work with layers of meaning: 'the technological mediation has a voice of its own, in fact, and insists on its role in the experiential meaning of the music' (Brøvig-Hanssen & Danielsen 2017:5). In Chapter 5 this framework is developed in relation to my work to consider the concept of physical signatures: the specific sonic (and other) signs which are embedded in the work.

Sound art

The extended turntable project also functions as a sounding kinetic sculpture. As such it fits in a lineage of sonic art and sculpture, and installation art, as well as amongst experimental music practitioners who use the turntable. Contemporary (non-turntable)

practitioners using instruments which take the form of sounding kinetic sculptures or experimental mechanical musical instruments in sonic art contexts include Pierre Bastien, Wannes Deneer, Bear Kenchington, Rie Nakajima and Yuma Takashita. Mechanical Techno is situated amongst such artists' work. Another practitioner, Sam Underwood, whose work encompasses mechanical instrument design in experimental performance and composition contexts, features as a collaborator, as discussed in Chapter 7. A significant number of turntable artists create abstract, experimental, noisy work using their systems, including several mentioned above. The recent experimental turntable supergroup of Maria Chávez, Mariam Rezaei and Victoria Shen uses a variety of techniques drawn from turntablism, experimental music and noise, including Shen's self-built adaptations (Pothast 2023:41) which resonate with this project as turntable extensions. My collaboration with Cath Roberts on electronics detailed in Chapter 7 shares some aesthetic concerns, foregrounding noise and texture, with a focus on the use of time-bound musical processes within an improvising live context. Practice research by Richards and Shaw identifying the role of the artist in performance-installation as 'the attendee' (2022:146), has informed this project. A contrasting role presented by Morten Riis in relation to his *Steam Machine* project is that of the 'repairman' (Riis 2016:22). My research project interrogates these roles and develops the work to examine other roles which may be taken on when using a mechanical contraption in performance contexts.

Improvisation as a method of sound- and music-making is common amongst sonic artists and practitioners of experimental music, and also performs an important role in my practice. MacDonald and Wilson's *The Art of Becoming: How Group Improvisation Works* (2020) presents a model of the process whereby ongoing evaluation is key in a cyclical flow. The model is helpful to my understanding of the methodologies of this research project, the creative work undertaken and the process of witing this exegesis. Chapter 3 analyses the approach in more detail. The ways in which other improvising musicians discuss their work has also informed the project, including foundational work by Bailey (1993) and Prévost (1995), as well as more recent discourse from Mwamba (2019), Hamilton (2022) and others. Improvisation occurs in other contexts than the direct act of sound production. One such instance is Ingold's discussion of

making as an itinerant and improvised process, as opposed to a hylomorphic top-down structuring activity (Ingold 2013). For Ingold, making entails working with materials and following the flows of the process, sometimes on a meandering, non-linear path which leads to surprising results. This he opposes to the classical notion of the maker (or composer, artist) contriving a fully formed master work, then building the idea exactly as envisaged. As he writes, 'the forms of things arise within fields of force and flows of material' (Ingold 2010:91). This research project follows Ingold's conceptualisation and investigates the ways in which such flows of material interact, in doing so foregrounding improvisation.

Instrument design

One of the main activities of the research project is the design, making and development of new interfaces and instrumental components for use with the extended turntable. Understanding what is meant by an instrument, and how it works in use, is fundamental to the project, and here Jensenius' *Sound Actions: Conceptualising Musical Instruments* (2022) has been invaluable. In particular: the concept of action-sound-coupling as a visible cause-and-effect chain for sound production (ibid:99); the discussion of the different roles which contributors take on (within the 'musicking quadrant') (ibid:7); and the notion of activities which happen in real-time and out-of-time in relation to the musical work (ibid:21). With a focus on automated musical instrument systems and physical-mechanical devices, my research project develops the ideas proposed by Jensenius in a new direction, touched upon but underexplored. The multiple intertwining histories of musical instrument design—organology—and the relationships to notation and inscription provided by Magnusson (2019) are important to this project. My work sits somewhere adjacent to the line of development Magnusson sets out, that is, from acoustic instruments to analogue to digital, as Mechanical Techno is consciously hybrid: it combines components from across these realms without hierarchy. Where Magnuson's work is of particular relevance is in discussion of notation systems, machine notation, and various types of inscription. '…new digital instruments combine three distinct levels of sonic writing in their bodies: the material (instruments), the symbolic (notation), and the signal (audio recordings).' (2019:238) Through different methods of live inscription, leading to varied types of machine

notation, this project uses these concepts to contribute to the field, as discussed in Chapter 6. Jensenius draws on Small (1998) for the concept of musicking—the active verb encompassing all the activities which contribute to the performance and creation of music—and this concept is also important in my research. 'To music is to take part, in any capacity, in a musical performance, whether by performing, by listening, by rehearsing or practicing, by providing material for a performance (what is called composing), or by dancing.' (1998:9) The active web which Small sets out forms the core of Waters' concept, the 'performance ecosystem' (2007). Waters argues for the importance of considering external elements outside of the instrument itself when discussing and evaluating new musical instrument designs. An instrument can only be understood through its practical use in performance contexts: in relation to the physical space, the soundsystem, the audience, and the other elements which form the complex assemblage of the performance ecosystem. At a larger scale, Born defines the extended networks which musicking sits within as four 'planes of social mediation': social relations, imagined communities, wider social structures, and institutions (Born 2011). This research project situates the development Mechanical Techno, as a series of new musical instrument designs deployed into practical use, within these broader assemblages.

Throughout the thesis, reference is made to the 'affordances' of the system or its constituent components. The term is commonly used in scholarly writing on musical instrument design, including extensively by some of the aforementioned authors. The term merits a brief definition here and some context within the field. As Tanaka explains in a paper on interface design, 'Affordance is a concept fundamental to interaction design practice. Arising from Gibson's seminal work in perceptual psychology, it maps potential action relationships between subject and object based on qualities of the object and capabilities of the subject' (Tanaka 2010:89). In general terms, an object can suggest possible methods of use to the person interacting with it, typically through visual recognition and prior experience with similar objects, but may also offer other potential uses which are not immediately recognisable. Jensenius describes sonic affordances in straightforward terms as 'the possible sonic outcomes based on the properties of an object' (2022:35). Considering affordances in the design of new

instruments it is also necessary to take the opposite into account, that is, the limitations imposed, as Magnusson writes: 'It is a necessary property of all technological artefacts to amplify certain possibilities of experience while at the same time reducing that very experience.' (2019:51) Throughout this project the balance between affordances and limitations is investigated.

Musical instrument design is a broad field, with much research being presented through conferences such as NIME and academic institutions including IRCAM, and historically STEIM. The development of Mechanical Techno sits within this stream of research, and indeed an aspect of the project, iteration without refinement, was presented at the 2023 NIME conference. Previously, my collaborative mechanical musical instrument with Sam Underwood, the *Mammoth Beat Organ*, was presented in a keynote performance at NIME (in 2020). In such a broad field there are trends towards different disciplines and approaches. The development of Mechanical Techno follows an experimental and anti-solutionist path, and as such relates to the specific strand of research seen in work like the exploratory 'makes' of Richards et al (2023), the 'rough-hewn instruments' of Koutsomichalis (2020), and the 'infra-instruments' of Bowers and Archer (2005). Discussion of the effect of the design process takes place throughout this exegesis, with the main focus on the technical developments in Chapter 6.

Mechanical musical instruments are a distinct category and require a different understanding to instruments designed exclusively for direct human playing. A brief outline of the history of mechanical musical instruments here serves to set the context for this discussion. Both the technical mechanisms of the devices and their cultural and functional contexts are relevant to the development and understanding of Mechanical Techno. The first known programmable machine was a flute playing automaton described by the Banu Masa brothers in a manuscript from circa 875CE. The water-powered mechanical device used a barrel with pegs and a series of levers to activate different notes of a flute (Long et al 2017:202). A similar type of activation design is used by barrel organs and many music boxes. The setting of the pins creates a fixed composition which can be played by activating the rotation of the barrel. Typically this kind of device is limited in its scope and can only play a set number of compositions, capped by the physical space available on the barrel and how close together the levers

or pins are set. Barrel devices from the eighteenth century onwards use a variety of activation mechanisms and sounding devices, ranging from tuned tines directly plucked by the pegs, to complex external systems played indirectly by pneumatic or mechanical switches, which might produce sound via bells, reed pipes, percussion instruments or plucked or bowed strings (Patteson 2016:24). Disc-based sequencers work similarly with the plane of rotation moved through ninety degrees. The main advantage of disc systems is that the switching of compositions can be achieved more easily, by replacing one disc with another, and discs are more compact and thus easier to store than cylinders (Long et al 2017:200-201). Player pianos and pianolas are another lineage of mechanical musical instrument, comprising a vast array of technological developments (Ord-Hume 1970). Development began after pianos became widespread, initially with a separate external device which could be offered up to a regular piano and play the keys mechanically. Later these devices were built into pianos, affording either activation by mechanical means or by a human player. Player pianos typically use pneumatic switching meaning they can be programmed by a piano roll: a roll of paper with slots cut into it, which is fed into the device and across a tracker bar. When each hole passes the bar it causes a different switch to activate for the duration it is present—the switch causing the piano key to press. In early models the speed of the roll feed was manually controlled meaning the operator could affect tempo through the track (Satz 2010:77). Some later designs also had programmable strips for other settings including pedal presses and key strike force (Patteson 2016:27). Fairground organs and café organs typically use a similar system to the piano roll, often with punched card books as opposed to rolls (Cockayne 1970). Such orchestrions would often include multiple types of instrument—organ pipes, reed instruments, tuned percussion, drums, xylophones and glockenspiels. Other functions might include ‘exotic’ percussion instruments like temple bells, gongs and woodblocks, sound effects like whistles and horns, and augmentation to the main instruments such as fluctuation of airflow to produce tremolo, or damping on percussion instruments (Satz 2010:77). Fairground organs often display some of the mechanisms for the audience to see, such as featuring the percussion section at the front enabling the movement of the sticks and beaters to be visible.

Automated mechanical musical instruments have served a variety of functions and been used in many social contexts. The key factor distinguishing them from human played instruments—that they do not necessarily require the same musical ability to operate—allows them to function in a significantly different way. Music boxes, which tend to be relatively small and are designed for indoor use with a small number of listeners, were typically designed as novelties. They would be used to entertain guests or provide amusement, and sometimes as a vehicle for more serious composition (Kemper & Cypress 2019). Barrel organs and street pianos were typically used to provide music outdoors, the operator (the organ grinder) taking money to play songs for customers, or otherwise busking for money (Ord-Hume 1970:21). Fairground organs played loud and brash popular songs to draw attention to other attractions at a fair, or set a jovial atmosphere (Cockayne 1970:176). Café organs replaced dance bands in small venues, providing raucous party music, or otherwise served a similar role to juke boxes. In these latter cases a similarity can be drawn between the machine operator and the DJ: A person who selects pieces of music and sets them to play back for an audience, often for dancing or another functional purpose.

As discussed in the introduction, there are several ways in which the term ‘mechanical’ has been understood in relation to musical instruments, and these distinctions are important to disambiguate in order to situate the research project. To call something ‘mechanical’ implies physicality. Simple machines such as a lever, pulley or screw are used to change movement and force. Pneumatic devices, such as the switches and pneumatic motors used in player pianos and fairground organs, are mechanical and physical in the same way, but include enclosed air as part of the mechanism (Ord-Hume 1983:168). Electromechanical devices are used within electronic circuits to convert movement to electrical signals and vice versa. Examples include a potentiometer, which changes its resistance dependent on rotational position; a relay, which uses a small signal to close a physical switch allowing a larger current to pass; or a washing-machine timer cam, which runs the various parts of each stored programme through rotary motion and physical switching. Speakers and microphones are special cases of electromechanical device, functioning to convert sound (as vibrating movement) to electronic signals, and vice versa. Physical movement is a process in any

pneumatic or electromechanical component. Sound is also always physical: vibrations in air and matter. Acoustic sounding devices such as strings, reeds, and cymbals are physical objects vibrating to move air. Aerophones of different types—organ pipes, brass instruments—use various means to chop up or modulate moving air into vibration patterns. A speaker converts electronic signals to physical movement, pushing air to create audible sound. Conversely, a microphone converts the physical vibration of a diaphragm into an electrical signal. Sonic output always has a physical component, pushing air or vibrating matter.

Most musical instruments have both a mechanical component and a human component, as Bartók argued in 1937 at the height of the popularity of mechanical musical instruments: '…if a lever is a machine, then any music is also mechanized music if its origin derives from the use of levers in conjunction with the human body.' (Bartók 1993:289) This is most clearly illustrated by way of examples. A piano is an acoustic instrument, activated by a human player at the keyboard. In order to make sound, a key is pressed: a series of lever mechanisms are activated, and a felt hammer mechanically strikes some strings. A vibration is set up in the strings which is amplified by the resonant construction of the soundboard. The strings themselves may be considered a mechanism, their vibrational movement generating the sound. After the human player's initial keypress, the rest of the process is mechanical. 'The piano string, moreover, is vibrated by means of mechanically produced energy transfer. In reality, therefore, we could designate piano music as a more or less mechanized music.' (ibid:290) Jensenius considers two elements of 'sound-producing actions', first 'selection actions' and second 'excitation actions' (2022:73). During the selection phase a musician may choose which string to pluck or which organ stop to pull. The excitation action is the plucking of the string or the sounding of the organ pipe. Excitation can be mechanically assisted; it is either 'direct' or 'indirect' (ibid). Plucking a string with a finger is direct excitation, pressing a piano key is indirect. 'Indirect excitation actions occur when an object is between the body and the sound-producing element, such as when playing with a bow, pick or key.' (ibid) Certain instruments use mechanisms for modulation of acoustic sound. An example is a vibraphone, using a motorised device to open and close the resonant pipes beneath each bar, providing vibrato. A vibraphone

could thus be considered an electromechanical musical instrument. Similarly, a Hammond organ with its tone-wheel—a physically rotating ridged-edged disc that generates tones through electromagnetic induction—uses a combination of mechanical and electronic technology. Artists have created instruments using electronic signals to mechanically control physical instruments. One example is Sarah Angliss' *The Ealing Feeder*, a robotic carillon that uses solenoids to play tuned bells via MIDI signals (Angliss 2025). The instrument itself can be played via a keyboard or pre-programmed patterns: its input may or may not be automated, but its acoustic output is played physically by an electromechanical actuator. Each of these instruments could be described as 'mechanical' to a greater or lesser degree; each also requires human input to generate sound. The key point here is that physical movement—from some sort of physical mechanism—is used in the creation or modulation of each sound produced.

Increasing development of musical instruments has taken them further from the human player, and away from the physical domain, into electronic sound generation. Any electronic device can be described as a machine, as it runs a process initiated by a user to produce a predetermined outcome. Whilst the processes may become increasingly invisible, there are nonetheless physical and material operations taking place. In studying computer hard drives, Kirschenbaum uses the term 'forensic materiality' to refer to the analysis of material components and processes storing the inscriptions, and 'formal materiality' for the study of the contents of the texts inscribed (Kirschenbaum 2012:13). Both aspects are required to give a complete picture. Computers are routinely described as machines, and they serve the function of completing a process according to user input and pre-written instructions. Such a machine, however, would be less likely to be described as 'mechanical'—summoning images of a hand-cranked steampunk contraption—and disregarding this distinction can lead to ambiguity. In most contexts, a machine (such as a computer) running a sound-making program with a human controlled interface (such as a piano keyboard) would be considered a musical instrument. The machine in this example would not necessarily be described as 'mechanical' without obviously visible moving parts, the exception perhaps being the keyboard interface itself.

Automation is another connotation of the term mechanical, which is relevant to Mechanical Techno as it has long been associated with both musical recording and musical playback. When the phonograph and gramophone were developed, the new devices were seen to be in a lineage with previous mechanical music playback technologies, and not in a positive way.

> 'Critics of the new recording technologies now used the term as a slur. … *mechanical music* came to mean essentially "recorded music"; though the term was still used to refer to the products of older devices such as orchestrions and music boxes, it more often referred to newer ones such as gramophone records. In both cases, the expression had a decidedly negative connotation.' (Patteson 2015:25)

This further broadening of the term 'mechanical' to include recorded music developed from the technologies which enabled automated playback. The gramophone was seen as a mechanical device for playing back voices and instrumentalists, just as a music box played back musical works via its own sounding mechanism. 'Mechanical' therefore became synonymous with 'automatic'. Automatic instruments might include music boxes, fairground organs, gramophone players, aarti machine temple bells, MIDI playback, analogue drum machines, modular synthesizers, generative computer programs, and a host of other music-making or playback devices. Discussing the use of multiple low frequency oscillators used to control parameters to create complex changing patterns, Jensenius states that 'such processes are part of the change from "sound makers" to "music makers." For the performer, such long semiautomatic processes may feel like the instrument plays "itself."' (2022:91) This distinction is helpful in situating the role automation plays in musical instrument use. A device that can be switched on and left to play music without intervention is a music maker. A device that creates a sound but requires adjustment, modulation or other forms of 'playing' to be considered musical would be a sound maker. These definitions account for the intention of the musician and the framing of the perceiver: a turntable, for example, though designed only as a playback device, could be considered both a sound maker and a music maker dependent on context and use. Magnusson discusses examples of automation often seen in digital musical instruments in reference to

Schnell and Battier's term 'composed instruments' (2002:1): 'Composed instruments typically contain automation of musical patterns (whether blind or intelligent) that allow the performer to delegate musical actions to the instrument itself' (Magnusson 2009:168). The kinds of actions that might be delegated include the selection of ranges of notes (such as scales rather than individual pitches), sequences and patterns, rhythms and arpeggios. With the processes and decisions shared between performer and instrument, these composed instruments become split systems: 'These systems are therefore split systems between the physical interface and the programmed sound engine.' (ibid) Such split systems are commonplace across live electronic music making, and especially with new hybrid instrument-systems.

There is a clear lineage from the mechanical-pneumatic automatic control of the player-piano to the digital automation afforded by MIDI technology (Diduck 2018). Not least, the continued use of the piano roll patented in 1883 by Emil Welte (Long et al 2017:199) and incorporated in many DAWs (including FL Studio, Ableton Live and Logic Pro) for notating tunes and MIDI programming. Both formats are automatic, but only the former would be considered mechanical from a physical perspective. In a similar way to the spectrum of mechanisation and human playing in sound generation, automation can be produced by a variety of means: mechanical, electromechanical, pneumatic, acoustic, analogue and digital. Nevertheless, the term 'mechanical' has been applied universally.

The 'negative connotation' noted by Patteson (2016:25) was an allusion to the perceived non-expressive nature of music made by machines, with expressivity identified as the factor that differentiated human playing from mechanical reproduction. The term 'mechanical' is still often used as a pejorative applied to music that is unvaryingly repetitive, dynamically static or monotonous. Some composers did consider the machines as potentially useful for communicating their musical ideas. 'Because of their accuracy in representing the ideals of the composer, mechanical instruments were considered capable of transmitting expressive meaning from mechanical performer to human listener.' (Kemper & Cypress 2019:453) While the precision and accuracy of reproduction were welcomed by some, negating potential misinterpretation from fallible musicians, mechanical playback was also criticised. '… even during the late eighteenth century, critics viewed automata as "soulless" and therefore as incapable of

expression.' (ibid) The apparent lack of expressivity from such machines was therefore rooted in their total obedience to the composer's wishes. Because the instrument follows the procedure perfectly, it has no agency to deviate, no way to change the outcome or capacity to surprise. Where a human player can add unplanned embellishments, either deliberately ornamenting the written score or through inevitable microvariation in sound activation, a machine mindlessly follows the algorithm it is fed. Magnusson further discusses the apparent opposition between human played and 'mechanical' music in relation to digital instruments, which in some instances further embed this type of perfect automation: 'What the digital system does not easily lend itself to are tempo changes, variable dynamics, metre changes, flexible durations (accelerando, crescendo etc) - in other words, what the human being excels at when playing music.' (2018:55) These factors are emphasised in the Western classical music tradition, and are seen to exemplify the way that emotion and meaning are conveyed through such works. Much music education, then, valorises the importance of the human player: 'flexible, fallible, instinctive, emotional, individual.' (ibid) This is opposed to the (usually negatively conceived) characteristics of the machine: 'time perfect, repetitious, logical, perfect, normative.' (ibid) Examining and unpicking these opposing tendencies is one of the main themes of the research project.

Assemblage

The term assemblage as used throughout the thesis is drawn from Deleuze and Guattari's concept primarily as outlined in *A thousand plateaus: capitalism and schizophrenia* (2013). Various secondary sources further contribute to the understanding as used herein, including from Adkins (2015) and Buchanan (2017). The concept as applied to the Sheffield performance presented in Chapter 4 draws on Nail's clear definition of the term in the context of political theory, in *What is an assemblage* (2017). Nail's paper itself is positioned in part as a response to DeLanda's *Assemblage Theory* (2016), which diverges from Deleuze and Guattari's original concept in two ways. First, DeLanda disputes the opposition between assemblage and strata (as things which are either rhizomatically or hierarchically structured) instead positing a spectrum of assemblages which can be more or less stratified. Second, which is most pertinent to this thesis, DeLanda introduces the concept of nested assemblages, whereby each

assemblage comprises components which are themselves assemblages, moving both up and down in scale, on a flat ontological plane. Though the thesis draws on these philosophical concepts, they are used as tools and framing devices within the creative practice, offering ways of conceptualising the work and generating insights. The thesis does not intend to contribute to philosophical scholarship, but to borrow these concepts to generate knowledge in other fields. The concept of the assemblage directly informs the Sheffield performance which leads Chapter 4, but is also relevant throughout. The thesis itself is conceived as an assemblage of heterogenous components including audio, video and text. As a component it is nested within larger assemblages such as the creative and scholarly fields to which it contributes.

Liveness

Auslander's *Liveness: performance in a mediatized culture* (2008) acts as a starting point for considering ways in which liveness may be understood in the context of new technologies. The significance of intimacy and immediacy in contributing towards a sense of liveness, both in immanent and mediated situations, is drawn from Auslander's text. Jensenius' *Sound Actions: Conceptualising musical instruments* (2022) is another key work here, with the various concepts discussed above relating directly to themes of liveness. The apparent paradox of the liveness of performance which includes pre-recorded elements and self-playing machines is discussed, referring to several sources, including Feaster's work on early recording techniques (2007) and Eisenberg's *The Recording Angel* (2005). Rietveld's discussion of such dualism in digital DJ performance is relevant, noting the way in which the technologies in use affect types of performance: 'affordances of digital performance technologies have intensified a blurring between music production and music performance, as well as between pre-set composition and improvisation.' (Rietveld 2019:131) Parkinson and Bell's (2015) discussion of live coding, and where the practice might fit in a spectrum of modes of live presence (from the stadium EDM show to the real-time composition of non-idiomatic improvisation) has also been a touchpoint in considering liveness in my work, and is developed further in Chapter 4. Having outlined the core texts in the fields relevant to the thesis, the following section identifies specific areas warranting additional research, which this thesis addresses.

Gaps in knowledge

The research project contributes knowledge to the four areas of study outlined above: turntable performance practice, electronic dance music, sound art and instrument design. In the first of these categories, the project analyses use of the turntable as part of an automatic system, rather than as either for continuous mixes (as the majority of DJ sets) or as a tactile, playable instrument (as a scratch DJ). Considerations of live inscription as a performance technique, which are covered by Lippit (2020) in relation to his turntable practice, are underexplored in relation to other technologies such as those used in the extended turntable system. As the discussion of the research design in the following chapter shows, the development of new instrumental devices for interacting with the turntable leads to new ways of using those devices, furthering this research. By prioritising physical-mechanical processes the project develops a new kind of 'machine aesthetic' (Rietveld 2018) distinct from techno's wholly electronic production methods. In addition, the research expands on Jensenius' work conceptualising musical instruments to include automatic and mechanical systems, including an exploration of different roles that can be taken on during performances with such systems. The project also covers the development of the musical assemblage as opposed to black box technology, that is, exposing the processes and methods of music production, both visually and audibly. Through the visual exposure of sonic processes, the research investigates how liveness can be embodied in the system itself, and in doing so addresses the paradox of liveness in performance with an automated machine.

Authors have considered instruments and instrument-systems as assemblages, or components within larger assemblages, and highlighted the importance of considering the broader context within analysis of the devices. Water's concept the 'performance ecosystem' (Waters 2007), for example, makes this importance explicit. Consideration of nested assemblages within musicking contexts has not been discussed, however, which this thesis does: considering musicking assemblages at different scales, and the top-down and bottom-up influences and causal relationships which contribute. The scales of assemblage analysed here range from individual instrumental components up to collaborations with other artists and their instrument-systems, allowing for insights into a diverse range of practices and approaches. Specifically, plugging Mechanical

Techno into collaborations with other operators and instrument-systems affords the opportunity to analyse how these new assemblages function. As a whole the project was designed to allow for an exploratory approach to both the practical aspects of making new work and to the theoretical considerations of the research and writing. The following chapter discusses this research design, identifying the methodological framework and methods employed during the work.

Chapter 3. Research Design

Introduction

The aims of the research project are: First, to develop and investigate Mechanical Techno through practice, testing its capacities for performance and recording, and seeking out new affordances. Second, the project aims to consider the extended turntable as an assemblage, and foregrounds assemblage as a process. These aims are met via the research framework and practical approaches to knowledge making that are set out in this chapter. As a practice-as-research project, there are numerous complementary activities which take place simultaneously and feed into one another. Following Nelson's model of practice-as-research as 'theory imbricated within practice' (Nelson 2022:46), these activities are categorised as making, reading and reflecting. The approach to the project is construed as arising from a maelstrom of activities, with scheduled time for reflection-on-action. Drawing on Ingold's description of non-hylomorphic making and MacDonald and Wilson's model for the process of individual choice during group musical improvisation, the importance of improvisation across the entire project is highlighted. Two major approaches in my creative practice are the idea of iteration without refinement or 'ironing in the creases' (Dunning 2024) and the process of messing about, which are both also introduced here.

Practice-as-research

The methodological approach of this project broadly aligns with Nelson's concept of practice-as-research as 'theory imbricated within practice' (Nelson 2022:46). Nelson's model of praxis emphasises that knowledge can be acquired through both 'practical being-doing-thinking, and more abstract conceptual thinking, typically understood to be verbally articulated (in books and articles)' (ibid:45). Generalised categories of activity—making, reading and reflecting—form a triangle producing the different types of knowledge. Nelson is careful not to flatten the model, describing it as more closely resembling a crystal, for its 'sense of multi-faceted, dynamic entanglements' (ibid). My creative practice incorporates numerous distinct and overlapping activities which can

be categorised as making: Live performance, studio recording, instrument design, and collaboration.

Live performance forms the basis of my practice, both as an outcome (producing specific performance events) and as a method of road-testing and assessing new designs and components. Forty-three performances were staged during the research project in total, with each one producing documentation and written reflections. Appendix A shows a timeline of the performances and recording sessions. One performance is discussed in depth Chapter 4, as the culmination of development to that point. The use of Mechanical Techno in the home studio to create recorded tracks (fixed-media compositions) is both a method of production and another experimental ground for ongoing development of the system. Chapter 5 discusses four compositions made in this way, including an analysis of the two-stage recording process. In developing new instrumental components for the extended turntable system, several physical artefacts were made. Through experimentation, prototyping, iteration and use in performance contexts, a number of discs, sensors, modules and interfaces were produced. The devices are discussed in Chapter 6. Four new collaborative duos were also instigated during this research project. The capacity for the Mechanical Techno assemblage to plug in to other instrument-systems to form new collaborations is discussed in Chapter 7. Each of the sets of outcomes derives from the various interrelated making activities that form my practice.

The process of making in my practice does not begin with a fixed idea and aim to execute that idea perfectly. Rather, ideas, concepts, and intentions are thrown into the mix and interrogated experientially. The work follow's Ingold's description of non-hylomorphic making.

> 'Here, every work is an experiment: not in the natural scientific sense of testing a preconceived hypothesis, or of engineering a confrontation between ideas "in the head" and facts "on the ground", but in the sense of prising an opening and following where it leads. You try things out and see what happens.' (Ingold 2013:6-7)

Though the different making activities are separated in this exegesis for the sake of clarity, in fact they occurred simultaneously throughout the research project. For example, rehearsals for performances often also served as recording sessions; both worked as proving grounds for new instrumental makes and techniques. The process is a continuous one, and the created output is not at any point considered 'finished' but always folded back into the work in a cycle of continuous development. An approach of working with the materials, following the flows of activity, and allowing for an iterative change over time. Again, this resonates with Ingold's description of making as a process of growth, in which the maker is defined as an active participant working with active materials. 'These materials are what he has to work with, and in the process of making he "joins forces" with them, bringing them together or splitting them apart, synthesising and distilling, in anticipation of what might emerge.' (Ingold 2013:21)

In parallel with the practical concerns of the project, reading scholarly texts by academics and practitioners in the relevant fields has informed the work throughout. Attending performances and exhibitions and listening to music by other practitioners have also been important to the research project, and these were reviewed in my journal. At each stage of the project, documentation was collected for further analysis. In the case of practical work, this included photographs, sound recordings and videos, but also a regular journal. After each performance, recording session and workshop session, notes were taken pertaining to the intention and outcomes. Additionally, for each collaboration, a recorded conversation about our work was scheduled, and the resulting audio transcribed. This additional text collected during the making process became further source material for the project, and excerpts from these is included throughout the exegesis.

Models of reflective practice tend to incorporate cycles. Reflection does not only occur once, but forms part of a repeating flow of processes. Typically, based on principles of design where a project involves developing a solution to a problem, the cycles encourage iteration towards a final product. The 'Lewinian Experiential Learning Model' for example, is a four-quadrant circuit with stages covering abstract idea generation, experimentation and testing, concrete experience, and reflection (Kolb 1984:21). The final stage here feeds back into the start of the cycle for the next iteration. Reflection

enables the cyclical feedback which gives the model its strength. 'This information feedback provides the basis for a continuous process of goal-directed action and evaluation of the consequences of that action.' (ibid:22) In an analysis of the way reflection plays a role for practitioners in different professions—architecture, psychotherapy, engineering—Schön differentiates between 'reflection-in-action' and 'reflection-on-action' as distinct activities due to the context in which they take place (1983:61). Analysing a situation or approach as it is happening may give significantly different answers than an investigation into the same events with hindsight. Both of these models informed the way in which reflection was incorporated into the structure of this research project.

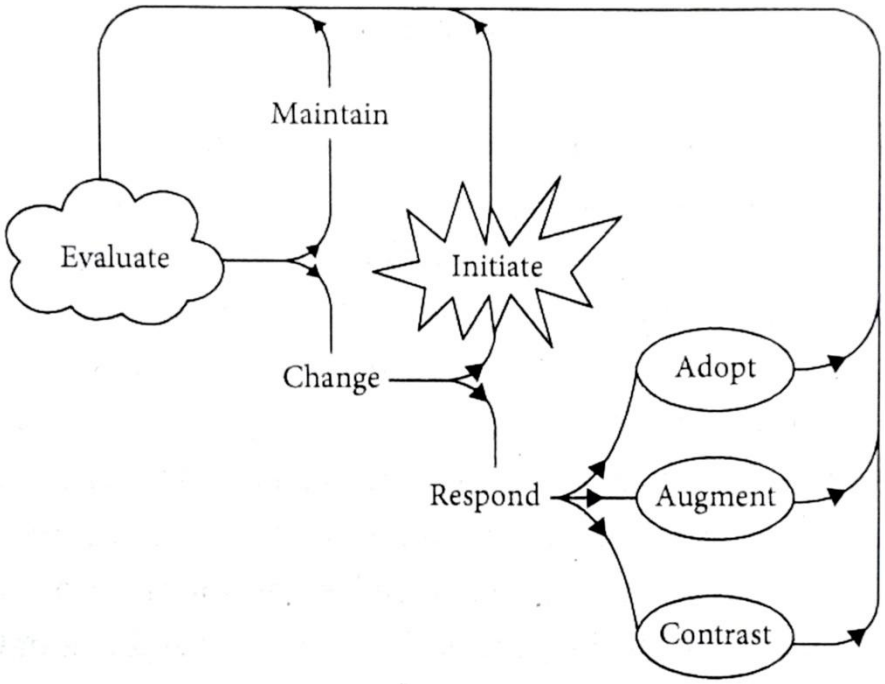

Figure 3.1: MacDonald and Wilson's Model for the process of individual choice during group musical improvisation

Reflection as evaluation within a cycle can also be applied to a much less goal-oriented activity, that of improvisation. MacDonald and Wilson's 'model for the process of individual choice during group musical improvisation' shows a cyclical flow chart with several phases: a decision tree which ultimately always returns to its starting point, 'evaluate' (2020:78). Following evaluation, the player can choose to maintain or change the current action. To change offers additional choices: initiate or respond. The latter has three further options, to adopt, augment, or contrast the others' playing. Following

any decision and resulting action, the player again evaluates and rebegins the process. Each player makes individual evaluations throughout the process, which contribute to the broader whole created jointly by the group. The principles of this model informed my research throughout, and improvisation is a fundamental concern of all aspects of the project.

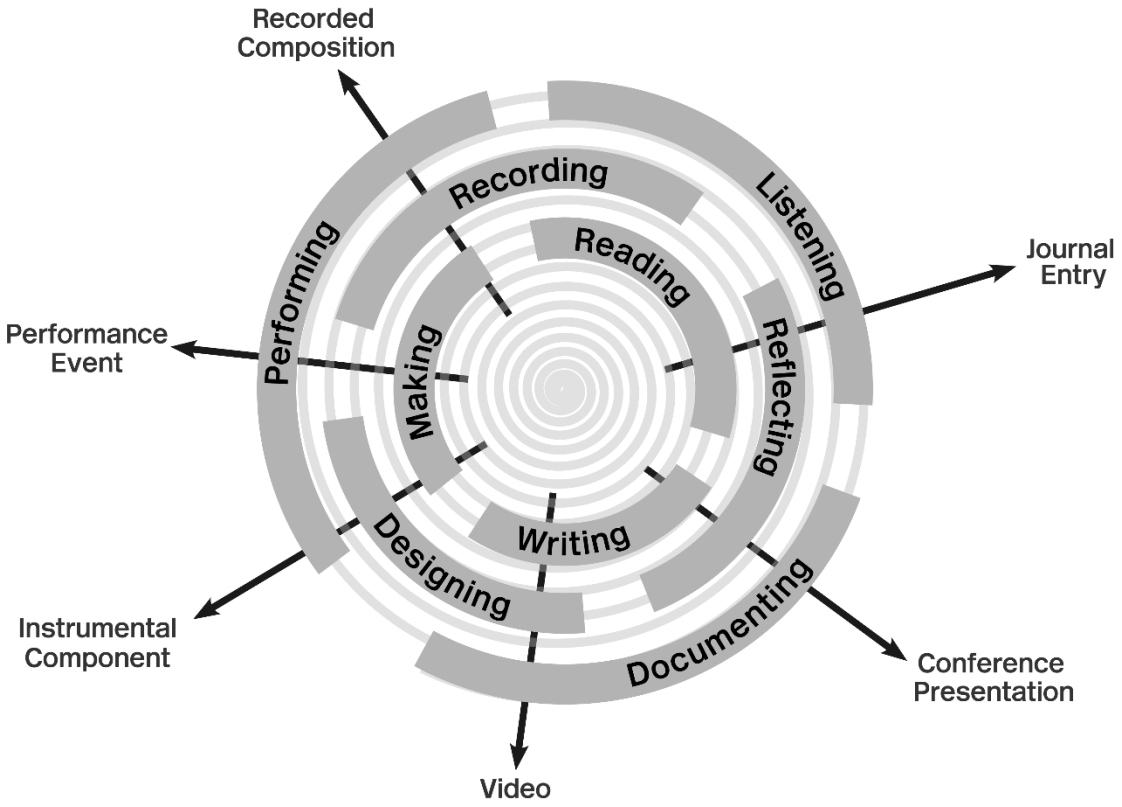

Figure 3.2: Maelstrom of activities

Project structure

In a comparable way to the simultaneity of the making activities related to the project—designing, building, performing, recording—other research activities have also tended to take place concurrently. Documentation and reflection happen during the same period as making. Performing on the same line-up as other artists in the field gave me the opportunity to see new work whilst also presenting my own. Reading theory and current writing was not separated into a specific time period but was undertaken throughout. As such, I conceived the multiple actions as a maelstrom of activities, illustrated in Figure 3.2. I conceptualise my practice happening in lots of swirling cycles,

feeding into one another and creating other currents and eddies. Cycles of reflection and action constantly overlapping, influencing and reinforcing each other in the churn of praxis. Figure 3.2 also illustrates how different research outcomes emerge from, or perhaps get flung out of, the maelstrom. Outputs from my research practice include instrumental component and interface designs, performances and recordings, but also documentation videos, journal entries, conference presentations, and written publications. These 'multi-faceted, dynamic entanglements' (Nelson 2022:45) between each of the various processes are the catalysts for the various research outcomes. Through this model I am able to consider the whole of the research process as engagement with an assemblage—of my existing practice, other artists' work, writing, and making—and the process of engaging with each of these aspects simultaneously.

To enable more formal space for reflection-on-action, that is, evaluation of activities from a more objective outside perspective, two weeks of reflection and writing were scheduled at the end of each three months of work in the project. In practice these happened on a more ad-hoc (improvised) basis, but still allowed for both types of reflection. Reflective writing was collated in the journal, excerpts from which are used to illustrate insights at appropriate places in the thesis. For each of the collaborations, a recorded conversation was undertaken, discussing and reflecting on the project to enable further analysis. These reflective conversations are excerpted in Chapter 7 along with documentation of the collaborative work.

Approaches

Three specific approaches that were used throughout the project are described here. Improvisation, which is not only applied in a musicking context but also across all research activities; ironing in the creases, an approach to design and development consciously avoiding 'improvements' which close off unique affordances; and messing about as a productive creative strategy. Improvisation is at the core of the research project in all aspects of the work. Live performances incorporated structure and improvisation to varying degrees. The recording process (analysed in full in Chapter 5) is a two-stage activity with improvisation playing a major role in both stages. The design, prototyping and making processes foreground experimental and playful improvisation.

Journaling and reflective writing took place without planned structure or editing, to be reviewed and sampled later. An important feature of the process of improvisation is the relinquishing of control over the situation and materials it affords, as Butler explains in relation to electronic music performance: ‘In order to improvise successfully, musicians often seek to release their agency—in other words, to lose themselves. Decisions and the actions they entail become intuitive and immediate rather than conscious and considered.’ (2014:125) This notion of relinquishing agency to enable intuition to take over informs my practice wherever improvisation is deployed. Fundamentally the process is exploratory and experimental, following Ingold’s conception of making. ‘Rather than reading creativity “backwards”, from a finished object to an initial intention in the mind of an agent, this entails reading it forwards, in an ongoing generative movement that is at once itinerant, improvisatory and rhythmic.’ (Ingold 2010:91)

One of the concerns of the project relates to the aesthetic framing of the system as a machine which often surprises through malfunction, wonkiness or error. The instrument design aspect of the project includes research, experimentation, road-testing and iteration, however care is taken not to make devices work too perfectly, so as to keep their idiosyncratic character. I have named this somewhat counterintuitive design methodology as ‘iteration without refinement’, or ‘ironing in the creases.’ Ironing in the creases is a reflective iterative process which avoids needless improvement for its own sake, consciously carrying forward behaviours, attributes and artefacts which might normally be considered as mistakes, problems or annoyances. For further explanation see the paper on the subject presented at NIME 2024 and published in the conference proceedings (Dunning 2024).

Play, playfulness and silliness are important tools in the creative processes used throughout this research project. Messing about as a method is a kind of casual experimentation, or a playful form of improvisation. As part of an anti-solutionist mindset—making space for 'partial, problematic, flawed, and sometimes plain silly ideas' (Blythe et al 2016: 4971)—messing about can offer new lines of flight within the creative space, opening up areas for further exploration. For a complete discussion of my understanding of messing about as a creative process, see the chapter published in the proceedings of the Innovation in Music 2024 conference (publication forthcoming).

As a practice-as-research project the methodology follows Nelson's model of as 'theory imbricated within practice' (Nelson 2022:46), with equal weight given to making, reading and reflecting. Diverse research activities coexist in lots of swirling cycles, constantly overlapping, influencing and reinforcing each other in the churn of praxis: the maelstrom of activities. A non-hylomorphic approach to making centralises improvisation in all aspects, including a reflective iterative process which consciously carries forward so-called mistakes, problems or annoyances (ironing in the creases) and incorporates messing about as a positive, productive and exploratory process towards identifying new affordances. The concept of the nested assemblage structures the entire project, with each of the following chapters considering the work at different scales. Having established the methodological framework, Chapters 4 to 7 present the creative portfolio, and examine and discuss the creative practice undertaken during the research period and the insights that derive from it. In turn the chapters focus on: A live performance, four studio compositions, new instrumental designs, and four new collaborations.

Chapter 4. Instrument-system as live assemblage

Introduction

This chapter argues that by considering Mechanical Techno as a live assemblage, new affordances are revealed, imparting a sense of machine liveness through a distinct mode of turntable practice. The musical assemblage emerges through the combination of multiple cyclical processes, a fundamentally different approach to the way turntable performance is typically conceptualised. As a system with exposed processes, Mechanical Techno embodies a sense of machine liveness. Documentation of a full live set leads the chapter, coupled with the description of the approach to the performance and the ideas it embodies. The concert at the Sheffield Crucible Tanya Moiseiwitsch Playhouse, which took place on 30th November 2024 (Image 4.1), was the culmination of development of the Mechanical Techno system to that point. Full documentation of the event is included in Video 4.1 Sheffield Performance, with specific sections referred to by timing. The aim was to more deeply interrogate aspects of the concept of the assemblage and integrate these into the structure and process of the performance. Four specific aspects were considered, and each is analysed further in this chapter. These are: Concrete assemblage, abstract machine and personae; Assemblage as both noun and verb; Tendencies towards stasis and change; and Deterritorialization and reterritorialization.

Concrete assemblage, abstract machine and personae

The concept of assemblage can be seen as comprising three aspects: concrete assemblage, abstract machine and personae. While these can be identified by their roles in the assemblage, they are not separable from it. ‘The abstract machine does not exist independently of the assemblage, any more than the assemblage functions independently of the machine.’ (Deleuze and Guattari 2013:117) Nail’s interpretation of the three constituent aspects uses the alternate terms ‘elements’, ‘conditions’, and ‘agents’ (Nail 2017).

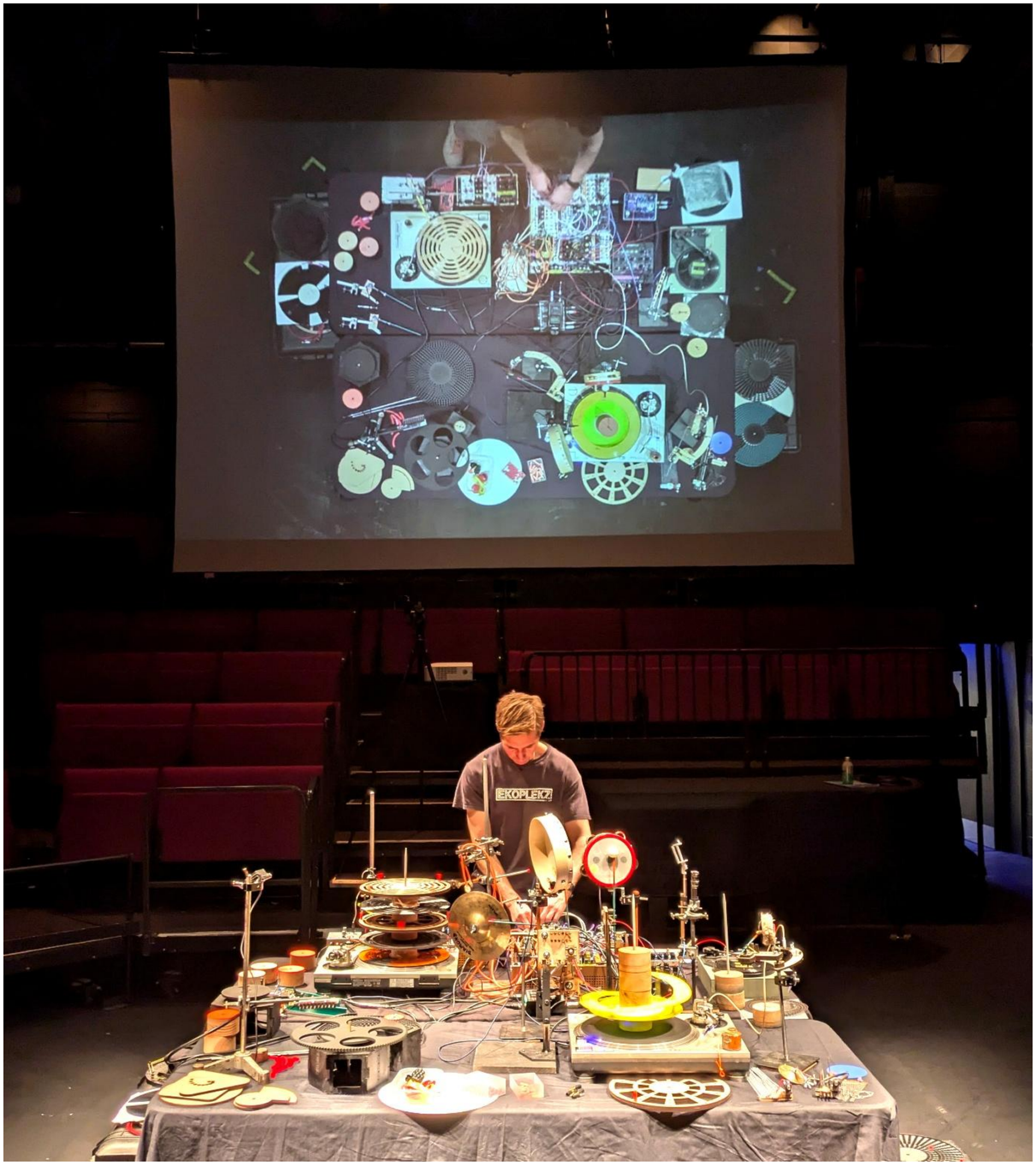

Image 4.1: Performance setup at Sheffield Playhouse, 30 November 2024. Photo by John Burton.

The concrete assemblage encompasses the constituent parts or components of the assemblage: the specific entities which contribute to the whole. These might be people, buildings, technologies, or other tangible, physical elements. The abstract machine is the set of relations, or conceptual structure, which provides rules and foundations to organise the assemblage and its layout, and govern the connections between the elements: the conditions. It is intrinsically linked and intertwined with the concrete assemblage.

> ‘We think the material or machinic aspect of an assemblage relates not to the production of goods but rather to a precise state of intermingling of bodies in a society, including all the attractions and repulsions, sympathies and antipathies, alterations, amalgamations, penetrations, and expansions that affect bodies of all kinds in their relations to one another.’ (Deleuze and Guattari 2013:104)

The personae are ‘the mobile operators that connect the concrete elements together according to their abstract relations’ (Nail 2017:27). The persona of an assemblage is its third-person agent (the ‘we’), the collective of actors which enact the interactions between the elements, as defined by the set conditions.

Considering the Sheffield concert as a process of live assemblage, a simplified analogy designates the physical components of the performance as the concrete assemblage, and the codes, rules and other incorporeal elements as the abstract machine which governs the assemblage. In this analogy, the personae would refer to myself as the key proponent and, arguably, the extended turntable as a second active agent in the system.

Concrete assemblage

The performance made use of an expanded version of the Mechanical Techno setup with four ‘stations’ around the table, each consisting of an extended turntable system. The specific components and makes are analysed in more detail in Chapter 6. Image 4.2, an annotated video still, shows the four stations which will be referred to below: Turntable 1, Turntable 2, Oscillator Turntable, and Slow Platter.

Turntable 1 runs most of the rhythm parts for the performance. The main interfaces used here are the in-built tonearm and cartridge, Mono Comb switch array, piezo drum triggers, and optical reflection sensor. Each output is processed by the modular synthesizer system, which also acts as the mixer for all sound output. Turntable 2 runs all of the small percussion, including geared beaters via the worm gear mechanism. The in-built tonearm is also used, and for some of the performance the MIDI Comb switch array. All amplification and processing is via the modular system. The Oscillator Turntable is used with various vinyl records via its own magnetic stylus and, later, to run the laser tone-wheel disc. The Slow Platter initially plays the MIDI Comb switch array via

magnetic fruit and ball-bearing discs, later running as a low frequency oscillator with the cam follower potentiometer arms, via the Resistance module. In addition to the interface modules developed for this research project (Resistance, Mono Comb, MIDI Comb), processing is via the modular system and some external hardware. The modular system serves several functions: signal processing, audio processing, drum sounds, and synthesis.

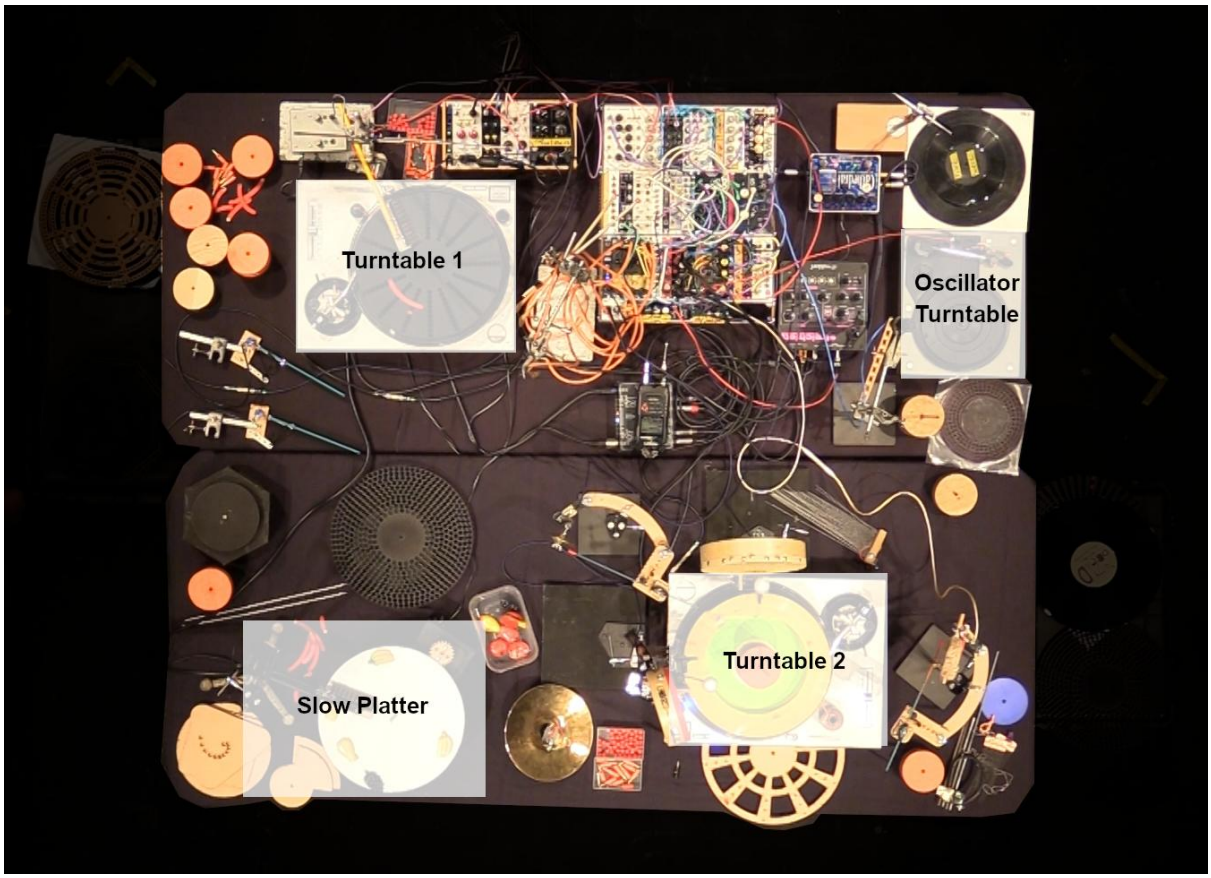

Image 4.2: Sheffield performance setup

Signal processing includes converting the piezo audio triggers to CV trigger signals, including double-hit correction; envelope generation from the optical reflection sensor; and producing audio from the laser tone-wheel sensor input. Audio processing includes preamps for the turntable tonearms; preamps for the contact microphones on the small percussion; high pass filters; delay units; and audio mixing for output. Drum sounds are via dedicated modules: a Befaco Kick All bass drum generator; Tip-Top Audio 909 hi-hat module; Ladik Drum Boy multi percussion module; and an Erica Synths sample player. Drums are summed into an Erica Synths mixer module, which includes a compressor. There are four voices synthesized by the modular system. The two low-pass gate circuits

produce simple percussion from noise- or tone-generators, or the Oscillator Turntable output. Two subtractive synthesizer channels each use an envelope generator, voltage-controlled amplifier, voltage-controlled filter (by Doepfer, based in the TB-303 filter circuit) and an oscillator—either a dedicated analogue voltage-controlled oscillator (with pitch set by the Mono Comb module) or an input provided by the Oscillator Turntable. Two additional pieces of external hardware are used: a Waldorf Streichfett string synthesizer module, played by the MIDI Comb; and an Electroharmonix Cathedral stereo reverb pedal, used to treat the output from all the small percussion instruments. Stands, clamps, wooden cylinders, records, discs and inscription components (such as ball-bearings and magnetic fruit) make up the remainder of the instrumental components. As the solo musician and performer for the piece, my own body completes the concrete assemblage.

Abstract machine

For the purpose of structuring the performance in Sheffield, the abstract machine was taken as 'the network of specific external relations that holds the elements together' (Nail 2017:24). Discussed in this section are the degree of coding and decoding of the assemblage, and my own self-imposed rules—a code of practice.

Coding

For DeLanda, one of the two variable parameters of any assemblage which can be used to categorise it is its '*degree of coding and decoding*. Coding refers to the role played by special expressive components in an assemblage in fixing the identity of a whole' [original emphasis] (2016:22). Two examples of expressive components are DNA and languages. Specific linguistic examples are given which might be seen in a social assemblage such as an institution: 'linguistically coded rituals and regulations,' including 'written rules, standard procedures, and, most importantly, a constitution defining the organisation's rights and obligations' (ibid). Similarly, Nail lists the types of codes expected in a social assemblage as including 'codes of kinship, codes of communication, codes of exchange, codes of location (places of worship, places for eating, places for rubbish, and so on)' (2017:29). In developing the Sheffield

performance I asked: What codes affect the Mechanical Techno assemblage at this specific event?

Two types of causation are possible through coding in relation to an assemblage: internal causes, from constituent components (or 'bottom-up') and external influences, from the broader constructs into which an assemblage is plugged (or 'top-down'). DeLanda gives examples from changes in weapon manufacture: the imposition of formal regulations to create interchangeable parts for rifles had a top-down impact on the structure and organisation of the workshop. In the other direction, 'the replacement of muskets by rifles had bottom-up effects on larger assemblages, causing further deterritorialisation of the phalanx' (DeLanda 2016:82). In Mechanical Techno, top-down influences come from factors such as institutional coding, setting, space, genre expectations and aesthetics. Bottom-up causation flows from the design of the systems in use, the performance approach and the aesthetics: factors in turn generated by my own code of practice, as explained below.

The concept of an instrument-system relates to Schnell and Battier's term, the 'composed instrument' (2002:1). Though defined specifically in relation to computer music, the term can also be applied to hybrid systems like Mechanical Techno. To call a system a composed instrument is to acknowledge that the system design itself leads to specific musical outcomes, just as writing a musical score does. 'The term of the *composed* instrument underlines the fact that computer systems used in musical performance carry as much the notion of an instrument as that of a score, in the sense of determining various aspects of a musical work.' [original emphasis] (Schnell & Battier 2002:1) Working with an instrument-system necessarily involves a multitude of different types of notation, inscription, and language, as Magnusson writes: 'Composing with machines means engaging with different notational languages, such as formal rules, electronics or code.' (2019:120) Given that the constituent parts require different sets of codes, the process of composition itself is changed. 'Composition therefore becomes systems design which involves integrating an assemblage of heterogeneous elements - hardware, code, protocols, and standards - that, together, constitute the new music.' (ibid) Such combinations of notational languages, computer code, aesthetic rules and so forth, can all be considered forces of coding within the assemblage, so part of its

abstract machine. The following section analyses some of the codes, including the notational languages, which contributed to the assemblage of the Sheffield performance.

The event was billed as *Sounds Of Now: Gritstone Turntables (Double Bill)*. The other performance at the event was a new project by artist Leafcutter John, using his 'home-made quad turntable to conjure reeling melody and rhythm from the very texture of gritstone' (Music In The Round 2024). Our event was part of a series called *Music in the Round*, which typically programmes contemporary classical music, predominantly with acoustic instrumentalists. The established mode and typical bookings of the series had a regular audience, and by implication an established code. Preparation for the performance included negotiation with the organiser over framing the set within the context of the concert series, including a short email interview to inform regular attendees (on the series mailing list) about my work, as an attempt to pre-emptively temper expectations. I described my work as using 'a DJ turntable as the engine of a ramshackle mechanical music system' producing a 'techno-infused performance, which is in turns abstract, clattering, cosmic and polyrhythmic.' (ibid) This in turn set certain genre expectations, which are discussed further below.

The musical and social relationships which are brought about in a performance are, for Small, what generate meaning in the act of musicking. Through analysing the setting and social ritual of a hypothetical symphony concert, he explains the ways in which the building and the space in which the performance is set influence the music:

> 'The great building, then, dramatizes and makes visible certain types of relationships. It isolates those within it from the world of their everyday lives, it brings some together and keeps others apart, it places some in a dominant position and others in a subordinate position, and it facilitates communication in one direction but not in the other. … The relationships of the building are not, of course, the total meaning of the event, being only one strand of the immensely complex web of relationships that is the performance. But they do establish some general limits, or parameters, for those relationships which can be, and are, brought into existence every time a musical performance takes place there.' (Small 1998:27)

The Sheffield performance took place in a black-box theatre space. Audience members were seated on two tiers of seats, on three sides of the room. A large projection screen was mounted on the fourth side of the auditorium, visible to all. The room was acoustically treated and the soundsystem integrated into the ceiling-mounted lighting rig. As one attendee later posted on social media, 'Got a nice view from tiered seating, it was really nice to be in a space designed for looking at tables.' The setting of the event, its framing within an established concert series, the coupling with another performer with a similar approach, the textual material used to promote the show, and my reputation as an artist all contribute to a set of expectations. Though I was never given direct instructions on the type of music to make or my approach to performance, the setting and context had an impact on my work. As such these unspoken codes of conduct can be considered as forces acing upon the assemblage.

Genre expectations also exerted a force on the development of the performance. Describing the set as 'techno-infused' implies rhythm, repetition and electronic sounds, as discussed in Chapter 2. The formal musical elements of techno as a genre exert a certain force on the project, and by referring to the genre its inbuilt codes are implied. Hemment discusses perhaps the strongest signifying element of techno, its rigid metre, as analogous to its DNA: 'The rhythmic template of the "four-to-the-floor" was an elegant piece of code, beautiful in its simplicity. In the expanded field rhythm is less like a computer algorithm than a biological code such as DNA, as biological code is context dependent and gives rise to organic forms infinitely more complex than the information it contains.' (2004:86) Mechanical Techno contains within it some DNA from the wider genre and, though the disruption of such generic coding is part of the project, it also underpins the work. There is also direct inclusion of some of the sonic DNA of techno, through the recognisable musical components used. One example is the use of the 909 hi-hat module, which is modelled on the original drum machine's sound and function. Rietveld highlights the importance of the TR-909 to the techno aesthetic: 'Even though these drum machines were taken out of production by Roland not long after their introduction, the sound of the TR-909 drum machine is iconic, dominating the sound of techno and related dance music genres.' (2018:125) Similarly, the use of two Doepfer A-103 filters, themselves modelled on the iconic TB-303 bassline synthesizer, allows for

an audible connection to acid house and acid techno which commonly utilise that synthesizer. Thus, the signposts to techno as a genre are not only the rhythm structures and long repetitive arrangements but also embedded within the sounds themselves.

Mechanical Techno as a performance stands on the boundary of two related but distinct fields. On one hand, the music that the system makes is broadly compatible with dancefloor focused electronic music (the broader techno umbrella) and can be appreciated in that way. Simultaneously, it is a performance-installation with a sounding kinetic sculpture. Despite the clear visual connection between the sound sources and the music made, there is a potential disconnect in the expectations of how such music might be produced. Usually dance music is made with a laptop or selection of drum machines and synths, a somewhat incomprehensible black box. A typical sound art performance with a table full of sounding sculptures would often make abstract, arhythmical music. The juxtaposition of the two could be considered a weird construct, confusing the expectations of both. In Fisher's work defining the weird, he states, 'the sense of *wrongness* associated with the weird - the conviction that *this does not belong* - is often a sign that we are in the presence of something new.' [original emphasis] (Fisher 2016:13) I have previously described the specific aesthetic of my sound as 'music that sounds a bit wrong' (Dunning 2024:231). The intention is to create something recognisable as electronic dance music, but with a sense of weirdness, irregularity or breakdown. With influence from both techno and sound art, the intention is to make something which disrupts both. As Demers writes on the aesthetics of experimental electronic music, 'the interesting moments in any genre occur, of course, when expectations are in some way thwarted, when a work does something it is not "supposed" to do according to the rules of its genre.' (2010:10) By identifying the genre expectations applying pressure to the performance, the intention was to be able to thwart them in this type of way. Identifying the external influences on the Mechanical Techno assemblage in Sheffield—the relationships imposed by the space, the institutional expectations, the pressures of genre and field—allows for a clearer picture of how the assemblage works. These are the top-down forces from the broader assemblage. In turn this makes room for 'interesting moments' (ibid) and new meanings, new affordances for the system.

The Rules

Throughout the development of the Mechanical Techno project, I have set myself boundaries and limitations within an aesthetic framework. Previously unwritten, I consolidated and refined The Rules through this research project. Leading up to the performance in Sheffield, I had already played fourteen solo shows with different iterations of the setup and in different contexts. Testing and refining these restrictions was one of the objectives throughout this period. By the Sheffield performance, they were well established. The Rules are a code of practice: a declaration of principles or a manifesto, for both the ethics and processes of the project, from which the aesthetics are then derived. All technical, performance and aesthetic decisions have been (and continue to be) determined by parameters given by The Rules. One major influence on establishing these self-imposed guidelines was Mathew Herbert's document *Personal Contract For The Composition Of Music (incorporating The Manifesto Of Mistakes)*, published in 2000 and updated in 2003 (Herbert 2003). Of most relevance were the following two points, regarding the encouragement of accidents, and the inclusion of extraneous sound from sampled audio.

> '5. The inclusion, development, propagation, existence, replication, acknowledgment, rights, patterns and beauty of what are commonly known as accidents, is encouraged. Furthermore, they have equal rights within the composition as deliberate, conscious, or premeditated compositional actions or decisions.' (ibid)
>
> '8. Samples themselves are not to be truncated from the rear. Revealing parts of the recording are invariably stored there.' (ibid)

The Rules are grouped under three categories, with some crossover. The complete list is below. Further explanation follows, and these rules will be referred to when discussing the specifics of the live performance later in the chapter.

Prioritising liveness and action-sound-coupling:

- Do it physically wherever possible
- Avoid orphaned actions: when a thing happens, a sound happens
- No fade-ins, no cueing, no previews

- Exposed interface: nothing happens ‘in the box’
- No backing track of any kind
- Program patterns in real-time or visibly wherever possible
- Show working: demonstrate processes

Prioritising noise, density, complexity

- Sources of unpredictability (and frustration) should be retained and not smoothed out
- Tuning is by ear; scales are unacknowledged
- Non-hierarchy of sound sources: All types of sound source have equal weight
- An abundance of types of signal flow and component interaction

Prioritising the machine

- No ‘playing’ by me
- No showboating (no solos)
- Emphasise the character of the machine, don’t clean up too much

Prioritising liveness and action-sound-coupling

As a live performance project, the priority of action-sound-coupling is intended to enable audience members to understand the processes by which the sounds are being produced and modulated. The key components of liveness being considered here are immediacy, intimacy and risk. To ‘do it physically wherever possible’ refers to a performance strategy prioritising action-sound-coupling, directing attention to the method of sound-making via the machine. Certain musical results can be achieved by multiple means. Where a physical option is available—such as making an adjustment on the turntable tower rather than a mixer fader—the former should be chosen. ‘Orphaned actions’ occur when a physical action results in no sound. The action-sound-coupling is broken because there is no result following the cause. As such, orphaned actions are to be avoided where possible. During a DJ set it is normal to cue up a record on headphones (without the sound routed to the output) so that the appropriate start point can be found and a mix can be made seamlessly. This results in a set of actions which are visible but not audible—orphaned actions. Avoiding the cueing of sounds in

Mechanical Techno means this is averted, but also that the potentially messy, non-musical 'working out' of finding the right sound or pitch is included in the mix output. Part of the project's aesthetic is a strict adherence to this type of direct causality, often at the expense of a clean or smooth musical outcome. Use of backing tracks and pre-recorded passages is not unusual in electronic and experimental music performance. Changes which occur in pre-recordings do not have a visible causal action and are thus avoided. Whilst recordings are used in the project—in the form of dubplates or modified records—they are not allowed to play out in full. Forcing a locked groove from a record removes its linearity, transforming it to a looping component which must be interacted with in order to produce change. An exemption is the use of modified records with a weighted tone-arm restriction, which can sometimes randomly change grooves in between rotations. This playback is still not linear in the same way as straightforward backing track playback, and the physical process which causes the random changes is visible with close observation.

Prioritising noise, density, complexity

Each of the rules and restrictions declared in this category relate to the musical outcome of the project, with an intention to create electronic music which avoids the attributes typically given to automatic and mechanical music, 'time perfect, repetitious, logical, perfect, normative' (Magnusson 2019:54). Sources of unpredictability in the Mechanical Techno system typically derive from physical actions, themselves often a result of imprecise fabrication or alignment. The results are sometimes minor, like microtiming changes in rhythm patterns, and sometimes much more noticeable. Both types change the sonic outcome, the aesthetic of the music which the system produces. In technical terms these are malfunctions, mistakes, failures. The machine is inadequate in completing the task it was designed for. As a maker, my instinct is to correct these failures by making the machine 'work better'. However, The Rules dictate that, on the contrary, these issues are to be encouraged: they are unique behaviours which produce a characteristic sound. The process of identifying and nurturing these frustrating characteristics is an example of 'ironing in the creases' (Dunning 2024).

As demonstrated in Video 6.1, the devices which require tuning used within the system are designed to be tuned by ear. Choosing a specific scale is not possible and often

note selection is unstable or difficult. Building a non-user-friendly interface is something with precedents in the NIME field, including Bowers & Archers' infra-instruments (2005) and Koutsomichalis' rough hewn instruments (2020), and was influenced by anti-solutionist design strategies such as 'the principles of absurdity, uselessness, ambiguity, exaggeration, estrangement or irony' (Tost et al 2021:84-5). The restriction in my case comes from a desire to push back against both the 'claviocentrism' (Diduck 2018:40) of the MIDI keyboard and most DAWs, and the trend of 'digital perfectionism' (Strachan 2017:133) enabled by all popular production environments.

Deleuze and Guattari's concept the rhizome (2013:9) influenced both the non-hierarchy of sound sources and the multiplicity of potential connections in the system. Sound sources might include off-the-shelf synthesizers, hand-made instruments, 'noise' from various sources (including record crackle and circuit hiss) and the sounds of the machine itself. The non-hierarchy also refers to distinctions between digital, analogue and acoustic sources. There is a deliberate inclusion of both 'clean' and 'noisy' signals in order to maximise unusual combinations. This rule increases the likelihood of creating 'chimeras and previously unimagined sounds' (Hemment 2004:83) through combinations of disparate elements. The intention is to instil a sense of weirdness, bringing sounds together which don't seem to belong (Fisher 2016:10). Similarly, inclusion of multiple signal types—MIDI, CV, electrical audio, acoustic sound, physical movement—and, where possible, combining these signal types together, is a strategy used throughout the project. Whilst these combinations have the potential to produce unique effects in themselves, they also increase the complexity of the system, enabling me as performer to relinquish a certain amount of agency, and also enabling the emergence of previously unforeseen affordances. Jensenius depicts a simple instance of this phenomenon, using multiple out-of-sync LFOs: 'For the performer, such long semiautomatic processes may feel like the instrument plays "itself."' (2022:91) Though it may feel as though the machine is expressing agency, this is not a claim for deliberate intention. Fergusson's term 'imagined agency' is helpful in understanding this balance. The state arises from the 'unpredictability and the confusion inherent within systems and situations that rely on interdependent and ambiguous elements' (Fergusson

2013:136). Mechanical Techno's imagined agency is one of the factors which also characterises the machine itself as a persona of the assemblage.

Prioritising noise and complexity through the physicality of the system is one of the factors which distinguishes this project and its sonic outcomes from other processes of creating electronic music. The power of physicality to contribute complexity and difference to a composition is noted by Sarah Angliss with regard to *The Ealing Feeder*:

> 'Like any mechanically driven sounding object, the bells of the carillon exhibit a subtle unevenness in timing and volume as they are struck. There are also creaks and movements; slight chaos in spring bounces and sympathetic resonances you'd expect with any instrument with moving parts. These irregularities add an aleatoric charm to the sound, a quality I doubt I could convincingly model in code.' (Angliss 2018: 323)

Whilst it may be possible to model such behaviours, as Angliss suggests this would be difficult. As Magnusson explains, the sonic properties of an acoustic instrument are often implemented through bottom-up exploration rather than the top-down implementations of digital instruments: 'As opposed to the generic explicitness of the digital instrument, the acoustic instrument contains a boundless scope for exploration as its material character contains a myriad ways for instrumental entropy, or "chaotic" non-linear behaviour that cannot be mapped and often differs even in the same type (brand and model) of instruments.' (Magnusson 2008:174) Though here referring to the player's exploration of sounds through technique, my argument is in agreement with Angliss in that the physicality itself also contributes surprising and unpredictable actions and behaviours to the system, which premeditated planning would exclude. In developing such a project, it is necessary to work in an itinerant way, following the flows of materials (and components) rather than imposing laws (Ingold 2010:91).

Prioritising the Machine

The balance of agency between performer and system is an important aspect of the project, and these rules aim to give additional opportunities to explore this. The primary and possibly most restrictive rule is that as a performer I don't directly play any of the music or perform any solos. At its most basic level this excludes actions like playing a

riff on a synthesizer keyboard (although this might seem to qualify according to other rules, as it has a strong action-sound-coupling). It also excludes more performative turntable playing actions like scratching and crossfader work. Some ambiguity in interpretation occurs at longer time scales. Making music with the system inevitably involves 'playing' at an arrangement level: in essence bringing in and out musical elements in order to create a structure. The type of playing in question here regards the most direct 'excitation actions' (Jensenius 2022:73) which produce an immediate sound. Excluding live playing pushes the focus of my performance towards enabling the machine. The system plays the music; my role is to enable it to do so.

The final element is the importance of the characteristic sound of the machine itself, which also relates to the rule regarding non-hierarchy of sound sources. An example would be the use of contact microphones for the small percussion instruments. The creaking and movement of the triggering mechanism is amplified almost as much as the sound of the percussion strike, and this is intentional. Crackling sounds resulting from the use of dubplates and modified records are also an important sonic component of all music made with the system. Fisher discusses the use of record crackle, either through inclusion in sampled material or as a sound in itself applied as a textural element, in terms of its referentiality: 'If the metaphysics of presence rests on the privileging of speech and the here-and-now, then the metaphysics of crackle is about dyschronia and disembodiment.' (2013:48) These effects are produced by the dual nature of the sound, and the way it reveals its own method of production. 'Crackle unsettles the very distinction between surface and depth, between background and foreground. In sonic hauntology, we hear that time is out of joint. The joins are audible in the crackles, the hiss…' (ibid) With the Mechanical Techno system, the crackle is neither identically played back nor superimposed, but happens in real-time as a (by)product of the other sound-producing processes. Paradoxically it both gives away the pre-recorded nature of some of the other sonic material (such as the synthesizer dubplates) and simultaneously occurs in the present moment. These types of sounds would normally be too quiet to hear, but are deliberately foregrounded in Mechanical Techno, which also adds a layer of intimacy to the resultant music. In live performance, the acoustic sound of the various triggers, switches and motors can often be heard in quieter

sections or by audience members closest to the instrumental setup. Whilst these are not amplified, the damping of such sounds is not a priority in designing the interface. Such noises are inherent to physical media and mechanical systems and can be a signifier for listeners towards the processes that are producing the music. Riis identifies this within his mechanical musical instrument practice: 'The mechanical parts are assembled solely to fulfil a given functionality. However, they are sonically inseparable from the previously described sounding outputs of the apparatus, making the sounds of the machine itself essential to the musical expression that it is capable of generating.' (Riis 2016:13) Within Mechanical Techno, the sound of the machine itself is a critical element to the unique music which is created and, as will be discussed further in Chapter 5, contributes a physical signature to the music which carries meaning.

Personae

The personae, as Nail states, are 'the mobile operators that connect the concrete elements together according to their abstract relations' (Nail 2017:27). Understanding the Sheffield performance through the assemblage analogy, my role as performer was exactly as a 'mobile operator'. I visited the London Museum of Water and Steam on a day when the large pumping engines were running. In my journal I noted the way in which the volunteer operator was working:

> *It's kind of like a performance but the machine is the one that's doing the performing and the operator is just getting things going. ...operating the machine is necessary, the operator is not a performer, but moving in a way that their movements look like they are performing.*

This is the type of interaction I aimed to convey during the Sheffield performance: tending to the machine and enabling it to create the music, to do the work. One way to conceptualise this type of interaction is that the operator takes on the role of the attendant. Richards and Shaw use the term 'attendee' for their roles working in a performance-installation context.

> 'Performance-installation implies a performance style governed by the constraints of objectively making and installing things and of "unperformance". Performance is seen as an extension of labour. Melodrama, seeking extra-object

> activity and exaggerated performance gestures, is often played down. Moreover, attending to, rather than playing a sound is an important aspect of performance-installation. This implies that some form of autonomy exists in the sound, or sound-making object. The attendee (the performer/unperformer) observes and listens and acts only when "called upon"." (2022:145)

In my work I prefer the term 'attendant' as a more active alternative to 'attendee'. To be an attendee could imply only turning up for the event, where as an attendant's role is in service of the environment or technology. A toilet attendee would make use of the facilities; a toilet attendant would work on the facilities' upkeep. As an attendant to the Mechanical Techno instrument-system, my role extends beyond acting 'only when "called upon"', as part of the role is to maintain the planned structure of the performance as a whole. As an active operator I can both allow the machine to run and make changes to its course.

A similar performance approach is identified by the aforementioned Riis, who defines his role as 'the repairman' to his steam-powered mechanical music system. The project engages with the history of physical machinery and its function, highlighting 'the fact that machines have always been breaking down, and there has always been a physical mechanism that challenged the predetermined functionality of the machine' (Riis 2016:22). This intrinsic mode of working with the machine dictates Riis' role during a concert: 'I must take the role of the repairman as much as the performer in order to safely guide this apparatus through a performance.' (ibid) Part of my role working with Mechanical Techno overlaps with the repairman role, sometimes very directly. At 21'58 in Video 4.1, the Mono Comb switch array fouls in the mechanism, leading to a note of the bassline sticking in the 'on' position. At 22'08 I notice the breakdown and move around to Turntable 1 to rectify it, removing the broken switch array and reinstating it. Such repairs are an important element of the performance, requiring live troubleshooting. These glitches cannot be planned for or built into the set, and do not occur in every single show. They are both problematic and desirable. Such incidents highlight the liveness of the performance, the precarity of the contraption, and the risk involved in using this system. Whilst 'repairman' is an appropriate term here, I prefer

‘attendant’ both as it can include the other activities undertaken in performance, and it avoids the use of a gendered term.

In addition to my own role, the machine itself can be seen (or felt) to have its own agency within the performance—it completes some operations under its own volition, once those processes are set in motion. In *Improvising with Machines: A Taxonomy of Musical Interactions*, myself and Parkinson identified a range of roles which a music system can take on, in a process of offloading tasks during musical performance (2025:340-351). Though initialised and controlled by the human agent, with variation and planned complexity of interactions, the system can appear to generate its own characteristic contribution. Fergusson’s ‘imagined agency’ (2013:136) is useful here in describing the feeling of improvising with a system which appears to contribute even if it does not have the capacity for active intent.

Performance approach

The self-imposed rules, strategies and on-stage behaviours which contribute to performance approach are a set of codes by which the performer abides. In many, perhaps most, contexts, these codes are unwritten and unspoken. Making them explicit here is an attempt to understand the working of the performance as a live assemblage. Certain of these codes have been developed over the decade of working with the Mechanical Techno system, whilst a new aspect, working as a mobile operator, was implemented for the first time for the Sheffield performance.

Of particular importance in the performance was the notion of ‘playing by the rules.’ One of The Rules relates to the overall aesthetics of the project, others apply to the design and building of components for the system, and most are to be followed during performance itself; the latter category defining the boundaries of my actions and therefore the performance approach. The rule concerning ‘non-hierarchy of sound sources’ is primarily an aesthetic concern. Those relating to instrument design deal with exposure of interface, retaining unpredictable elements, tuning method, emphasis of the machine’s character, and the inclusion of multiple signal paths. These rules are incorporated into the system in the way the components are designed and built, and thus enforce certain behaviours during performance. An example would be tuning the

MIDI Comb module by ear, which happens at 35'43. In this instance, the coding of the constituent elements has an effect on the broader assemblage: an example of the type of bottom-up causation noted by DeLanda (2016:82). The remainder of The Rules relate directly to my performance approach. Cueing or previewing sounds is impossible with the system as the available mixer modules do not allow for pre-fade listening. This means that any sound brought into the mix may need altering once it can be heard. At 34'28 I change the preset on the MIDI string synth, preparing for the next section. The new preset has a much shorter attack envelope, so comes in very loud in comparison to the rest of the mix; I stop Turntable 2 which is triggering the synth, to halt the sound and restore the balance. This 'mistake', which took me by surprise and changed the dynamic of the music produced, would not have occurred if I had been able to preview the sound before introducing it. Such occurrences highlight the liveness of the performance directly, demonstrating the precarious nature of the process and what is at risk.

To 'do it physically where possible' changes the way I arrange the sounds in relation to one another, create changes in dynamics and build the structure of the music. At the most basic level, each sound which can be triggered or played by the machine is already turned up on the mixer prior to the performance: every trigger is 'live' and will make a sound as soon as it is touched. This avoids 'orphaned actions' and lends a sense of immediacy to the performance. There is no latency, no disruption to the direct cause-and-effect between my (and the machine's) actions and the resulting sound. Doing it physically also applies to my method of dropping individual drums in and out of the mix. Whilst it is possible to do this with the mixer controls, a more obvious visual signal is to reposition the physical trigger on the turntable. This is how I drop out the bass drum sound at 9'31, reintroducing it the same way at 10'00.

Programming patterns visibly or in real-time serves several purposes, primarily to emphasise the process through action-sound-coupling but also affecting my performance approach and the musical outcome. Programming during the performance enables me to improvise with patterns and rhythms, which would be restricted if the setting had happened beforehand. At 4'15 I can be seen programming the bassline for the Mono Comb, and at 8'01 making a bass-drum pattern by programming the peg disc. Though these actions happen out-of-time (to use Jensenius'

terminology), typically this is only a few seconds before the programmed pattern is activated. The resultant anticipation and deployment is somewhat similar to the way sounds are introduced in live coding: writing a line of code silently which activates sounds moments later when it is executed. Certain programming does happen in real-time, that is, on the turntable as the record is spinning. An example can be seen at 41'13, adding ball-bearings to the disc triggering the MIDI Comb, which adds some random notes to the sequence. The impossibility of precisely programming a pattern leads to unpredictable note sequences. To some degree, chaos in the rhythm pattern is tempered, as the disc is quantized to sixteenth-note triplets, though there is still close enough resolution that the triggers do not always sound cleanly on-grid. Hitting specific 'correct' notes is similarly impossible, as ball-bearings don't always stay in the correct concentric track; programming pitch is more a case of scattering the ball-bearings towards the inside or outside of the disc for more lower or higher notes. The role of the setter in mechanical music is typically performing an out-of-time technical activity, converting a pre-determined musical score into an inscription which a mechanical device can read. Through including these activities as part of the performance—in real-time or closely preceding the sound activation—the process is exposed for its creative potential. Inscription becomes a potentially improvised, responsive action and the decision-making process itself becomes clear.

In any assemblage, there are tendencies towards both stasis and change: the codes which govern the system can be restrictive with a rigid system, but can be flexible within a looser system. That is to say, the rules can sometimes be broken. One example within the performance was during the section with the ping-pong balls between 28'56 and 29'30. Here, my interventions flicking the ping-pong balls against the triggers and riding the delay feedback controls can clearly be seen as me 'playing' the machine and the modular synthesizer effects. I am in contravention of both the 'no playing' rule and the 'no solos' rule. The rules are to some degree arbitrary for the production of coherent music; they exist in order to impose a specific framework which enables a specific output to be made. Just as the design of the instrument itself is a 'musical-theoretical framework' (Magnusson 2019:45), the code of performance prescribed by The Rules is one of the factors defining the musical outcome of the performance event.

Playing by the rules is, according to Huizinga, fundamental to the successful functioning of play itself: 'All play has its rules. They determine what "holds" in the temporary world circumscribed by play.' (Huizinga 2009:11) In order for the temporary world to hold and continue to function, the rules must be taken seriously: 'The rules of a game are absolutely binding and allow no doubt. ... Indeed, as soon as the rules are transgressed the whole play-world collapses. The game is over.' (ibid) Similarities between playing games and playing music can clearly be seen: rules and transgressions, improvisation and reactivity, communication and embodying different roles. That the verb 'to play' is shared seems no coincidence. Mechanical Techno is consciously playful. An emphasis on having fun as a performer, and equally the absurdity of the contraption and musicking process contribute to this. The success of these qualities relies on my taking the performance seriously as a performer. Such seriousness is, for Huizinga, an important aspect of play: 'As soon as we proceed from "play is non-seriousness" to "play is not serious", the contrast leaves us in the lurch — for some play can be very serious indeed.' (Huizinga 2009:5) Taking the role seriously is the main way in which the rules of play are upheld, and 'temporary world' it creates is maintained.

Caillois responds to Huizinga's conceptualisation, categorising play according to whether a game is competitive, based on chance, a form or role-play, or to do with relinquishing control (for example, a fairground ride). Caillois also emphasises the importance of rules in most forms of play, even in those which might not have explicit goals or tasks to compete: 'No fixed or rigid rules exist for playing with dolls, for playing soldiers, cops and robbers, horses, locomotives, and airplanes - games, in general, which presuppose free improvisation.' (Caillois 2001:8) He explains that the implicit rules in such play involve taking on a role, 'of acting *as if* one were someone or something else, a machine for example.' [original emphasis] (ibid) In the Sheffield show, my performance roles are embodied according to The Rules, which, although fairly rigid from my perspective, are not shared with the audience and are not explicitly stated anywhere. I am acting *as if* I am the operator of a large, steam powered pumping machine in a museum. This seriousness on my behalf affords the absurdity of the performance. Caillois' main focus is on games with rules (which he calls *ludus*), at the

deliberate exclusion of freer, more chaotic play (called *paidia*). These forms he defines as opposites: 'e.g. the preference for cacophony over a symphony, scribbling over the wise application of the laws of perspective.' (Caillois 2001:53) The distinction here calls to mind Nietzsche's concepts of the Apollonian and the Dionysian (2000:68); or the opposing tendencies present in assemblages: tendencies towards stasis and change, stratification and the rhizomatic. The Mechanical Techno performance in Sheffield is constrained by the codes of The Rules and the system's aesthetics, but also includes elements of free play.

As discussed in Chapter 3, 'messing about' is an important process in my methodological toolkit. Within the cyclical-reflective process of improvisation, messing about activates unplanned strategies, creates new connections, and can introduce new ideas which might not otherwise have emerged. Within the structure of the Sheffield performance there was little room for messing about, though as the process is one option in my toolkit of actions, it had the potential to be deployed even if this was not realised. During the section using the ping-pong balls, between 26'47 and 29'48, I can be seen playfully exploring the physicality of the setup and the parameters of the delay unit. Arguably this is also the moment at which I deviate most from The Rules, straying into 'playing' or 'soloing' territory. Through free play the tension between coded and non-coded actions can be seen most clearly, messing about having an element of recklessness and rule-breaking.

By necessity the Mechanical Techno performance has a pre-planned structure. In order for a complete musical track to be made, a number of elements need to be present: typically a bassline, a main drumbeat, some additional percussion, and usually some other pitched components. Due to the nature of the system, elements need to be added in a certain order. The physicality of the setup contains an embedded structure. For example, once the main tower is built, it is not possible to remove a disc from the lower levels without first removing the higher ones. Within this set of restrictions, there are numerous areas where improvisation can happen. Throughout the research project I varied the approach to performances between fully structured and fully improvised. One of the main ways to allow for improvisation was in the selection of records. A large pool of pattern discs can be combined in numerous ways. The peg records and ball-

bearing discs can be programmed with unique patterns each time. At two performances (Bexhill United FC on 8/7/23 and Birmingham Centrala on 29/9/23) I presented a selection of pattern discs to members of the audience to choose from for each section of the performance, resulting in unplanned combinations of rhythm triggers. Working in collaboration with DJ Food, the record selection was made during performance without a set plan, and resultant tracks were thus fully improvised (this collaboration is analysed further in Chapter 7). As Ingold explains, structure and improvisation (or 'planned action' and 'itineration', more specifically) are not necessarily mutually exclusive activities:

> 'In practice, planned action and itineration are not alternative procedures. The practitioner does not have to choose between one and the other, or to find some way to combine them. This is because directions do not, in themselves, tell practitioners what to do. A signpost means nothing until it is placed somewhere in the terrain. Likewise, every direction draws its meaning from its placement in a taskscape that is already familiar thanks to previous experience. Only when so placed does it indicate a trail that can practicably be followed. And to proceed from one direction marker to the next, practitioners have to find their way, attentively and responsively, but without further recourse to explicit instruction.' (Ingold 2001:137–8)

During the performance, despite a relatively fixed structure, and a performance I had rehearsed in full several times before the public show, the specific route from point to point remained flexible. Groove and combinations were built by ear and feel, durations between sections were not fixed, and the flow of actions could take place in multiple different ways to lead to 'correct' outcomes.

One of the main reasons for using the peg discs and ball-bearing discs is to avoid the restriction of pre-programmed patterns for use with the drum triggers and comb switch arrays. Such patterns are created on stage, and this becomes a type of improvisation. This live inscription is discussed further in Chapter 6. The choice of which drum sounds to use, how to tune them, and tuning and sound design of a modular synthesizer patch or the MIDI synth are also completely flexible and can be changed in an improvised way. My typical approach to the final mix is to balance it by ear according to the sound in the

space, again a reactive and responsive method which happens in real-time. An example of this happens at 20'30 when the cymbal percussion record from the Oscillator Turntable comes into the mix very loud, and I adjust the volume on the modular synthesizer shortly after. Upon introducing each element to the mix, the timing of rhythms and relationships happens through a process of improvisation. As each element is added, its start point, sound and level are fine-tuned so that it makes sense with the overall sound. Tweaking the combination of elements is a process of sculpting the groove. Danielsen discusses a parallel process in the way funk musicians work together:

> '…it would be better to call it optimisation than variation – optimisation of the different elements so that they become even more integrated and comfortable within the whole. This continuous optimisation is often described as "locking" or "nailing the rhythm." It is not a carefully considered process, and it never really ends; instead, it goes on automatically, continuously, manifesting in the form of better or worse periods of interaction.' (Danielsen 2018:42)

Within the performance, however planned the structure might be, the honing of the groove is always an improvised process. It comes about through exactly this process of optimisation: small adjustments to rhythms, relationships, tuning, filtering, effects, positioning.

One significant performance decision was new, not something I had used with the Mechanical Techno project before: working as a literal 'mobile operator', moving around the central table from station to station, making adjustments. Actively moving around the machine emphasises the attendant role. The motion produces a larger scale action-sound-coupling where my physical movements emphasise that each action is an intervention to the function of a larger, automated machine. The fact that I do not stay at one station for long demonstrates that my role is that of making adjustments rather than directly playing the music. My role as mobile operator was a type of play, embodying the codes of The Rules, and involved improvisation and optimisation throughout. My actions were in order to 'connect the concrete elements together according to their abstract relations' (Nail 2017:27). In some instances this is literally the case, for example at 22'32 where I remove the MIDI Comb switch array from the Slow Platter and

connect it to Turntable 2, enabling a new configuration. At 26'20 I spend a few seconds repatching the modular synthesizer to enable the drum triggers to play the 'donk' samples associated with the ping-pong balls: connecting elements together via patch cables. At other points the connections are less directly physical, making sonic connections between components through rhythm, tone and texture.

Tendency towards stasis and towards change

There are opposing tendencies within any assemblage towards both stasis, that is, towards slowing down, and towards change, by implication towards speeding up. Delanda notes the importance of variations in speed. '…assemblages are everywhere, multiplying in every direction, some more viscous and changing at slower speeds, some more fluid and impermanent, coming into being almost as fast as they disappear.' (2016:7) Considering the work itself—both as sounding sculpture and its sonic output—as an assemblage in constant flux, itself made up of arrangements of assemblages, I identified different timescales at which the work was changing. Through my actions in the performance and the design of the physical aspects of the system I aimed to provide a strong action-sound-coupling at each timescale it would be legible. The timescales are outlined in the following section.

The duration of the complete performance was approximately 45 minutes. Effectively there are three sections, connected fluidly together. First, a piece consisting of a 90bpm rhythm with acoustic percussion and organ tones, which peaks in both tower height and sonic content at about 12 minutes. Second, a piece with a modulated acid bassline and several layers of rhythmic elements which culminates in sounds triggered by ping-pong balls at around 27 minutes. And finally, a denser, heavier, rhythm focused electronic piece which peaks at around 42 minutes. These peaks are the points at which all elements of the system are engaged, I have assembled the sculpture, and the groove has found its consistency. The timescale between these peaks is between 12 and 15 minutes.

Scale	Timescale	Frequency	Actions
Performance	45 minutes		Duration of the complete performance
Arrangement speed	12 – 15 minutes		Assembling sculpture towards musical peak
Operator adjustment speed	1 – 2 minutes		Walking one cycle of the table, making adjustments
Slow platter speed	15 – 25 seconds		Triggering sounds via MIDI, or changing pitch or frequency cutoff via CV
Standard turntable speed	1.3 – 1.5 seconds	33 1/3 – 45 RPM	One cycle rhythm loop, one bar of music
Oscillator turntable speed	1 - 5 seconds	10 – 50 RPM 0.16 – 0.83 Hz	One loop of record containing audio recording
Audio rate	0.05 seconds to millisecond range	20 – 20,000 Hz	
Arduino clock rate	Microsecond range	Up to MHz range	

Table 4.3: Performance timescales

The standard unit of time within the work is derived from the rotation of the turntable itself. This sets the tempo of each piece and restricts the duration of any looping element. The two main turntables were run mostly at 33 1/3 RPM during the performance, with some sections at 45 RPM in the first part. In the second section, Turntable 2 is set to 45 RPM minus approximately 1.25% in order to sync a three-beat pattern against the four-beat pattern on the Turntable 1. The timescale for a single cycle of the turntable at the standard settings is either 1.3 seconds (at 45 RPM) or 1.5 seconds (at 33 1/3 RPM). Applying the same principle to aspects of the performance at different scales gave a taxonomy of speeds and timescales, ranging from the duration of the entire performance to the clock speed of the processor in the digital modules, as illustrated in Table 4.3. Identifying the different speeds at which the different elements

of the assemblage function demonstrates a parity between the concept of nested assemblages and nested cycles at play within the work. Assemblage (as a verb) happens in a nested way too, from cycles of code occurring every few milliseconds, through the rotation of the turntable, to the cyclical nature of the whole performance within a programmed calendar of performance events.

Deterritorialization and reterritorialization

Territorialization of an assemblage is 'the degree to which the components have been subject to a process of homogenisation, and the extent to which its defining boundaries have been delineated and made impermeable' (DeLanda 2016:3). In DeLanda's adapted concept of assemblage, territorialization is a parameter which can be anywhere on a spectrum from complete territorialization (homogenous components and strictly defined boundaries), to totally deterritorialized (diverse components and fuzzy, indistinct boundaries). Because all assemblages have a tendency towards stratification (as well as towards change) any deterritorialization tends towards a reterritorialization: boundaries which become loose will generally coagulate into new formations—potentially new assemblages. In planning the Sheffield performance, I considered the process of de/reterritorialization in relation to both the physical-sculptural aspect of the setup and the sonic output from the machine. Through the intentional prioritisation of action-sound-coupling, the two aspects were intrinsically linked. The Mechanical Techno machine is a visual representation of the music—a diagram of itself.

Part of the design process was the inclusion of multiple different types of components, connection possibilities and sound sources. This is reflected in two of the rules: 'An abundance of types of signal flow and component interaction' and 'Non-hierarchy of sound sources'—heterogeneity is built into the design itself: my attempt to create a deterritorialized assemblage. The design choices follow through to the sonic output of the system, with diverse combinations of sounds including record crackle, acoustic percussion, electronic drum sounds, subtractive synthesis, a commercial digital synth voice, and the sound of the machine itself. The boundaries of the system change throughout the performance, as each of the extended turntables which comprise it are

built, unbuilt and reconfigured several times. The assemblage changes form throughout. Similarly, the resulting sonic output varies over time at different speeds, as discussed above. Physically and sonically the assemblage is deterritorialized and reterritorialized several times throughout the performance: its boundaries change in consistency over time. In describing the forms of improvisation used by producers and DJs in their performance, Butler uses the chapter title 'Making It up and Breaking It Down' (Butler 2014:113). The phrase alludes to the type of live arrangement, live song-structuring, that happens in such musicking. In the Mechanical Techno performance, making up and breaking down happen in both the physical and sonic realms. Expanding the height of the sculpture and adding to the musical composition is a kind of claiming territory: filling physical and sonic space. The frequency spectrum becomes de- and re-territorialized throughout the performance.

Assemblage as both noun and verb

Key to the consideration of the concept of assemblage was ensuring it was applied both to the combination of elements (the assemblage itself) and actively as a verb (the process of assemblage). The performance in Sheffield began with all elements visible on the central table. The process of assembling the machine each time—totalling three full builds—drew from the things already collected. The parts which are laid out on the table but not yet in use are still a productive part of the assemblage. Though they may be inactive in directly producing sound, their presence indicates their potential use later in the performance. The music, and sculptural construction which produces it, emerges from the collection of items presented from the outset of the performance. And as each section of the performance develops, it is contingent on the layout immediately previous to it. The Mechanical Techno performance works as a live assemblage through its continually changing shape, the re-arrangement and fitting-together of its diverse constituent components. Each configuration converges on a groove, the sonic assemblage thickening in consistency as more elements are combined. The process of 'making it up and breaking it down' (Butler 2014:113) is a real-time demonstration of assemblage in action. Mechanical Techno is indeed a 'process of composition'—as opposed to 'compilation', as Buchannan insists is necessary (2017:458)— creating new sculptural configurations and musical collages in real-time.

Single-cycle-loop music

As an assemblage, the mechanical techno system, and ultimately the music it makes, is built from numerous overlapping and interconnected single-cycle-loops. Ultimately, this distinguishes the practice from most other forms of turntable practice. Typically when single-cycle-loops are deployed by turntable artists it is as a small element of a broader practice which either prioritises continuous playback or individual sound production. In typical dance music DJ practice using vinyl, long sections of each track are played, with overlap between the tracks 'in the mix' producing new juxtapositions of sounds. Occasionally single-cycle-loops are used, and there is indeed a market for such locked-groove records both as DJ tools and artist's releases. It is rare and something of a novelty, however, for a DJ set to comprise only or mostly of locked grooves. I staged a performance using this concept in a hybrid DJ set at the beginning of this project, in February 2023. An artist who regularly uses this approach is DJ Food, with whom I collaborated for the project (see Chapter 7). Shorter timescale manipulation of the turntable is the typical domain of the scratch DJ or turntablist, employing various techniques to manually produce individual sounds or short phrases from vinyl. Often a scratch DJ will manipulate the record on the platter with one hand, affecting playback speed and direction, whilst operating the mixer controls with the other hand, giving access to the volume level (that is, the amplitude envelope) and EQ controls. This turns the turntable into a direct playing instrument as opposed to an automated playback device. Skill in fast and precise manipulation of these two sets of parameters gives rise to diverse turntablist techniques. A number of artists within experimental turntable practice employ similar approaches, sometimes directly referencing scratch DJ practice (such as Mariam Rezaei and DJ Sniff) and sometimes framed as a different but parallel tactile sound-making approach (such as Maria Chávez or Joke Lanz). Typical analysis of turntable practice has focused on these two approaches—continuous mixing or instrumental playing—which can be seen as poles on a spectrum. For example, some current dance music mixing DJs will incorporate scratching into their sets, such as Eris Drew and Jerome Hill. Beat juggling is a core skill of scratch DJs, developing from the initial driving force of hip-hop DJs to extend the break by replaying short sections back-to-back. This technique sits somewhere in the

middle of the spectrum, combining quick dextrous skill with the combination of sections to two records into a continuous contiguous piece. Use of locked grooves as single-cycle-loops is typically missed out of this broad analysis.

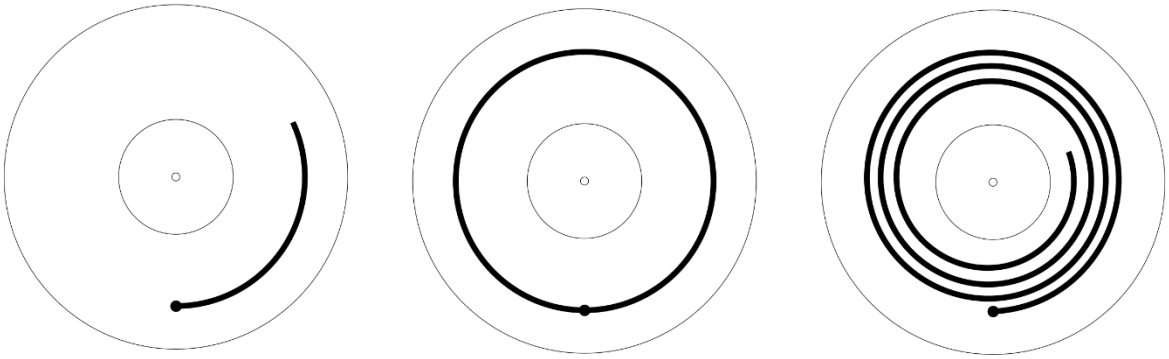

Figure 4.4: Individual sound playback, single-cycle-loop, continuous playback

Locked groove loops are not a new invention, having been one of the building blocks used by Pierre Schaeffer in the earliest musique concrète compositions (Baumgärtel 2023:35). Hip-hop and scratch DJs sometimes made use of stickers with raised corners to nudge the needle into a repeated groove. In the experimental field, Maria Chávez has discussed playing DJ sets comprising only of the run-out grooves of records (2012:38-29), Christian Marclay has used forced-locked-grooves in performances (Gordon et al 2005:110), and Thomas Brinkmann released an album of compositions made from looping clicks and pops made by cutting patterns into runout grooves (Brinkmann 1999). I would argue that, before now, the use of single-cycle-loops has not been recognised as its own field of practice within turntablism. By The Rules of Mechanical Techno excluding both the use of continuous playback ('no backing tracks') and individual sound production ('no playing by me') the project focuses in on the single-cycle-loop as its core element. Working with an automatic machine formed of single-cycle-loops is also a fundamentally different mode of performance than either instrumental playing or working with linear playback. As an attendant to the system, tasks include setting processes in motion, tending to spinning plates, making minor adjustments, live troubleshooting, and setting the pace by working at a higher

arrangement level. As an attendant the work is that of the live composer, but also as a component within the assemblage which has its own momentums and inertias.

Machine liveness

The sense in which a performance is 'live' can be difficult to conceptualise when elements of the music-making process are automated and certain audio which is produced is from a recording. 'After all, performing on an instrument is based on the continuous *inter*action between the human body and the instrument.' [original emphasis] (Jensenius 2023:xvi) At times in performances where automation plays a significant role (which includes DJ sets and live coding performances as well as Mechanical Techno) the interaction between the player's body and the instrument may be minimal, confusing the definition.

In a controversial blog post by the DJ end electronic musician Deadmaus in 2013, the artist discusses their spectacular live show and the extent to which it is largely pre-recorded. The stadium-scale performance features a synchronised lightshow and pyrotechnics with the artist having minimal control over the audio output aside from performative filter sweeps and hyping up the crowd. Parkinson and Bell's 2015 paper for NIME analyses the performance in terms of its liveness, contrasting it to the non-idiomatic improvisation of guitarist Derek Bailey, in order to unpick how live coding practice may sit somewhere inside a continuum defined by these two poles. The key element for the authors is that live coding, like Bailey and unlike Deadmaus, 'reveals the compositional labour to the audience.' (Parkinson and Bell 2015:176) My own analysis of liveness with an automated system broadens the authors' understanding. While I agree that Bailey and Deadmaus can be placed at opposing ends of a spectrum, I argue that there is another dimension at play here, and that the understanding of liveness can be broken into two separate spectra which interact. The two continuums are: machine playback versus human playing; and pre-composed versus improvised.

As discussed in Chapter 1, all musical instruments can be considered on a spectrum between wholly human controlled and wholly mechanical: this was proposed by Bartók in 1937 at the height of the popularity of mechanical music. It is clear that Bailey and Deadmaus reside at opposite ends of this spectrum. Bailey's sound making is almost

entirely from direct 'excitation actions' (Jensenius 2022:73), Deadmaus's set uses none of these. But the argument for live coding (and other music made with machines, including Mechanical Techno) would also place the practice much closer to the automated end, that is, apparently less 'live'. For this reason, the second continuum is helpful, offering a distinction between music which is pre-composed as opposed to improvised. In tabletop roleplay games, two methods of planning are referred to as the railroad and the sandbox. Players on the railroad are on a single track with no option for deviation, whilst those in the sandbox have complete free play and no imposed direction. The distinction can be made considering the capacity the players have for choosing their own path. Often games are designed with a balance between the two styles. The analogous opposition in musical liveness, then, is not necessarily between two types of text as composed and improvised, but between two processes: pre-composition which has already happened, and improvisation which happens at the time of performance. The difference relates to the potential for deviation, and in any instance this is governed as much by the codes of the genre and audience expectations as it is the artists' wishes.

With the examples of musical performance given above, Bailey and Deadmaus once again sit at opposite ends of the spectrum. Bailey's live performance is completely unplanned, exploratory and free-roaming. The only constraints are the total time of the performance and the expectations of the style of playing (that is, external codes which may be more or less unspoken). In contrast, the Deadmaus performance is to a large degree pre-recorded and, though minor changes to the sound and opportunities for solos or showboating may be included, the track order, duration, pacing and structure are completely inflexible. It is on this spectrum that the distinction between an improvised live coded performance and a Deadmaus concert is made clear, as the live coder, like Bailey, has free choice to roam around the map at will. In contrast, whilst in a classical concert none of the music is automated, with every note activated by a human player (albeit with some mechanical assistance such as piano keys), the score is highly restrictive allowing only the smallest amount of deviation in terms of playing style.

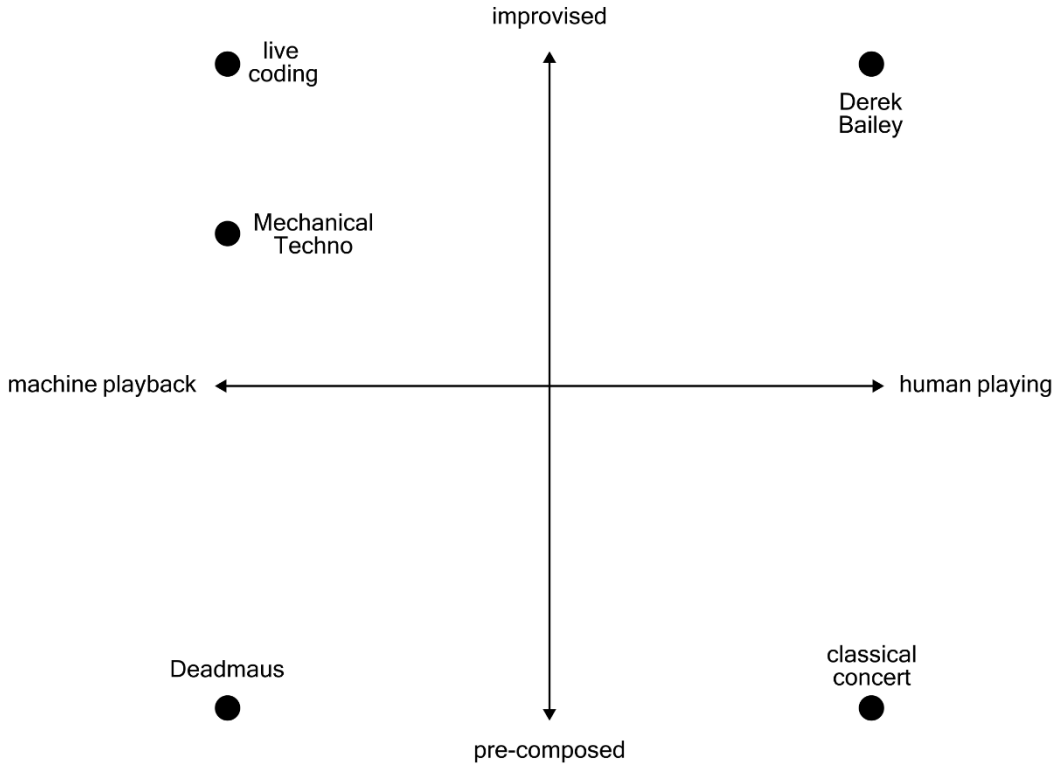

Figure 4.5: Liveness spectra

Figure 4.5 shows the two spectra on an X-Y chart, and how I understand the artists mentioned here sitting on the graph. The Sheffield performance had a planned trajectory, but offered opportunities for improvisation relating to pacing, the specific way in which components were combined, and the balance of sounds in the mix. As such, though the overall structure was set, the capacity for deviation from the path was still high.

Mechanical Techno expresses its liveness through the visible action-sound-coupling of the devices at play, the capacity for changing the plan, and the high chance of error, breakdown or malfunction from the physical-mechanical elements. This latter factor can lead to a sense of agency ascribed to the machine, a potentially uncanny sensation. 'Musical instruments are extensions of our bodies; they become part of our bodily organs, as etymology teaches us. Machines can be instruments too, but they have traditionally been separate from our bodies: their power derives from elsewhere, as if by magic.' (Magnusson 2019:110) Because Mechanical Techno works as a live assemblage, where the processes of musicking happen in real-time and in full view of the audience,

there is the capacity for the machine to produce a sense of curiosity, wonder or enchantment. In a recent article about an innovative design for a sewage treatment works, a journalist described the interior of the building as follows: ‘There’s a seeing-how-things-work fascination to the place, as in cutaway drawings of machines in a children’s book.’ (Moore 2025) A Mechanical Techno performance works in this way, exposing the processes which activate the assemblage. Seeing-how-things-work fascination is something of a paradox. By making every process visible and exposed, the mystery of the machine is stripped away. Demystifying the machine risks making it mundane or obvious, solving the puzzle so leaving nothing to be curious about. But exposing the process enables a sense of fascination in spite of the clarity. Sangild notes a parallel phenomenon arising from the use of the glitch in music: ‘The conceptual and the sensuous are intertwined. The deconstructive disenchantment of technology becomes at the same time an aesthetic reenchantment.’ (Sangild 2013:268) The ramshackle construction and inaccurate mechanisms of Mechanical Techno also embody a typical glitch format, which enhances the effect. ‘A glitch is a minor malfunction or spurious signal, often related to a system or electronic device. It is not a collapse of the machinery. The machinery is still running, but the performance is poor - either annoying, problematic, or downright useless.’ (Sangild 2013:258) The inherent glitchiness further signals the precarious liveness of the assemblage, the ever-present risk of failure or breakdown which fuels the sense of plate-spinning precarity. The Mechanical Techno live performance shows how these elements and affordances come into being through the process itself. Semmerling et al identified three factors which lead to a sense of fascination, able to be seen in both historic mechanical musical instruments and some modern kinetic sounding sculptures: the ‘magical invisible’, marvel at the complexity of the machine, and the philosophical dimension of such projects (2018:239). Historically, automata were often deliberately designed to hide their internal machinery, specifically to engender a theatrical sense of wonder at their apparently impossible actions. Conversely, where mechanisms were visible, the craft and ingenuity employed was designed to generate wonder: ‘Here fascination is triggered by the complexity of the mechanisms as well as the competences and skills of those who construct them.’ (ibid) Finally, the existence of the automated machines themselves brought up questions around human and machine agency, the nature of

performance and other philosophical and aesthetic concerns which might not have previously been conceived of. Though Mechanical Techno aims to make visible the processes at play, which would in theory exclude the first of these three factors, there are always certain aspects which are not possible to discern. Sometimes this is due to the subtle movements, such as the vibration of the stylus, sometimes due to necessary 'in-the-box' processes such as conversion of signal types. Here the project comes up against one of the boundaries of the aim to avoid 'black box' processes. At a certain scale a decision has to be made for the processing to happen out of sight and not be exposed. An example would be the coding of the Arduinos in the various modules. Whilst the units are designed to work with analogue controls and as part of an analogue Eurorack modular system, the internal processes happen digitally and seamlessly inside the box. In part this is due to scale and the impossibility of visibility. Physical-mechanical processes are innately easier to see with the naked eye. Where possible, however, the complexity of the physical mechanisms is demonstrated throughout the performance, and the precarity of the system's actions can contribute to this. Finally, Mechanical techno seen as an assemblage—including the material components, codes and conditions, and myself as agent—is a manifestation of the blurred boundaries between performer and instrument, operator and machine, and imagined and real agency.

Conclusion

By considering the extended turntable as a live assemblage formed of components, conditions and agents, new affordances of the system were investigated. The liveness of the assemblage is enabled by the constituent parts and the ways in which they interact. Individual components afford specific options for interaction and modes of performance. The codes embedded within the devices offer bottom-up influence on the assemblage; the codes explicitly implemented (such as the those laid down by The Rules) and implicitly applied (such as genre expectations) apply top-down forces which also temper and shape the assemblage. Consideration of the cyclical aspects of the project at different timescales reframes it as a different mode of turntable performance. Working with the assemblage as a mutable, flexible system generates a specific sense of liveness through the exposure of processes. In doing so, the system no longer

functions as a black box, ‘made invisible by its own success’ (Latour 2000:304), though there are technical limits after which such exposure is not possible. Through both its exposed processes and its visible failures and points of breakdown, Mechanical Techno expresses itself as a live assemblage. Mechanical Techno is effective when used for live performance, but also produces new possibilities in a studio recording context. The following chapter analyses these possibilities.

Chapter 5. Instrument-system as Physical Audio Workstation

Introduction

This chapter discusses the use of the Mechanical Techno system for creating fixed pieces of recorded music. Four tracks are presented here as a selection of a larger number which were produced through this research project. Composing fixed, recorded music with the system questions the prioritisation of the visual aspect of the work. To address this, the chapter discusses how the process and the machine's character can be communicated through audible clues and broader contextual signifiers. Mechanical Techno in the studio is proposed as a 'physical audio workstation', sharing similarities to software music production environments but with a deliberately awkward and frustrating workflow. This approach is contrasted to recent trends in commercial A.I. developments, and finally compared to other alternative electronic music systems which share a similar ethos.

Music production as a research method

Working with the Mechanical Techno system for creating pieces of recorded music is a key aspect of the project. As discussed in Chapter 3, most research activities happen concurrently: recording sessions are usually interspersed between prototyping, making and live performance. Testing a new instrument build or a rehearsal for a show may turn into a recording session. Often, new functionality of a component is discovered during studio work and fed back into the research. A studio session acts as research and development as much as it creates outputs (fixed pieces of music). In total, fifteen recording sessions were undertaken during the research project, distributed throughout (see the timeline in appendix A). Not all of the mixes captured in these sessions were deemed suitable for release and, as will be discussed below, the selection of pieces for a specific release or function is an important part of the composition process. An album titled *Quern* comprising of twelve tracks is due for release on cassette and download by Brooklyn based label Jollies Records in 2026. Four of those pieces are included here.

Composition portfolio

My suggestion to the reader is to listen to the compositions at this stage before continuing on to the discussion that follows. Each of the pieces is referred to by title and elapsed time where relevant. A written description of each of the tracks is included in Appendix B, providing more detail on the sound sources and techniques used.

The four compositions discussed in the chapter are:

5.1	Chronic Data Poisoning	(4'16)
5.2	Tentacle Motion Study	(5'29)
5.3	Suboptimal Beats	(3'14)
5.4	Perpetuum Mobile	(3'02)

Composition process

Just as assemblage is a live and ongoing activity, according to Small, music is best understood as a verb: 'To music is to take part, in any capacity, in a musical performance, whether by performing, by listening, by rehearsing or practicing, by providing material for a performance (what is called composing), or by dancing.' (1998:9) Jensenius draws from Small's conceptualisation in order to discuss the various roles which musickers take on, and that these activities can happen both in 'real time' and 'out of time' (Jensenius 2022:21)[1]. The 'musicking quadrant' (ibid) identifies four groups of roles, categorising them on two axes: whether they relate to the creation or experience of music, and whether they occur out-of-time or in real-time. The 'perceiver' covers audience members at a concert and home listeners, but is also a role a musician may embody during performance—listening to their own work and that of others to inform their playing. To be a perceiver is to engage in a real-time activity. The out-of-time experiencing counterpart is the 'analyst': one who experiences music outside of its moment of creation in order to, for example, write a review of a concert. A musician (or 'performer', in Jensenius' terminology) is involved in creation in real-time. The

[1] Jensenius uses the terms 'real time'/'real-time' and 'out of time'/'out-of-time' at different points in the text. For consistency I have used 'real-time' and 'out-of-time' throughout.

counterpart for out-of-time creating activity would include ‘instrument maker’, ‘composer’ and ‘producer’ (ibid). The Mechanical Techno composition process incorporates activities which take place before, during and after the studio recording session. Figure 5.1 gives an overview of some of the work involved in a typical session, in a roughly chronological order.

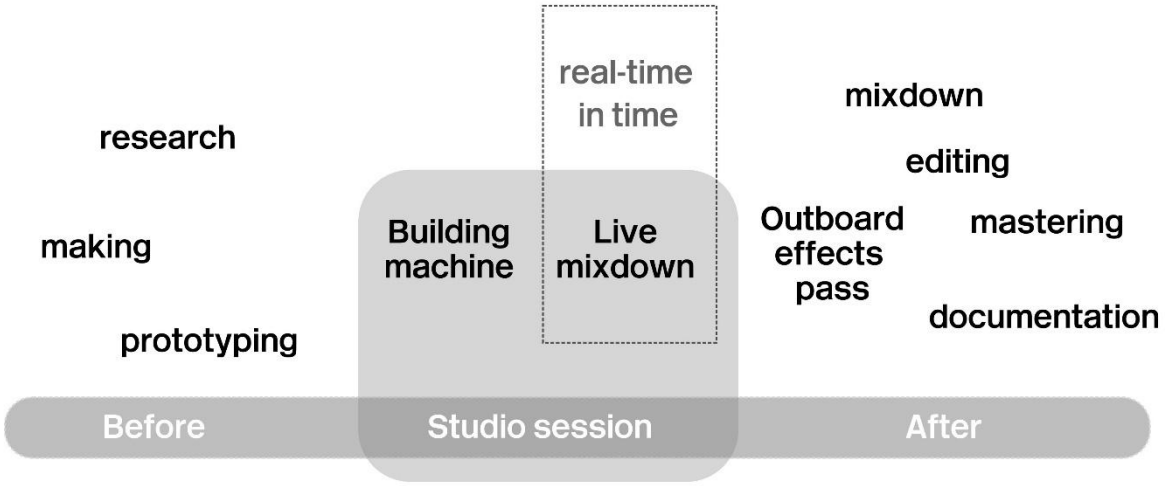

Figure 5.1: Timeline of work for a typical recording session

Before recording, the various processes include designing, prototyping, making and testing new interfacing and processing devices; sourcing records to sample from, or recording sounds to cut to dubplates; preparing new pattern disks, designing, cutting and attaching the labels to records; and selecting, testing and configuring other hardware devices such as synthesizers and sound modules. Preparing new fixed-inscription records is a process of creating score-fragments for future use in recordings and compositions (as shown in image 5.2). Creating these records is an ongoing process. As they are generally made in batches (due, for example, to booking the plotter-cutter, or placing an order for several dubplates together), new records were made throughout the research project: in between rehearsals, recording sessions and performances. The recording session itself is a two-stage process. First, a new configuration of the assemblage is built. Elements are added and balanced until a groove is established and the full piece is playing back automatically. The second stage is to perform a live, improvised mixdown of the elements, creating the structure of the

track in real-time. Each of these processes will be analysed in more detail in the following section.

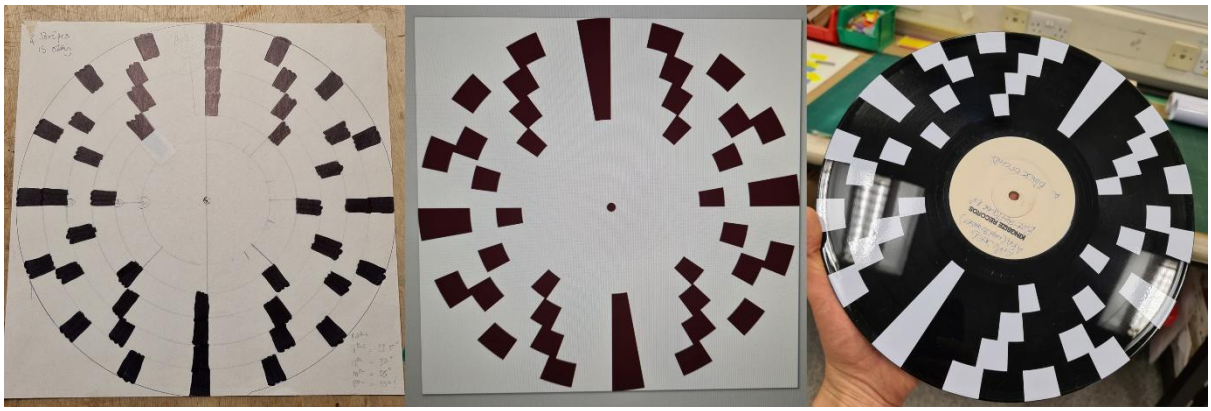

Image 5.2: Making a pattern disc: hand drawn design, computer drawn design, complete disc with stickers attached.

In the often-cited 1979 lecture *The Recording Studio as Compositional Tool*, Brian Eno portrayed his own process as additive, analogous to adding layers of paint to a canvas: 'in-studio composition, where you no longer come to the studio with a conception of the finished piece... You can begin to think in terms of putting something on, trying this on top of it, and so on, then taking some of the original things off, or taking a mixture of things off, and seeing what you're left with—actually constructing a piece in the studio.' (Eno 2004:187) This additive approach is contrasted with dub remixing techniques: 'These are better understood as a subtractive process, where the tracks recorded on a multi- track tape represent "a kind of cube of music, [that] is hacked away at – things are taken out, for long periods."' (Albiez & Dockwray 2016:149) While I find the analogies compelling to a degree, the way they relate to time is somewhat more complicated. Live performance features in both the additive and subtractive forms of studio work, and this is inherently time-based. In the first this would likely be instrumental playing, and in the latter, a different kind of performance at the arrangement level, perhaps more like a conductor or bandleader than an instrumentalist. Nevertheless, there are parallels in my own studio practice, comprising the two-stage process.

After the recording session, several processes take the raw recordings to a finished state. There is often a gap of several weeks or months in between capturing the recording and moving to this stage: I prefer to hear recordings from a new perspective and start the process afresh, as a way to reappraise the compositions. Depending on

how the performance was captured, some amount of mixing and sound shaping will be required. Some sessions are multitracked and have groups of instruments on separate channels in the DAW. Effects such as equalisation and compression may be applied. In some cases, audio is sent out to external effects such as spring reverb tanks, digital reverb and delay, to add stereo variation (the 'outboard effects pass' labelled in Figure 5.1). In order to maintain the integrity of the performed aspect of the recording, no live playing or tweaking of effects parameters is included at this stage: the process is more akin to re-amping than an overdub. Some sessions are recorded quickly to stereo, in which case there are fewer options to effect the individual sounds. In this case, some equalisation and dynamics may be applied to the whole mix. A set of master bus effects will be added to all recordings, typically compression, equalisation, stereo widening and sometimes a harmonic exciter. Whilst not a formal mastering stage, these effects serve the purpose of colouring the tone, emphasising texture, drawing the sounds together and enhancing percussive dynamics. Editing is kept to a minimum but is an important part of the recording process. Wherever possible, only a 'top and tail' edit is used, framing the piece by selecting its start and end points. On rare occasions, a few bars may be edited out or two sections of a session spliced together. Typically this is only if a section is overly repetitive without significant variation. Edits are made 'vertically' rather than selectively, cutting through all tracks at once. Effort is made to keep the consistency of the piece, removing redundant material rather than introducing dynamic changes. The recording process generally follows the same restrictions dictated by The Rules set out in Chapter 4. One of the most restrictive implications is that only one live (real-time) performance pass is allowed; that is, no overdubs are permitted. Though not explicitly stated in The Rules, allowing overdubs would be like using a backing track, would break the legibility of action-sound-coupling, and would begin to favour my own playing over that of the machine. So, although The Rules were developed with a focus on live performance, they also guide decision making in a studio context. A final stage of the process is in selection of tracks for a specific purpose. Curating the selection into a format for the intended release—for example, an album or an EP—and determining track order and flow are part of this process. Selecting track titles is also an important task in completing the pieces.

The two-stage process

Mechanical Techno began as a studio only project (as it seemed as though the setup would always be too cumbersome to transport to perform live) and was always developed to work in two stages: building an automated machine, and performing a live dub mixdown. Music by the Metre was a precursor project, which I began in 2012. The format was based on Situationist International artist Giuseppe Pinot Gallizio's concept of 'Industrial Painting.' The artist set out to automatically make abstract paintings on rolls of paper, to be sold by the metre in order to destabilise markets, as he notes in the 1959 manifesto: 'Perhaps the machine is the only instrument qualified to create art that is inflationary and industrial and therefore based on the Anti-patent'. (Pinot Gallizio 2005:171) A contemporary newspaper article describes the machine in use: 'Seen from up close, it consists of a series of intertwined pulleys moved by a small two-stroke engine. A long roll of paper unwinds and shuddering tubes automatically spatter ink spots. A knife cuts the finished product into pieces, all in a chaotic and sputtering circular movement.' (Jean François Chabrun, L'Express, October 8, 1959, quoted in Bertolino et al 2005:171) My project was intended as an audio homage to Pinot Gallizio's method, creating an automatic machine to produce abstract music, which I then distributed on audio tape by the metre (Image 5.3). The machine itself was an assemblage of multilayered phasing loops and stochastic processes running simultaneously: Record players, tapes, synthesizers, effects units and often a live microphone capturing local environmental sound. The resulting sonic output was a multilayered, constantly changing collage of rhythm, drone and texture.

Image 5.3: Tape spools sold by the metre, and the assemblage producing the sound. Supernormal Festival 2014.

In 2013 I played a number of improvised performances using the output from the machine recorded to four-track cassette, mixed down live with some external effects processing. Mechanical Techno subsequently developed from experiments during a workshop I ran at my studio in November 2013 (Dunning 2013) during which I played a crackling record loop through the trigger input of an analogue synthesizer, creating something like a monophonic acid bassline. Recognising that the addition of a four-four bass-drum would make the beginnings of a recognisable acid techno loop, I began working towards that aim. The project developed technically and aesthetically through further studio experiments (see Weissenbrunner 2017 for a good overview of the early stages of the project). Building the early versions of the Mechanical Techno machine drew on techniques from Music by the Metre, the key structural difference being synchrony of rhythmic elements. The first studio recordings followed the format of the live version of Music by the Metre: effectively a live dub mixdown. The same two-stage process remains using Mechanical Techno in the studio. The stages are further analysed in the following sections.

Building the machine

In its purest form, creating a machine which self-plays is a type of process music. Steve Reich's 1969 manifesto states: 'The distinctive thing about musical processes is that they determine all the note-to-note (sound-to-sound) details and the overall form simultaneously.' (Reich 2004:431) An automatic music machine will run according to its construction until some intervention stops or changes it—unless designed to stop itself, like Yves Tinguely's 1960 self-destructing installation *Homage to New York* (Tinguely et al 2016:71). Reich's use of phased repetition both in tape pieces and later works for percussion rely on a predetermined algorithm—dictated either by the mechanisms of the tape players or musicians following a pre-written score—and thus do not allow for intervention, deviation or improvisation. The process works as an algorithm, the execution of which produces the music. Building a groove with Mechanical Techno is the process of physically creating a set of instructions from which the music is produced. Constructing the assemblage is a process of arranging components into a working musicking machine, in a step-by-step process (Image 5.4). The process involves constant evaluation, adjustment and heuristic processes to find something

that works. Like Eno, I do not 'come to the studio with a conception of the finished piece' (2004:187). I never have more than a rough plan of what kind of shape the composition might take. The process is one of piecing it together, dependent on how the whole sounds at any given moment, and what elements might work next. That is to say, building the machine is an improvised activity, following a similar cyclical process to that depicted by MacDonald and Wilson's model (2020:78). I think of the build towards an automatic piece as one of optimisation, similar to a funk band 'locking in' to the groove of a track. Danielsen's description of optimisation is again relevant here: 'It is not a carefully considered process, and it never really ends; instead, it goes on automatically, continuously, manifesting in the form of better or worse periods of interaction.' (Danielsen 2018:41) The evaluation stage in the cycle depends on physical-structural factors, technical connections and, ultimately, the developing aesthetics of the piece. This way of building and optimising the machine also fits Ingold's notion of non-hylomorphic making: working with materials, following the flow of the process, and shaping the emergent outcome as it happens. 'To improvise is to follow the ways of the world, as they open up, rather than to recover a chain of connections, from an end-point to a starting-point, on a route already travelled.' (Ingold 2010:97) Ultimately, whilst the build stage of my process happens out-of-time (in relation to the musical recording), the process itself happens as a step-by-step, improvised and contingent set of actions.

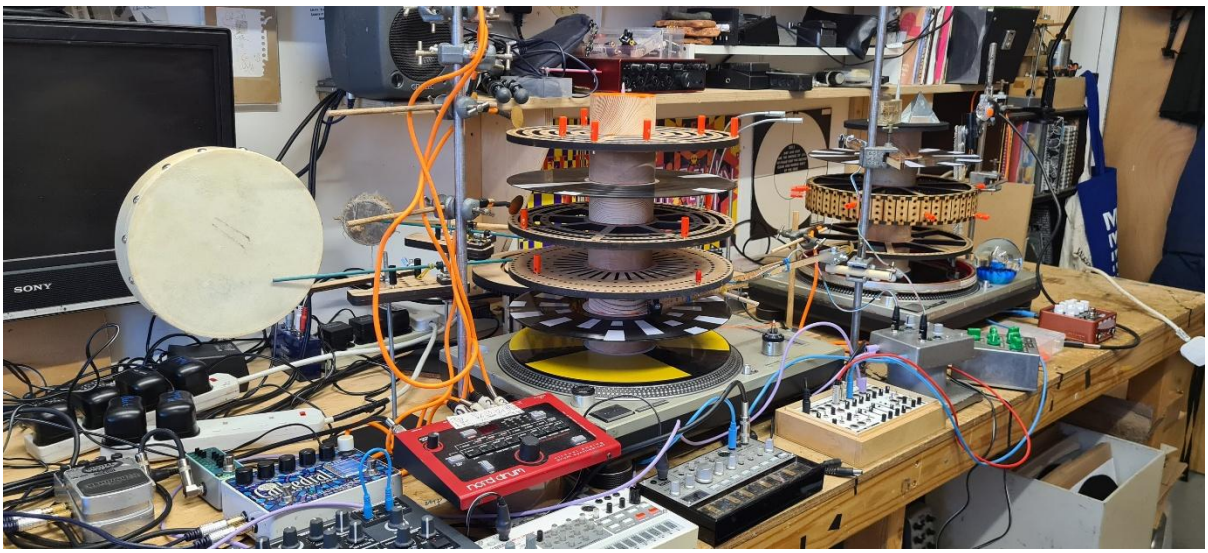

Image 5.4: Mechanical Techno studio setup.

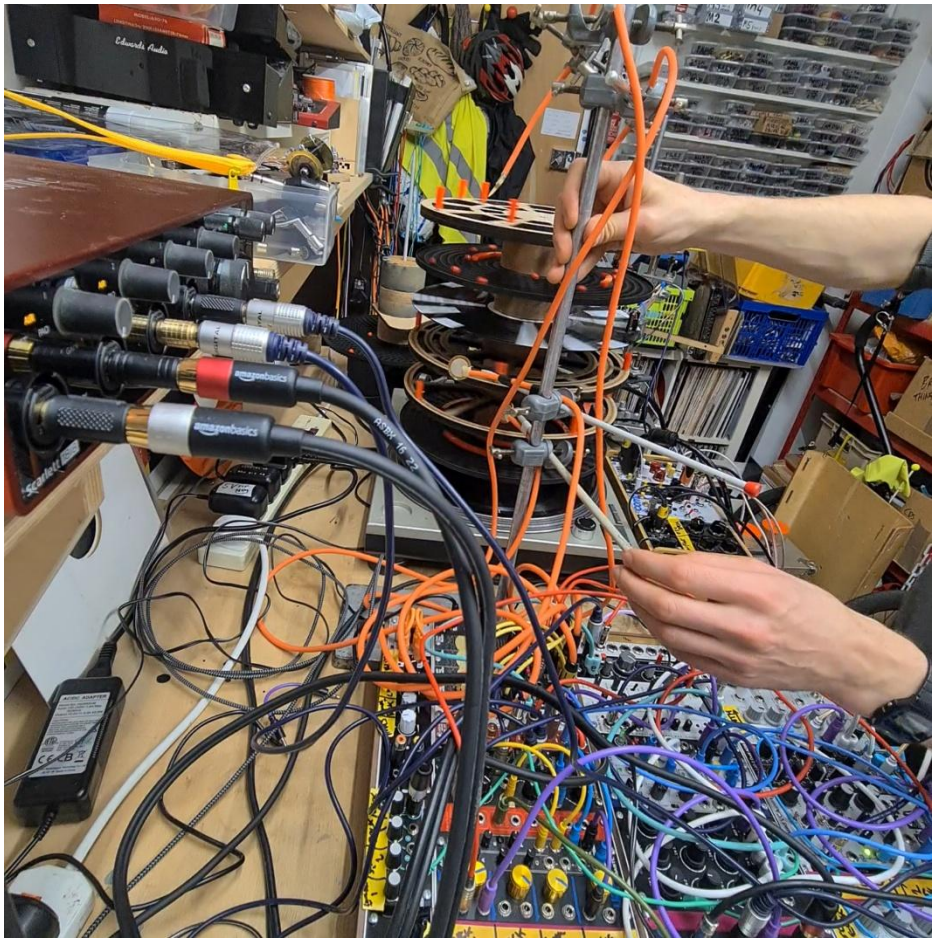

Image 5.5: Playing by hand in a studio session.

Live mixdown

The second stage in Mechanical Techno recording directly borrows the process of the dub mixdown from the Jamaican producers who invented it. For each recording, the machine is left to run, and I make adjustments to different parameters over time to shape the output into a final fixed piece (Image 5.5). A dub mixdown is another improvised process, one which paradoxically happens in real-time but using pre-recorded material. Dub production pioneer King Tubby set the standard in the kind of subtractive process described by Eno. “Tubby fixes his improvisations in the form of records, and he draws on a number of structural, spatial, rhythmic and timbral techniques to stamp his identity on each version.’’ (Williams 2012:245) The concept of fixing an improvisation in this way—often in a unique version, a single dubplate for each mixdown— is a sort of performance-to-tape which carries a specific sense of liveness. This is despite the paradox of the source material being pre-recorded, derived from instrumentalists playing live but captured onto magnetic tape. The dub mixdown is a

collaboration between musician and machine, recording and real-time performance, forming a musicking assemblage. ‘What made dub unique in the context of pop music both in Jamaica and worldwide was the creative and unconventional use recording engineers made of their equipment.’ (Veal 2013:64) Such innovation enabled dub producers to create a new musical language, one that ‘relied as much on texture, timbre and soundspace, as it did on the traditional musical parameters of pitch, melody and rhythm.’ (ibid) According to Veal the most important contribution of dub is the concept of the version, the deconstructive remix of the main single, typically released on the B-side of the 45: ‘the remix engineer draws on various strategies to manipulate the listener's anticipation of musical events, and defamiliarize the vocal song on the A-side.’ (ibid) Dub disrupts ideas about liveness in recorded music in a unique way, and differs from the studio techniques typically used in rock music production. ‘Rockism could be defined as the quest to eliminate surface noise, to “return” to a presence which, needless to say, was never there in the first place.’ (Fisher 2013:49) Fisher is referring here to the additive studio process of building compositions through overdubbed takes, each practised to perfection and recorded as cleanly as possible, a trend which arguably led to the ‘digital perfectionism’ (Strachan 2017:151) prevalent in much music today. In opposition to this, dub combines two instances of live performance, happening on two distinct timelines, into a new work. Initially the first is played by live musicians. Whilst not typically improvised, being based on structured songs, the playing itself is live. Though necessarily multitracked (to enable the dub mixdown to be made), they are usually recorded as part of a single live session, not made of multiple discontinuous takes. Dub melds two instances of liveness from different timelines within each version produced, embodying the type of dyschronia which Fisher identifies as radical in hauntological and Afro-futurist musics: ‘We hear that time is out of joint.’ (2013:48) Mechanical Techno borrows the dub mixdown approach to create a fixed recorded piece from the live running machine.

The dichotomy of liveness in recording

Both Eno’s description of the additive and subtractive approaches to in-studio composition and Fisher’s identification of dyschronia as a trend in more contemporary music point to the complexities in the way liveness is related to recording. Common to

both is the role technology plays in the mediation of sound from source to tape, and this varies greatly by genre. 'In classical music, folk and jazz, the recording medium has traditionally had a documentary function, in that its main purpose has been to capture a given live performance. Popular music, on the other hand has been virtually determined by technological mediation.' (Brøvig-Hanssen & Danielsen 2016:3) Though the performance itself may or may not have happened live, the fact of recording itself requires mediation. Mediation has in fact been present since the birth of recorded sound, as Feaster identifies, with early studio recordings often orchestrated in such a way that the quieter instruments could be heard over louder ones by proximity to the recording horn. This type of mediation is described as "'performing for the machine," emphasizing ways in which the recorded enactment is itself adapted to the medium' (Feaster 2007:40). Any recording made in a studio is likely to be more mediated than may initially be apparent. There is always a signal chain often including microphones, preamplifiers, a mixing desk, equalizers, compressors and more. 'The word "record" is misleading. Only live recordings record an event; studio recordings, which are the great majority, record nothing. Pieced together from bits of actual events, they construct an ideal event. They are like the composite photograph of a minotaur.' (Eisenberg 2005:87) Though a certain proportion of recordings purport to document live recordings, these may themselves be fabrications, an example being the first disc of James Brown's 1970 album *Sex Machine*, which has full band studio recordings with added reverb and overdubbed crowd sounds to manufacture a simulation of a live atmosphere (Brown 1970). Considering that all musical recordings, even those classified as live, require some level of technological mediation, perhaps a more useful metric is to consider the degree to which a recording feels 'alive'. In describing this concept, Eisenberg notes two ways in which this can be achieved: documenting actual live performances, and, in contrast, through studio production techniques. The first 'sometimes conveys a real sense of occasion, through the spontaneity of the music-making and through accidents of ambience (as tawdry as coughing, as serendipitous as church bells at the start of a Richter Debussy recital)' (Eisenberg 2005:92). This is not a guaranteed route to making a recording feel alive, as 'sometimes a live recording sounds embalmed; whatever animated the concert seems to have escaped' (ibid). The second, the use of studio production techniques, offers a different route to making a record seem alive.

‘Aggressive mixing and overdubbing, especially in rock, can give a sense of conscious intelligence and so of life.’ (ibid)

The studio techniques outlined here are examples of the use of mediation for a specific sonic outcome. Sometimes an effect could be used to enhance the sound it is applied to, whilst remaining relatively unnoticeable, and in other instances the effect might be deliberately emphasised to draw attention to itself. Brøvig-Hanssen defines these types of effect as opaque and transparent mediation.

> ‘Mediating technology is imperative to all forms of popular music-editing operation such as splicing, and processing tools such as reverb affect the sound whether we notice them or not. When we do not, it is because we perceive the technological mediation as *transparent*, not because there is none. Similarly, when we *do* notice these operations, it is not necessarily because there are more of them than usual but because they are used in a way that attracts our attention.’ [original emphasis] (Brøvig-Hanssen 2019:195)

Inclusion of opaque mediation is a technique used throughout the Mechanical Techno tracks included here, specific examples of which are recounted below. Use of the terms ‘transparent’ and ‘opaque’ could lead to some confusion due to the way I understand the term in relation to my work. I consider a musical process to be transparent when it draws attention to its method of production, producing a clearly audible causal relationship. This is exactly contrary to Brøvig-Hanssen’s definition, where transparent is synonymous with invisible, and a mediating technology drawing attention to itself would be opaque. For this reason, more useful terms could be ‘concealed’ for transparent or unnoticeable mediation, and ‘exposed’ for mediation which is opaque and clearly audible. Where appropriate I have used these alternative terms instead. The following section discusses the extent to which the two-stage process can be communicated through Mechanical Techno recordings.

Communicating liveness

The previous chapter analyses the importance of the visual aspect of Mechanical Techno in live performance, directly in relation to emphasising action-sound-coupling. Given that a studio composition strips away this visual aspect, what are the

implications of creating music which is presented only as an audio recording? How can a Mechanical Techno recording communicate its live processes? A partial answer may be found returning to Reich's process music manifesto: 'I am interested in perceptible processes. I want to be able to hear the process happening throughout the music.' (Reich 2004:431) For Reich, the listeners' capacity to detect and analyse gradual changes over time throughout a piece gives them the clues needed to discern the structure of the work. As Reich's process pieces relied on simple rulesets creating complex musical outcomes—'pieces of music that are, literally, processes' (ibid)—the audible work is the real-time demonstration of the compositional algorithm. The governing principles are manifest in the sound itself.

The first stage of Mechanical Techno recording—building—produces a piece of process music that contains clues to its working in the audio output. The second stage—mixdown—delivers another set of sonic signposts, pointing to my actions as performer in live-arranging the piece. A third layer of information comes from extra-musical contextual material related to the presentation of each finished piece. These three categories of perceptible signposts are discussed below. To be clear, I wouldn't expect a listener to be able to identify each of these specific sonic signposts in a recording, but their cumulative combination leads to an overall aesthetic that sounds weirdly different to other electronic music. I describe my aesthetic as 'music that sounds a bit wrong' (Dunning 2024:233), aiming for a sense that unusual things are happening somewhere in the process, even if the specifics are clouded.

Mechanical signatures

Aspects of the machine which help audibly identify the processes at play are categorised here as perceptible processes, system characteristics and examples of opaque mediation. The three categories are discussed in turn below.

Perceptible processes

At the fundamental level, the fact that the metre of the compositions is based on a single-cycle-loop belies the basic process: that the tracks are made with a turntable looping. By restricting the process to exclude backing tracks—that is, any sound source which plays out rather than repeating—ambiguous playback sources are removed. All

the tracks repeat on a four-beat cycle, apart from *Suboptimal Beats* which repeats every two beats (due to the turntable being set to 45 RPM and the loop running at half-time), further highlighting this process. An exception to the 'no backing tracks' rule is the synthesizer dubplate used in *Perpetuum Mobile*. From the start of the track, the record is forced into a locked groove, repeating on one cycle. The sound drops out at 0'44 and when it is reintroduced at 1'37 the stylus has been moved to a point earlier in the record: It plays several complete cycles of non-repeating audio, before dropping back into a one-cycle loop (as the thread holding the tone arm becomes taut) at about 2'09. As the record eventually complies with the rule, playing a loop rather than continuous audio, it serves to accentuate the mechanical process: it would be possible to play continuously, but is deliberately forced to loop.

Tentacle Motion Study is perhaps the closest in structure to Reich's phasing loop pieces. Whilst the main metre derives from the one-cycle turntable loop, the bassline is generated by cogs with unusual ratios (as shown in image 5.6). Furthermore, whilst the relationship between the rhythm pattern of the bassline and the other elements is difficult to discern in the first half of the piece, the introduction of the string synth from 2'24 which matches the filter pattern makes the process more clearly perceptible. Similarly, the automation of the pitch of the sub bass part in *Perpetuum Mobile* is clearly on a cycle which is not synchronised with the other arrangement changes in the track.

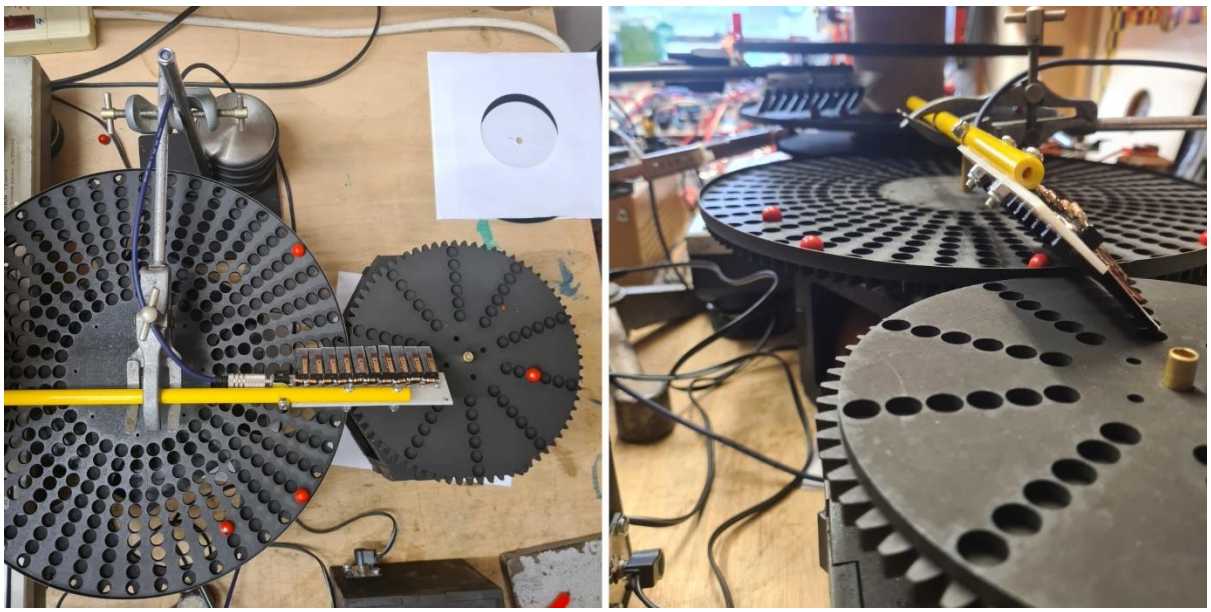

Image 5.6 cogs driven by the main turntable

System characteristics

Rhythms produced with Mechanical Techno always contain microtiming variations in comparison to a strictly gridded metre. There are several causes of this irregularity, each relating to the physical construction and mechanical activation of the sound sources. The piezo discs which trigger the majority of the drum sounds (such as the offbeat hi-hats in *Chronic Data Poisoning*) are sprung back into position through a combination of gravity and the springiness of the cables which hold them, which can lead to small variations per cycle. Often the trigger pegs are held at slightly different heights, which can move the hits slightly off grid. The vertical formation of the tower means that layers higher up will wobble eccentrically more than those lower down. This can lead to a push-pull variation in rhythm which is significantly different to the way sequencers would normally add shuffle or 'humanising' variation. This is usually most noticeable in continuous sixteenth note hi-hat patterns, such as in *Perpetuum Mobile*, where the rhythm seems to push for the first two beats of each cycle and pull for the remainder. The alignment of each layer to the others is never physically locked and is difficult to make precise. This leads to a certain sloppiness between parts in all rhythms produced by the setup. These idiosyncrasies of the design and build each contribute to a variety of microtiming variations in each track produced.

Irregularity in timing is not the only aspect of a rhythm pattern which gives clues to its origin.

> 'Rhythmic patterns consisting of grid-ordered events seem to lack a human touch—that is, the deliberate and unintended variations that musicians add to their performances. However, this lack of flexibility in timing is only partly responsible for the machinelike or "stiff" impression of sequenced grooves. … An equally important aspect of machinelike musical rhythm … is the absence of the small variations in *intensity* and *timbre* that are always present in a played series of drum strokes. In played music, the force with which drums are struck will not be constant.' [original emphasis] (Brøvig-Hanssen & Danielsen 2016:58)

Changes in intensity and timbre of drum sounds generated with Mechanical Techno depend on the specific sound sources used, and can produce a variety of effects.

Tentacle Motion Study uses triggers from flicked piezo transducers via an audio-to-trigger module; as such each pulse is of a fixed voltage and duration, so the drum voice (a 909 hi-hat) should respond the same every time. Each hit is the same timbre and velocity, creating an effect different from a live drummer. The rhythm plays an unusual pattern (five beats over a four-beat cycle), creating an effect different from a typical drum machine. This combination of machine precision with loose programming exposes the process as distinctive, even if it might not be exactly clear to a listener in what way it is unusual. In contrast, *Suboptimal Beats* features an acoustic frame drum amplified by contact microphones. As it is mechanically activated by striking with a beater, there are subtle changes in both intensity and timbre with each hit: the physicality of the process ensures no two strikes will be exactly the same. This discrepancy is enhanced by the effects processing on the sound, a solid-state delay which changes its delay time via the slow platter LFO, at a rate unrelated to the metre of the track. The combination of amplified acoustic percussion and time-shifting effects processing serves to expose both the unusual sound source and the automated systems at play.

The various ways in which the system is programmed also affect the rhythmic relationships of the different parts. As the layers are not locked together it is possible to set patterns or individual sounds at unusual positions relative to one another. An example is the muted cymbal sound in *Chronic Data Poisoning*, which hits each cycle between the third and fourth beat. In combination with the other percussive elements in the track it gives and ambiguous syncopation which would be difficult to either play manually with consistency or to programme on a standard sequencer precisely. This kind of 'accurate inaccuracy' (Brøvig-Hanssen & Danielsen 2016:109) has been possible with DAWs for some time, through non-quantized shifting of loops on the visual timeline, but is difficult to replicate through human playing: 'There is a limit to how far "out" a human musician can place his or her own beat without abandoning the firm ground that is needed to maintain the steadiness of the pattern that constitutes the groove.' (ibid:101) Combining this technique with the variation of microtiming, timbre, and intensity from a physically triggered acoustic instrument creates a kind of *inaccurate inaccuracy* which is unique to Mechanical Techno.

Tuning (or lack thereof) and pitch combinations generate another set of characteristics which offer sonic clues to the system's processes. First, the exclusion of the option for accurate tuning in preference for tuning by ear, and second, the various physical and electronic processes built into the system which create inconsistencies in the output. Different elements used in the system respond differently to speed, pitch and tuning. Using records and dubplates which have pitched content means the output is dependent on the rotational speed of the turntable. Speeding up the track increases the pitch. As Perpetuum *Mobile* uses a synth dubplate on the turntable running at 140BPM (approximately 8% faster than standard speed), the pitch of the audio on the record will also be increased by about 8%. Whilst the recorded audio was taken from a synthesizer using MIDI with twelve tone equal temperament tuning, speeding it up by an arbitrary amount can throw off the pitch. Other sources do not follow this dependency, such as external synths, and will keep the same pitch regardless of turntable speed. The analogue oscillators are tuned by ear. The laser tone-wheel used in *Suboptimal Beats* (audible most clearly around 1'30) cannot be accurately tuned as its pitch is dependent on the oscillator turntable, the control for which is complex and unreliable. The MIDI Comb module is capable of sending polyphonic pitch information to the string synth, either as chords as in *Perpetuum Mobile*, or as lead lines such as the high part in *Suboptimal Beats*. The scale from which these notes are taken is generated by arbitrary numerical divisions from an upper and lower MIDI note value, and as such cannot be deliberately programmed to adhere to any given scale. Tunings and pitch combinations which are difficult to control make explicit the complex relationships between the components in the system and set the aesthetic apart from electronic music produced with more conventional means. Some early sample-based hip-hop and UK hardcore/rave tracks included material with clashing keys or unusual pitch relationships, either due to technical limitations (pitching samples before time-stretch) or producers' decisions. These often led to unique sounding music which exposed its production methods—the music would have been different if the technology had been more 'advanced'. A similar process is at play with Mechanical Techno, where the sound of the music itself exposes the decisions and processes which led to its production.

The interfaces used in the system are designed to be fallible and function in an imprecise way. This, too, is often apparent in the sonic outcome. Both the Mono and MIDI Comb modules use physical-mechanical switch arrays to produce analogue signals, which are then digitally processed before the signal is outputted. Both the mechanical and analogue steps can introduce irregularities, manifest in similar rhythm patterns but with note values which are inconsistent. The varying notes in the high-pitched string synth riff in *Suboptimal Beats* (for example at 2'10) are a result of these factors, as are the variations in bass note in *Chronic Data Poisoning*, noticeable at 2'20. Each of these instances contribute to a sonic instability which reflects the build and function of the machine.

Certain sound sources expose their processes through extraneous sounds made during their activation. For example, the mechanically activated small percussion instruments are each amplified with a contact microphone, which always picks up some of the pre-strike mechanism sounds, creaking and other noises. Though these sounds are typically too low in the mix to be obviously the result of causal actions, they may contribute to an overall noisiness in the audio signal. As the output from these microphones is often treated with reverb or delay effects, the minor noises can linger and become more noticeable in the mix. Similarly, the various switches and triggers each produce sound acoustically as well as mechanically, which could potentially be picked up by the microphones. This type of mechanical bleed-through is an example of 'the sound of the machine itself' (Riis 2016:13): Such noises, permanently entangled in the machine's output, are a direct way in which the process is exposed.

Opaque mediation

The ways in which the sounds are further mediated also produces specific characteristics: 'the technological mediation has a voice of its own, in fact, and insists on its role in the experiential meaning of the music.' (Brøvig-Hanssen & Danielsen 2016:5) The mediation is 'opaque' when the voice of the technology can be heard. Brøvig-Hanssen gives three specific moments at which opaque mediation is likely to be perceived: 'The first is when it disrupts the spatiotemporal coherence of the music. The second is when it disturbs our familiar way of hearing a sound. The third is when it operates at the border of what we understand as being the music's interior and exterior.'

(2019:202) Within Mechanical Techno compositions there is a tension between the live and the recorded, between real-time and out-of-time processes. Fisher's discussion of the way in which record crackle draws attention to dyschronia within electronic music is relevant here, when using samples from earlier recordings. 'We are suddenly made aware again of what the first listeners to phonograph recordings were acutely conscious: that we are witnessing a captured slice of the past irrupting into the present.' (Fisher 2013:49) This effect also emphasises the means by which the audio can be reproduced: 'The crackle, meanwhile, reminds us of the technological means by which this capturing of time was made possible.' (ibid) In my work, the record crackle is produced live, and incorporated into the composition as a deliberate textural or percussive element rather than a byproduct. It announces the process by which certain sounds in the mix are produced. The rhythmic clicking synchronous with the sampled sound, the non-exact repetition, and textural and timbral variation indicate an immediacy and liveness in the sound's production. *Tentacle Motion Study* and *Perpetuum Mobile* each feature crackle produced by slightly different processes, in both cases tying in the rhythm and texture to the mix as a whole.

A second spatiotemporal disruption Brøvig-Hanssen notes is the layering of different artificially reverberant spaces in impossible ways. Chude-sokei describes the impossibly reverberant dimensions generated by dub as presenting an 'architecture of machine spaces' (2018:50): listeners are under no illusion that these are transparently mediated soundscapes, aware they are more akin to sonic fictions. Through the use of different reverb pedals and analogue delay modules, the Mechanical Techno recordings draw on both of these approaches: generating various impossible spaces and layering them together. The auto-panning and reverb from the Streichfett used for the staccato organ tones in *Chronic Data Poisoning* creates a disorienting false sense of space, in contrast to the more 'realistic' room sound (that is, transparently mediated) created through a stereo reverb for the acoustic percussion on the same track. What this signifies to the listener is not, as in Brøvig-Hanssen's example, that several takes were recorded at different times, treated independently and layered back together, but that the sounds in question are from different sources happening concurrently, treated independently but immanently to their production. The obvious use of effects

processing in Mechanical Techno tracks is another technique which points out the layers of mediation at play. The constantly shifting solid-state delay applied to the acoustic percussion in *Suboptimal Beats* is a clear example of this approach. The repeating delays of the initial sound are imperfect, and change in pitch in an unrelated rhythm to the metre of the piece. It is clear on listening that parameters are moving according to some automated system. The delay sound draws attention to itself and the processes of the machine.

A moment at which an effect 'operates at the border of what we understand as being the music's interior and exterior' (Brøvig-Hanssen 2019:202) is one which draws the listener's attention to the framing of the piece of music itself, through whichever technology is presenting it. Audible splices in tape cuts, glitches from a skipping CD or, again, noticeable record crackle, are moments in listening where the technology reveals itself. The deliberate inclusion of these artifacts in a piece can serve a similar function but to reveal the role of the technology via the hand of the producer. Typically these moments would signify altering the recording at a stage after it has finished being produced. Mechanical Techno recordings avoid this type of opaque mediation, intending to keep the coherence of each as a live recording. Tracks are not edited after the fact, overdubs are not used, and dynamic changes tend to happen slowly or in stages, rather than all together. In fact, maintaining consistency in the structure of the music's interior is vital to the second stage of the process, which is characterised by human rather than machine signatures.

Human signatures

As the automatic processes of the machine are perceptible, so are the distinct manual processes enacted by the performer. The arrangement of each piece has a structure, a different shape which emerges from my interactions with the machine, and these relate to the process of performance. As automation is central to the project, the separation of roles between myself and the machine resonates with the 1951 Fitts list, an early text in the field of function allocation. 'In the Fitts list … human and machine are construed as actuating and information processing systems with different capabilities, on the basis of which it is possible to determine what should be automated and what not.' (de Winter

& Dodou 2011:2) Taken literally as the Fitts list is written, the recommendation is that 'those functions that are better performed by machines should be automated, while the other functions should be assigned to the human operator' (ibid). Considering the processes of Mechanical Techno in this way connects the approach to the machine/operator pairing which has been important throughout the project, and also allows for mechanical signatures to be considered separately from human signatures.

Working with the form of the dub mixdown imposes certain restrictions which are apparent in the resultant recording. It is these limitations which provide the strongest clues to the performance approach used. One clear difference between fully automated electronic music and a live mixdown is that, as a human player only has a maximum of two hands, typically only two parameters or sound-sources can be interacted with at a time. Performing a complex 'drop' with such a system is not possible, as usually this would require several elements changing simultaneously. For example, during the breakdown in *Tentacle Motion Study* (between 2'06 and 2'50) the new synth sound is faded in gently, followed by the drums which are brought in on a quick fade. There are no risers or automated 'continuous processes' (Smith 2024:101) used, which would signal pre-programmed automation. The arrangement of *Perpetuum Mobile* is mostly generated by adjustments of the filtering on the lead synth line, varying between the sixteenth notes of the hi-hat trigger and the rhythm pattern of the string synth chords. At moments of increasing intensity, such as the small break at 1'38, elements are dropped out and reintroduced in sequence rather than all simultaneously: the bass drum drops out, the ride cymbal and synth dubplate are introduced, then the bass drum drops back in. The automated sub bass pitch continues throughout, on a consistent cycle through the whole piece. Such combinations indicate that there are two hands on the controls, and that the mixing is happening by hand.

A different kind of interaction informs the structure of *Chronic Data Poisoning*. Here the arrangement is led by the changing pattern of the staccato organ sounds, produced by the MIDI Comb using the ball-bearing disc with prime number divisions. Throughout the piece a consistent rhythm loop underpins the processual aspect, with minor changes in intensity through tweaking parameters on the drum modules. In the first half of the track, my main activity was to add new ball-bearings to the disc, increasing the

complexity and density of the organ sounds. This voice is faded out from about 1'30 for the breakdown, during which time I was (silently) removing ball-bearings from the disc. The process begins building again from approximately 2'30. From 3'20 to 3'36 I remove most of the ball-bearings again (using a magnet) to drop the pattern down to the two longer notes per cycle. For the remainder of the track, longer notes play, desynchronised, as I stop the triggering disc to try (unsuccessfully) to remove the remaining plastic arc segments. Throughout the whole track it is clear that the sequencing and arrangement are happening through some unusual and slightly chaotic process, and that parameters are changing at a rate playable by human hands.

This type of '"by hand" quality' (Hamilton 2022:12) can be heard at numerous points in the compositions. In *Tentacle Motion Study* at 1'20 when the bass drum is reintroduced, it takes a few beats before it is realigned properly with the other elements, causing a stumbling feel to the rhythm. The open hi-hat sound at the end of *Chronic Data Poisoning* (4'15) was played literally by hand, as I accidentally knocked the trigger whilst stopping the turntable—there are no other instances of this sound elsewhere in the piece. Hamilton posits that, 'Before the digital age, all artefacts had this "by hand" quality', and that the change occurred in two stages: precision engineering and computerised automation (2022:12). Mechanical Techno retains the quality in both respects, as the engineering is imprecise and the automation is either mechanical or manual. Ultimately, executing actions by hand leads to imperfections, and these are perceived in the output as signifiers of process. 'One can see a process displayed in a product; imperfectionism stresses the dynamic nature of the process, as opposed to a static product.' (ibid:17) The perceived liveness of my performance in the recordings comes from the combination of the restrictions inherent in performing the mixdown manually, the processes I perform in certain pieces made audible in the end result, and the imperfections in execution from doing the work by hand. In addition to the clues presented in the audio itself, another set comes from the extra-musical information which accompanies any composition.

Contextual information

Music doesn't usually happen entirely divorced from context, and prior knowledge about an artist or specific piece can give clues to its creation. The recording as a musical work necessarily requires a medium of delivery, and this is part of the work itself. In the same way that a live show can be considered a performance ecosystem (Waters 2007), a recorded composition exists not only as the audio content, but also the medium in which it's contained, the method of playback, the packaging and additional material included with the recording. No music exists in isolation. The online presence of Mechanical Techno, packaging and album artwork, and track titling provide additional contextual information which point towards the music making process. Mechanical Techno has had a lot of online engagement in the last ten years, with one video from 2015 reaching six million views (Dunning 2015) and my Instagram account which posts regular clips having over twelve thousand followers. As such the process is likely to be recognisable to the majority of people who would choose to listen to the recorded compositions, and there could be an expectation that the process is unusual from any listeners already familiar with my work. Album artwork might include images of the machine in use, or other visual references to process. Figure 5.7 is the digital artwork for the album *Beaux Timbres* by myself and Sam Underwood, designed by Charlie Noone, which both shows a collage of process photos from the recording and includes shapes derived from some of the modified records and the beaters from Sam's machine used in the pieces (Underwood & Dunning 2024). Typically, a release will include some amount of written information about the process. The liner notes for my 2019 album *Music for Climbing Walls*, for example, state: 'Recordings made with the Mechanical Techno turntable sequencer setup,' and 'Tracks mixed down as live dubs to stereo, no overdubs or multitracking' (Dunning 2019). The pieces included here are due for release as an album in 2026, and similar descriptive information will be included with that release. Such aspects of the contextual information around an artist and their releases create a set of clues a listener might piece together to inform their understanding of a certain composition.

Figure 5.7: Beaux Timbres artwork by Charlie Noone

Mechanical Techno tracks are typically titled in a way which might flavour them with certain concepts, themes or sonic fictions, for example, referencing science fiction tropes of self-replicating machines. There is also often an allusion to the music making process in the titles. Sometimes the names are slightly silly or jokey, referring to the absurdity of the project as a whole. *Chronic Data Poisoning* refers to recent disruptive practices whereby website owners include deliberately incoherent text within their sites, so that large language models scraping the internet to illegally use copyrighted material for training purposes receive useless or polluting datasets. Anti-A.I. themes are present in the work in general, and the chaotic, randomly generated sequences used in the track might reflect the garbled information used on these subversive websites. *Tentacle Motion Study* alludes to the rubbery, slippery movement in the bass synth in the track, and is intended to carry notions of both unruly nature and scientific experiments. *Suboptimal Beats* references the imprecise and impractical method of production, and the resulting outcome. Where records intended for DJ use might sometimes have a B-side labelled 'bonus beats,' indicating a useful tool, the idea of suboptimal beats is supposed to denote something more useless. In classical music describing a piece as *Perpetuum Mobile* would indicate fast, continuous and repetitive notes giving a rapid pulse to the composition. This is reflected in the sixteenth-note hi-

hats which also trigger the lead synth line. The term can also refer to a perpetual motion machine: an impossible hypothetical contraption which runs indefinitely and breaks the laws of thermodynamics. Whilst the titles are not direct descriptions of the processes involved in recording with Mechanical Techno, they allude to some of the themes and concerns of the system and the way it is used.

Throughout music history, the communication of meaning has been a debated issue. With the invention of recorded music and the development of electronic music composition, and particularly Pierre Schaeffer's musique concrète and acousmatic music, tensions between a composer's intention and the listeners' reception and understanding were explored. Though sometimes depicted as unyielding in his insistence on the need for a new kind of listening, perceiving the purely abstract 'sound object', Schaeffer acknowledges that the way in which a listener experiences music is out of the composer's control: 'Every object perceived through sound is only so because of our listening intention. Nothing can prevent a listener from destabilizing this, going unconsciously from one system to another or else from *reduced* listening to one that *is not*.' [original emphasis] (Schaeffer 2017:272) Demers identifies trends in the approaches more recent acousmatic composers take, grouping such artists as post-Schaefferian: 'they all agree that sound contains references to its actual or perceived origins, to some external association, or to some combination of the two. Sound, in other words, is a sign that indicates something beyond itself and as such can never exist as pure abstraction.' (Demers 2010:37) Though not intended as works of acousmatic music, tracks made with Mechanical Techno belong to a broader tradition of experimental electronic music and as such the project shares some of the same concerns. The pieces produced are stacked with references to process and sound-making origins as well as external points of contact. The reception and understanding of these signs is entirely determined by the listener, though additional layers of context can also potentially cast a certain light over their perception.

Physical audio workstation

Mechanical Techno in a recording context can be considered as a physical audio workstation, as it serves a function similar to the way in which a producer might use a

digital audio workstation. Brøvig-Hanssen & Danielsen use the term 'digital signatures' for the audible artefacts, both transparent and opaque, which define the sound of much contemporary music. Mechanical Techno recordings manifest *physical signatures*: comprising the mechanical and human signatures outlined above and the extra-musical information of the packaging. As an example of the parallels between the digital and physical systems, the popular DAW FL Studio separates the pattern window and the arrangement window. Creating a track with that program is typically a two-part process of first building a loop and second arranging the song and adding parameter automation. This two-part process is analogous to the build and mixdown stages of using Mechanical Techno. All music production platforms have built-in restrictions and design which lead the user in a certain direction. Indeed, any musicking system—be it a software environment or a set of instrumental components—enforces parameters and frameworks upon its user: 'the musical instrument is a theory of music' (Magnusson 2019:45). Indeed, the design and function of all systems are replete with the coding of the people who developed them: 'The objects around us — the technologies that serve as props in our thinking and music making — are stuffed with people and their ideas; in them we find programmes of action, manuals of behaviour, and political and sociocultural constructions, including aesthetic tendencies.' (Magnusson 2008:170) Because of these embedded codes it is necessary to be wary, or at least aware, of the tools we use. 'Technological objects are therefore never neutral, they contain scripts that we subscribe to or reject according to our ideological constitution.' (ibid) Throughout the process of developing Mechanical Techno, acknowledgement of this has been explicit. The Rules themselves help to guide and govern the aesthetics and framework of the project. Two specific points of difference between typical DAW functionality and that of Mechanical Techno relate to rhythmic precision and tuning.

Strachan acknowledges the extent to which digital platforms have changed the music which is made with them: 'The ubiquity of the DAW within recording practices across the production of popular music more generally … has had a profound effect upon both how recordings are made and the sonic characteristics commonly found in recordings.' (2017:151) Of several technical practices that Strachan highlights, the use of rhythm correction has had perhaps the most profound impact on the overall sound of much

contemporary music. '…plug-ins and built-in functions of DAWs … allow for a level of editing, rhythmic precision and dynamic consistency in recordings of acoustic drums and percussion that had hitherto been the preserve of electronic drum machines and sequenced, sample-based percussion tracks.' (ibid) The cumulative result of these types of practice is a sense of 'digital perfectionism.' (ibid) Strachan concludes that 'the internal functionality of DAWs afford a level of precision and ultimately a digitally constructed notion of perfection in contemporary recordings.' (ibid:152)

In parallel with rhythms that are locked to a grid, most DAWs default to a twelve-tone equal temperament tuning. The ongoing dominance of MIDI as the framework for running most instrument plug-ins and outboard synthesizers is one factor in this normalisation. Diduck's term 'claviocentrism' is helpful in understanding this phenomenon. 'From myriad imaginable instruments and infinite points upon the harmonic grid, pianos reduced music to twelve possible notes, emanating from one central musical device.' (Diduck 2018:34) In such a system, non-Western tuning is only possible through changing specific settings, and microtonal pitch variation is not available as a default option. The key concern in this reduction of possibilities is that, along with pitch correction plug-ins and commercially available chord packs, the claviocentric framework contributes to convergence on digital perfectionism. Magnusson recognises these tendencies and asks what embedded ideologies they contain. 'We see that the piano keyboard "tells us" that microtonality is of little importance (and much Western music theory has wholly subscribed to that script); the drum-sequencer that 4/4 rhythms and semiquavers are more natural than other types.' (2009:171) The specific workflows that the DAW enables also have an upward impact on the types of music created with it. The DAW, 'through its affordances of copying, pasting and looping, assures us that it is perfectly normal to repeat the same short performance over and over in the same track' (ibid). Through the design of the system, Mechanical Techno aims to circumvent these restrictions. All rhythmic elements have the potential to wander off-grid, and all tuning is by ear. Where MIDI is used, the distribution of available notes follows an even distribution between two points set by analogue dials, so conventional scales are impossible to implement. The physicality of the assemblage directly contributes to the inconsistencies in rhythm and pitch through

wonkiness, inaccuracy and play in the system: repetition is present, but never as an entirely perfect copy.

Several other significant differences between the system and a DAW relate to the way Mechanical Techno imposes a certain workflow in practical use. Three examples are the lack of a 'save' option, the difficulty to 'undo' actions, and the constant need for workarounds. In ordinary use with a DAW it would be possible to save and later open any project, and straightforward to work on different songs in the same session, or work on a single piece of music at sessions weeks or months apart. Mechanical Techno has no option to save the setup state and open different projects: A whole track has to be made from scratch to completion in one session. This means the workflow is, by necessity, focused on a single composition at a time. Similarly, each stage of the process is contingent on the ones before it, in a very physical sense. As the layers of the tower are built up, they become locked in. Undoing is still possible, but to do so means potentially losing later elements which might rather have been kept. The process encourages commitment to each element as it is introduced. Troubleshooting is a necessary skill for composing with the system: sometimes it feels like nothing will work how it should. Unconventional workarounds are necessary, and this often leads to radically different sonic results than expected or planned for. Fundamentally these aspects of the process lead to a frustrating workflow. By design, the system is often annoying to use. I have to work hard to make something I like.

Much discourse around the use of A.I. tools for music making has related to the improved efficiency and efficacy of process they enable, with one CEO arguing that these developments were necessary because 'the majority of people don't enjoy the majority of the time they spend making music' (Guttridge-Hewitt 2025). Despite almost unanimous derision of these comments from others in the field, the point remains that the proponents of these technologies retain a focus on product over process. There is a tension here because Mechanical Techno automates a lot of the musicking, which could be comparable to use of certain A.I. tools. Ultimately the difference is in valuing the processes, specifically the difficult and frustrating ones, and prioritising the journey over the destination. Though Mechanical Techno is a very specific way of making music, there are parallels with other modes of production, such as other hardware-focused

practice (like modular synth performance), or the various iterations of live coding around the Algorave scene. Rietveld and Randell describe a similar process using hardware and virtual modular synthesis systems: 'Within a generative patch, the artist is not in complete command, as the sonic outcomes are surrendered within the serendipity of a dynamic process between the human musician and the electronic instrument.' (2024:175) Starting from scratch, including improvisation and troubleshooting as fundamentally creative activities, struggling against an annoying workflow and following the flows of the (sonic and physical) material can lead to a wildly different destination than envisaged at the start of the process. Ultimately these types of techniques can be applied regardless of the chosen musicking environment.

Conclusion

Use of the Mechanical Techno extended turntable system in the studio context affords multiple avenues for novel electronic music composition. The two-stage composition process takes into account the development of the constituent components, the arrangement and connections of a new assemblage, and the live performance of a mixdown with the newly formed system. Along with the uniquely chaotic and unpredictable characteristics of the devices, these processes contribute to a specifically weird and unusual musical aesthetic.

Considering the system as a Physical Audio Workstation, which favours real-world and tangible processes over in-the-box digital ones, allows for the foregrounding of the awkward and difficult over the smooth and slick. Such an approach mirrors anti-solutionist design principles, such as those proposed in the concept of 'inconvenient design' (Tost et al 2021:81). The authors define this approach as part of an increasingly common trend:

> 'On a methodological level, there is a small but growing body of research that explicitly rejects the search for *solutions* and suggests rather *anti-solutionist* strategies as a means to define the disciplinary problem space around *solutionism*, and through practice, to offer designers new experimental approaches that impact the way to design things.' [original emphasis] (ibid:83-4)

Specific principles drive the approach in order to meet these aims, including 'absurdity, uselessness, ambiguity, exaggeration, estrangement [and] irony' (ibid 84). Furthermore, these principles open room for exploration of concepts that would usually be avoided or excluded from the research space: 'provocation, irritation, user-unfriendliness, unpleasantness, discomfort, friction, limitations, and constraints.' (ibid:85) Mechanical Techno as a physical audio workstation likewise welcomes difficult and annoying interactions which would typically be designed out of a user-friendly (convenient) system.

The neat allocation of functions either to the machine or the human operator, as advocated in the Fitts List, only reveals part of the process. Points of interest occur when the distinction is blurred, when human playing emphasises the mechanical or vice-versa. In the assemblage there is no hierarchy between agents. Both the mechanical processes and the human operations contribute equally to the final output. They are codependent, but both can fail independently. The moments of friction and breakdown only serve to emphasise the process further. Through the inclusion and foregrounding of sonic elements which might be characterised as noise—such as crackle and hiss, misfires and stumbles, and microtiming variation—clues towards the mechanical processes at play are embedded within the music itself: the grain of the machine. These combine with signifiers of live production: imperfect execution of adjustments and other manual errors which denote a by-hand quality to the mixing process. A final set of clues are produced by contextual information such as titling and liner notes. Together these form a set of physical signatures which combine to help explain the processes at play from within and around the recorded compositions. Ultimately, Mechanical Techno compositions stand against both the tendencies towards digital perfectionism in much of contemporary music, and against the obfuscated black-box automation of software reliant on artificial intelligence or large language models. Having examined Mechanical Techno in use as a complete assemblage—in both the performance space and the no-place of the studio—the following chapter zooms into the individual components of the concrete assemblage, to analyse how the design choices and making process relate to the system's capacity for production.

Chapter 6. Instrumental Components: Extending the Turntable

Having discussed Mechanical Techno at the scale of instrument-system in the previous two chapters, here the scale of assemblage in question has been zoomed in, considering the constituent components individually. By zooming in to look at each component it is possible to ask of each, what can it do? What additional possibilities does it afford?

A diagram of a turntable

A turntable itself is an assemblage of constituent parts, all of which are prerequisite for it to function. Figure 6.1 shows the functional elements of a turntable. The motor produces rotary motion which in turn causes the record to move. The inscription on the record interacts with the sensor, the output of which is processed into either sound or a control signal. Variations and iterations of each of the elements were developed during this research project.

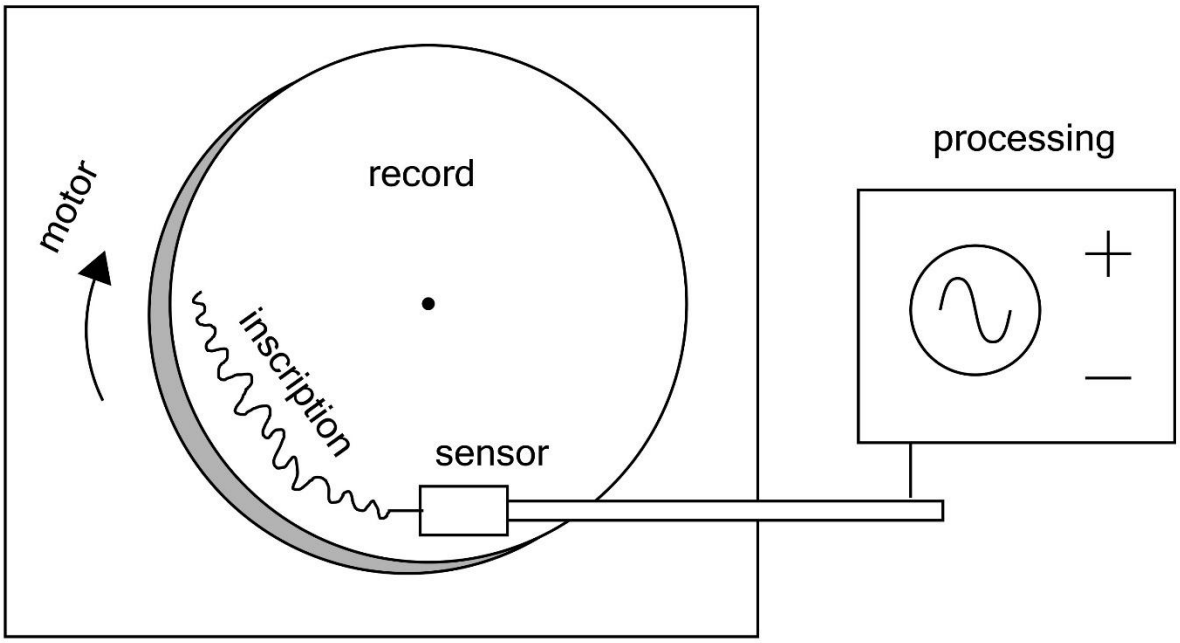

Figure 6.1: functional elements of a turntable

Defining a musical instrument can be difficult, and one of the challenges is determining its limits. One approach is to differentiate between the instrument and the person playing it. 'Intuitively, we might say that the instrument is what is left behind when the

performer is no longer present.' (Kvifte 2008:48) However, as a lot of instruments include parts of the human body in their functional apparatus—a tuba player's lips are the sounding element of the instrument—the definition leaves only inert, nonfunctional objects. Including the person in the definition however, as Kvifte explains, risks including the entire universe: the person needs food to have the energy to make breath to blow the tuba, the food is grown through photosynthesis dependent on the sun, the sun was created by the big bang. Kvifte's dilemma is similar to that posed by the fractal nature of the holon or the nested assemblage. At some point it is necessary to set the boundaries of the study. For this chapter, the turntable is delineated by its functional elements only.

The instrumental components presented here are of various types, including whole Eurorack modules, laser-cut discs, modified records and adapted instruments. Each was developed in order to explore the affordances they present, rather than to solve a set problem or match a design brief. I follow Bowers et al in describing the objects and devices as 'makes,' from a Research through Art and Design (RtAD) perspective:

> "'Makes" are a means for developing insight rather than as a test of a pre-existing theoretical framework from which the instrument, interface, artefact, or whatever is derived. As such, the RtAD approach offers an alternative orientation to engineering methods or experimental methods derived from psychological research which, say, develop specifications on the basis of theoretical deliberation or investigation of user needs.' (2023:1)

Video 6.1 Technical Developments illustrates the following makes developed during this research project:

Modules

- DC motor
    - Slow platter
    - Oscillator turntable
- Resistance
- Mono Comb
- MIDI Comb

- Utility modules

Sequencing

- Optical discs
    - Track changer
- Peg discs
- Ball-bearing discs
    - Slow platter & geared secondary platters
    - Platters driven by the main turntable

Percussion

- Small percussion instruments
- Worm gear and slow percussion

Certain devices shown in the video were already in use with the system prior to this research project. Specifically, the optical reflection sensor, which was built for me by Tom Richards in 2017, and the peg disc records with divisions of sixteen which I made in the same year. They are shown by necessity to illustrate further developments.

The open work

The development of new devices for use with the extended turntable is part of the composition of an open work, Mechanical Techno: creating components which can be combined in multiple ways to create new iterations, outputting performances and recorded works. 'Every performance *explains* the composition, but does not *exhaust* it. Every performance makes the work an actuality, but is itself only complementary to all possible other performances of the work.' [original emphasis] (Eco 2004:245) An 'open work' as defined by Eco initially refers to a musical composition which leaves certain decisions to the performers, meaning different iterations of the same work lead to different sonic outcomes. 'For Eco, the open work is where a new level of autonomy is given to the individual performer, not merely in terms of interpretation, but also in terms of creative judgement in how to develop the piece.' (Magnusson 2019:98) Whilst initially referring to a specific type of musical work, Eco extrapolates the concept to also apply it to literary works, proposing that texts can be interpreted in multiple ways. Closing down

the meaning of a work to one linear understanding is limiting and restrictive. In its broadest sense, the extended turntable is an accumulation of objects, devices and components which can be assembled in a variety of ways to produce different artistic and musical outcomes. The forming of the components each time—the assemblage—is the process by which a new performance or composition is made. As such, while any one instrumental element can be considered a complete project (a make) in its own right, the core purpose of creating these is towards an as-yet-unplanned future composition. There is intentionally no endpoint at which the project will be considered complete.

Certain affordances were designed into the system, whilst others became apparent through use in live and recording contexts. Each of the developments took several iterations, prototypes and modifications before reaching an appropriately useable state. For example, part of the reason for using Arduino microcomputers to run the modules was to enable future changes to the code, adjusting functionality, which would be more difficult to achieve had the same device been 'hard wired', made solely with analogue electronics. Below, developments relating to each of the functional aspects of the turntable are briefly recounted, followed by the insights arising from their development and usage.

Motor

The motor of the turntable provides the movement required to animate the inscription so it can generate output via the sensor. It also serves as the clock for any automated piece, generating metre via the layout of the patterns. The primary driver for the development of the new Motor module was twofold: using a second turntable as an oscillator, and using a slow platter as a controller running at a different clock speed. Specific use cases are demonstrated in Video 6.1.

Oscillator turntable

The development of the oscillator turntable (Image 6.2) derives from the prioritising of action-sound-coupling. In a typical modular synthesizer system, changes in the oscillator only happen in-the-box and have no visible counterpart. Using a turntable as an oscillator makes physical, and therefore visible, any changes. Changing oscillator

waveform now involves either switching out a record or physically moving the sensor to another part of the disc. Variation in pitch is now also physical and visible—albeit subtly so. An attempt to make the rotary motion more clearly legible was to label the discs in a large and contrasting font.

The sonic results of replacing an electronic oscillator with a turntable are typically to add more noise to the system, in the form of vinyl surface noise, modulation from eccentric rotation, cycles out-of-sync with the main tempo of the main turntable, and slew in transferring between notes. These artefacts are all desirable within the broader aesthetic of the music (as physical signatures), adding complexity, texture, changes in timbre and difference to the repetition. Access to a turntable which can run at faster speeds, and can be modulated with control voltage signals, also opens it up for use with different combinations of records and sensor types, such as the textured records and the optical discs shown in Video 6.1.

Image 6.2: Oscillator turntable and Slow platter

Slow platter

The slow platter (Image 6.2) is a versatile component in the system. Primarily it is used to make changes over a longer timescale than the single-cycle-loop of the main turntable. Turning at between four and eight RPM means each cycle completes in a range of about seven to fifteen seconds (or approximately four to eight cycles of the main turntable). Use cases such as functioning as a low frequency oscillator, optical sensor track changes, and note variation at arrangement rate each provide variation over time. The sensors and mechanisms are designed to make visible the processes as they occur. As the platter is not locked in synchrony with the main platter, these

variations are typically out of the standard four- or eight-bar cycle. Physical effects of the device such as cams slipping or sticking due to friction add inconsistency and irregularity to patterns.

Record and inscription

Within the functional model of the turntable, the record serves the purpose of carrying the inscription. For the purpose of this project, records are classified into two types: those with a permanent inscription, and those which can temporarily store an inscription and be rewritten. Fixed inscription records used in this project are dubplates, various oscillator discs, and rhythm pattern records. Rewritable records used are peg discs, ball-bearing discs, magnetic records and the empty platter.

Fixed inscription records

In the case of an audio recording, a vinyl disc acts as a storage device for the inscription. Records can be changed over and kept for retrieval later. Using a turntable for performance, records become an archive of possible sound sources. Sourcing and selecting records is a core skill for a DJ. Their reputation is often built on the type of music they play and their unique collection of tracks: 'the DJ operates as a type of curator as well as performing producer.' (Rietveld 2019:123) Similarly, an instrumental DJ curates the selection of available sounds in a comparable way to an improvising musician rehearsing scales or techniques: A toolbox of available sonic material from which to draw. With a typical vinyl record, the inscription is already written to the disc; the two are inseparable. Depending on the process of manufacture, an audio recording is embossed into the disc (in which the shape of the surface is changed, forcing the groove wall up, but material is not removed), cut into the disc (resulting in removal of a small amount of material in the form of swarf), or pressed into softened material by a mould (as most commercially produced records). In the case of the latter, the mould is created through a multi-step process from a master disc which has been previously cut on a lathe. In all cases, the shape of the material is permanently changed by the process.

Though the object is permanently inscribed with sound, the inscription is by no means unchangeable. Turntable musicians have experimented with modifying existing records

to create new sounds and effects. Milan Knížák's *Destroyed Music* project explored multiple ways of damaging records and using the defective discs in recorded compositions for their unique sonic properties (Kelly 2009:140). James Kelly's PhD thesis documents numerous techniques including overcutting records and etching (Kelly 2019:79,67). Maria Chávez stores records out of their sleeves, loose in a rucksack, to cause new scratches and scuffs over time, changing the otherwise familiar recordings for each playback (Thompson 2017:67). Dylan Beattie performs live lathe cutting as real-time inscription, inscribing different materials and often overcutting sound in the same session (Beattie 2024). JO Kazuhiro's *Fragmented Music* project uses slices of plastic laser-etched with zig-zag grooves, to make a radial jigsaw puzzle which is part oscillator and part sequencer (Algorithmic Pattern 2025). Though a record player is designed as a playback device—to read the inscriptions on records—in fact every playback also changes the surface material, albeit in a minor way. As Lippit notes, the turntable itself is a writing device as much as a reading device. 'This characteristic that defined the phonograph as a machine to both "write and speak" can be applied to the modern-day usage of the turntable and record in turntablism that is both an act of "listening and playing."' (Lippit 2020:69) Purely because of the way the needle always marks the disc, '…while we are following a trace from the past, we are also engraving a new trace upon it with the moment of recalling. Therefore, every recollection is not a reproduction of the past but a production of a new experience that is engraved with the moment of recollecting.' (ibid:79) Fixed inscription discs used with Mechanical Techno are described below, along with some of the ways in which the inscriptions can be modified.

Dubplates

A dubplate is a unique lathe-cut record, inscribed in real-time from another sound-source.[2] A number of artists also cut dubplates for specific works or performances, as it provides a way to create unique sound-sources tailored to their technical and aesthetic approach. Marina Rosenfeld has an archive of dubplates used in performances and

[2] To disambiguate, the term is also used for a specific disc type: a metal disc coated with acetate, which was the original type used for lathe-cut records. Most lathe-cutting services now offer 'vinyl dubplates', which use a plastic disc.

installations, which include vocal recordings and other instrumentation (Rosenfeld 2015). Lippit recounts making records for specific pieces, selecting content to achieve specific musical ends (Lippit 2020). During this research project I used two sources of dubplates. First, discs from my own archive created for installations and performances since 2009. These include field recordings such as a droning electronic alarm, a pair of cymbals left in the rain and amplified by contact microphones, a drumstick dragged along a long railing, bowed cymbals, low frequency analogue synthesizer notes, and the footsteps of pigeons inside a pigeon shed. Due to their use in public interactive installations and improvised music performances, the records are in bad condition and produce significant surface noise on playback. Second, a set of new dubplates were made for use with the project. I made recordings of several synthesizers owned by friend and musician Justin Paton and at the London South Bank University recording studios, including a Roland Juno-6, an Access Virus C, and a Moog Grandmother. Each recording ran for approximately ten minutes and changed throughout. Some were chord drones, some shorter stabs, some fast arpeggiated notes. Rhythm in the pieces was loose, played by hand without a click track, and intentionally different to the 133.333 BPM single-cycle-loop, to ensure any locked grooves produced with the dubplates would sound off-kilter. The synthesizer dubplates were used both on the oscillator turntable for variable pitch, and the main turntable to create loops.

Oscillator discs

Other fixed-inscription records were produced specifically for the oscillator turntable. Initial experiments with using the optical reflection sensor at audio rate—running control voltage gate signals fast enough to be heard as a tone—were unsuccessful, as the sensor had a threshold of the smallest increment it could read. These records were repurposed as textured discs, read by a piezo transducer head-shell, and used in the modular system as oscillator tones. The discs made for the optical laser-LDR (light dependent resistor) sensor were also used with oscillator turntable, as a tone wheel. Patterns of shapes could produce slightly different waveforms, and tracks of shapes overlapped to produce modulation (Image 6.3). Printing the shapes orthogonally rather than radially also gave shifting phase and pitch per cycle. Making multiple discs for the oscillator turntable created a catalogue of sound-sources for use as a monosynth,

switchable in a visible way and contributing unique timbres and unusual modulation. A specific effect of the discs used with the oscillator turntable is that modulation speed changes with pitch. Modulation of the tone is locked to the cycle speed, because it is produced by the eccentric rotation of the disc on the platter. As the pitch increases, so the speed of modulation of the timbre increases. The effect sounds something like digital playback of a sampled synth note, rather than an analogue synth playing the original voice, as in a typical analogue system the rate of the modulating LFO would be independent of the oscillator pitch.

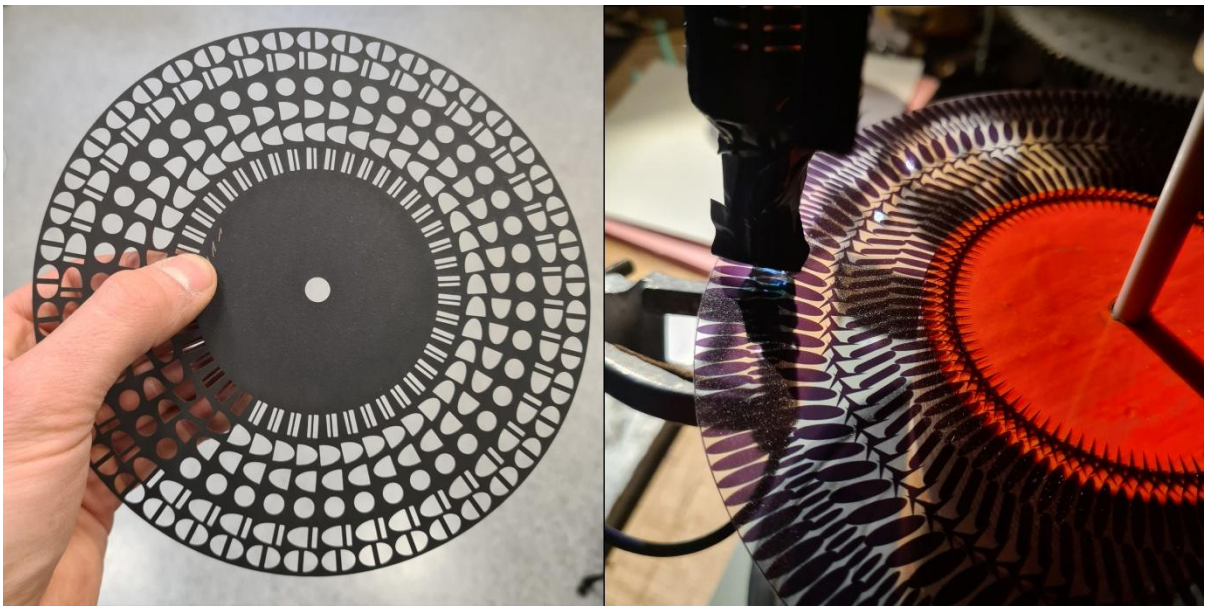

Image 6.3: Optical discs

Rhythm pattern records

Discs designed for use with the optical reflection sensor contain single-cycle patterns (Image 6.4). The sensor, though using analogue circuitry, is a binary device: it either outputs a five-volt signal or no signal. Designing patterns for these records happens significantly before any performance takes place. Hand-cut patterns can be made quickly, and these result in rhythms without precise timing. Minor inconsistencies in timing can generate significantly different results, and often the hand-cut records are less effective than more precisely cut records at delivering a specific effect. For example, to generate shuffled sixteenth notes at the edge of the disc, alternate segments need to be aligned about four millimetres behind the position of a straight sixteenth division. Cutting by hand it is difficult to be consistent with this small measurement, resulting in a pattern which sounds sometimes shuffled and sometimes

straight. The overall effect of using all hand-cut patterns is rhythms which sound slightly messy but generally lack a coherent groove. Through experimentation, combinations of precise rhythms with the slight misalignment of the layers and eccentric rotation of the platters produced more interesting results. To cut more precise patterns, designs are made using a vector graphics program (Inkscape) and cut with a plotter-cutter. Whichever method is used, rhythm patterns are planned and cut in advance.

Image 6.4: A selection of rhythm pattern records.

Each record can contain several tracks of patterns, placed in concentric circles, and the relevant track is selected by moving the position of the sensor. Combinations of patterns on the same disc typically share one or more notes consistent across all tracks. This ensures that, when changing tracks, part of the pattern remains constant, maintaining some integrity. A typical organising principle is to design each track to increase in density of notes. In a musical context, changing tracks can then give the feel of the intensity of the music increasing. Some discs are designed with very basic rhythms, some more syncopated patterns, and some with combinations on the same disc. New disc designs included divisions of eight and ten, or eight and twelve, on the same record. Designing the patterns carries some uncertainty. To a degree I can count out the pattern in my head as I design it, but my mind's ear is not always accurate.

Designing patterns with unusual time divisions makes this process more difficult. This uncertainty in outcome encourages experimentation at later stages of performance and recording. Each disc has its patterns 'locked in', permanently imprinted upon it. Practical use of these discs leaves open a number of possibilities. As the pattern only generates on/off signals, these can be sent anywhere in the modular system: used for hi-hat patterns, basslines, chord stabs, synth lines or clock signals. Alignment of each record is also completely unquantized. The start note of any pattern can be set anywhere in the cycle.

Writing over fixed inscription discs

Whilst each of these types of disc is permanently inscribed, there are various ways to adjust or amend the inscription during playback. Marking and damaging records by cutting into them during playback can cause rhythmical clicks and pops, through to much harsher noises. In my free improvising practice, I have used knife blades, dentistry tools and other metal objects to create new textures and rhythms on recorded discs during performance. Playback of records with homemade alternative styluses can also damage and alter a record's surface, as a kind of destructive noise-overwriting. The optical pattern discs can be amended temporarily during live performance by placing pieces of tin foil on the disc, or more permanently with small pieces of adhesive vinyl, which I deployed in several performances. Other inscriptions can be made with a white marker pen, as demonstrated in Video 6.1.

Rewritable records

Although in all cases, permanent inscriptions can be changed, damaged or interrupted to some degree, it is generally not possible to wipe the slate clean and start again. Use of alternative sensors affords opportunities for records with the capacity for temporary inscription. Several types of rewritable record have been developed for use with the extended turntable system, as illustrated in Video 6.1. The peg records, ball-bearing discs, magnetic disc and the empty platter are discussed below.

Quantization

Most types of programmable disc used have sockets for fixed trigger positions. The peg records use 4mm holes to accommodate banana plugs. The ball-bearing discs have

8mm holes within which the 9mm diameter ball-bearings locate. Though the pegs and ball-bearings can be set into different sockets for new sequences, the sockets themselves are in fixed positions, enabling certain rhythm patterns and excluding others. This is analogous to the steps of a step sequencer or quantization in a digital system. Consideration was given to the layout of the discs and the affordances different types of quantization might offer. The existing peg discs were divided into thirty-second note triplets, with divisions of sixteen marked to facilitate quick programming (Image 6.5). With this relatively high resolution, a flexibility is achieved: it is possible to set any trigger forwards or backwards on the grid, create looser or tighter patterns, and offset beats as required.

Image 6.5: Peg record with quantization.

The same approach informed the layout of the sockets on three of the four ball-bearing discs: holes placed as close as possible whilst maintaining the structural integrity of the disc, to enable more micro-variation in timing as well as more precise patterns where required (Image 6.6). Within this, some variation was included. Whilst the socket pattern on one disc repeats four times, meaning granular patterns can be repeated, another has a prime number of sockets in each track, so exact alignment across tracks

is not possible. The most strictly quantized ball-bearing disc is cut with divisions of sixteen, with significant blank spaces in between. This affords real-time programming on-grid, by rolling ball-bearings into position. The Lego disc has its own type of quantization, due to the orthogonal rather than radial arrangement of the studs. Within a four-four rhythm, regular triggers can be produced by aligning to the grid. With smaller divisions, accuracy becomes compromised.

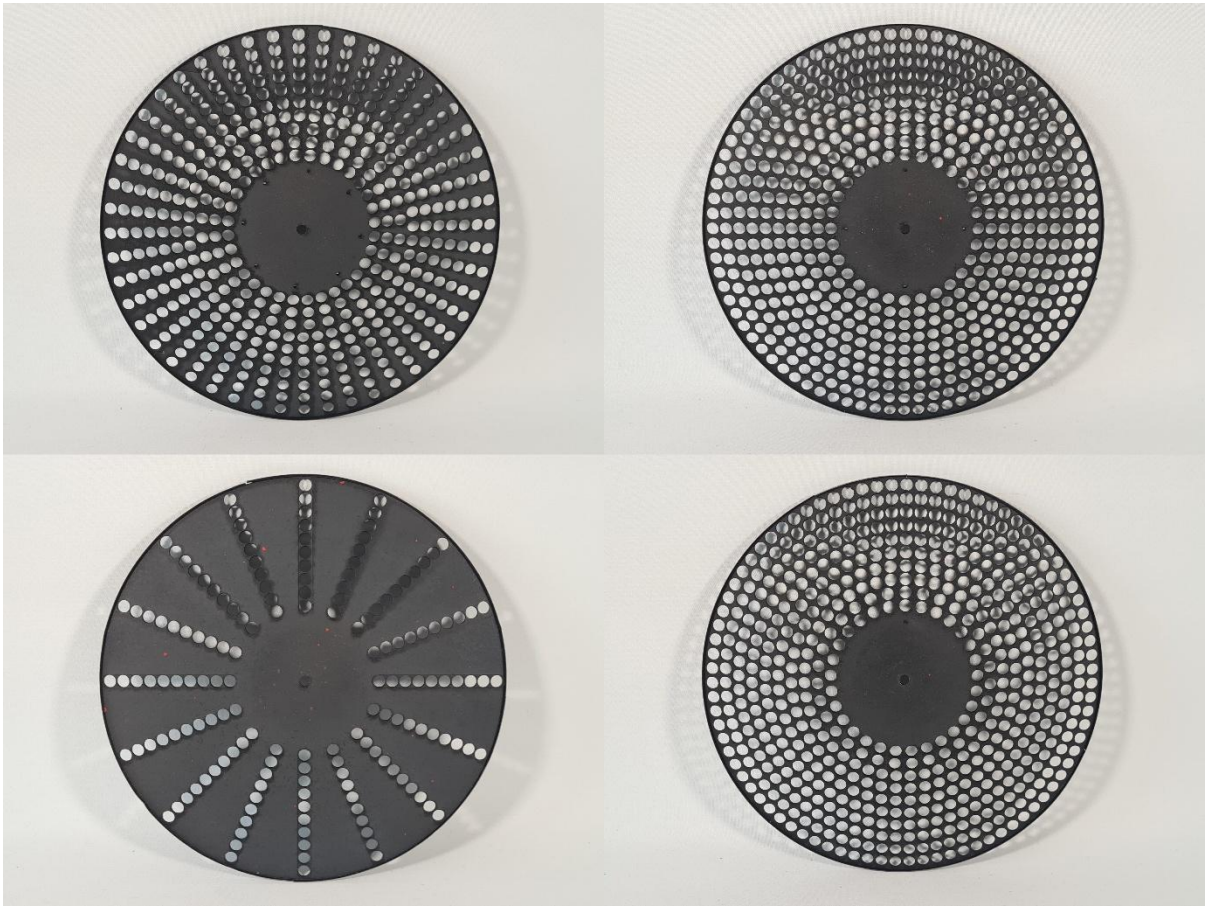

Image 6.6: Ball-bearing discs with different types of quantization.

Unquantized discs

Use of a metal disc with trigger elements held by magnets provides freely repositionable patterns. Single small magnets were used as drum tiggers and with both Comb modules. Magnetic fruits were used to generate note clusters with the MIDI Comb, programable in real-time (Image 6.7). Sometimes when in contact with the switch array the magnets would slip, due to insufficient force to overcome the physical pushback of the switches: the resultant position change would vary the pattern each cycle, a unique effect. Some other turntable sequencers use magnets to produce sequences. The ODM *Malista System* uses hall-effect sensors to generate MIDI triggers, with magnets

positioned on a grid printed onto paper, but the option for misalignment as the grid is a visual guide (sonicstate 2023). The device does not offer real-time repositioning of the magnets due to the transparent shelf on which the sensors are placed. The Playtronica *Orbita* uses coloured magnets also to trigger MIDI and is reprogrammable in real-time and unquantized (Pas 2022).

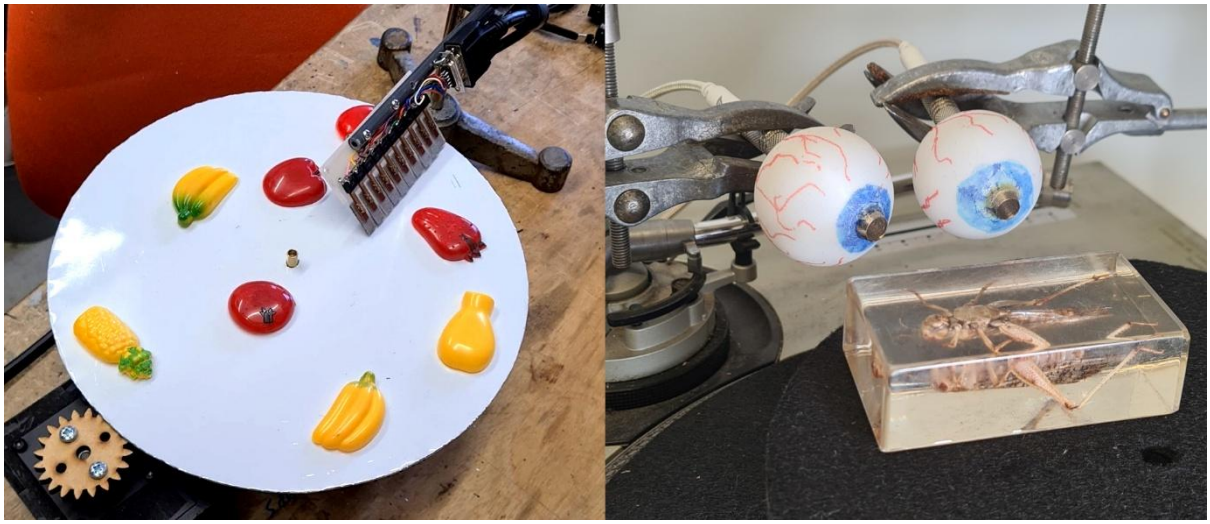

Image 6.7: Magnetic fruits and the MIDI Comb switch array. LDR sensors with an insect encased in resin.

The empty platter

Numerous turntable artists have worked with the concept of performance without records. Artist group Institut fuer Feinmotorik (IFF) produce minimal rhythmic music using a large-scale prepared turntable setup, notably without any records. The group's project *Octogrammoticum* consists of '8 turntables, 4 DJ mixers + end-mixer, which is served by the group members. Anything (except records) which somehow fits between turntables and pick-up cartridges (household-rubberbands, paper-stickers, rubbergums, handicraft-tools + various tinker-trivias) may be played' (Institut fuer Feinmotorik 2009). *without records* is a large sound installation by Otomo Yoshihide and Yasutomo Aoyama from 2008 consisting of dozens of turntables modified to mechanically create rhythms and clattering noises (Yoshihide 2015). Considering the functional aspects of a turntable presented here, I would argue that in both cases the empty platter is used as the record, and the objects and preparations added to it are the inscription. These may be temporary items like IFF's paper-stickers, or more permanent like the modifications produced by Yoshihide and Aoyama. With the extended turntable system, the empty platter works as a vehicle for sequencing objects in several

scenarios. These include wooden cylinders placed to move the cam follower arm with the Resistance module; prisms affecting the light sensor (Image 6.7); and stones playing the MIDI Comb (all shown in Video 6.1). In these instances, the platter serves as an unquantized ground for the placement of objects. Use of cam shapes on the slow platter works in a similar way, as although each has a fixed shape it can be placed at any angle in relation to other cams on the spindle, generating unquantized new combinations. The option to combine quantized and unquantized patterns in the same piece, and to shift start points in relation to one another, creates an unusual set of affordances, leading to unique performances and compositions.

Sensor

The role of the sensor is to convert physical movement into an electrical signal (or in the case of a gramophone or other acoustic device, amplifying physical vibration to an audible volume). A standard turntable stylus does this through an electromagnetic transducer: the stylus is a cantilever which moves inside a coil of wire, generating an alternating current. Other sensors in the extended turntable system use different methods of converting movement into electricity.

Alternative styluses

The modification of needles, cartridges and head-shells has been a source of innovation throughout the lifetime of the turntable, both by commercial manufacturers and individual artists. The standard steel gramophone needle could be replaced with other materials, such as bamboo, to change the volume and tone of the amplified sound. Turntable styluses come in diverse varieties: tailored to usage, from audiophile home-listening to scratch DJing; and tailored to price point from cheaply mass produced to custom made and highly specialised. Each has its own sonic imprint affecting factors like noise floor, tone, dynamic response and fidelity of reproduction. Artists' experiments with cartridges and styluses include Andrea Borghi's springs and wire coils, and Takuro Mizuta Lippit's piezo transducer devices. Styluses used with the extended turntable system included different types of standard DJ cartridge and a cheap magnetic pickup from a low-quality consumer turntable. A cartridge fitted with a pair of piezo transducers was used for textured records, with screw attachments to fit

different materials to the contact microphones, such as metal wire, cocktail sticks, springs and fishing wire (Image 6.8).

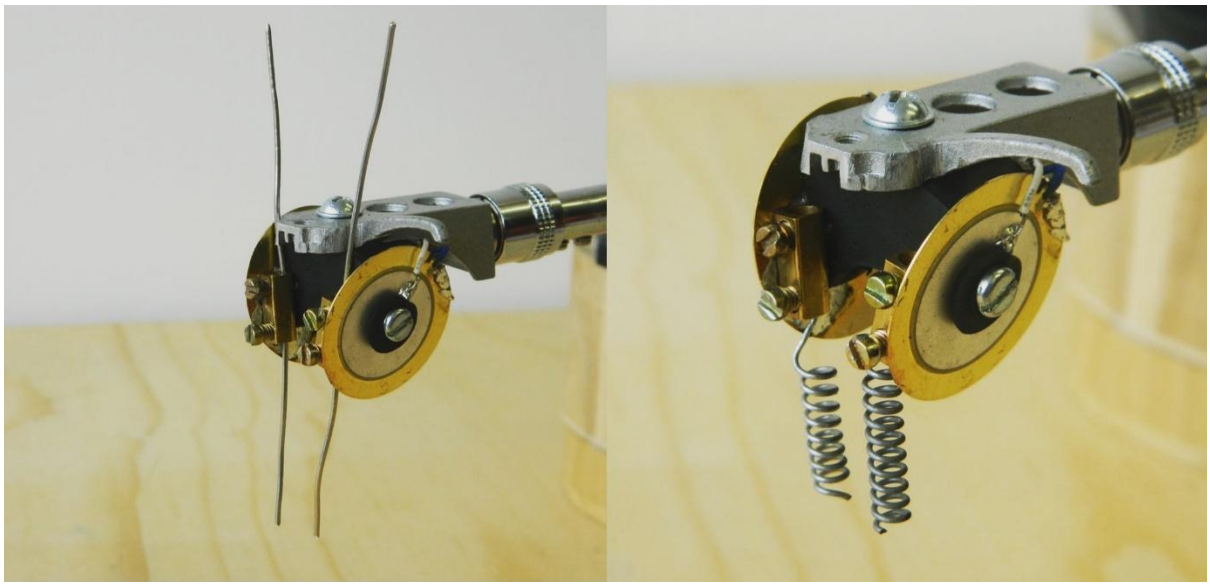

Image 6.8: Contact microphone stylus, shown here fitted with wire and with springs.

Piezo triggers

Piezo transducers are also used with the peg records to generate signals used for rhythm triggers (Image 6.9). Physically flicking one of the metal discs produces a short and sharp voltage spike across the output, which can be heard as a click when processed as audio.

Image 6.9: Piezo trigger and drum with mechanical beater.

Mechanical beaters

The mechanical beaters used for playing small percussion work slightly differently to the other sensors in the system. As the peg comes into contact with the beater, the

beater is displaced through a cantilever mechanism, increasing tension in the elastic band. As the peg moves past the end of lever, the beater is pulled back into its original position, striking the percussion at its maximum extension (Image 6.9). The initial contact with the peg does not make the sound, but sets up the beater to strike the drum a moment later. The drum produces sound acoustically and is also amplified by a contact microphone. Despite this difference in process, each beater-drum-microphone subassembly can be considered a sensor as they convert the physical motion of the pegs (inscription) into a usable signal.

Image 6.10: Comb switch arrays for the Mono Comb and MIDI Comb.

Comb switch arrays

Each of the comb switch arrays uses multiple switches arranged in a comb formation. This enables reading up to ten tracks of physical patterns from the record (Image 6.10). The design was influenced by the Polyphon type of music box, which uses a metal disc pricked with holes to create raised pegs, which in turn pluck the tines of a tuned metal comb. A similar device is used as a switching interface in the project *Ujino and the Rotators*, albeit with a bar permanently fixed across the platter of a turntable. In that project, each switch controls a relay allowing the rhythmic switching of mains electricity: powering and de-powering vacuum cleaners, blenders and guitar amplifiers (Munteru 2017). The comb switch arrays can also be used with other objects and devices producing the inscription. Stones, magnetic fruit, magnets and Lego were used. Whilst each set of objects produces its own sonic affordances according to its physical characteristics, they also afford different visual effects. The magnetic fruit are brightly coloured and stand out against the white background of the metal record. As such, they

look jolly, fun and potentially quite silly (Image 6.7). The colours of the stones are more natural and neutral, usually placed on a black felt background, have more angular shapes. They imply more of a seriousness, perhaps something of a pastiche of certain sound art practices. Though similar audio results may be produced with both—clusters of MIDI notes or pitch-bending mono CV—visually they can make different associations for perceivers.

Light dependent resistors

Use of LDRs allows for the physical motion of the turntable to be converted to varying electrical signal without physical contact. The light level changes the resistance, which can be processed in multiple ways. Running LDR sensors at different speeds produces either control signals at arrangement speed, rhythm patterns at turntable speed or audio-rate signal at oscillator speed. The signal is affected by physical objects disrupting the light beam (for example, prisms and other glass objects as shown in Image 6.7, or discs cut with patterns of holes). As such, use of LDR sensors affords opportunities for physical programming by moving the position of the objects.

Cam follower arm potentiometer

The cam follower arm uses a potentiometer as its hinge, providing variable resistance over time with physical position changes (Image 6.11). The device can be used at turntable-speed to make changes over one cycle, or longer durations with the slow platter. As such it provides a flexible way to produce variation over time through affecting parameters like pitch or frequency cutoff. Smith identifies such 'continuous process' as important components of electronic music, which can contribute stylistically to specific genres. 'In general, continuous processes are used more prominently in subgenres that are perceived as being more intense, psychedelic and especially more electronic, than others.' (Smith 2024:101) Specific subgenres may favour certain types of continuous processes. 'For example, acid house is known for a distinctive "squelching" sound and dubstep is known for its "wobble bass". It is also common to hear conversations in EDM culture about which subgenres have the most frequent and intense risers.' (ibid) Whilst the cam follower can work as a mutable low frequency oscillator—generating control signals with waveforms from regular

geometrically shaped cams—other shapes, objects and programmable discs can produce a range of continuous control signals (as shown in Video 6.1).

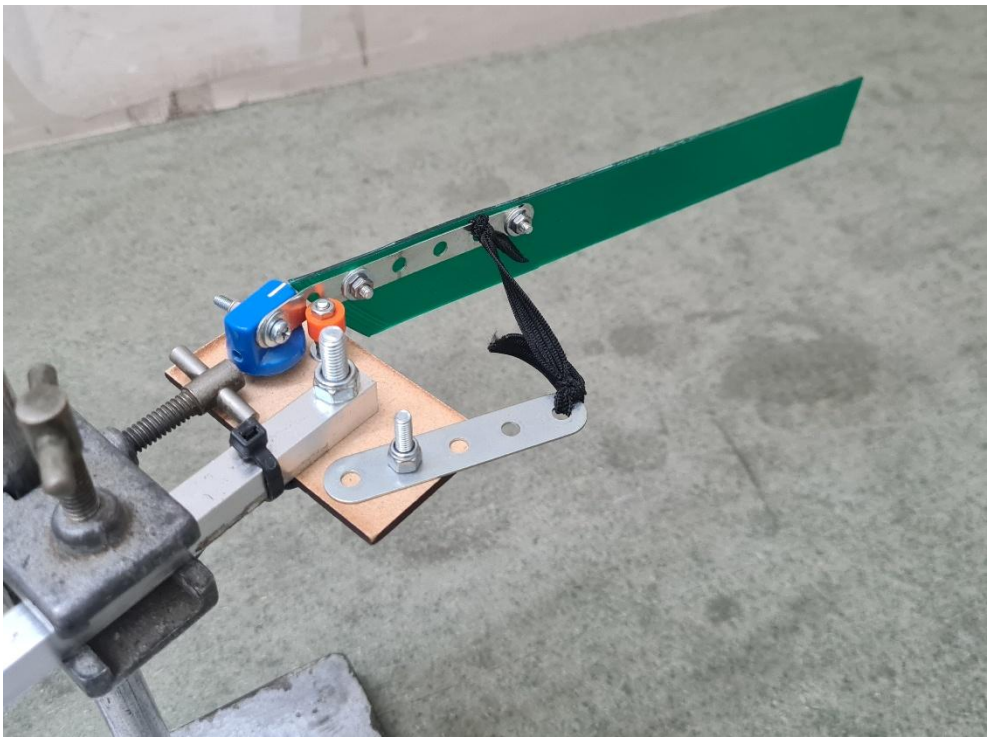

Image 6.11: Cam follower arm.

Image 6.12: Mechanical track changer.

Mechanical track changer

The mechanical track changer works using a cam follower and discs inscribed with a circuitous groove with dwell at up to four positions (Image 6.12). The groove forces a sequence of positions which are translated to another tonearm by a connecting rod. Though the track changer does not directly cause sound, it uses an inscription to translate physical movement to arrangement-level pattern changes. In this way it can be seen analogous to a low frequency oscillator for arm position.

Processing

The processing element of a functioning turntable modifies the output from the sensor in order to make it usable as sound. A standard turntable requires a phono pre-amplifier to both increase the signal from the stylus to line level and apply equalisation according to the RIAA curve. Typical use in a DJ setup would also include a mixer, with further equalisation and amplitude controls. As Lippit explains, the mixer itself is an integral part of the DJ's instrumental setup, stating that his own practice, 'not only transforms a singular device into an instrument, but constructs an instrumental setup from a collection of devices', explicitly including the mixer in this broader understanding of the instrument (Lippit 2020:34). Through this research project, a strategy of modularisation was increasingly followed, developing components which could be used interchangeably in different ways, opening up capacity for different connectivity and routing.

Modular synthesizer system

The design of the modules built during this project followed Eurorack specifications. This allowed for integration with numerous existing components, and a framework for easily powering and connecting multiple devices. 'On a practical level, a standard format resolves issues in integrating equipment with different voltage to pitch standards, module sizes, and power requirements, thus providing a platform for designers to create modules that fit and function within a single environment.' (Randell & Rietveld 2024:175) Modulization has the added effect that different kinds of device can be used within the same system: 'the Eurorack standard facilitates the cross-fertilization of established analogue designs with digital counterparts.' (ibid) Almost all

of the control signals and audio used in the setup were processed using the modular system developed during the research project (Image 6.13).

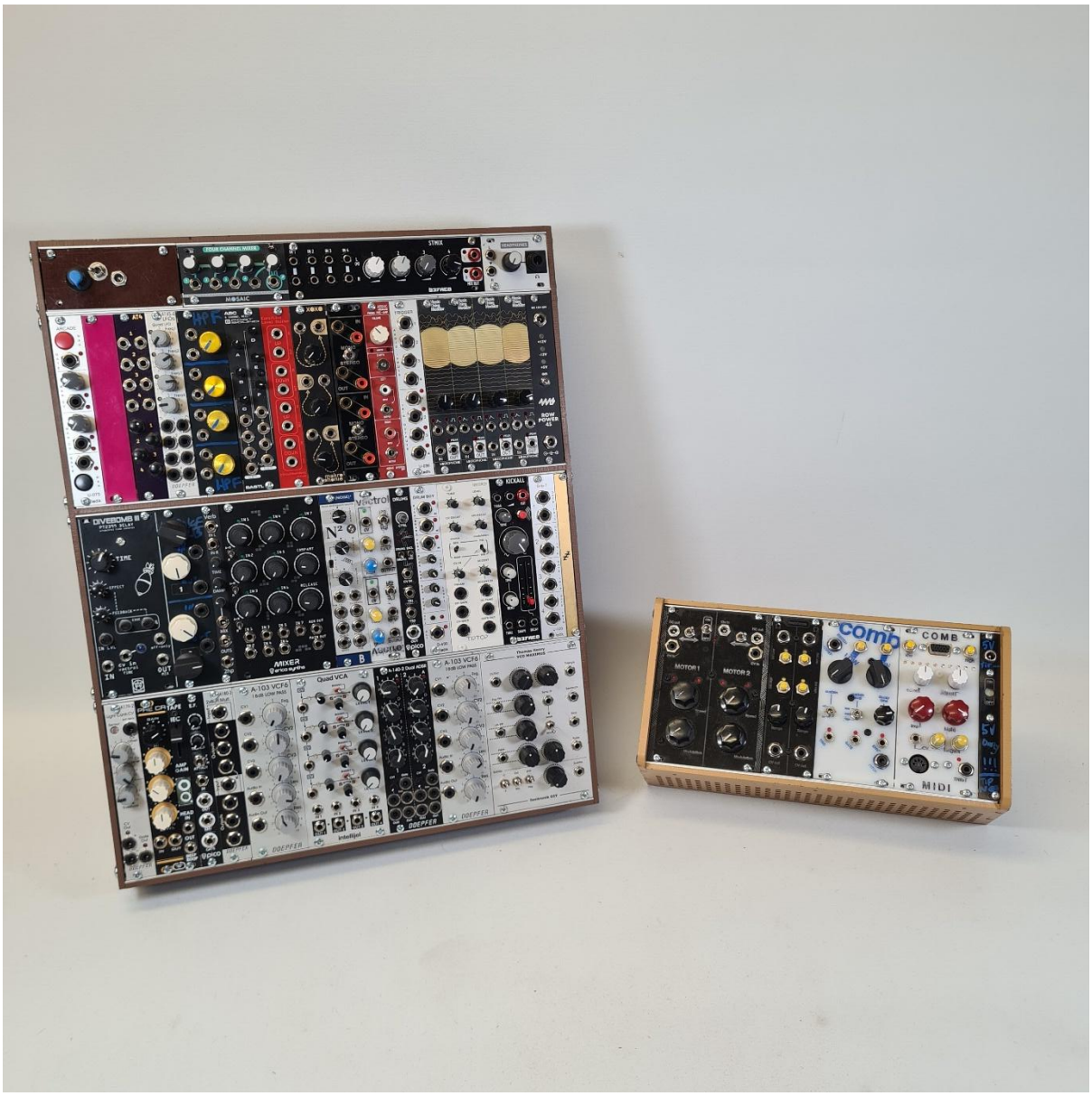

Image 6.13: Modular synth system.

Audio

Many of the signals generated by the extended turntable system are analogue audio. Processing to a usable signal from a stylus—via cartridge, magnetic pickup or piezo transducer—includes amplification and equalisation. Oscillator turntable output is usually a constant signal, which is later sculpted into rhythm patterns via other modules. Audio signals from the piezo triggers (used with the peg records) are converted to control voltage triggers, with some amount of analogue processing to avoid double hits. Other audio might be used via an envelope follower to create a

continuously changing control voltage. All audio signals are summed and balanced with a mixer, sometimes with additional effects (such as reverb and delay) applied.

Control voltage

Signals generated by components in the system may be triggers, gates or continuous voltages dependent on use. Specific modules such as an audio-to-gate, gate-to-trigger and envelope follower enable conversion between these types. Trigger signals are sharp voltage pulses at around one millisecond duration. They are used for initiating playback of a drum sound or an envelope (which itself is a continuous control signal). Gate signals alternate between zero and five volts, effectively either in 'on' or 'off' state. Gates are usually used for generating envelopes including a sustain period. Continuous signals are typically used to change parameters like amplitude, pitch, or filter cutoff over time. The modules developed for this project run at zero to five volts. One of the main appeals to my aesthetic using CV is that signals are fluid and continuous, and not locked to specific values. Typically, a signal can be boosted or attenuated to change its scale and maximum limits and, without some sort of specialised tuner or pitch quantization device, these need to be tuned by ear. In this way, the use of CV directly contributes to the aesthetics of the project.

MIDI

Developed between several manufacturers in the 1980s, musical instrument digital interface (MIDI) was an attempt to standardise the way electronic musical instruments would interact with one another. Since its implementation, MIDI has become almost ubiquitous: 'after thirty-five years, MIDI still functions as the circulatory system of most digital information in modern music production.' (Diduck 2018:21) Only one module in the extended turntable system uses MIDI: the MIDI Comb. The module opened opportunities for interfacing with numerous external devices, including Sam Underwood's solenoid-controlled air distribution system. The tuning system which ignores standard scales, and the inclusion of analogue control input and output on the device, were attempts to round off the edges of the digital control parameters, avoiding as much as possible the 'claviocentrism' (Diduck 2018:34) mentioned previously.

Mixing signals

Throughout the design process, opportunities for cross-use of signals were prioritised. The standardised format of Eurorack modules makes interconnections straightforward. CV signals are flexible enough to be used in a variety of ways. For example, pulses designed as gate signals played fast enough can be heard in the audio range. With filtering and modulation, a control signal can be used as audio. The MIDI Comb module outputs digital note data but also CV triggers, which can be used to interface with analogue devices in the modular system. It also has a reprogrammable CV input, which can modulate its parameters sent from external devices with analogue signals.

The role of the setter

As discussed previously, a significant aspect of the musicking work happens out-of-time in relation to the music which is produced. This out-of-time programming is similar to the work of the mechanical musical instrument setter. The role of the setter in eighteenth century mechanical music is a key creative function which was often overlooked.

> ‘The preparation of the programme for a mechanical musical instrument was the task of the organ craftsman who was skilled in music. His (uncredited) labour—he was generally not the actual or titular organ-builder but a member of the builder's staff—was expected to result in a musical machine that would perform to the expectations of the client and/or the public at large.’ (Ord-Hume 1983:186)

Working with an automated mechanical music-system, the role of the setter takes on a great significance. Setting a pattern is part of the composition process, creating a fragment of rhythm which can be incorporated into a musical piece via triggering or modulating sounds. In broad terms the patterns chosen offer specific rhythmic affordances and close off other possibilities. The more precise work of setting in this instance contributes ornamentation, microtiming variation, a looser or tighter rhythm feel: the subtle differences which contribute to a sense of machine-liveness in the groove.

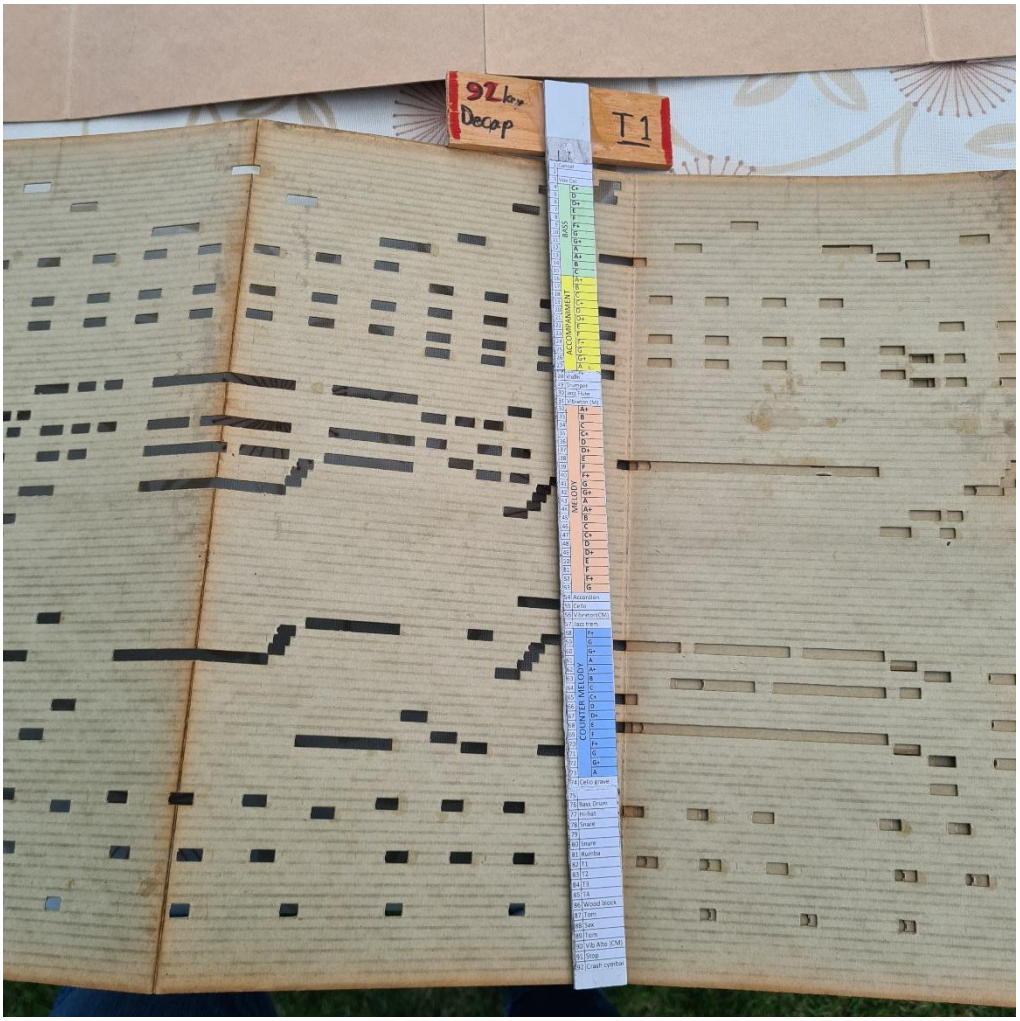

Image 6.14: Hand cut piano roll for fairground organ, with guide bar.

In August 2023 I visited the collection of a fairground organ owner and setter in Stevenage, for an open day at which several of the machines in his collection were played for public listening. He kindly showed me the equipment and process used for creating new piano rolls for the machines, which followed two stages. First, a MIDI file was reformatted with a DAW to rearrange the position of certain notes and beats to match up with the available voices the fairground organ could play back. This was then printed to sheets of paper as a template. Second, a manual process of punching holes into card for the organ, at which stage further subtle adjustments were made, necessary for the correct function of the machine. Image 6.14 shows an example piano roll, with the guide bar used to check which slot activates which section of the organ. Most pneumatic activation worked almost immediately, as a swich would open a pipe at the onset of the signal. Certain mechanisms of the organ worked differently, such as percussion which might trigger late: the setter's role is to know how early to cut the

activation hole so that all the instrumental voices properly coincide. Through heuristic strategies the setter learns the character of the individual machine and how to translate the strictly gridded guide notes into an appropriately musical sounding piano roll. Historically, not all piano roll programming was done note-by-note manually. Use of a marking piano allowed a pianist to perform normally, their keypresses marking a paper roll which as later cut by hand. The performance was 'recorded' in a mechanical way, to capture the nuance in timing and tempo of the player directly. This process allowed performances by composers—for example, George Gershwin and Claude Debussy—to be repeated through playback on a reproducing player-piano, a device which 'plays back' the use of pedals as well as keypresses.

The role of the setter in automatic music is similar to aspects of the role of the musician in performing from a score. Part of a musician's task is to translate notation into physical movements which activate sounds. The player follows the instructions of the score, though always instilling something of their own personal playing style in the process. Similarly, in the translation of the composer's score into a physical pattern for the machine to play, the setter's personal style can come through. In automated music the musician's role is split into two: the setter translates the music and the machine executes the sounding actions. Contemporarily, the activities of the setter remain important across many types of automatic music. A piano roll is included in a majority of DAWs as one of the primary ways of programming melodies and refrains. This can be achieved by a number of means, but commonly by either adding notes with mouse clicks and drags, or by live playing on a MIDI keyboard (often a combination of the two). The other common way to programme DAWs, drum machines and some synthesizers is via the step sequencer. Typically sixteen notes long, each step can be set to perform different actions: trigger a drum at a certain velocity, tie with the next note, or accent the current sound. This type of programming is a form of translation between the writer's intention and the language readable by the machine. The process of programming a tune (the setter's main action) is largely determined by the architecture and interface of the device in question. The limitations of MIDI enforce twelve tone note divisions, for example. Programming the TB-303 bassline synthesizer was notoriously difficult to master, and its idiosyncratic often design led to unusual sonic results which may or may

not have been at the artist's initial intention. Two factors are important here, then: the process by which a device is programmed, and the effect the design of the interface is likely to have on the musical outcome. The descriptions of the extended turntable components above seek to explain how these were considered during the research project. A third factor relates to liveness: to what extent can the programming happen in real-time?

Real-time programming

Mechanical Techno, through the design of the extended turntable system, affords programming in several timeframes—during performance, real-time and out-of-time—which distinguishes it from both traditional mechanical musical instruments and typical use of a DAW for composition. Parallel processes can be found in both live drum machine use (Butler 2014:128) and live coding practices (Knotts 2022). Designing fixed inscription records is a comparable operation to the combined work of the composer and setter. Fragments of rhythm are permanently programmed for later use, sometimes with the only fixed intention to allow new possibilities to be explored. Discussing the nature of playing improvised music, composer and vibraphone player Corey Mwamba notes the relationship between preparation and spontaneity: 'I don't really see improvising as a spontaneous act. I actually perceive improvising to be one of alacrity, and alacrity means a readiness to respond. That's what we prepare for. … In my opinion improvisers actually do things … that they have prepared to do.' (Williams 2019) Preparing pre-programmed discs with rhythm fragments sets up components for future performances, requiring alacrity to deploy at the appropriate moment. With a toolbox of score fragments, in performance I am ready to respond to the assemblage as it is being built. The setting process—making the fixed inscription discs—happens out-of-time, but affords real-time interaction with the system.

Programming the peg discs during performance happens immediately before activating the pattern, visible to the audience. Video 6.1 shows this in action during a live performance, at 24'55. Though this is not a direct action-sound-coupling, as the action of programming in itself does not produce sound, the process is exposed and acts as a demonstration of the technique used for activation. This visible programming is a type

of indirect or deferred action-sound-coupling. A similar process is seen in live coding, whereby a line of code is written during performance (the process of which does not itself cause any sounds to play), then executed shortly afterwards (activating the sounds). Programming as deferred action-sound-coupling in Mechanical Techno is like physical live coding, demonstrating the creation of an algorithmic pattern out of tangible objects, then using that pattern to make sound. The ball-bearing discs work in a similar way to the peg discs, as they can be programmed just in advance of use, but also offer the capacity for both live programming and live editing. Ball-bearings can be added to the disc whilst it is spinning and triggering sounds, and, with the use of a magnet, they can also be quickly removed. In this way, the disc is both programmable and editable in real-time. The device is similar in this regard to a step-sequencer in live mode, where the pattern will continue to play and any changes to the programming will be heard the next time the cycle comes round. The physicality of the process with the ball-bearings, however, makes setting patterns difficult and often creates unexpected or unintended results. The unusual quantization options presented by each of the discs (for example prime numbers, divisions of ten) also differentiate the outcome from standard step sequencers. A similar set of affordances is enabled by the steel disc with magnets, and the empty platter with different objects, which can be added, adjusted or removed in real-time. As the shapes used tend to trigger multiple notes and note clusters, these produce markedly different results than most standard sequencers. In each instance it is to a large extent the physicality of the system which produces these unique effects.

Conclusion

By breaking down the Mechanical Techno assemblage into its constituent components, and analysing the capacities of those components, sets of affordances and combinations of possibilities can be further understood. Considering the system in a modular way and developing Eurorack format modules for the system allows for an approach to system design which has a direct throughline to the aesthetic output of the work, as Magnusson explains:

> ‘For a musician using modular synths, the design and construction of a unique module (such as an oscillator, a filter, or a timed gate unit) is clearly a creative act, but the creativity is not only in the technological domain: it is musical too, in that the module becomes the scope of possible musical creativity; it becomes the generative framework from which the music derives. The assemblage of modules in the modular synth becomes a compositional process in which the scope of the music is defined, and the musical possibility of the creator becomes clearly identifiable.’ (Magnusson 2019:118)

Recognising the role of the motor in setting clock speed, or track tempo, suggested the addition of extra motors running at different rates. This allowed for new sound sources (via the oscillator turntable) and new ways of including automated arrangement (via the slow platter). Sensor developments afforded new timbres and the generation of different types of signals for use in interactions with other components. Signal processing and the combination of different types of signals, namely audio, CV and MIDI, opened up a broad range of possibilities.

The role of the setter is unique to mechanical music. Though the role encompasses tasks such as sequencing a pattern (which might apply to drum machine programming) or adding notes to a piano roll (found in the majority of DAWs), the setter also makes numerous decisions to do with ornamentation, quantization, microtiming variation and the way the machine ultimately functions. Through these methods the setter fills the sequence with their own preferred characteristics. Even in the heyday of mechanical music, before recorded sound, ‘Ornamentation was not just a way of life, it was not only attractive decoration for a melody, it was also as individual as a performance by a particular player’ (Ord-Hume 1983:193). Through use of components which afford unusual quantization or unquantized patterns, Mechanical Techno infuses its music with its unique character.

In the work of DJ Sniff, inscription (both deliberately planned and generated through wear and tear or maltreatment) manifests as both a physical act of marking records and a metaphorical process related to memory—the inscriptions are a type of storage as well as being a physical mark. Lippit notes the process by which specific records which have suffered damage during use and transportation (in effect, bearing new

inscriptions) contributes to the development of the work: 'It is hard to deny a sense of disappointment and remorse when new damage occurs because they are valuable possessions, but at the same time they are also traces that link personal memories with a physical object… With scars on the surface representing memories accumulated through listening and performing, these two records by now felt like a part of the instrumental setup…' (Lippit 2020:80-81) Using Mechanical Techno, the programming of inscriptions within the system becomes the main way of making new musical works, both in the performance space and the studio. And these inscriptions are a vital part of the instrumental setup. This composition happens at different relative timeframes within the work. Ahead of time (pre-performance) composition includes the sticker pattern records and dubplates. Immediately before activation (visible in performance) composition includes the peg discs and ball-bearing discs. And acts of live inscription (live composition of patterns) include modifying existing ball-bearing patterns, making pen marks, and adding tin-foil shapes to currently-playing records. The different forms of active inscription as composition afford different musical outcomes, and within the Mechanical Techno system these combine in infinite new ways. Combinations of quantized and unquantized patterns, shifting start-and-end points, and single-cycle-loops at different scales are the building blocks of the musical output of the system.

Whilst consideration of instrumental components allows for analysis of their individual sets of affordances, such specificity can miss the emergent properties that arise when the component is used within an assemblage, the 'properties of a whole caused by the interactions between its parts' (DeLanda 2016:9). For this reason, the following chapter zooms the focus back out from the constituent components, past the scale of Mechanical Techno as an assemblage, to consider how the system can be plugged into other musician-instrument relationships to form assemblages at the scale of collaborations.

Chapter 7. Collaborations as assemblages

Introduction

In this chapter, my work with four collaborative duos is analysed. Each combination is considered as a new assemblage, its constituent components are identified, and detail is given on the dynamics and forces which are at play. Working in collaboration with the extended turntable system means plugging it into a new assemblage. In the examples presented here the other elements of the system are other solo musicians with their own instrument-systems. The four collaborators with whom I worked are Cath Roberts, Sam Underwood, DJ Food, and Heavy Lifting. Each of the four collaborations allowed for a slightly shifted focus towards the specific areas of research under consideration: sound art and experimental music with Cath Roberts; instrument design with Sam Underwood; turntable practice with DJ Food; and electronic dance music with Heavy Lifting. It should be noted here that each of the collaborations also contributes to other areas of the research, as there is overlap across the fields. A collaborative assemblage does not operate in isolation, always forming part of a larger system (itself an assemblage), as Waters writes: 'Musical instruments are made with particular social situations and conducts in mind, and tend to be mutually constructed within the bounds of that environment too.' (2021:136) Because of their embedded and networked relationships, instruments as assemblages form components in larger assemblages: 'They are therefore assemblages within a further assemblage (player-instrument-social expectation), which is contiguous with (indeed inseparable from) the previous one.' (ibid) Where specific performance events are mentioned, the event is considered at the scale of the performance ecosystem: considering audience, performance space, soundsystem and other artists as part of that assemblage. In describing contributions of scene, genre and artistic field to the abstract machine which guides each collaboration, consideration is given to still larger assemblages at that scale. For each of the four collaborations, an excerpt from a live performance introduces the work. The concrete assemblage and abstract machine elements are identified. Insights from the collaborative work are discussed, with extracts from my both my journals and the

recorded conversations with each collaborator about our work together, to highlight the process and key themes.

With Cath Roberts: Music as a constellation of processes

In the collaboration with Cath Roberts, we performed improvised, textural, noisy electronic music featuring bass synthesizer drone, machine sounds, mechanically played percussion, amplified metal tines and granular sampling. Video 7.1 Graham Dunning & Cath Roberts (TACO! excerpts) shows three short sections from our performance at TACO! in Thamesmead, London on 29th July 2023. This was our fourth performance together and took place the day after a recording session at London Southbank University's Elephant Studios (Image 7.1), which also served as a kind of rehearsal and opportunity to discuss our approach and aesthetics.

Image 7.1: Graham Dunning & Cath Roberts recording session at LSBU Elephant Studios, 26 July 2023. Photo by Jack Driscol.

Concrete assemblage

Cath Roberts is 'an improviser, composer and artist whose work combines acoustic and electronic improvised music, experimental composition, and DIY

publishing/printmaking' (Roberts 2025). Cath is well established in the London improvised music scene, performing regularly in numerous ongoing projects and with new pairings, and running two event series foregrounding experimental improvised music. For our collaboration Cath used a minimal tabletop electronics setup, consisting of a Soma Lyra-8 synthesizer, a Bastl Instruments microGranny sampler, and a mixer. The Lyra-8 is an analogue synthesizer consisting of eight oscillators which can interact with one another in chaotic ways, and touch contacts allowing for physical playing. The microGranny is a low-fidelity granular sampler which mangles recorded sound, creating noisy textures and drones. Throughout the collaboration we discussed what kind of audio might work well for our aesthetic. The sampler was initially loaded with recordings of Cath playing the baritone sax and some stock drum samples. Later we experimented with self-sampling (with recordings from one of our previous performances) and recordings of Cath's voice reading from a book on architectural design.

Physically the extended turntable setup consisted of a DJ turntable and mixer, second tone arm, mechanical small percussion, several types of metal tines amplified with contact microphones, and a cassette Walkman capable of recording. My intention for the collaboration was to maximise use of the mechanical aspects of the turntable, in order to investigate the aims of this research project at its most basic level. As such several new configurations were developed. Different performances used different setups, including one set where no turntable was used. Techniques and processes were experimented with and developed throughout the collaboration. My choice of recorded material—considered similarly to Cath's selection of sample material—was to use records of machines and machine noise. This included sound effects records with various forms of transport, and field recordings of steam trains and aircraft. With the cassette Walkman I used tapes I had recorded myself, limiting the selection to field recordings with noisy timbres. These included contact microphone recordings of a piece of driftwood dragged along a beach and a dry bush in high wind, and field recordings of a hissing reed marsh and an idling canal boat engine. Figure 7.2 shows a diagram of the collaboration.

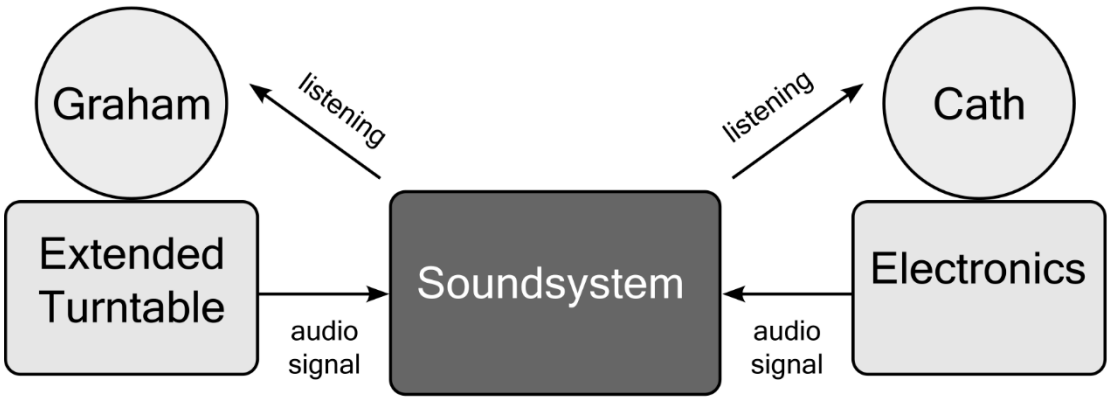

Figure 7.2: Diagram of Graham Dunning & Cath Roberts collaboration at TACO!

Abstract machine

Numerous structuring factors and interpersonal forces affected the organisation, aesthetic direction and musical outcomes of the project. Our initial pairing was an invitation from improvising musician Phil Durrant to perform together for his series Overtones & Undertones, at Iklectik, an arts and experimental music venue in London. Though there was no explicit instruction as to the genre of music we might play, instrumentation or musical direction, our expectation was to perform something with at least some shared approach to the others on the bill. Two other groups were scheduled for the show, both ensembles of improvising musicians using combinations of acoustic instruments and electronics. Our choice of instrumentation was made independently, with Cath choosing to focus on electronics as a relatively new direction for their practice and me taking the opportunity to develop some extended turntable affordances in a new context. Whilst that performance was the first time we had worked together as a duo, our creative practices had converged at several points previously and we had an established working relationship. Cath had booked me to perform solo and in other collaborations at the LUME event series. In 2022 I released a cassette of Cath's solo electronics improvisation on my label Fractal Meat Cuts. We had also both played together in the Colin Webster Large Ensemble, an eight-piece improvising group led by a saxophone player with whom had both independently collaborated. Additionally, in 2021 we led a week of workshops in experimental performance and composition for students of Aldeburgh Young Musicians. As such there was a certain shared aesthetic

and tacit understanding of the way each other may approach such a collaboration. Our work in the collaboration consisted of four live performances (Image 7.3), one studio recording session (Image 7.1) and several informal technical rehearsals. The contexts in which the performances took place also set certain unspoken expectations as to the direction, sound and pacing of the sets. All took place at experimental music events, but with subtly different atmospheres and audiences.

Image 7.3: Cath Roberts & Graham Dunning live at Hundred Years Gallery, 27 May 2023. Photo by Plague Arish.

Discussion

Through use in performance, it became clear that the process of setting up each configuration of the machine was a key element of the performance, affecting the pacing of different sections, my capacity to respond musically to Cath's playing and how each segment could flow into the next. My contribution to the collaboration became the activation of a series of processes, with Cath running their own processes. Sometimes our actions were responsive and sometimes independent. The performance retained its improvisational structure as the order, duration and deployment of each process was flexible and optional. The improvised nature of the work was the basic

organising principle and the force which governed each of the performances. In our discussion we acknowledged our experience as improvisors as the foundation of the project.

> *CR: In theory, it doesn't really matter what you're both using to make sound. Actually, that's the core of it; it's about how the two people interact. The two people who provide this certain kind of music. … What is this duo? What is the thing? What are we doing? And what is this relationship?*
>
> *GD: I don't really want to use the word "skill." But having experience in the process of improvising is what's important. And I think you can do that with any instrument.*

The process-based nature of my actions with the extended turntable led to an improvising style which set a certain pace and flow to my contribution to the work. Building a sequencer on the turntable, for example, means pre-planning within the performance, and certain actions which are visible but produce no sound (such as mounting the central axle on the platter). The way that the sonic output builds and flows relates to the processes of physically activating the sounding elements. Reich's description of process music directly excludes improvisation: 'The distinctive thing about musical processes is that they determine all the note-to-note details and the overall form simultaneously. One can't improvise in a musical process—the concepts are mutually exclusive.' (2004:305) Here, the processes are used within the improvisation, rather than the other way round. Elements of process music become building blocks which can be deployed inside the improvisation. The organisation of the sounding elements and combination of ourselves and our devices (that is, the assemblage of the system) led to the development of a conceptualisation of our compositions as layers of textures and frequencies, rather than discrete notes and melodies.

> *GD: If you're thinking about the composition as different layers or blocks of sound, for something to stop suddenly can be almost as interesting as something coming in suddenly.*

CR: Another thing that I've noticed myself doing with the Lyra 8, especially on the big soundsystem, is to suddenly add a load of throbbing bass underneath something. … Putting in a continuous texture underneath.

The processes are, to a degree, derived from the technical components from which the assemblage is composed. Using predominantly noisy, unpredictable and non-musical sounds and sound-making processes both limits the possible direction of the project and affords conceptualising the output in this new way. Though we discussed approach and outcomes at points throughout the collaboration, improvising during performance is its own type of communication: we neither planned specific structures nor relayed instructions during the performance, relying instead on listening to the whole as we created it. There were moments where each of our intentions for the direction of the piece did not match: points at which we were not working towards the same outcome. These moments of clashing intention can be seen as another type of noise in the system, a 'failure' in communication which can lead to unusual and sonically interesting outcomes. And indeed, as Cath mentioned in our discussion, the use of unpredictable devices can contribute by scuppering intention.

CR: It's not always about intention. Like we were saying earlier, we don't necessarily want to know exactly what's going to happen. I definitely don't want to know that. And it's even more exciting if you don't know what's going to happen with the sound that you produce yourself. Which is what the electronics brings for me.

The characteristics of the machines and devices used in the performance were discussed as a specific contributing factor to the mode of playing and sonic outcome. A certain amount of relinquishing control can contribute to the experience of collaborating as part of a whole system.

CR: I've just learned to do it by playing. And the equipment definitely feels more like a bandmate. Or it's more like an agitator, some kind of intervention in the performance, rather than a tool I can completely control.

... having a stimulating experience of unpredictability or indeterminacy coming from the equipment. I wouldn't be that interested if I knew exactly what every button and knob combination was going to do.

We viewed the collaboration as a process of working independently with our own devices, but together to create a unified sonic outcome. The importance of continuous evaluation was clearly important, as formulated in McDonald and Wilson's model of interactions in group improvisation (2020:78). Significantly, paying attention to the whole as opposed to individual parts was essential to the success of the work.

GD: I feel like I'm listening to the sound as a whole thing. It's not really a thought-based process, or conscious anyway. You're almost intuitively reacting to what the soundscape sounds like.

CR: I think a lot about making space. So if I've got something running, then I'm thinking, what else is happening? And do I need to get out of the way here? Or should I move into another area, another frequency range, in order for this other thing to sound better. Or in order to change. To make room.

... But I feel like I'm constantly evaluating what I'm responsible for doing. Because often you can't tell who's doing what.

Ultimately, the project can be seen as one of sculpting the sound together, and reacting to the result in real-time. The music which is created is not a static, fixed entity, but something constantly evolving and changing, an emergent amorphous whole dependent on all aspects of the performance ecosystem.

GD: I think it's interesting that we are both listening to the whole thing. It's almost like we're both sculpting something together.

CR: Yeah. That's how I think about it actually.

GD: Like this object in space. It's a lumpy thing that changes.

CR: And it's changing over time.

By using multiple partially self-playing processes, whether they are produced by chaotic analogue oscillators or rotating electromechanical systems, the collaboration creates

layers of textures, drones and sound which produce an evolving whole. Though each of us is using our own setup and there is no direct interaction between the devices, almost all the sound produced is amplified through the same soundsystem: Our signals combine and are brought forth into the space together, experienced simultaneously by us as players and the other listeners in the room. External noises and audience sounds add additional layers of process. The complete performance ecosystem becomes an instrumental assemblage producing and bound by the music. Rodger et al argue for such an ecosystemic approach in evaluating musical instruments: 'To avoid the issues associated with treating musical instruments as devices, we should jettison the idea of an instrument as an essentialised singular thing, but rather think of it as a constellation of processes (affordances) which may be shared with other instruments, and which may change over time.' (Rodger et al. 2020:407) The collaboration between myself and Cath Roberts works as such a constellation of processes.

With Sam Underwood: Combined modular mechanical musical instrument

Our collaboration combined our individual modular, mechanical musical instruments into one assemblage. We improvised together to make electroacoustic music with elements of drone, polyrhythm, dub and noise. Video 7.2 Sam Underwood & Graham Dunning (Line Up! excerpts) shows three short clips from our performance at Line Up! Festival in Malvern, Worcestershire on 25th August 2024 (see also Image 7.4).

Concrete assemblage

Sam Underwood is a 'sound artist and musical instrument designer' (Underwood 2025) and also a research practitioner who was completing a PhD at the time of our collaboration. Sam's instrument design work is primarily with novel acoustic instruments and mechanically activated devices. For this new collaboration Sam used *ams*—the acoustic modular system, the focus of his PhD research. *ams* takes the principles of a modular synthesizer, including voltage control, interoperability and flexible interconnection and applies them to a series of acoustic instrumental components. As such, the sonic output of the device is entirely acoustic and mostly mechanically activated. Sounding devices include small percussion played with

solenoids using flexible beaters, organ pipes activated with mechanical bellows and blowing fans, and a feedback plate affected by physical interaction. *ams* is also capable of generating chaotic sequences with a rotating plate with distance sensor and magnetic coupling.

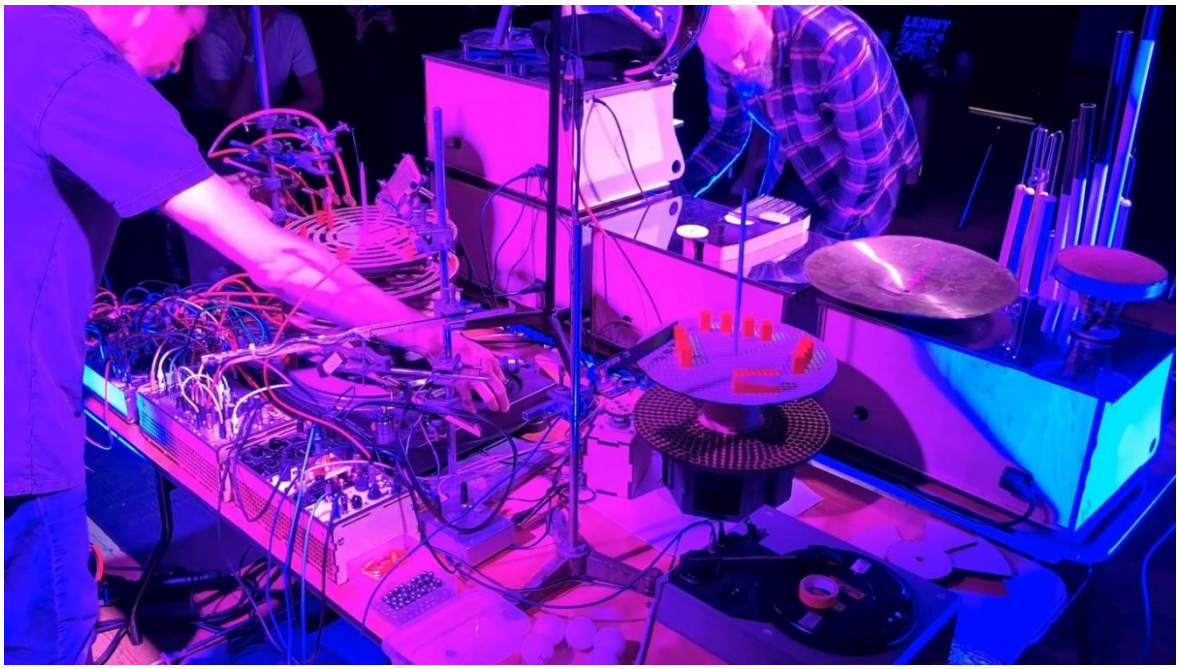

Image 7.4 Graham Dunning and Sam Underwood at Line Up! Festival, Malvern, 25 August 2024. Video still.

Image 7.5: Graham Dunning & Sam Underwood live at Galerie Paradise, Nantes, France, 3 June 2023. Video still.

The extended turntable setup I used in this collaboration varied across our time working together. The initial plan was to use the Mechanical Techno configuration and investigate ways in which the two contraptions could interact. At the first meeting in May and June 2023 (Image 7.5), limitations in the available connections between the system became apparent. For those sessions, additional sound-making devices such as amplified tines and a keyboard sending MIDI were used and a proportion of the sounds were human-played rather than machine-played. For the subsequent performance in August 2024 (excerpted in Video 7.2) I built new modules in order to be able to interface with *ams* in more ways, focusing on the extended turntable as a multi-mode sequencer.

Abstract machine

Sam Underwood and myself have a longstanding friendship and creative collaboration. We first met around 2009 at Sonic Weekend, a music recording residency, and have played in multiple musicking contexts since then, including alongside saxophonist Colin Webster in the improvising trio DunningWebsterUnderwood. Our longest running collaboration is the *Mammoth Beat Organ*, a large, acoustic, mechanical musical instrument we built in 2018 and have been developing and performing with since. As such we are very familiar with each other's musical tastes, performance approaches, and aesthetic preferences.

Our approach to performance in the collaboration was something of a combination of manifestos. To some degree these overlap, but certain aspects were unique to one or another of our approaches and had to be negotiated. Common to both our work is a prioritising of action-sound-coupling. This is both built into the machines we use and informs the way in which we play. We both favour an approach somewhere between playing planned pieces and improvising. Each of the performances had a number of set-pieces and a relaxed attitude towards pacing. More structure was present for the first two shows in Summer 2023, whereas the performance excerpted here had a looser, almost totally improvised structure. We both preferred playing in-the-round for the performances, setting up two tables facing one another and encouraging audience members to meander around the space to see the sound-actions in the moment of being made. One important aspect requiring discussion was regarding amplification

and overall sound level. By design *ams'* output is fully acoustic and Sam prefers to perform without amplification in order encourage close listening from the audience and afford better action-sound-coupling through located sound. In contrast, the extended turntable system takes advantage of amplification for its characteristic sound. Use of record crackle as a sonic element and amplifying objects with contact microphones both take quiet sounds and greatly increase the volume level to bring out the details in their sonic character. Bass and sub bass are used frequently, which require a significant level of amplification to be properly heard. Our compromise was to perform quietly—set at the volume level produced by *ams*, and with *ams* remaining unamplified —but with the extended turntable amplified with studio monitors on the tabletop (localised) and a sub-woofer under the table for the lowest frequencies.

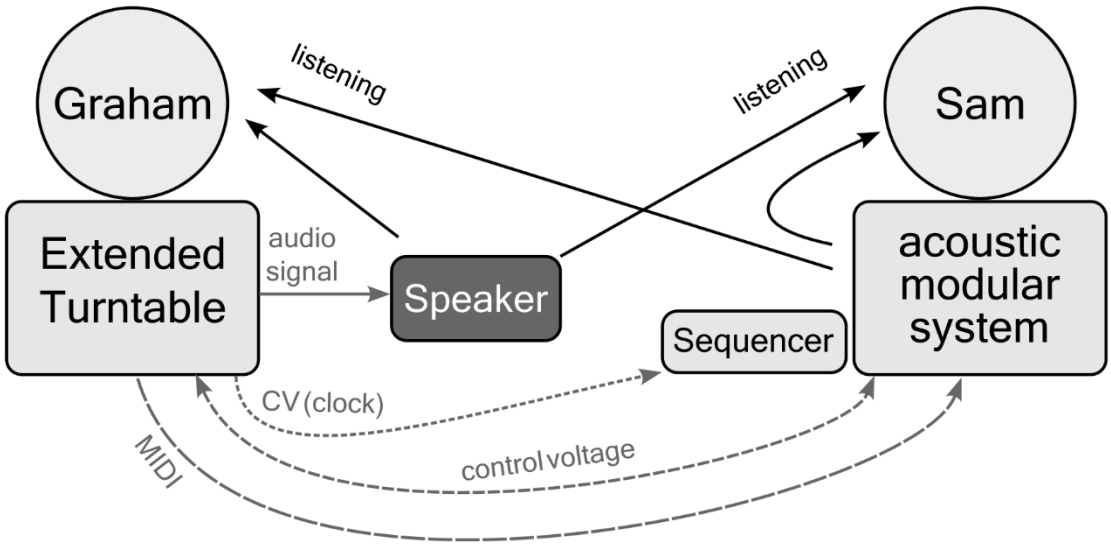

Figure 7.6 Diagram of Sam Underwood and Graham Dunning collaboration at Line Up!

Discussion

An important aspect of the project concerned the joining of the machines. *ams* is designed around use of control voltage for much of its function and also includes an air switching module which responds to MIDI (shown in Video 6.1). At our performances in 2023 we choreographed a moment into the show, passing a patch cable across from my setup on one side of the table to Sam's devices on the other, in order to visually demonstrate the interconnections of the devices. Though not made explicit in the 2024 show, there were more interconnections and control methods from the extended

turntable system to *ams*, with MIDI from the MIDI Comb controlling Sam's wind chest solenoid valves, a signal from the optical reflection sensor running as a clock for Sam's sequencer, and control voltage signals feeding both ways between the two systems. Figure 7.6 illustrates the connections.

> *SU: I think it is a part of something we're conscious of with our systems generally, that the visual element is quite important. But also performatively there's some relevance to that side of things. Not just a musical outcome but a thing happening live in front of your eyes as well.*

The performative relevance of prioritising action-sound-coupling in both of our work is to encourage a sense of intimacy, through seeing the subtle mechanical processes at play, and ultimately to forefront the liveness of our processes. The in-the-round stage setup and overall low volume level used in each of the three performances were also intended to foster intimacy, audience curiosity and connection.

> *SU: One of the aspects of* ams*, along with a lot of modular performances, is that I have my back to the audience. And that was broken a bit as a setup when we played together, because we were more in-the-round. There were two sides to the machine at that point.*
>
> *GD: There's no front.*
>
> *SU: There is no front and back. … If I'm playing solo with* ams*, I've necessarily got my back to the crowd. … But it was quite exciting that, with your stuff there, we were more properly in the round. People could surround the machines, and they could see stuff going on wherever.*

The process-based nature of our performance styles also became a relevant factor in our performances. Specifically, as with the work with Cath Roberts, setting up a new group of components to perform a certain function takes time, and this sets a particular pace by the amount of sound which is produced by the process.

> *GD: …whether it's deliberate or not, both of our systems have something built in, which means that even if you are busy all the time, things have a duration to them. And it takes a while for things to change over.*

Duration and the relative length of different planned pieces within the performance was a flexible set of planned actions, underlining the centrality of improvisation within the work.

> *SU: I think we're both open to the idea that any of the pieces could have not been performed, because there wasn't time for them. Because another couple of pieces had gone long. Or canning a piece just if it didn't feel right. Or even if it's just reached its length after two, three minutes or whatever, that's fine.*

In the performance in Malvern excerpted here, the whole piece was improvised without a predetermined structure. As there was a gap of a year between the two sets of performances, we had each had time to better learn our respective devices, becoming more comfortable with using them in a spontaneous setting. The performance uses textural sounds, clattering rhythms, discordant polyphonic organ patterns and, later, techno-influenced beats. Whilst interconnections were worked out and adjoined in advance, the music itself was not explicitly planned. There was an expectation that the piece would crescendo with a rhythm-heavy section, but this was based on likelihood of outcome from previous performances and rehearsals, not set in stone. Certain of the interconnections lent a contingency across the two devices. For example, the clock signal generated by the optical reflection sensor on the turntable was necessary for Sam's Keystep Pro sequencer to run—ultimately controlling all of the drum solenoids from *ams*. Likewise, the ball-bearing disc controlling the MIDI Comb was sending pattern information to *ams*' air distribution device, switching which organ pipes would sound—with no active sequence, *ams'* air output would be static. The dependence of one device on the other set a specific dynamic for the performance, where my focus was necessarily skewed towards producing sequences, and Sam's towards generating sound and modifying sound-makers. As such, the concrete assemblage made a significant contribution to the shape of the performance.

The quiet overall volume level and the close, in-the-round performance produced an unusually intimate and intense environment, with a feeling of both awkwardness and absurdity. The silliness and capacity for a novel relationship with the audience was something we were aware of as the operators of our machines, and something we fostered in the performances.

SU: ...you spend a long time working on the nuance of them, and working out how they work. But it is important for us to understand that they are quite ridiculous. They look fucking nuts and hilarious and daft. I feel like the right mood is to acknowledge that and understand that. And you definitely end up in settings where that is one of the features of the overall performance. And it can lead to really nice, funny things happening.

GD: There's been occasions where one of the ping pong balls drops off my turntable and someone passes it back to me. And that's always a really nice moment. But it's not something I could do on purpose or plan for. Because it would just feel so disingenuous.

Alongside the playful nature of the performance, the actions taken need to be done authentically. At its heart, our work is not a comedy performance, but an authentically performed musical one. Part of the likelihood of the music working is that there is a sense of trust between us as performers and the audience in the space. This was also something we tried to build into the structure of the performance.

GD: We did have a plan of what the first piece was going to be. Those initial few moments help you gain the trust of the audience. If it's not a kick in the gut, it needs to at least look deliberate. And like you're acting with purpose, and that you know what you're doing. For them to trust you and follow along. That it's going to be a deliberate performance.

SU: There's an invitation that you as a performer are offering to the audience. Initially as to why they should bother sitting there and listening to your noise. And then it becomes a relationship like most others, really. I feel it's a very two-way thing when playing live.

Sonically the project has elements of the more abstract, textural music made in the collaboration with Cath Roberts, along with rhythm elements towards building a groove. The distribution of processes, sequencing, sound-making and textural layering between myself and Sam meant that a complex musical outcome emerged from a combined effort.

SU: … just the difference in the groove would indicate to me a different type of sound was required at my side. Be that just something that's louder, or just fits a certain aesthetic more. Which I felt was a was a two-way thing as well. Often the main groove of a piece was slightly more determined, I'd say, from your side than mine. But then your response in terms of what you built into the piece from your side was also in response to the groove that just kind of happens.

GD: So, we know how the systems are going to work together, we know what ingredients are going to go into it. But then at each stage, as that section progresses, you're making decisions about: introducing a new sound, how does it fit with what's already there? And so, at that level, it is an aesthetic decision: what works here? You don't just throw something in and not change it, regardless of what it sounds like. … We're both listening to the whole piece, and then paying attention to the new sounds that are coming in. I don't know, maybe you'll take something else away to give things room. But it's a step-by-step process of building something in the moment.

Building a piece together in the moment is an important aspect of the collaboration, and in the true sense of improvisation, not something which can be meticulously planned for.

GD: …you can't really predict when it's going to be a groove that you like. Because it can be such a subtle thing. Like the specific bass tone that I'm playing resonates the sub speaker or the room in a way that's really satisfying, at the same time as the beat notes that your organ pipes are making. It sounds interesting and it all gels together. We've set the groundwork for that to be a possibility that can happen, but you can never predict when it's actually going to work.

The liveness of the performance comes through the unpredictability of the sound coming together, the risk that the musicking assemblage may fail and be either reduced to a flat, static whole or just never coalesce into a satisfying musical outcome. The process of listening to the whole whilst making adjustments comes from both sides of the table, from each of our instrumental assemblages, but, importantly, via the

combination of the two together. The electronic, mechanical and sonic interconnections are the foundation upon which the assemblage is built, and open up opportunities for immanent sound-making exploration.

With DJ Food: Extended DJ Set

First billed as a 'modified turntablism soundclash' (RobinTheFog 2023) the collaboration was conceived somewhat like a back-to-back dance music DJ set, but with two extended turntable systems rather than a standard DJ setup. Video 7.3 Graham Dunning & DJ Food (FogFest excerpts) shows three edits from our performance at Iklectik on 5th August 2023. Visuals were produced and projected live, by PuttyRubber (Laura Murphy) using analogue video feedback, and Chromatouch (Leon Trimble) using modular video synthesis. Throughout the research project we performed as a duo three times (Image 7.7), and had two rehearsal sessions. An album, *E-x-t-e-n-d-e-d Turntablism Vol.1* (2026), was also collated from edits of these sessions.

Image 7.7: Graham Dunning & DJ Food live at Next Festival, Bratislava, Slovakia, 29 November 2023. Photo by Šimon Lupták.

Concrete assemblage

DJ Food began as multi-producer project in 1990, with varying lineups since that time, finally becoming a one-person operation led by Kevin Foakes, also known as Strictly Kev. In live performances as DJ Food, Kev uses an extended turntable system he has developed called the *Quadraphon*. The system comprises a DJ turntable with three additional tone arms, one attached to each of three sides of the case on a sliding rail, meaning their angular position relative to the platter has some capacity for adjustment (Image 7.8) This means four styluses can be used simultaneously on the platter at approximately ninety degrees separation. The signal from each stylus is sent to a DJ mixer with four stereo channels, and an auxiliary delay unit—the Zen Delay by Ninja Tune—designed for performance use and capable extreme delay times, feedback and tone colouring. Kev uses commercially available locked-groove records as the primary sound source. Some records are releases by individual artists making techno, acid house, drum n bass, breakbeat or ambient music. Others are released as bootlegs or DJ tools including loops from various artists' tracks and often not authorised by the original producer. In our work Kev also used a handful of non-locked-groove records, mainly acapella vocals, drones and other sonic textures, and a dubplate of an extended spoken word sample he had made for our first performance.

My extended turntable setup for this project was the one-turntable Mechanical Techno configuration. For each rehearsal and performance I selected sample records and pattern disks which would be appropriate for making for 4/4-time dance music. As one of our performances required air travel, and all the events we played at had multiple artists on the bill and relatively short setup and breakdown times, a reduced setup was required. Our three performances took place in August and November 2023, and October 2024. As such, I developed new interfaces and techniques in between shows and the setup varied considerably. Notably, the final performance made extensive use of the Mono Comb module for creating acid basslines and lead lines. Figure 7.9 shows a diagram of the collaboration.

Image 7.8: Quadraphon turntable by Kev Foakes

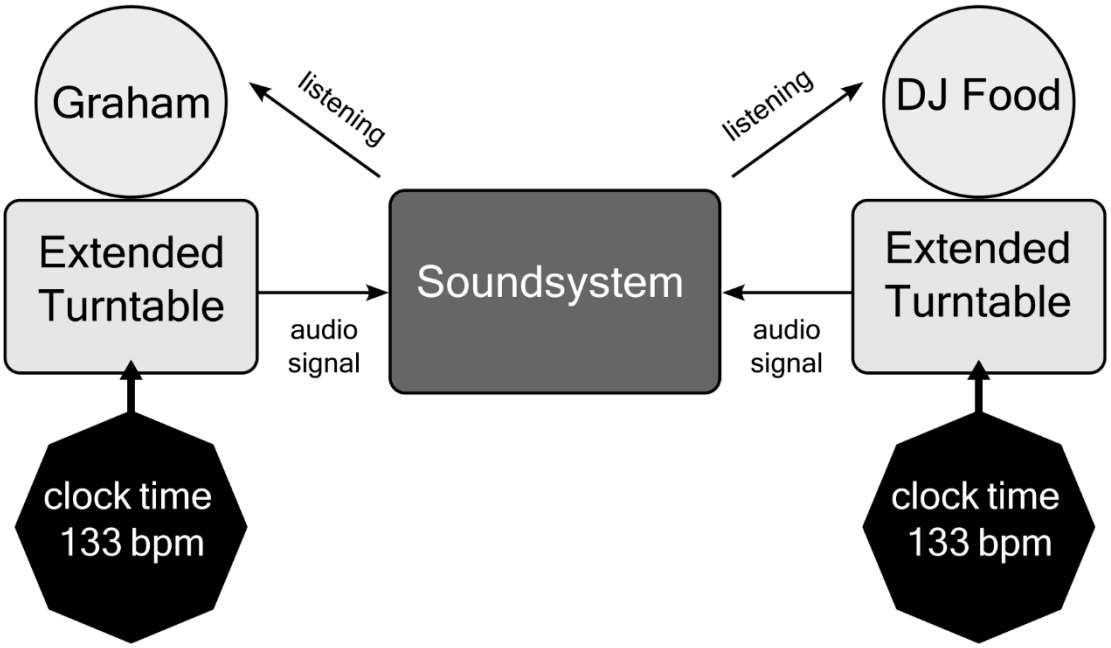

Figure 7.9: Diagram of Graham Dunning & DJ Food collaboration at Fog Fest

Abstract machine

Fundamental to both of our work is the 4/4-time 133.333 BPM single-cycle-loop produced by a turntable playing at 33 1/3 RPM. Rhythm and tempo were a fundamental factor in the project. Whilst we discussed tempo variation and in rehearsal experimented with half-time 45 RPM (90 BPM) compositions, the live performances had a fixed metre. The quartz locking speed of the turntables was the key enabling very long overlapping mixes. In terms of genre, both Mechanical Techno and the Quadraphon typically play 4/4-time dance music, drawing on house, techno, UK garage and other subgenres. In each case we are not known for sticking within genre boundaries (this is a defining feature of the DJ Food project), and we each incorporate more experimental aspects in our aesthetic. Kev's use of the Zen Delay adds layers of shifting spatiality, sometimes broaching into drone and noise, with a psychedelic effect. Mechanical Techno embraces messy patterns, sloppy synchrony and noisy signals, factors generally avoided in generic dance music. The visual aspect of both projects is also important. We discussed different options for projections, staging and lighting dependent on the situations in which we performed, including other artists performing live visuals, projected close-up video, and performing in-the-round. The initiial invitation to collaborate came from tape musician and sound artist Robin The Fog, at the venue Iklectik in London. Promoting the performance as a 'modified turntablism soundclash' (RobinTheFog 2023) set certain expectations. The choice of venue and other performers, all established experimental electronic musicians, also informed our aesthetic direction.

Discussion

The two solo projects which came together for this assemblage —Mechanical Techno and the Quadraphon—have similar technical setups, aesthetic outcomes and performance approaches. Both are extended turntable systems, using the turntable to drive additional components. Both are used to create dancefloor-focused electronic music with an experimental feel and using long transitions with repetitive looping sequences. In each of our solo sets, individual tracks are built up and dismantled with sections of changeover in between. These similarities contributed to a sense that the projects were effective in combination from the first rehearsal.

KF: Within ten minutes, we'd locked into some sort of groove. … I thought it was incredibly swift, how we locked into a particular groove, and found our space.

… There was a sort of intuition there, which I find has come with the best performers I've played with before. But it was almost too easy.

Though certain sections of the sonic output were abstract and used drones and textures rather than rhythm loops, generally the direction was towards dance music. Following the expectations of these related genres gave a framework to the performances.

GD: You wouldn't necessarily call it either house or techno. It's hard to give it a specific genre label, but it's generally within the realms of electronic dance music, and that has certain tropes.

The key difference between the collaboration and a standard DJ set came from the capacity to play multiple sound sources simultaneously, creating dense and maximal sound collages. Though initially conceived as a back-to-back set, with only one player mostly in the mix at any time apart from in transitions, in practice we were both contributing to the main mix for nearly all of the time. As such the resultant output felt much more like an evolving combination rather than a back-and-forth exchange. Nevertheless, working with another player meant the option of leaving space for other sounds in the mix.

GD: It was often quite maximal. There is a lot happening at the same time. But I was surprised that there weren't harmonic or melodic clashes. I think we had that intuitive thing. I think we would both be paying attention to, for example, not both having a big bassline happening at the same time.

KF: I'd be following the groove, or trying to follow the groove, and not have ten things happening at once. Most of the time I've got four things set up, but I'm never playing four things at the same time. I'm chopping stuff in and out because repetition can be boring.

For each performance only the introduction and ending were planned. All points in between were improvised. A certain amount of discussion around pacing took place, but I found this was quickly forgotten once performing. Kev's choice of locked-groove

records—the whole of the material he used in the performance—was always something of a mystery from my perspective. Certain loops were reused from one performance to the next, but the majority were entirely new. My own selection of material was typically a small collection of pattern discs and sample records which were chosen for a broad range rather than for specific combinations. With such potential for variation and infinite combinations of material, the flow of the performances was left to our listening and responding in the moment, which added an element of risk to the shows.

> *GD: There are sections where it does sound like there's not really much happening. You're waiting for something to change for it to become interesting again. That is part of the risk, like you say, you can get stuck. You will run out of track. You can get stuck on a section and not know how to get out of it.*
>
> *KF: It has to be about listening.*

Following the last performance in October 2024 I wrote in my journal regarding the ways in which we were listening:

> *There is a certain detachment in our playing whereby each of us is focused on our own work and not necessarily what the other is doing. I assume we are also simultaneously listening to the whole mix and how our contribution affects it. At times it feels as though the overlap and combining of our sounds is serendipitous or purely coincidental, it's a kind of unplanned joining.*

In this way it feels as though there is a relinquishing of control to the system itself as a whole. Any individual change can only affect the final output to a certain degree, so each sound is only part of a larger collage. As we discussed in the conversation:

> *GD: It's almost like one machine that we're operating. Obviously, there are distinct parts. But the sound literally mixes together all into one. The thing that we're creating is one whole thing. We're two operators of the same sound machine that's making the thing.*

The concept of creating a new piece of music from two layered existing tracks has long existed within the framework of the DJ mix. ‘DJs and fans of dance music often describe this new musical entity as “the third record.” For DJ impact, the creative essence of the

third record lies in manipulating and reconfiguring elements of pre-existing sources to "make it your own".' (Butler 2006:243) This is the closest connection the duo with DJ Food has to a standard DJ set. In our case, the third records produced happen for almost the entirety of the performance. As such the whole assemblage can be considered as a collaborative sound collage.

> *KF: That's why I became a DJ, to fuse different things together in unique ways. They're the highlights for me of any DJ set, where a DJ puts two things together and makes a third. But in our case, we're putting multiple things together and making something that never existed before. And will never exist again.*
>
> *GD: This does feel like a collaborative sound collage. We're responding to each other, but building something together out of these components which may or may not be recognisable from previous rehearsals.*

Where both of our systems can be considered as extended turntables, the combination of the two systems into a collage music format renders the complete assemblage as an extended DJ set. With elements of the sound collage split into smaller building blocks, and turntables locked into synchrony via the inbuilt quartz clock, the assemblage affords endless opportunities for 'third record' compositions, spanning almost the entire performance. Combination of multiple sources creates a complex intertextuality between them.

With Heavy Lifting: Extended Turntable as Physical Algorithm

Our duo used live coding and the Mechanical Techno setup, with shared control of certain sound sources. We played strange and sometimes silly dance music at an Algorave, prior to which we had three informal jam sessions by way of rehearsal. Video 7.4 Heavy Lifting vs Graham Dunning (Peckham excerpts) shows three segments from our performance at Peckham Digital Festival on 20th July 2024, also shown in Image 7.10.

Concrete assemblage

Heavy Lifting is the solo project by Lucy Cheesman, 'using TidalCycles live-coding software to scramble samples into seasick beats' (Cheesman 2025). Lucy is active in

the live coding community, running workshops to teach software and coding performance practice, regularly collaborating with other live coders including Yaxu, Digital Selves and hellocatfood, and as a member of several projects such as TYPE (The Yorkshire Programming Ensemble) and TRVE YORKSHIRE KVLT ENSEMBLE. Tidal Cycles (often shortened to Tidal) is a 'live coding environment for algorithmic patterns' (TidalCycles 2025) which is fundamentally loop-based with a constantly running clock. Tidal plays back samples at designated points in the loop, working as a sequencer which is capable of complex interdependent patterns and transformations. Tidal can also play soft-synths and, with the appropriate connections, output MIDI to external hardware devices.

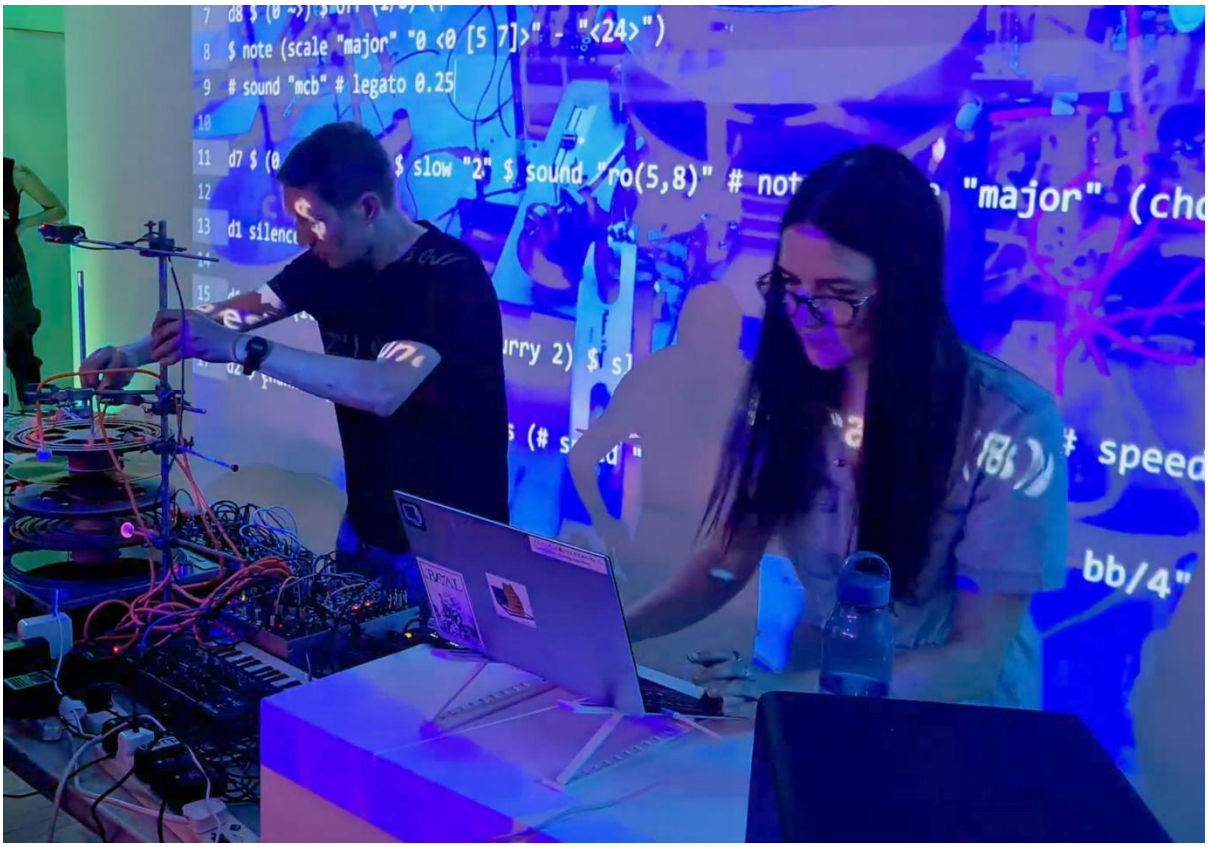

Image 7.10: Graham Dunning & Heavy Lifting live at Peckham Digital Festival, 20 July 2024. Video still.

I used the Mechanical Techno single turntable setup for the project, with the addition of the slow platter with cams, and Resistance module with the cam follower arm. From our initial discussions about the collaboration, we planned to enmesh our systems together as much as possible, with the intention of creating a single system of which different aspects could be controlled from our own interfaces: Lucy's laptop and my

extended turntable. Whilst we each had a stereo output from our own systems to play back sound independently, other sound-sources were controlled jointly. The note selection and rhythm patterns of an Arturia Microbrute monosynth were controlled by MIDI from Tidal, whilst the oscillator pitch and frequency cutoff came from the extended turntable. Audio from the turntable stylus was fed into a Korg Kaoss Pad effect unit, the parameters of which were controlled from Tidal. A third audio feed from Tidal was passed through an analogue filter which was modulated from the extended turntable. Figure 7.11 illustrates the connections.

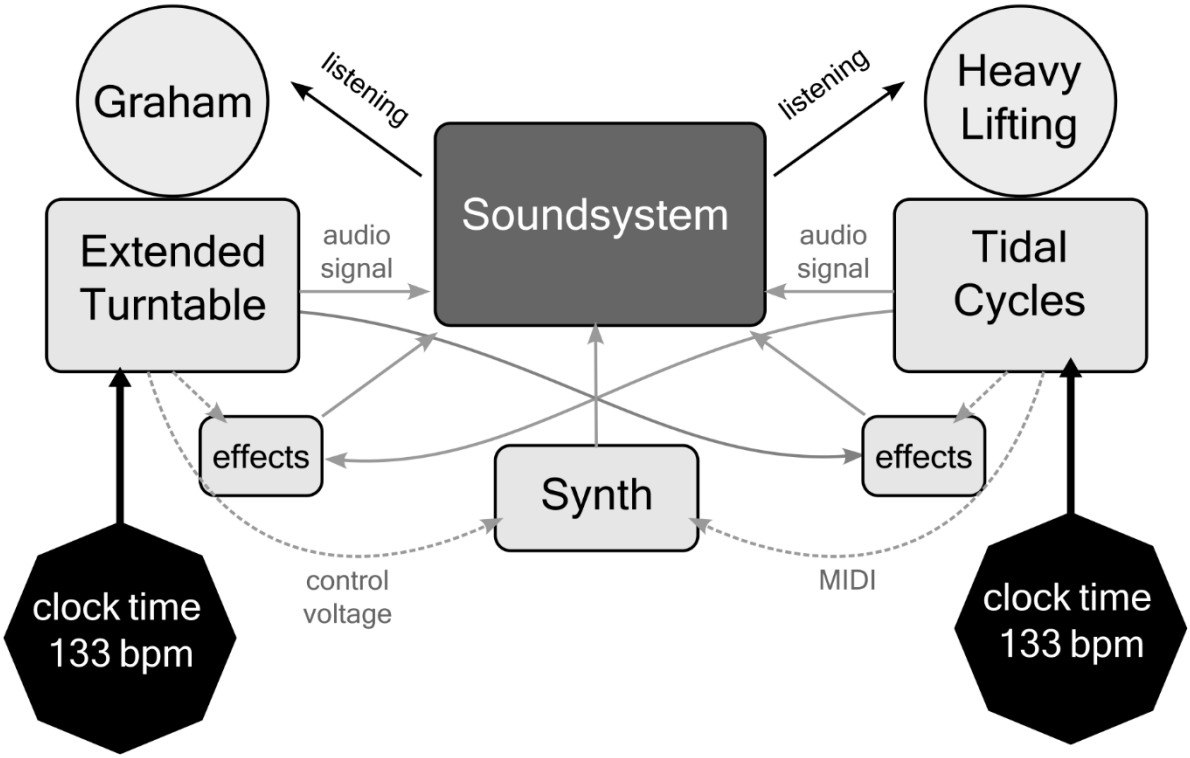

Figure 7.11: Diagram of Heavy Lifting vs Graham Dunning collaboration at Peckham Digital Festival

Abstract machine

Whilst using the extended turntable system with live coding was new to our collaboration, we had worked together previously both using TidalCycles, performing together at Algoraves in 2019[3] and 2022, and releasing an album of edits from our rehearsals for the second show. As such we had an established aesthetic and were

[3] For our first performance we were billed by the promoter as 'Heavy Lifting vs Graham Dunning', and the name for the collaboration stuck.

familiar with each other's approaches in a slightly different context. In the press release for the album, we described our approach in the following way: 'Layers of complexity become whirling fractals of sound - The sections flow together and we often lose track of where and how the noises are being made.' (Dunning and Cheesman 2022) Prior to our performance at Peckham Digital Festival in July 2024, we met three times to test ideas and technical possibilities, and discussed how the collaboration would work (image 7.12).

Image 7.12: Graham Dunning & Heavy Lifting rehearsal, 26 March 2024.

The performance was scheduled for the Algorave at the end of a day of participatory workshops, at which both of us led our own sessions. The broader set of expectations from the organisers and attendees, and conventions implied by the setting as an Algorave—and promoted simply as 'live coded music' (Peckham Digital CIC 2024)—had an effect on our approach. The aesthetics of the project rely on tropes from several genres of electronic dance music, though with a playful exploration of rhythm elements and sounds which does not intend to fit within any specific style. Drum sounds, synths, samples and percussion are drawn from techno, house, electro and UK garage. Rhythm

patterns came from the same genres, with regular use of four-four bass-drums, off-beat hi-hats, sixteenth note divisions and sometimes garage shuffle. These references would be familiar to an Algorave audience, as would the free and playful experimentation, intentional introduction of complexity, and extensive use of repetition. A common factor in both our practices is to share our processes visually. Usually in Heavy Lifting performances, Lucy's computer screen is projected behind the stage, allowing the audience to read the code she writes and see it changing in real-time. This has parallels with the visual aspects of the extended turntable system. We used an external camera on the setup and overlaid the code, projecting both streams together as we played. Our intention here was to mirror the dual-system approach by combining the video feeds as well as our audio and signal chains.

Discussion

The integration of the two systems contributed to the possibility of getting lost in complexity, losing track of connections and sound-sources: a state we discussed as difficult to manage but ultimately something to embrace.

> *HL: There were moments during our practices where I felt like I didn't know what was going on, but in a bad way. And there were moments in that performance where I didn't know what was going on in a good way.*
>
> *GD: One of the through-lines between this and our previous collaboration is that space that opens up when everything gets a bit too much, chaotic. The machine's sort of running away with itself. And you don't know why or how it's got to that state.*
>
> *HL: It's sort of bound to happen, I think. I feel like there's enough uncertainty in what we're doing that I feel like that's bound to happen, right? Maybe not.*
>
> *GD: I think it's partly because we are willing it to happen.*
>
> *HL: We tolerate it, we tolerate it as well. … I think we both probably tolerate quite a high level of chaos.*
>
> *… I like that plate-spinning feeling in a performance. I always really enjoy that.*

The line between over-complexity (leading to chaos), and maximalism (leading to a desirable loss of agency) is a fine one, and the balance is something which needed to be observed in order to maintain it. We discussed the sense of risk involved in working this way, performing in an unplanned manner, and how appropriate the approach may or may not be depending on setting. The state of chaotic flow we allow to happen during performance can lead to a satisfying aesthetic outcome but also risks either becoming unmanageable or falling flat.

> *HL: I guess it has to go wrong sometimes for it to work when it goes right. Right? Otherwise, if it went right every time, that feeling wouldn't be there.*
>
> *GD: that's what's at risk ultimately. That the magic doesn't happen sometimes.*

The risk that the performance might not have the specific effect planned for is not uncommon in electronic dance music, especially with DJ performances where the mood and reaction of the audience can have a profound influence on the outcome. As Rietvield notes, the sonically dominant force of the soundsystem 'can create a contemporary ritualised type of transcendence that leaves dancers free to vote with their feet: with just one messy mix or mistaken music selection, the magic can be broken' (Rietveld 2018:125). As a performance at an Algorave, which consciously shares aspects of setting and expectations with electronic music club culture, the ability for the audience to connect to the music and want to dance was an important consideration. Though not the only criteria by which the set might be considered to succeed or fail, the acknowledgement of the sense of 'magic' was important. Waters also highlights this potential issue in his discussion of performance ecosystems, whereby the assemblage of the environment is necessary but not sufficient to making one that produces something that works:

> 'Complex dynamical systems do not result from the aggregation of all simple heterogeneous elements. In aesthetic terms the law of 2+2 equalling 5 is a goal to aim for but not easily achieved, and rarely by conscious microscopic design and control of each and every element. And not all complex behaviours are desirable - the perceptual result of aggregated complex behaviours may be considerably less than the sum of its parts.' (Waters 2007:13)

At certain points during the performance, the shared controls and interconnected systems led to an unusual process. The settings on the monosynth which we were jointly controlling were configured in such a way that it was unresponsive. Pitch variation was recognised but note lengths were not.

> *GD: We both noticed something wasn't right, but neither of us knew what it was. That's interesting. Both, without directly communicating with each other, trying to troubleshoot it in different ways. Trying to see what that was.*

The setup of the systems required both of us to investigate the problems with the device at the same time, leading to a kind of collaborative troubleshooting within the performance.

Though the technical processes we were using through the performance were materially very different, with Lucy interacting via the computer keyboard and myself physically building the Mechanical Techno machine, in terms of control the processes were similar. In both cases, a pattern is created first, in a way which is visible to the audience. Lucy writes a line of code, I press pegs into a wooden disc. Next, the pattern is activated which leads to it generating sound. In Lucy's case, executing the line of code flashes a highlight bar on the screen, the code runs and the pattern plays. In my case, dropping the peg disc onto the spinning turntable, then positioning the drum triggers begins the activation of the pattern. In both cases this is a two-step process (programming/activating), with both steps made visible to the audience. The extended turntable is a physical algorithm, generated in real-time, a kind of spatial live coding. We discussed the advantage of the approach in both our systems, that even if the audience are not fully aware of all the processes at play, the sense of building something in real-time can still make sense.

> *HL: Maybe when you've written 300 lines of code in advance, it's harder for the audience to understand absolutely. If they are literally seeing you type, character by character, on the screen, they're on that journey with you. And they understand that the first minute of your set is not going to be fully formed, because you're literally creating it in front of them. ... We were making*

something. From scratch is not quite the right phrase, but building something new up in front of them.

By integrating the two systems in such a way that certain controls were shared, as well as combining both the audio and visual output, we built a complex and unruly algorithmic assemblage. Our playing was entirely via generating and executing code, both as text and as physical patterns.

Four collaborations

All of the projects work towards the manifestation of the collaborative assemblage. Each of the collaborations analysed in this research project tend towards one of the primary fields of study. From each collaborative pairing, certain themes were highlighted. Working with Cath Roberts through process-infused free improvisation, to create abstract and sometimes noisy soundfields, the focus was towards sonic art. Improvisation was the basic organising principle, with the specific actions we each took predicated to a degree by the equipment we chose to use. Foregrounding process-based set-pieces within each performance, such as building a small sequencing contraption on the turntable, lent a certain pace and structure to the sets. The rules and processes of the project were both an element with which to work and a limiting factor affecting the range of possibilities. Our prior experience as improvisors and tacit understanding of the kind of music we wanted to produce gave the us foundational skills for the project. A sense of relinquishing control, both to one another and to our machines, became an important element of our work. Listening to the whole sonic output rather than focusing on our individual machines' voices, there was a sense in which we were sculpting a whole together, in a combined constellation of processes.

The duo with Sam Underwood saw Mechanical Techno paired with another self-built mechanical musical instrument system, *ams*, foregrounding musical instrument design as an area of study. Both systems prioritise action-sound-coupling, and we share a preference for combining process-based structure and improvisation. Certain compromises were made regarding the performance ecosystem, notably the attempt to match the volume levels of the two systems between *ams*' quiet acoustic output and Mechanical Techno's amplified, full bass level. There was a deliberate aim to enhance

the interconnectivity of the devices, with the MIDI Comb being built specifically to interact with Sam's switching windchest. Certain musical processes were shifted towards one or other of the machines, with Mechanical Techno taking on more of the sequencing role and *ams* producing a bigger share of the sounding elements. An important aspect of the performance was the sense of ridiculousness in both of the systems, and the risk of failure or breakdown produced from the machines themselves and our choice to perform them in an unplanned improvisation.

Turntable practice was the primary research area of the duo with DJ Food, whose Quadraphon extended turntable has similarities in approach to Mechanical Techno. Envisaged as an extended DJ set, we made upbeat dance music foregrounding the 'third record' as a combination of numerous different prepared elements. As the majority of the audio used was prerecorded or preprogrammed, the work had a distinct sense of sound collage. Improvisation was again important, and though the flow and pacing was different to the more abstract work with other collaborations, there was the same sense of co-operating a single machine and the relinquishing of control to a sonic whole.

Working with live coder Heavy Lifting, the combined assemblage was an algorithmic dance music machine, with one input via the computer keyboard and one via a set of physical interfaces. We deliberately entangled our machines to the extent that certain components were under fully shared control. The integration of systems led to moments of getting lost in the complexity, experienced as a desirable loss of agency or plate-spinning feeling. The work necessitated a degree of collaborative troubleshooting, a novel performance mode: In these moments, both of us would intuitively try to fix the problem without direct communication. The performance involved generating and executing code, both as text and physically programmed patterns. By integrating the systems and sharing controls, audio, and visual outputs, the combination became a complex and unruly algorithmic assemblage.

Through an overview of the four collaborations together, some shared concerns were highlighted. In each duo, the combination of prepared processes, pre-programmed patterns or recorded music meant there was a certain element of sound collage, analogous to working with pre-existing visual material to make visual art. Complex systems including both technological components and open-ended improvisatory

processes lead to a resignation of agency to the system and loss of control. Across all the projects, the importance of the whole assemblage was fundamental: our work was ultimately towards building a machine together, sculpting the same sound simultaneously. These shared concerns are discussed further below.

Collage music

The creation of collage music was most pronounced in working with DJ food, where almost all of the material was either pre-recorded or pre-programmed, or sequenced immediately prior to execution within the performance. As Butler notes, the use of such material is a key tenet of many dance music artists' live work: 'Recordings can be *prior* to performance. They can come unfixed. Recorded compositions can be the very formative material *of* improvised performances.' [original emphasis] (Butler 2014:171) Indeed, the invention of recorded sound itself opened up the capacity for these kinds of music, not only the recordings themselves but the inherent noises of the media within which they are contained:

> 'Moreover, in preserving sound as a material trace, recording created an artefact that is available to be reworked, and so a second order domain of sonic transformations. Envisaged as a means of storing and documenting audible events, the tradition of recording inaugurated by the phonograph ruptured the metaphysics of sonic presence and opened up the interstitial spaces of copies and recordings. This opened the door to a new kind of music making, one based in a foregrounding of interference, citation and secondary processes, a *plastic art* working within and through the grain of the machine.' [original emphasis] (Hemment 2004:80)

Collage music in this sense is best understood through the analogy of cut-and-paste paper collage. Each instance of the 'third record' created in a longform mixing DJ set is like a visual collage comprising two existing works juxtaposed together. The original sources are recognisable and distinguishable, but the resulting work is something new. A scratch DJ set may use tiny fragments of manipulated audio brought together into a more pointillist, fractured sound collage. In a visual analogy this might be a work made from small sections cut from magazines to create a wholly new visual composition, but

with recognisable elements. Both types of collage exist on a spectrum, at one end using small numbers of whole large/long sections with minimal manipulation, and at the other end using multiple tiny fragments. A third way, somewhere in between, uses repeated identical sections to form repetitive patterns. In a visual collage, this could be chopped up printed patterned media; in a piece of music, the repeated single-cycle-loop. The use of pre-recorded audio material need not necessarily be the same as sampling. For example, creating tapes of self-recorded field recordings for use in a noise set does not use others' work at all. Dubplates containing single tones are entirely pre-recorded, but have potential for fully instrumental use. In the visual collage analogy, this could be equivalent to taking landscape photographs to cut up for a collage. Or selecting coloured pieces of paper, such as in Matisse's later collage works. Mechanical Techno's use of patterns and recordings means it is always making some kind of collage music, both used independently and within a collaborative assemblage.

Complex systems

Shared across all four projects, the sense of complexity and losing control became an important theme, 'making a system sufficiently complex that one can't know what will happen' (Waters 2007:8). Here emergent properties come to the fore, new affordances enabled by the complex interconnections which were neither visible nor predictable by inspecting the individual components. The sense of uncertainty and risk was a driving factor in the improvised nature of each of the collaborations, and depended on the specific assemblages in use. The complexity brings an unknowability to the system, a kind of high-level cognitive noise which opens up directions for the work beyond possible planning. Working in a duo, each player's intentions may be unknown to the other, each makes assumptions as to the direction of travel, and there may be a mismatch. The complex system affords this possibility for this 'non-matching intention error', a kind of noise which cannot be planned for, but can only be built in from the bottom-up in the way the system is put together. The complexity of the system was in the most part generated by the concrete assemblage, the physically complex set of interconnections which afforded so many possible directions of travel.

When an assemblage comprises a complex system, with multiple simultaneous and interacting operations as well as multiple agents, there is capacity for loss of agency to the whole machine. Improvising together through these sometimes-messy moments potentially led to a flow state and often resulted in exciting and unplannable music. Group flow here, characterised by 'the radical loss of self-consciousness and sense of action-awareness merging' (Cochrane 2019:140) occurs when shared across both performers. In fact, the cognitive task is shared not only between the players, but also across all the processes performed by the machines. Group flow could be characterised in this instance as the assemblage itself entering a state of flow. This assemblage flow state, which can feel uncomfortable as it arises from a state of confusion and loss of control, can only occur within instrument-systems which are to some extent self-playing. Magnusson notes how such a shifting of focus can contribute to detachment during performance: 'To work with symbolic tools means that one has to continually switch modes from focusing on the world to focusing on the tool with regular intervals and to a more pronounced degree than in acoustic instruments.' (2008:173) This mode of performance is not always conducive to generating good performances, and can be disruptive. 'This detachment from the terminus of our activities could be paraphrased as a disruption of flow and is present in the majority of existing digital music systems.' (ibid) Ironically it is this disruption of individual flow which can lead to the positive dislocation experienced when using a complex system, entering a state of group flow alongside the machine.

Sculpting a sound together

Finally, the most prominent theme recurring across the projects was the sense of sculpting a sound together: the output of the shared assemblage process. With DJ Food this manifested in the focus on dancefloor music and a set of psychedelic, disorienting sound effects. In contrast, with Cath Roberts the outcome was much more abstract, arrhythmic and textural. The direction this took was largely dependent on factors derived from the abstract machine: genre expectations, shared tacit understanding and aesthetics, and pressures from outside the narrowly defined collaborative assemblage, that is, the broader performance ecosystem. Working with two instrument systems to form a combined assemblage means working towards a shared outcome, building

something together in a combined set of processes, rather than working independently towards separate goals. A process of communal live assemblage.

Conclusion

Mechanical Techno as an assemblage can be plugged into other musician-instrument relationships to form new assemblages at the scale of collaborations. In each case the components of the concrete assemblage interact via and are held in place by a range of forces and connections. These could be physical, electronic, technological or otherwise material connections, such as audio cables or MIDI connections. Or they could be interpersonal, aesthetic, contingent or otherwise incorporeal, such as genre expectations or shared tacit knowledge. Insights from these new collaborative assemblages related to performance practice using improvisation together with process-based actions, as a constellation of processes. Different degrees of interconnectivity and interaction between the systems were mapped and analysed, and led to different sonic outcomes. The complexity of the systems at times led to moments of group flow across the whole assemblage. Conceptualising the collaborative process in each case as one of collage music allowed for an analogy with visual art and a way of understanding composition and performance within which certain elements are pre-planned, pre-written or played back. Plugging Mechanical Techno into larger assemblages enabled the project to be viewed from a different scale, allowing an investigation into the affordances of broader musicking assemblages.

Chapter 8. Conclusion

This research project set out to answer two sets of questions. First, what are the affordances of Mechanical Techno? What can it do? And how does the physical-mechanical approach to performance and production of electronic music differ from the electronic modes of techno? Second, how can assemblage as a process be used in musicking contexts? Can an instrument be considered a live assemblage, and how does that affect its creative outcome? What might it mean to consider a musical collaboration as a live assemblage? The primary method of research was the practice itself: live performance, studio recording, instrument design, and collaboration. Reading and reflection were integrated with making in a combined process, throughout a cyclical, evaluative interrogation. Mechanical Techno was considered as an assemblage at the scale of an instrument-system, in both live performance and studio contexts. Of twenty-one solo performances staged during the research project, the event in Sheffield in November 2024 was analysed as the culmination of the research to that point. From sixteen recording sessions, an album of material was collated, of which four tracks were presented and analysed. Performances in four new duos were discussed with excerpts from conversations with the other artists. Insights which were drawn from the work are summarised below.

Instrument system as live assemblage

The Sheffield performance considered Mechanical Techno as a live assemblage. Drawing from Deleuze and Guattari's concept, aspects of the project were considered as concrete assemblage, abstract machine and personae. This approach generated music in a novel way. It also allowed for granular analysis of the technical and physical components, forces and connections which combine them, and agents which interact with the system. A written declaration of principles was identified and developed as a framework for performance practice, instrument development and aesthetic outcome. Most literature relating to turntable practice emphasises the dual nature of the device: On one hand as a machine for linear playback, and on the other as a tactile and responsive musical instrument. Mechanical Techno uses the turntable in a different mode: focusing on its primary physical-mechanical aspect, the single-loop-cycle.

Though elements of this mode are sometimes present in both mixing DJ performance and as instrumental DJ technique, focusing exclusively on the turntable as looping sequencer is a previously unrecognised and under-researched area. Working with the turntable in this way, the performer is neither a composer-arranger (as a mixing DJ) or an individual sound instrumentalist (as a scratch DJ) but takes on the role of the attendant. As attendant, the performance mode is that of a machine operator, 'playing with something that runs' (Butler 2014), working with an automatic system which will play endlessly if left unchecked.

Working with the automated physical machine in a performance context engenders a sense of machine liveness. This can be identified most clearly by considering liveness in musical performance on two axes: the extent to which the performance is pre-composed or improvisation can take place; and the extent to which the note activations are made by a human or an automated process. Machine liveness is most clearly observed when there are elements of automation but with clear possibility for deviation from the mapped route. With a focus on exposing the processes at play—both the individual sound-making actions of the machine and the higher-level arrangement decisions of the operator—action-sound-coupling is foregrounded leading to a conscious exposure of process. This type of transparency (better denoted as 'exposed mediation', to avoid confusion with Brøvig-Hanssen's 2017 term which has the opposite meaning) paradoxically leads to a sense of wonder. This 'seeing-how-things-work fascination' (Moore 2025) is something which has been acknowledged in both sound installations and mechanical musical instruments. The sensation has been explained as 'marvel at the mechanical as a sublime feature of the automaton. Here fascination is triggered by the complexity of the mechanisms as well as the competences and skills of those who construct them.' (Semmerling et al 2018:239) This fascination is channelled by the machine-liveness of the system, a set of automated actions happening in real-time and deliberately made visible.

Instrument system as physical audio workstation

Working with Mechanical Techno in the studio for producing fixed media compositions both offers opportunities for new processes and poses questions about the importance

of the visual aspects of such a project. Using the system in composition practice it becomes a physical audio workstation. The two-stage process of recording with Mechanical Techno shares parallels with ways of using DAWs to write music. However, several differences—often limitations—in functionality lead to a uniquely frustrating workflow requiring troubleshooting, relinquishing control and intention, and ultimately changing the aesthetic outcomes of the work. Mechanical Techno in the studio produces uniquely unusual music, foregrounding anti-slickness, imperfection and a hand-made quality which can be missing from software-produced electronic music.

Though Mechanical Techno in a live context prioritises the visual as a means of exposing the processes at play, there are ways to give clues to these processes through recordings which do not have a visual element. Physical signatures are derived from the audible outcomes of the physical-mechanical way the system creates music and the by-hand quality of the dub mixdown. Microtiming variations, synchronous and phasing loops of varying lengths, combinations of quantized and unquantized patterns, misfires and slippages, untuneable instruments, surface noise, and the limitations of operation with two hands on the controls all contribute to a sense of physicality in the music. Furthermore, signs from the titling and packaging of the physical product can also point towards the methods of production. Through both the process and the product the system stands against digital perfectionism and also against obfuscated black-box music production.

Instrumental components: extending the turntable

Zooming in the scale of assemblage to look at the individual components making up the extended turntable system, including newly designed modules developed through the research project, allowed for investigation of the affordances of the individual makes. The turntable assemblage was conceptualised as a collection of functional parts, and in doing so various new approaches were developed. Focus on motor speeds gave rise to the oscillator turntable and options to change parameters at arrangement speed via the slow platter. New sensor designs afforded new possibilities for live inscription and writing patterns during performance.

The focus on inscription as a process of composition highlighted the importance of the role of the setter in mechanical music, a role which has been underacknowledged even at the height of the popularity of such instruments. The setter usually composes sequences and patterns ahead of time, but with the makes developed during this research project this could also be occur in real-time. The live setter is a physical counterpart to the live coder, producing mechanical sequences during performance for execution where the process is visible to the audience. Live inscription as a specific type of performance-composition is enabled by types of programming which can be interacted with in real-time. In exploring different physical inscription types—including real-time and out-of-time, and quantized and unquantized—a whole range of performance options were enabled, available for exploration in the studio and during live performance.

Collaborations as assemblages

Mechanical Techno was plugged into four new duos in collaboration. Each of the new assemblages focused on one of the four areas of study: sonic art through improvisation with Cath Roberts; mechanical musical instrument design with Sam Underwood; extended turntable practice with DJ Food; and dancefloor focused electronic music with Heavy Lifting. Conversations with each of the collaborators yielded insights for the individual projects, a majority of which also applied to all of them. Through use of pre-recorded material or prepared processes the projects can be viewed as collage music. Most notably in the duo with DJ Food, layers of existing recordings and new patterns extended the notion of the 'third record' to almost the whole extent of each performance. Through an analogy with visual cut-and-paste collages, it can be seen that collage music can be made of material of different durations (pointillist fragments or juxtapositions of extended excerpts) and can be minimal or maximal in the number of components. Where an instrumental musician may be considered similarly to a painter, mark-making in the composition with individual sonic strokes, the operator of an automatic playback system brings pre-rendered sections together to create new combinations, analogous to a visual collagist. Collage music is assemblage in action, and in a collaborative context the output is a joint endeavour.

Working in a duo with combined instrument-systems, the processes of operation are also combined. Making music becomes a process of sculpting sound together. The audible output runs and changes over time, sometimes with its own 'imagined agency' (Fergusson 2013), and operator input can change certain parameters but never the whole all at once. Work is a combined effort of both operators and both machines. The process is a communal task, with all communication or compromise agreed through the combined musical output (though occasional direct communication was still sometimes necessary). Sculpting the sound together is changing the arrangement and consistency of the musical assemblage, in real-time.

When the components, connections and interactions of the assemblage are sufficiently complex, there is the possibility that the performers will lose track of the processes at play. This can manifest in a sense of loss of control and relinquishment of agency to the system as a whole. Whilst this sensation can be confusing, difficult to work with and cause disruption to the performance, there is also the opportunity for the situation to trigger a strange sense of flow. Just as group flow, as Cochrane defines it, entails 'the radical loss of self-consciousness and sense of action-awareness merging' (2019:140), there is the opportunity for this to arise between and amongst the operator(s) of the machine and the automated components. In this instance the assemblage itself could be considered to enter a flow state. As Magnusson (2008:173) writes, 'this detachment from the terminus of our activities could be paraphrased as a disruption of flow,' but ironically it is this very detachment that can, under certain conditions, enable flow across the whole system.

Statement of contribution of new knowledge

Through the research project, the Mechanical Techno assemblage was plugged into different contexts—performance ecosystems—and combined with other systems. This allowed interrogation of its capacities to create new works, integrate into new arrangements, and suggest new modes of performance practice. In doing so, the project made contributions to four related fields of practice: turntable performance, electronic dance music, sonic art, and instrument design.

The project considered the use of the turntable as a sequencer as a distinct mode of performance practice, specifically focusing on its inherent capacity to produce single-cycle-loops. This is distinct to the way turntable use has previously been conceptualised. By understanding, operating and analysing the turntable as an assemblage and developing new devices at the component level, the project contributed innovations to the device as instrument. This included consideration of live inscription as a performance approach, combinations of multiple quantized and unquantized sequences, and development of a complex system with its own imagined agency. By plugging the extended turntable system into other collaborative assemblages its affordances were further expanded into new contexts.

As a live electronic music performance project, the work introduces physical-mechanical process into the electronically produced field of techno, affording the process to produce new music in a range of contexts. Focusing specifically on performance practice with an automated system allowed for consideration of different musicking roles, expanding on work by Butler (2014), Magnusson (2019) and Jensenius (2022). Working with Mechanical Techno in the studio generated insights into music composition process through new techniques and instrument designs, including developing a sonic language to communicate the project's unique 'machine aesthetic' (Rietveld 2018) of physical signatures and extra-musical contextual information. Considering the work as an assemblage, and using the active process of assemblage, has enabled the development of new approaches to both performance and composition. Working as a mobile operator, an attendant, is one example of this approach. Plugging Mechanical Techno into a collaborative assemblage enables new affordances at a different scale. Foregrounding the process of assemblage within the studio context, building a contraption in order to build a piece of music, is a process of improvisation with physical materials. The instrumental components specifically developed for the project contribute to its aesthetics and provide new ways of performing and producing electronic music through consideration of physical-mechanical processes, deliberately unpolished interfaces, and modular capacity for varied and complex use and interconnections. The design approach itself, following an itinerant and improvisational approach as defined by Ingold (2013), offers

considerations of iteration without refinement and recognition of limitations as opportunities. Use of the project in different scenarios including new collaborations, and the application of electronic dance music performance approaches to experimental music contexts (and vice versa), generated several insights. Electronic music viewed as collage music is a type of collaborative assemblage, whereby each participant contributes to sculpting a shared sound. Building a complex system can afford a positive sense of loss of agency, leading to an experience of group flow across both machines and operators. By considering the project as an assemblage at different scales and exposing the active processes at work, the project applied an approach opposed to black box technologies with their 'opaque and obscure' (Latour 2000:304) functionality. This also afforded a consideration of nested assemblages, and the bottom-up and top-down causal relationships which interact between them. These causal relationships produce emergent properties unique to the system and the approach, generating the unique machine aesthetic and sense of machine liveness through the musical-theoretical framework embedded within the instrument design. Having summarised the contributions this project has made to the relevant fields, the following section outlines the boundaries of the research and potential implications for further study.

Limitations, implications and further research

The main limitation in the execution of the research project was time. Due to the nature of the project itself as a long-term, ongoing project, and the scope of a PhD thesis as a piece of work of a certain size, an end-point had to be set. With more time and resources the project could have explored the boundaries of the project further, I could have built more new interfaces for the extended turntable, and the collaborations could have developed in other new directions. It is in the fundamental design of a modular system—and one which, in considering collaborations and performances as assemblages, can also be plugged into infinite other systems to form new assemblages—to be open ended. Out of necessity, limitations were imposed on the project, though it will continue beyond the PhD itself.

Conducting the work as a piece of practice-as-research also imposes its own constraints. With different framing or methodology, the project may have analysed data such as audience feedback to focus on its cultural impact, or taken a more technical engineering approach and pushed the mechanical aspects of the system further. By proceeding with practice-as-research as the framework, certain such avenues were closed off. The counterpoint to this is that the research presented here was generated through the same processes as those used in the creative practice itself: insights were generated in an improvised way, collating and collecting material via the maelstrom of activities for future editing and analysis, just as the making, performing and recording practice functions.

As explored throughout this thesis, the imposition of constraints on a system may reveal affordances elsewhere in that system. In my dual role as both instrument designer and performer I was able to switch fluidly between making devices and using them in the field, reflecting on both processes together. This informed the maelstrom of activities, shaping my unique methodology. Therefore, whilst the project could have been conducted in a less integrated way, with separate time given to making and performance, perhaps by different practitioners, a significant source of insight would be lost without the dual role. Furthermore, without the close entanglement of the different research activities and accompanying roles, the outcomes and insights would be significantly different.

The insights presented here may be considered unique to the system itself, though the intention is that the approaches and findings may also be applied to other artists' work and to other ways of working. Defining a third mode of turntable practice, highlighting the deployment of processes within improvised music, the roles of the setter and the attendant, and overall use of the concept of the assemblage as a framework could all apply in other areas of creative music practice. Future studies could incorporate and further develop such ideas and concepts.

Additional research outcomes

Additionally to this thesis, the research project generated several published and pending written articles. I presented 'Ironing in the creases: Developing an idiosyncratic

electro-mechanical musical Instrument by reinforcing its faults' at NIME 2024 and the proceedings of the conference were published in September of that year. An article co-written with my supervisor Adam Parkinson, 'Improvising with machines: A taxonomy of musical interactions' was published by the journal *Organised Sound* in December 2024. My presentations at Innovation in Music 2024 and 2025 will be published in the forthcoming proceedings. They are 'Messing about as creative process: anti-solutionist approaches in the maker's workshop, home studio and on stage' (2024) and 'Mechanical Techno in the studio: writing a track by building a kinetic sounding sculpture' (2025).

In addition to the live performances occurring during the research period (listed in Appendix A), several musical releases have been made public or are pending release. The album *Beaux Timbres* with Sam Underwood was released by Accidental Editions in October 2024. An album of live and rehearsal edits with DJ Food, *E-x-t-e-n-d-e-d Turntablism Vol.1*, was released in January 2026 through Kev's label Infinite Illectrik. An excerpt from my performance with Sam Underwood at Malvern Cube (discussed in Chapter 7) is was released on a compilation tape by Collapsing Drums in December 2025. An album of solo Mechanical Techno recordings, *Quern*, is scheduled for release by Jollies Records in 2026. And an album with Cath Roberts is completed and pending release. These works serve as a contribution of the work to the scenes within which they reside and also the broader musical landscape.

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Appendix A. Performance and recording timeline

Year	Month	Date	Solo gig	Collaborative gig	Recording
2022	Oct	7/10			solo: Wonky clocks
		9/10			solo: Noise things
		29/10	MT Demo, Hacoustic, London		
	Nov	1/11		GD + SB, Cube Cinema, Bristol	
		2/11		GD + SB, ESP, Yeovil	
		4/11		GD + SB, Flim Flam, Brighton	
		5/11		GD + SB, Iklectik, London	
		6/11		GD + SB, Peer Hat, Manchester	
		7/11			MSGG Mill session
		8/11		GD + SB, Centrala, Birmingham	
		9/11			GD+SB LSBU session
2023	Jan	3/1			solo: MT + modular
		12/1		CD & GD, Iklectik, London	
	Feb	25/2	Expanded DJ set, Iklectik, London		
	Mar	23/3			solo: pre-cov practices

Year	Month	Date	Solo gig	Collaborative gig	Recording
2023	Mar	25/3	MT + modular, The Herbert, Coventry		
		30/3		GD + SB, Arkaoda, Berlin	
		31/3		GD + SB, Dosenfabrik, Hamburg	
	Apr	22/4		CD & GD, Brak, London	
	May	9/5			solo: clocking but mostly bangers
		26/5		CD & GD, HYG, London	
		31/5		SU + GD, Askip, Nantes	
	Jun	2/6			SU + GD, Paradise, Nantes
		3/6		SU + GD, Paradise, Nantes	
	Jul	1/7			solo: 10 days improvising
		8/7	MT, Bexhill United, Bexhill		
		21/7			GD + DJ Food rehearsals
		23/7			CD & GD LSBU session
		29/7		CD & GD, TACO!, London	
	Aug	5/8		GD + DJ Food, Iklectik, London	
		27/8	MT, Line Up Festival, Malvern		

Year	Month	Date	Solo gig	Collaborative gig	Recording
2023	Sep	23/9	MT, Soundings, Worcester		
		24/9	MT workshop, Soundings, Worcester		
		26/9	MT, Shacklewell Arms, London		
		28/9	MT, Pattern Club, Sheffield		
		29/9	MT, Centrala, Birmingham		
		30/9	MT, Machina Bristronica, Bristol		
	Oct	15/10		CW Large Ensemble, Cafe Oto, London	
	Nov	18/11		Mammoth Beat Organ, The Birley, Preston	
		22/11			solo: MT tunes pre-Bratislava
		29/11		GD + DJ Food, Next Festival, Bratislava	
	Dec	10/12		Tonus, HYG, London	
2024	Jan	19/1	MT, Iklectik, London		
	Feb	16/2			HLvGD Studio jam
	Mar	8/3			solo: MT new with fancy bits
	Apr	26/4			HLvGD Studio jam 2

Year	Month	Date	Solo gig	Collaborative gig	Recording
2024	May	29/5			solo: MT pre-EMF
		31/5	MT, Centrala, Birmingham		
	Jun	1/6	MT, EMF Camp, Worcestershire		
		7/6	MT, KM28, Berlin		
		29/6			solo: MT Quick Stereo Tracks
	Jul	4/7			solo: MT Mixdowns with new plugins
		17/7			solo: MT solo quick mix
		17/7			MT HLvGD practice 3
		20/7		HLvGD, Peckham Digital Festival, London	
	Aug	1/8			solo: MT Pre-Awamu quick mixes
		3/8	MT, Awamu, Chiltern Hills		
		24/8		SU + GD, Line Up Festival, Malvern	
	Sep	24/9			solo: MT pre-Bedford studio jams
					GD+DJ Food rehearsals
	Oct	5/10		GD + DJ Food, Levitation Festival, Bedford	

Year	Month	Date	Solo gig	Collaborative gig	Recording
2024	Nov	14/11			solo: MT Quick grabs pre-Sheffield
		30/11	MT, Crucible, Sheffield		
	Dec	10/12			solo: MT Rec pre Accidental
		14/12	MT, Accidental Records, London		
2025	Feb	27/2	MT, La Vallee, Brussels		
		28/2	MT, Acid Solder Club, Utrecht		
	Mar	01/3	MT, Perifest, Deventer		
	Apr	25/4			solo: MT Sampling things
	May				
	Jun	12/6			solo: MT Studio mix track

Appendix B: Composition descriptions

Each of the four recorded tracks included in the portfolio from Chapter 5 is discussed below. The physical setup and automated aspect of the composition is outlined first, followed by my role in performing the piece as a live mixdown. Significant characteristics of each piece are analysed here. References to these elements inform the discussion in Chapter 5. Specific modules and devices mentioned in this section are explained in more detail in Chapter 6.

5.1 Chronic Data Poisoning (4'16)

Machine playback

The piece runs at 133.333 BPM, with all sequencing from one turntable running at the standard speed of 33 1/3 RPM. The bass-drum pulse is slightly syncopated, with the third strike hitting early. A snare drum doubles the bass-drum, though its sound is generally masked through compression. The snare can be heard to play alone at the start of the breakdown, at 1'34. A hi-hat plays on the off-beat, with delay: the amount is adjusted throughout the track, but delay time remains constant. Percussion sounds which play throughout the whole piece are from muted metal tines and a pair of miniature hi-hat cymbals. Both are slightly off the strict sixteenth notes grid and repeat once per cycle. The bassline is from a monosynth played by the Mono Comb, the notes of which randomly change slightly throughout – this is most noticeable around 2'20. The filter for the bassline is affected by both its own envelope and the bass-drum trigger envelope, providing emphasis. The monosynth also goes through another delay line, approximately on eighth notes, though not exactly. The MIDI Comb plays the Waldorf Streichfett synthesizer with an organ sound, with a very short release time. A stereo panning tremolo effect places individual notes at different points in the stereo field, which is not in synchrony with the metre of the track so appears random, adding a sense of movement. The notes played are in the upper mid-range. Two longer notes in the pattern, produced by arc segments, remain constant throughout until the final section.

Human playing

The fast, bubbling organ notes are played by a pattern of ball-bearings on the disk with prime number divisions, creating a chaotically random sequence which repeats once per cycle. Throughout the piece I programmed and re-programmed this sequence by adding and removing ball-bearings. The organ part is faded out in the middle of the piece for a breakdown to other elements. At this point I was removing the ball-bearings, to enable me to reset for a different random pattern in the second section. More and more ball-bearings were added to increase the density of the random pattern. In the final section, the ball-bearings are removed. The disk activating the MIDI Comb was stopped in an attempt to reset it, resulting in accidental playing of several long tones, and triggering an open hi-hat by hitting a drum trigger otherwise unused in the song with my hand. This happened to be in time.

5.2 Tentacle Motion Study (5’29)

Machine playback

The track runs at 129 BPM, and begins with a bassline, the rhythm of which is difficult to discern. The bass notes were generated by two ancillary platters running from the main turntable, at an unusual ratio of 4:5, with additional notes added at a different ratio, 4:3 in relation to the main turntable. Figure 5.6 shows the physical configuration of these patterns. The filtering of the sound is also modulated by triggers from the midi chords, which repeat once per cycle but are not introduced until after the breakdown. Coupled with the bass notes, a trigger output from the same module pulses the motor of an oscillator turntable, adding subtle vinyl push-pull sounds. The regular pulse is introduced by a modified record playing snippets of synthesizer and record crackle. The basic drumbeat is a four-four bass-drum with a snare sample approximately on the second and fourth beat. The snare sound is actually slightly ahead of the bass-drum creating a forward motion. A second gated noise percussion sound is somewhere between an open hi-hat and snare drum, adding some syncopation to the rhythm. The drums are summed into a compressor which emphasises the bass-drum and reduces other sounds when it plays. Hi-hats are triggered by a division of five. An electronic cowbell sound repeats twice per bar just before the snare, adding further subtle syncopation. Occasionally its pattern is interrupted.

Human playing

The first section sees development in the bassline, with some adjustment to the filter resonance and cutoff to emphasise it in the mix. The breakdown drops to the rhythm from the modified record and the electronic cowbell, along with the bassline and its shunting record. This was achieved by physically moving the bass-drum trigger and muting other sounds with volume controls. A new voice fades in: higher-register organ stabs with a one-cycle rhythm repetition and notes which occasionally shift at random. The rhythm of the new voice links with the bassline and ties it in more clearly with the rhythm of the track. As the bass-drum is reintroduced the timing is slightly off, stumbling into the rhythm and taking one bar or so to stabilise. This is a result of the method if its reintroduction: physically moving the trigger back roughly into position, then adjusting it to the correct point in the rhythm cycle. In the second section, additional hi-hats in divisions of five are introduced, the snare drum is fed into a delay unit which modulates over time and settles on a short delay time to give emphasis to the snare hit. My playing here is a series of small adjustments, noticeable in the recording as tweaking the sound. During another small breakdown close to the end, the bass-drums are dropped out for a bar, the chord stab voice changes, via manually adjusting parameters on the synth, and the notes become more staccato. The cowbell glitches and draws the track to a fairly abrupt end.

5.3 Suboptimal Beats (3’14)

Machine playback

The piece starts abruptly with a quick fade in and all sonic components already playing. With the turntable running at 45 RPM, each cycle was set to play two beats, giving the resulting 90 BPM tempo. The drumbeat is minimal, a four-beat loop with two bass-drum hits and a vactrol snare hit with a long release. The beat is loose enough to feel as though the snare is hitting slightly late each time. A sampled shaker provides additional syncopated percussion, taking its trigger from a monophonic synth voice produced by the Mono Comb module, percussive in itself, resembling a fairly low-frequency electronic woodblock type sound. This pattern repeats once per cycle but is not fully on-grid, lending a syncopated double-time feel to an otherwise slower tempo track.

The sound-source for the bassline uses the laser sensor and tone wheel with the oscillator turntable. The bass sound can be heard most clearly around 1'30 when the beat drops out. The pitch varies throughout from an automated pattern on the Lego disk and cam-follower arm on the slow platter. Further variation is added by percussion using the worm gear percussion mechanism, running on a second turntable also at 45 RPM. The mechanism adds frame drum sounds at unpredictably shifting times, most often not aligned to the rhythm directly but sparse enough and with enough repetition that they seem deliberate. These drum sounds are sent through a solid-state delay effect, with delay time affected by the slow platter as low frequency oscillator, at an unrelated frequency to the metre of the track. The effect causes delays to recur at different frequencies, or sweep upwards and downwards, dependent on the point in the cycle.

Human playing

Additional variation to the optical oscillator is introduced by hand: switching track shapes on the tone wheel and some manual control such as pulling back the oscillator disk several times around 2'49. A breakdown drops out the drums and introduces a high frequency riff from the MIDI Comb, played on an organ voice with twinkling reverb. The notes of the riff vary per cycle, though the rhythm remains constant—a result of the inconsistent note values provided by the physical interface. Later in the track the sound is adjusted to become more staccato, before dropping out altogether for the ending. To end the track, the main turntable is stopped, audible in the way the rhythm brakes slightly. The percussion sound adds one more hit after the other voices have ended, finishing on a delay run: Stopping the second turntable halts the percussion.

5.4 Perpetuum Mobile (3'02)

Machine playback

The track begins with a synth chord: a recording of a digital polysynth cut to a dubplate and played back on the turntable. Throughout the piece the sound mostly loops different sections of the recording once per cycle, as the tone arm is restrained by a thread. The beat appears straightforward and quite minimal but there are several factors causing minor variations to the patterns. The bass-drum provides a steady four-

four beat, and also affects the accent input of the 909 hi-hat sound. The hi-hat plays sixteenth notes with this accented variation. The pattern is not exactly on-grid and has a push-pull feel produced by the slightly eccentric rotation of the pattern disk due to its height on the tower. Adding further variation to the hi-hat pattern, vactrol filtered noise plays on syncopated hits. Later in the track a TR-909 ride cymbal sample is triggered by record with divisions of ten. All of the drum sounds are summed via a compressor, most noticeable in the way the ride cymbal sounds significantly louder when the bass drum is omitted, and is immediately squashed again on reintroduction (around 1'37). The piece runs from a single turntable with its speed increased, creating a tempo of 140 BPM. A string synth sound in a low register plays a one-cycle pattern throughout the track, most noticeable when the other sounds drop out at 2'43. This synth voice has significant stereo panning leading to a circulating, wide sound. A sub-bass pulse adds to the rhythmic drive of the piece. Its pattern remains constant throughout, though the pitch of the sound varies over time, changed by cams on the slow platter, running at about four revolutions per minute and not synchronised with the main turntable. The main melodic line comes from an analogue monosynth similar in character to a TB-303. The note pattern is generated using the Mono Comb and ball-bearing disk, however the rhythm pattern affecting both the amplitude and filter cutoff come from two sources: the fast hi-hat pattern hitting every sixteenth note, and the slower syncopated pattern from the MIDI Comb playing the chords. The amount to which each (or both) of these rhythm sources affects the lead line is the main parameter played through the recording, and serves to drive the arrangement. A minor textural detail is a filtered field-recording dubplate, also taking its trigger from the MIDI comb but also dependent on slow platter cam follower – as such it is intermittent and serves to emphasise the rhythms already playing.

Human playing

The majority of this piece is automated. Playing in this instance involves some amount of introducing and removing different layers of sound. When the synth chord is re-introduced at 1'38, the sound is allowed to play out for several bars before the thread forces the groove to lock again around 2'11. This presents a combination of human playing and automation: initialising an automatic process as part of the wider

arrangement. The remainder of the human playing in the piece is shifting the balance of the triggers for the mono-synth filter envelope. With one trigger playing constant sixteenth notes from the hi-hats and the other following the chords provided by the MIDI Comb, the levels are varied throughout to emphasise the different rhythms. At points, both sets of triggers are used, causing the patterns to interfere.