Musikarbeiter –
Collapsing Dichotomies and Divisions Between STEM and Creative Frameworks in the Practice of Music Technology and Education

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Abstract

Science, Technology, Engineering and Maths (STEM) skills and creativity are often constructed as being in opposition in the English educational system. These binary constructions are evidenced in the prestige and funding attached to each in universities. The same binary positioning and hierarchical constructions can be detected in the choices of A level combinations that schools are prepared to timetable, and are also evidenced in some of the specifications so far released for T Levels in the creative industries.

This research proposes that STEM techniques can be an inextricable part of creative endeavour, and therefore that STEM and creative paradigms need not be in opposition but in some cases (in particular technical creative media such as music technology) can form an indivisible whole, forming a blended practice. A literature review examines ideas of phronesis and praxis, craftsmanship and aesthetics. Exploring the nature of this practice, it draws on Sennett's (2009) and Dunne's (1997) explications of practice acquisition and development, and Dewey's pragmatic conception of knowledge acquisition. The discussion also addresses Dewey's (2018), Benjamin's (2008) and others conceptions of creativity and the nature of artistic experience, particularly as applied to technically reproduced art, and introduces ideas around sociomateriality and the acquisition of agency.

In the light of these considerations, after an overview of STEM-like ("positivist") and interpretivist methodologies, and a critique of the idea that these are incommensurable, this thesis examines the acquisition and induction into practice of aspiring musikarbeiter ("music workers") using an actor-network theory lens. Drawing on the experiences of contemporary practitioners from different technical areas of the industry, and of music technology educators, the thesis teases apart and pays attention to the role of STEM and "STEM-like" skills and methods, as well as craft skills, aesthetics, and creativity, in the translation of musikarbeiter into the networks of music technological employment and artistic practice, and how their roles change as this occurs. The thesis discovers common experiences of aesthetic recruitment, technical *interessement* (often involving specific hardware or software skills) and the abstraction and generalisation of those skills in order to achieve agency, and frames a suggestion for curriculum intent in terms of "skills/creativity/autonomy".

Key Words: Science, Technology, Engineering and Maths (STEM); Creative Education; Curriculum; Curriculum Intent; Music Technology.

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Table of Contents

Abstract **2**

Acknowledgements **3**

Publications and Conference Presentations **4**

Table of Contents **5**

Table of Figures **8**

1. Chapter 1 - Context and Problem: Dancing About Architecture ***9***

1.1: Introduction **9**

1.1.1: A Note on Style 11

1.2: Divide and Exit (Sleaford Mods, 2014) **12**

1.3: A Blended Practice **14**

Critical Incident 1 - Creative Engineering 15

1.4: 808 State of Mind (Dijon 2015) **17**

Critical Incident 2 – Doing the Work of Art 18

Critical incident 3 - The Application of Theory. 20

1.4: The College, the Curriculum and the Question. **23**

1.6: Summary **26**

2. Chapter 2 - Literature Review: You Can't Say Discourse Without Saying Disco ***27***

2.1: Introduction: Education and Implication **27**

2.2: Praxis and Practicality **28**

2.3: Craft and Creativity **32**

2.3.1: Peril and Performance 36

2.4: Art and Artificiality **38**

2.5: *Techné* and Technicality **45**

2.6: Sound and Subversion **47**

2.7: The *Techné* of the Kairos **51**

2.8: Summary **54**

3. Chapter 3 - Methodology, Epistemology and Ontology: The Real is Struggle ***55***

3.1: Introduction **55**

3.2: The (Al)lure of Positivism **56**

3.3: Meaning and Encounter **60**

3.4: Critical Theory **64**

3.5: The Presence of the Thing: Music, Technology, Methodology, and Method **65**

3.6: "The Things….Are Also People" (Adams, 1980) **69**

3.6.1: Tilley's Boomerang 70

3.6.2: Actor-Network Theory 71

3.6.3: Bringing it All Together 73

3.6.4: "Tell Me Stories" 74

3.7: Data Gathering and Thematic Analysis **74**

3.8: Method: Conclusion 76

4. Chapter 4 - Method and Analysis: Data Panik 79

4.1: Introduction 79

4.2: Architecture and Morality – Study Design and Ethics 80

4.3: Gathering the Data 83
4.3.1: The First Set of Participants 83
4.3.2: Initial prompt questions 85
4.3.3: The Second Set of Participants 86
4.3.4: Second set of Prompt Questions 88

4.4: Considerations Around data analysis 89
4.4.1: The Initial Transcripts 93
4.4.2: First Coding Run 94
Interlude: A note on NVivo 95
4.4.3: Results of Initial Coding 97
4.4.4: Second and Subsequent Coding Runs 97

4.5: My Themes and Where They Come From. 98
4.5.1: Working With Themes and NVivo 99
4.5.2: Working With Themes and ANT 100

4.6: The Themes 107

4.7: Initial Findings 108

5. Chapter 5 - Results: The Mobilisation of a Musikarbeiter 110

5.1: Setting the Scene - Play and Performance, Critical Incidents. 111

5.2: Theme 1 (Mobilising): Ways of Translation 115
5.2.1: People and People 116
Interlude: Human Affordances 119
5.2.2: People and things 120
5.2.3: Democracy and Agency 127

5.3: Theme 2 (Aesthetic Mobilisation): "They're Making Art!" – Aesthetics, Enrolment, and Interessement 129

5.4: Theme 3 (Non-Human Actors): The Joy of Tech 135

5.5: Theme 4 (Educators and Educating): Delivering the Musikarbeiter 144

5.6: Theme 5 (The Fairacres College Network): Musikarbeiter in Action 151

5.7: Summary 157

6. Chapter 6 – Interpretation: What Does Anything Mean? Basically (The Chameleons, 1985) 159

6.1: The Problem Reproblematised 159

6.2: "Why'd You Have to Go and Make Things so Complicated?" (Lavigne, 2002) 161

6.3 What did the Literature Say? 164
6.3.1 Overview 164
6.3.2 The Literature and the Themes 164

6.4: What Did the Participants Say? 167
6.4.1: Aesthetic Recruitment 168
6.4.2: Technical Interessement 169
6.4.3: Human Affordances 170

6.4.4: Creativity and Deliverables 171
7. Chapter 7 - Conclusion: Implications for Practice..... 173
7.1: What Did the Educators Say? 173
7.2: Conclusions 174
7.2.1: Skills 175
7.2.2: Creativity 176
7.2.3: Autonomy 177
7.3: A Final Word. 178
8. Reference List 179
9. Appendix 1: Ethics Application, Emails to Participants and Proforma. 195
Appendix 1.1: Ethics Application. 195
Appendix 1.2: Text of Email Sent to Participants 200
Appendix 1.3: University of Sunderland Proformas 202
10. Appendix 2: Sample Transcripts 206
Appendix 2.1: Transcript of part of interview with participant B 206
Appendix 2.2 Transcript of part of interview with participant D 207

Table of Figures

Figure 1.1: The Korg SQ-1 Hardware Sequencer.....15
Figure 2.1: Part of a MIDI loop as originally pencilled in 34
Figure 2.2: The same part after the iterative adjustment process described in the text. 34
Figure 2.3: Example of a "comped" vocal part.....36
Figure 2.4: Stage set up for electronic performance illustrating the potential for catastrophe. 38
Figure 2.5: The difference in resolution between outer and inner grooves of a vinyl record. 44
Figure 2.6: Design for Loudspeaker no. 7 and no. 5, Gustav Klutsis, 1922 50
Figure 2.7: Tweaking a filter. 52
Figure 2.8: The frequency spectrum of the adjusted sound.....53
Figure 5.1: The Logic Environment View. 139
Figure 5.2: A medium sized modular synthesizer 141
Figure 5.3: The Ableton Push controller..... 148

Table 4-1: Table of participants.....89
Table 4-2: Suggested process for reflexive thematic analysis. 91
Table 4-3: Annotated codebook from NVivo project “Musikarbeiter 3”. 103

Chapter 1 - Context and Problem: Dancing About Architecture

1.1: Introduction

This research is situated in a Further Education (FE) college in England. FE takes place in a somewhat liminal space sometimes described as "forgotten education" or the "Cinderella sector" (for example Bewick 2023, or the former Education Minister Gavin Williamson quoted in Camden 2020) where many of the subjects studied are 'vocational' rather than 'academic'. These subjects seem to be accepted rather unproblematically as learning trades. A great deal of valuable work has been done on what this might mean (for example Sennett 2009 or Dunne 2005, who will be examined in depth, along with other writers, in the literature review in chapter 2) in terms of carrying out this kind of education well. However, there seems to be a dislocation with the way the 'academic' curriculum works in that the traditional division into "Sciences", "Arts", and "Humanities" does not suit these subjects at all. In fact, there is something about the nature of these subjects (and of the way that work is subsequently carried out in the "real world" beyond education) that seems to challenge these distinctions altogether.

This thesis therefore has something of a dual purpose. The primary research question is:
how is music technology constituted in practice and presented in terms of curriculum and learning? How are people brought into this subject via education, and are inducted into practice beyond it, as they graduate and work in the sector? And in particular, how do "STEM" or "STEM-like" tools and practices interact with "creative" ones both inside and outside education? This is investigated via an extensive series of interviews with educators and practitioners, and the story of this research and the findings are told in chapters 4, 5 and 6.

This is not, therefore, a thesis about pedagogy but a thesis about (in Ofsted's terms) curriculum intent. I do not intend for it to be a prescription – one thing that is very clear to me is that teachers in further education are often experts in their field who need no top-down intervention – but I do hope it will be useful in providing a framework for educators to think about curricula for, not just music technology, but also other "blended practices" such as film or animation that demand both creative and technical judgement. This thesis constructs an Actor-Network Theory (ANT) informed picture of how music technology students and other aspirants learn their craft and might be come to take up ("be translated into" in ANT terms) industry and/or artistic roles and how educators might enable that. In keeping with Actor-Network Theory I would also expect educators reading this thesis to mediate my findings, translating them as they go.

The literature review draws on ideas of phronesis/praxis, craftsmanship, and aesthetics. These were all important in framing my themes (commonalities) but also led me towards sociomateriality. I am keen to capture the idea that, in a technical subject, stuff matters; and also to be able to see *how* stuff matters and how in turn that links STEM skills and creativity. Drawing on the literature review I trace and draw out commonalities in how the work of music technology and music technology education are done in the stories told by my participants, and, taking direction from Ingold (cited in Adams and Thompson 2016), the way the role of a student as actor changes through time as they are translated into the networks of the music industry and artistic practice.

The participants helped me to construct a common narrative or proposal of how this can work: Firstly, they are recruited via aesthetic experience, then bound to a specific role ("technical interessement") often via becoming expert in a specific piece of hardware or software, which they are able to offer as a "human affordance" to other actors. They go on to broaden these affordances by generalising them into the ability to make trustworthy technical and aesthetic judgments, and finally are able to contribute to "deliverables", tightly technically framed (often digital) objects such as formatted audio files which will ultimately be translated into aesthetic experiences in turn. Those participants who are educators are concerned with technical and craft skill but also guiding their students towards autonomy, and hence, agency. Autonomy/agency becomes possible when students are able to generalise both technical and phronetic (see the discussion of Joseph Dunne below) skills, avoiding "lock in". They therefore need to master a process or several processes not a set of givens. I summarise these processes in terms of a "skills-creativity-autonomy" triad of areas of concern to educators in Chapter 7.

In order to keep the thesis to manageable length there are areas I did not explore and could be used to extend the research. Firstly, I limited it to my own field of practice, music technology, and it would be fruitful to see if my tentative model also resonates with the experience of students, educators and professionals in other areas such as technical media or game design and animation. Secondly, although I did try to find a balanced group of participants, I did not examine in depth the roles of gender or ethnicity or how they might lead to different experiences. For example Green (1997) suggests boys may be preferentially drawn to technical areas (and the gender balance of music technology classes tends to confirm this) but the early history of the Radiophonic Workshop (Neibur 2010) and computation (Hicks 2018) suggest that in contexts where technical roles are less prestigious, a larger number of participants are female, suggesting that the supposed male

affinity/female disaffinity for technical roles is purely related to social expectation. Again, it would be fruitful to extend the research into these areas to see if the same considerations apply.

In the background, though, is the constant thread that this dichotomy runs wider and that an oversimplified and inaccurate portrayal of STEM practice, known as "positivism", is common currency among social researchers, and a similarly oversimplified and inaccurate portrayal of social research theory and practice, known as "postmodernism", and unrecognisable to most social science researchers, is prevalent in much of the STEM community (for example Dawkins 1998, or the apparent misunderstanding of Latour and Woolgar (1978) by Kukla and Walmsley (2004 p141). This is also challenged by the nature of this subject (and perhaps other, similar ones). If a dichotomy between "STEM" and "creativity" is to be collapsed, then, as well as the detailed discussion of practice and induction into practice referred to above, the historically and philosophically situated background of that dichotomy needs also to be taken into account, and this is teased out in this chapter and more extensively in chapter 3 (where it has relevance to methodology).

This chapter forms an introduction to the context and problem. Starting with a brief description of my personal impetus for the research and a brief historical overview of the separation of STEM and creative practice in the UK academic tradition, it then introduces and justifies in more depth the idea that music technology is a "blended practice", incorporating elements of both STEM and creativity, and examines examples of the use of technology in extending practice. It ends by revisiting the college and examining how two different exam board specifications approach the subject, and restates the question.

In both this chapter and Chapter 5 "critical incidents" are introduced to illuminate particular issues or illustrate triggers that posed particular questions. These therefore have a similar function to the anecdotes discussed in Adams and Thompson (2017) in that they lead us to understand things as they happened in experiential terms. "In telling an anecdote, we are recounting in lived-through detail an incident or life happening that strikes, interests, or otherwise concerns us".

1.1.1: A Note on Style

In keeping with concerns and the arguments from Gadamer regarding "prejudice" (1975, cited in Usher 1996), Habermas's concern for democratic communication (Habermas, 1972, cited in Usher 1996 and Dunne 1997) and indeed Lynch's (1982) critique of Latour noted in chapter 3, I have become increasingly uncomfortable with the use of academic passive voice while drafting this thesis. I

have come to believe that in this context it projects (and indeed that the entirety of the style is intended to project) an aura of objectivity that militates against the kind of transparency of process that is a key part of the reliability criterion that Nowell et. al. (2017) suggest. Language on the lines of "Participants were contacted. It was decided that..." suggests that this is a disinterested process where I as researcher am neutrally extracting facts, exactly the kind of "positivism creep" warned about by Braun and Clarke (2022). I have also been influenced by the Cochrane Collaboration guidelines for plain language summaries (Pitcher, Mitchell, and Hughes 2022) and especially template statements (for example p10) where complex topic titles are summarised as "we found that x" or "we did not find that x".

The science fiction writer Bruce Sterling (1996) imagined a world of "open tower science" where papers had titles like "My Grand Fun Tracing Neural Connections with Tetramethylbenzidine" and while that is perhaps a step too far for academic practice, it maybe captures more of the motivations and concerns of researchers, and offers more transparency, than is currently the case. I have therefore in this and following chapters attempted so far as I can to abandon academic passive voice as a device and instead speak to the reader direct.

1.2: Divide and Exit (Sleaford Mods, 2014)

I have always been bothered by the dichotomy between STEM and creative subjects.

I remember having to choose A levels. I was interested in humanities and physics, but combining the two was felt to be unacceptable. In terms of curriculum organisation, there were good reasons for this - it turned out that doing physics without maths put students at a disadvantage, and I suspect that had I gone the other way, doing a humanity such as history without the literacy and textual analysis skills that went with English might also have been an issue. And you couldn't fit all four in the timetable. Others have noted similar concerns (for example Dalton 2021).

I was still trying to reconcile these interests at university by studying the history and philosophy of science. There, I learned about the concept of paradigms (Kuhn 1970): how people with different understandings of the world had such radically different conceptual frameworks that one person's knowledge simply could not be understood in terms of the other's. The views are held to be semantically incommensurable (see also Coe 2017, p7). Although this is something of a simplification of Kuhn's views, the implication is that people operating under different paradigms cannot truly

communicate. This didn't make a lot of sense to me at the time. It still doesn't now. For example, there are "paradigmatic" differences between Ptolemaic and Galilean astronomy, but those involved in these paradigms communicated with each other all the time. They did not misunderstand each other (indeed the church may have understood Galileo only too well when he called his straw man for their views Simplicio), they just disagreed.

In the same way creative and scientific education are hived off into different areas of the curriculum and are often construed in terms of practices that seem to have little to do with each other, with the implication that they operate on different paradigms. The differences between STEM and creative models of practice as constructed in the curriculum have deep historical roots and the reasons for their existence are not trivial or easily dismissed. As noted at the start of this chapter, my attempt to study physics without the attendant maths required to fully understand it did not go well. However, the current division of subjects is not universal throughout history, and has changed over time. For example, the renaissance division between the "liberal arts" (which included arithmetic and astronomy as well as logic, music and rhetoric) and the "practical arts" such as architecture and medicine cuts right across modern divisions. Nowadays we would put arithmetic, geometry, and astronomy into STEM along with medicine, music into creative arts, and linguistic disciplines such as rhetoric and grammar into humanities. The transition from the natural philosophy of the middle ages and the renaissance to the sciences and technologies of the early modern period is often crudely told as a "scientific revolution" in which a series of wrong ideas were discarded, and correct ones put in their place, usually by great men. A closer look reveals a more complex picture one of whose characteristics is a filtering of subjects into differently conceived disciplines. For example, Koyré (1980) and Schumaker and Heilbron (1978) discuss examples from the early modern period of more unified philosophical frameworks, yet within 100 years, philosophers such as Bacon and Hobbes were laying out a materialist world view with a more or less modern division of subjects. All this is to suggest that modern curricular divisions are not a natural "given".

That is not to say that there are no apparent differences that need to be addressed. As noted above, it seems possible to differentiate sciences from creative subjects via methodology. Most STEM practitioners in the physical sciences, if pressed on the issue, would cleave to some variant of Popper's (2002) epistemology (for example, Hawking, 2011, quoted in Neilson, 2012). Both Popper's supporters (Hawking, as above) and his critics (for example Habermas, as discussed in Dunne 1997) have put his work under the umbrella of positivism, in that it strongly privileges understanding of natural phenomena as cases of general law (although Popper would not have agreed, a topic which

we will again return to in Chapter 3). The attraction of Popper is that he is able to coherently account for the success and structure of science. It would seem that this is hard to reconcile with analyses of creative arts which to say the least do not lend themselves to positivist discourse. Indeed, from one perspective outlined by Coe (2017, p8) the very attempt to reconcile positivism and interpretivism can be seen as a species of positivism. Interpretivism is characterised by Waring in Coe et. al. (2017) in opposition to positivism as a family of approaches having "internal-idealist, relativist" ontologies; "subjectivist, transactional, interactive" epistemology, "ideographic, dialectical, hermeneutical" methodology and the aim of "understanding, interpretation and reconstruction". I will discuss interpretivist and positivist frameworks in more depth in chapter 3.

We need therefore to steer a path between a declaration that subject boundaries are essentially arbitrary and contingent on the power structures of the day, and considering them fixed and inviolable. Coe (2017, p5) suggests that the whole notion of paradigms (and specifically positivist and interpretivist ones) is problematic (a view which I share) and suggests a pragmatic approach. After all, artists and scientists continue to talk to each other, and the human condition is all the better for it.

1.3: A Blended Practice

"Working with machines rather than fighting [is] the radical, emancipatory challenge" (Sennett 2009 p118).

In 1981 Ralf Hütter of the band Kraftwerk took exception to the term "musician" in an interview, insisting instead "Wir sind Musikarbeiter" ("We are music workers" - Kybernetisch, 2017). Sennett (2009, p92) tells us of an Enlightenment perspective in which "the encyclopaedists wanted ordinary workers to be admired rather than pitied" and it is this paradoxical sense of the worker as an anonymous but heroic figure that seems to resonate with Hütter's declaration. In the recent biography by Uwe Schütte, Kraftwerk's studio is described as a kind of experimental laboratory (Schütte, 2020, p143). Schütte characterises Kraftwerk's practice in terms of an artistic manifesto with links to Weimar modernism blended with the use of scientific and engineering processes.

In this way, in the field of music technology STEM and creative practice can seem to be inextricably bound up. In this section I briefly introduce some examples of how this might happen. The remainder of the chapter further examines the nature of this practice and the ways in which it has been addressed in further education, in order to frame the issues and questions that arise.

Critical Incident 1 - Creative Engineering

It is the summer of 2018. I am playing with a hardware sequencer.

This particular device has two rows of eight buttons, with a dial above each button. Each button is a note/off, and each dial decides the pitch. Pressing the start button lets it play two parallel rows of 8 or fewer notes (playing two instruments, or two notes on one instrument), or one sequence of 16 or fewer, and there are various types of reversing and interpolation. I am trying to get a feel for all this, for the operating procedure. Insofar as I have a goal in mind, I am trying to figure out how the thing works.

However, something unexpected happens. I'm playing around with a tune in 7/4 time, twiddling knobs, figuring it out. I find that the tone unexpectedly modulates up an octave, but in an 8 note pattern, a kind of polyrhythmic modulation. This becomes the basis for a fresh composition that I would certainly not have thought of on my own without the input from this device. My attempt to discover procedure has resulted in the achievement of an aesthetic goal that had not even been set. (Day, 2018).

Figure 1.1: The Korg SQ-1 Hardware Sequencer

Image: Author's own

Now, the noteworthy thing here is not the tune, but that I would not have had this idea if I had been composing in a different way. It is possible to set up polyrhythmic effects in computer composition, but requires forethought, and this is even more true for composing in staff notation. Neither is it instrumental improvisation. For one thing, unlike improvisation, the musical result is instantly fixed in a process that combines elements of performance and recording, and can be precisely repeated as well as tweaked and modified. It was my attempt at exploring and mastering something that is essentially an engineering tool that allowed this to happen. This kind of thing is not unique or even unusual (for example Stubbs (2024) discusses how Tangerine Dream's piece "Phaedra" arose from their struggles to understand and come to terms with their newly bought – and quite expensive – synthesizers). I have come to conceive of this as an example of a mixed or blended practice that is not unique to music technology - it is potentially traceable in other modern creative disciplines such as computer animation, film, and game design. Although this is a musical process it differs in important ways from most accounts of classical composition or of improvisation (for example Sloboda 1985 p148-149; Elliott (1995) p90; or Collingwood (cited in Dunne 1997 and discussed below and in chapter 2). This part of the chapter takes a look at the nature of this kind of practice.

In his own examination of practice, the philosopher of education Joseph Dunne, in "Back to the Rough Ground" (1997) examines the useful Aristotelian concepts of *techné* and *phronesis*. *Techné* is treated throughout most of the book as "know how"; the productive knowledge required to make a thing, with an external goal (see for example Dunne (1997) loc 5534). For Aristotle, all craft skills and most of what we would now consider art were *techné*, and *techné* was what I was trying to acquire in the example above. Phronesis is a harder concept to pin down, but Dunne repeatedly states its defining characteristic as action. It is the ability to make decisions based on experience, tied up with *praxis* ("practical wisdom"). The example used in Aristotle is of justice - for him justice is a set of actions, and one cannot act unjustly while still possessing the phronesis of justice. Thus, in phronesis ends and means are inseparable. There is a great deal more to this, which I approach in chapter 2 as well as later in this chapter, but we can pull out a couple of further points. Firstly, Dunne argues that another characteristic of phronesis is that one cannot pull a particular from a general rule (loc 6979); thus phronesis is dynamic and not rule based, each situation needs to be considered separately.

Dunne is concerned with phronesis as an educational process, but the relevance here is that he argues (contra Aristotle) that aesthetic excellence is more closely related to phronesis than to *techné*. In Part 1:A.2 (loc 1401) Dunne draws on R.G. Collingwood to argue that art in general is an "exploration of expression" rather than something which you start with a clear and immutable goal in

mind. Artistic expression therefore shares two of the important characteristics of phronesis - each piece is a unique particular that cannot be reached by algorithmically following a general rule, and the action of "exploring expression" is what defines art rather than it being determined by any particular end result. Although there are deep problems with Collingwood's conception of art as explicated by Dunne (to be discussed in chapter 2), we can look at a different example of music technology to see this principle stated in similar terms. This is the producer Brian Eno interviewed by the journalist Mark Cunningham in 1994 stating it very clearly:

> "There is nothing outside of this process. This process called recording is the creative process. We don't have the canvas standing in front of any landscape, you are going to make the landscape here and now" (Cunningham 1994).

For Eno even something as apparently goal driven - technical - as recording an instrument is an emergent process of creation.

1.4: 808 State of Mind (Dijon 2015)

It is not just artistic creativity which characterises the practice of music technology but a willingness to creatively extend technology itself. This part of the chapter therefore looks at some examples of how musicians and technologists move beyond the kind of "happy accidents" described in critical incident 1. Arthur Koestler in "The Act of Creation" (1989) proposed that creative acts (by which he meant scientific as well as artistic ones) shared a common structure, and that this is the structure of a joke. He argued that this structure was *bisociation* - the bringing together of seemingly incompatible frames of thought - which is seen as incongruity in a joke but as a disturbance or dislocation in science or art. A similar theory has been advanced by Meyer (1961) who, approaching the problem of how instrumental music can provoke an emotional response, proposes that an emotional response is created in the listener when a piece of music first creates a norm - effectively an expectation of what is going to happen next - via its structure then disturbs or deviates from that norm (for example 1961 p254).

Sennett (2009, p209) talks similarly of intuitive leaps happening when we first "break the mould of fit-for-purpose" by repurposing a tool or practice, then "establishing adjacency between two unlike domains". One could identify examples of such leaps in the music/technical domain. As an example, the Roland TR-808 was a drum machine produced in the 1980s. The repurposing of the 808 has been much mythologised since, not least by the manufacturers themselves, but according to Roland's own

current promotional material (Roland 2020), at the time the main use for drum machines was perceived to be as an automatic backing for artists who did not have a drummer, mainly in light entertainment and for home use. The machine did not sell well and was not a particularly prestigious device, partly due to its analogue synthesis model which does not sound especially natural (although Roland claim that a main goal was to have "realistic sounding drums", any sound comparison between a TR-808 and an acoustic kit would show that they did not succeed). However, because of its availability and comparative cheapness (compared, that is, with the alternative, the more "realistic" sounding Linn Drum), it was taken up by musicians in the then experimental genres of hip hop and techno. This repurposing of something which its designers did not intend for it to do and could not have envisaged is the "breaking of the mould of fit for purpose" that Sennett discusses. A key factor in this example is the programmability of the 808 which allowed the user to compose their own drum patterns, and this new feature allowed the combination of an engineering (programming) domain with a musical (composition) domain. Dunne (2005) argues that a practice stays alive "only as long as [its practitioners] sustain a commitment to creatively develop and extend it, sometimes by shifts which at the time may seem dramatic and even subversive" (p153) and this can be seen as an example.

Returning to Sennett (2009 p127) a "domain shift" occurs when one type of tool is used for another thing. We may take another historical example in the use of distortion in electric guitars. This was originally produced as an accidental (and potentially undesirable) by product of overdriving early amplifiers and speakers which were intended by the manufacturers as providing a way of emulating the sound of an acoustic guitar, but louder. Histories of distortion talk about the role of guitarists in pioneering the sound by deliberately overdriving their amplifiers and otherwise taking advantage of happy accidents such as dropped amplifiers and faulty circuit boards, (for example Jones, 2018) and that the deliberate design of circuits to provide controlled application of the effect did not come until some years later (Brice, 2001, p121). Sennett argues that "the difference between brute imitation of procedure and the larger understanding of how to use what one knows is….the mark of all skill development" (2009 p58). Since we are talking of music technology the implication is that the practice demands a technical understanding (in the example above, being able to create a distortion circuit) rather than just repeating the circumstances of the happy accident.

Critical Incident 2 – Doing the Work of Art

It is 2015. A student is trying to solve a creative production problem. She wants to record a particular drum sound for her track. This is a question of musical timbre, similar in some ways to choosing whether to use clarinet or oboe to play a particular orchestral part. But the answer will lead her into

an investigation of three different microphones, measuring distances from the drumhead with a tape measure, and listening comparisons with a commercial track which has a sound close to what she wants. She is, in other words, performing a series of experimental tests.

The practice of music technology is also, let us remind ourselves, creative *engineering*. In the case above, the student is working towards an aesthetic goal using what can be characterised as STEM skills. She is experimenting with various parameters of her recording in a controlled way, isolating variables, and carrying out measurements in an attempt to achieve a result. She will at the same time learn a great deal about the underlying principles such as the effects of distance and angle on recorded sound, which she may learn to relate to the physical characteristics of the microphone and the different frequencies produced by the beater and the shell of the drum. In Sennett's depiction of process (2005 p153) this is analogous to training the hand, and soon this physical knowledge of where to place a microphone will be ingrained enough to do away with the tape measure and work by hand and ear.

However, the understanding of process goes beyond the immediate skills that are gained and even beyond repurposing a tool in the way Sennett describes. In time she will be able to integrate this knowledge into an abstract schema and will have internalised a theory of recording which may be mathematically quite precise. She will be able to apply it to, and modify it in the light of, other recording and production events. Although the recording engineer is unlikely in her process to be thinking about epistemology, the process conforms quite closely to Popper's (2002) conception of the development of scientific knowledge in that it can be conceptualised as abstracting hypotheses from experience, making predictions using those hypotheses, testing them in an experimental environment and modifying the hypothesis in the light of experiment. Although the experiential knowledge gained by carrying out microphone placement is in tune with Dunne's account of praxis as practical wisdom built from experience or Sennett's account of craftsmanship, her abstraction seems much closer to what Dunne calls "the official conception of *techné*" as "knowledge of" (for example Dunne, 2005 loc 5534) which in theory can be taught from a book.

Is this kind of abstract knowledge, then, a vital part of the practice? Perhaps, if we are to reach the full potential of Dunne's injunction to extend the practice, at some point it will become unavoidable. For example, suppose the student wants to make something sound "more full". To get what they want, the student might need to understand what part of the sound relates to fullness, and how to enhance this. They may eventually be led to an understanding of concepts from acoustics and audio

engineering, such as envelopes, thresholds, attack and release times, and the dB scale. Although they may not need these to start with (they might start by imitation and move on to explore and experiment), as they come to understand the concepts involved, this "under the hood" knowledge will feed into and enable their practice, allowing them to experiment further but this time with a deeper understanding of what they are doing.

Critical incident 3 - The Application of Theory.

It is 2012. A group of students have gone on a visit to a mastering studio. They are interested in how to maximise the volume of their track while conforming to modern broadcasting standards and keeping some element of perceived dynamic. The mastering engineer is bringing to bear theoretical knowledge ranging from the use and understanding of meters, digital audio, (bit depths, sample rates, dither and intersample clipping), and the output characteristics of digital to analogue converters. Furthermore, within a few years the engineer will have to reapply this knowledge as a new set of standards emerge in an industry-wide attempt to get to grips with a "loudness war" that is held to be degrading the quality of recorded music (Derutty, 2011).

Consider the amount of technical knowledge required to read and understand the Derutty article cited here. It assumes the readership will understand not just decibels but terms such as RMS, crest factor, signal to noise ratio, and so on. And we should also consider that *Sound on Sound* magazine is not a technical journal for sound engineers; it has a considerable lay readership. A working mastering engineer would be expected to have *more* technical knowledge than is shown in this article.

However, it could be argued that this type of knowledge is a different case from the examples of musical creativity above - that in fact we have two different disciplines, both coincidentally called music technology, one of which is creative/phronetic (as exemplified in critical incident 1) and one of which is technical/STEM (as exemplified in critical incident 2) working, whatever Eno may have said, towards a reasonably defined goal that has been established early in the process.

I would like to look at a historical and a contemporary example to show that although we may potentially be able to unpick these tendencies analytically, in practice they are intimately bound together. And according to Dunne and Sennett, it is practice that matters.

In Louis Neibur's (2011) account of the BBC Radiophonic Workshop, the BBC music department, for internal political reasons, was resistant to musical innovations such as Musique Concrète and

Elektronische Musik (p34). The BBC therefore only allowed the use of these ideas as sound effects, leading to the establishment of the Radiophonic Workshop as a separate entity. The workers were not referred to as musicians or composers but as "studio managers" (SMs) "engineers" and "tape editors capable of devising special effects" (a decision that would become problematic later when SMs such as Delia Derbyshire were denied writing credits and royalties). In the BBC's conception the engineer's role was to realise the creative vision of the SMs (p55) but the roles soon became blurred. For example, the senior SM Daphne Oram took considerable time recording tones from individual oscillators (p62), working on tasks that involved understanding both of recording and of electronics, that could then be made into tape loops (using the craft skill of tape editing), which in turn could be used to produce predictable notes in musical compositions (not only blurring the lines between SMs and engineers but also between special effects and music). Some of the results of this process can be heard on the EP "Electronic Sound Patterns" (Oram 1962). After leaving the BBC, Oram built an electronic instrument of her own devising, the Oramics machine, that was operated by drawing shapes onto film that was then drawn across home built optical sensors. Oram attempted to give an account of her process in "An Individual Note" (Oram 2016) and it is clear that to her the technical, the psychological, and the musical are inseparable (see for example her chapter on formants, p51).

A more modern example can be found on the YouTube channel "Look Mum No Computer!" (for example, Look Mum No Computer 2020). This is an edge case of someone who has been able to monetise the technological creation process almost for its own sake. A glance down the channel reveals (as well as the ongoing attempt to build a 1000 oscillator synthesizer) a musical hack of a 1980s video game console and the creation of an instrument using an array of "Furby" toys. Here technical understanding has come full circle into the humour that Koestler spoke of and a pure joy in making things.

These two examples may be considered as cases chosen to illustrate one end of a continuum. It is clearly not necessary for everyone who works in music technology to build an instrument from scratch inventing the technology as they go along. However, this thread runs throughout the practice, from a thriving musical Arduino community of people who build their own controllers, to creative object-oriented programmers using environments such as Max MSP and PureData, right back to the understanding of engineering concepts foregrounded in critical incidents 2 and 3. In the final chapter of "Back to the Rough Ground" Dunne attempts to rescue *techné* from what he regards as an overly limited conception. At loc 6437 he says "What is strikingly absent from Aristotle's treatment of *techné*...is in the first place, any account of what we might call "creativity" and in the second place,

any scope for what we would call “experiment” and at loc 6444 “we do not get any sense of a making that is itself intelligent, endowed with know-how which is learned and actualised in the very process of making”. These elements are precisely those which characterise the creative practice of music technology. But Aristotle also talks of “the *techné* of the Kairos”, a *techné* whose exercise is a praxis, and tellingly, one example given is of playing a musical instrument (loc 5671). This will be examined further in Chapter 2.

We can get further insight into the nature of this kind of blended practice by looking at Dewey’s (2018, originally published 1933) discussion of careful thought. Dewey believed that thought is driven by “the demand for the solution of a perplexity” and that intellectual activity was careful thought about specific things (loc 164). He goes on to discuss a “double movement” from an initial (partial and confused) picture to a general situation, then back to facts to connect them up. Dewey regards scientific thought as a special case of a more general careful thought process, which extends to the creative and aesthetic realms. It is noticeable that we again have a dislocation of some kind - a perplexity - at the start of this process, and the resolution of that perplexity in a novel way is part of the cycle of careful thought.

It appears that a music producer will necessarily need to carry out a large amount of this kind of careful thought. The processes involved in audio treatment (or electronic sound creation) involve problem solving (resolution of perplexities) as well as creative judgement. It may not be always clear to a practitioner what is required: it may only be apparent that the current sound is in some way wrong and that there is a general path to take that may make it more “right”. The notion of what is “right” may be hard to articulate (especially since it may consist of some kind of quality of sound such as timbre that is not precisely specifiable in language and may consist of a purely aural conception). The practitioner will make adjustments, focusing on sound design, but then typically will have to listen back to ensure that it “works” as part of the overall piece, whatever it may be. We may again compare this with Sennett’s view (2009 p20) that at higher levels of craftsmanship the issues become those of problem solving rather than simply trying to get things to work. An example of this kind of skill being gained in practice is the second critical incident at the start of the chapter, and the meticulous placing of drum mics and careful listening can be seen as analogous to Sennett’s description of “focal awareness” (Sennett 2009 p174) leading to “corporeal anticipation” where a practitioner is able to work one step ahead of the material.

1.4: The College, the Curriculum and the Question.

In this section I relate the above considerations to the educational practice of music technology. A living practice of this kind will attract and recruit new practitioners who may come to it in a variety of ways, some via formal education and some by other paths. An important one of those paths since the introduction of formalised music technology courses is Further Education. As a vocational part of the sector, it is our remit in FE to make students fit for practice, whatever that may turn out to mean. This study and the considerations above will therefore have implications for the acquisition of practice in music technology students.

An example case is my institution, an FE college of some 7,000 students, which I have anonymised in this thesis as Fairacres College. About five years before the time this thesis was started, the music area switched to a different exam board, and it is worth looking at the differences in educational practice required by these boards in the light of the distinctions that we have looked at between *techné* and phronesis.

Under the previous exam board (Pearson, 2010) the subject was divided into units each of which was subject based. So, for example, units were called "Sound Recording Techniques" or "Acoustics". The object of student work was to demonstrate understanding of the subject matter. At the end of the second year there was a final major project ("FMP") but most of the student assessment would have already been done by that point, and the final project was quite prescribed (it had to consist of 20 minutes of recorded material, involving at least some studio recording - electronic composition on the other hand was not mandatory).

I would characterise this as a curriculum tilted towards the acquisition of *techné* in Dunne's and Aristotle's conception, and of craft skills. There are concessions to aesthetic merit in the high-grade criteria (the word "flair" was used) but it could equally be interpreted to mean skill and precision in the application of craft.

This can be contrasted with the programme of the current exam board (UAL, no date). Students are expected to take part in a series of creative projects, with unit titles such as "Engaging an Audience" and "Production Project". The FMP is where all the grade resides, and a student who does well will not only be able to carry out creative production, but also should be able to demonstrate planning and research skills and critically analyse their own and others' work. The FMP is not prescribed, and students have carried out projects ranging from specifying and building acoustic panels to live

performance. The unfixed nature of the project goals and the requirement to justify one's decisions and negotiate with the achievement criteria are much closer to phronesis.

Teachers have found in practice that there are advantages and disadvantages to each curriculum. Under the first, it was very clear that there were skills that needed to be mastered in order to pass, and that students were expected to understand their materials in quite a deep way to attain higher grades. I should be clear what I mean here by "materials" since we are often operating in the digital realm: Since the object may be (for example) to produce a high quality recording, materials might be interpreted to cover a wide range of factors such as the formatting of digital audio files, characteristics of microphones, and the size and shape of the room. "The discussion the producer holds with materials" (Sennett 2009, p7) will be a discussion about things such as microphone placement or sympathetic use of production software. This has the advantage that it is very clear to students and staff what they have to do: there are a number of skills to learn, and the expectation is that students, although they may specialise, will have at least a basic understanding of all of them. There is some room at higher levels of attainment to start thinking about using the tools creatively, but much of it is concerned with the level at which Sennett says (2009, p20) "people...struggle more exclusively with getting things to work".

The disadvantages are that this curriculum was often felt to be too prescriptive. This especially became an issue when the industry practice we were urged to emulate outpaced curriculum specifications. For example students were required to produce physical DVDs of film sound after this technology had become obsolete in the industry. There was also a problem in that it did not capture creativity well, and if faced with, on the one hand a workaday piece of production highly competently carried out, and on the other something truly startling but which had flaws, it was clear from the criteria that the former should achieve a higher grade. There was something about the subject which the requirements of this exam board did not quite capture.

That something might be said to be summed up in Dunne's concept of a practice as being potentially transcendental (Dunne 2005) - "A practice is a coherent and invariably quite complex set of activities and tasks that has developed cooperatively and cumulatively over time. It is alive in the community who are its insiders (i.e. genuine practitioners), and it stays alive only so long as they sustain a commitment to creatively develop and extend it".

The current exam board (UAL, no date) explicitly rewards a student who is capable of creatively extending his own practice, and academic rigor is provided by the requirement for a student to "show their working" - the research, planning and creative decision making must all be documented and justified. In terms of the external goods or instrumentality of the education provided, it is clear that students who do well come out highly self-sufficient and capable of planning and carrying out quite complex projects unaided, which coincidentally (or not) are skills employers claim to value. Thus, it would seem such a curriculum fulfils Dunne's prescription.

And yet, there are issues here as well. The open nature of the projects sometimes means students do not learn underlying principles; there is plenty of emphasis on what Sennett calls "the hand" so students reach quite a high level of technique, but they can reach that level with a fairly superficial understanding of the nature of their tools. The concerns of each board are reflected in the titles they give to the programmes - one is "Music Technology" and one is "Music Performance and Production". The difference of emphasis is telling and the complementary nature of their strengths and flaws seems to indicate that we are indeed looking at a blended practice, one which was historically born by combining elements of engineering and musicianship into something that is not quite either, as described above. I would go further in asserting that the modern conceptions of art and media are full of such blended practices, from the technical and electronic skills evident on installation art, to the visual creativity and artistry required to produce game animation. It is by no means obvious that we can make a clear distinction in these practices between "STEM" skills used to achieve technical standards and "creative" skills that are directed towards aesthetic goals. Macintyre (1981) quoted in Carr (1995), and Dunne (2005) state that a practice has its own internal goods and ends that are determined by the practice and conceptualised and transformed by its practitioners. I am suggesting in this chapter that the internal goods of the practice of music technology are neither purely technical nor purely aesthetic and I have tried to demonstrate that they are often a mixture of both.

The additional future challenge which this research is partly intended to meet is the advent of T Levels. T levels are due in creative subjects in 2025-26 and it is possible that music technology will be brought under their remit. The potential threat of T Levels is a downgrading of creative content in favour of a concept of engineering straight out of the Radiophonic workshop of the 1940s and 50s, although at the time of writing that threat seems to have somewhat receded. If this is the case, it is hoped that this thesis will be helpful to teachers, who will have to engage with questions of what can be done meaningfully and how we can adapt.

This thesis therefore examines the nature of the practice of music technology as narrated by an array of practitioners from specialist sub disciplines such as recording, electronic production, live sound engineering and music education. By examining how (and indeed whether) STEM and creative skills are blended and reconciled in and out of education, I tease out the nature of this practice and attempt to abstract a useful framework for navigating any curricular challenges that may arise in the immediate and medium term and provide a model for the way similar technical/creative disciplines may be approached in the future.

1.6: Summary

In this chapter I have looked briefly at the background of the academic divide between STEM and creativity. I have briefly introduced my reasons (as rooted in lived experience and some of the literature) for proposing that is challenged by real world "blended" practice in the subject of music technology, and closed with an overview of how vocational educational practice grapples with this issue both through the lens of philosophy of education and by the way various exam boards and their associated curricula address the subject.

As befits an introductory chapter some of these issues have only been passingly addressed. The following chapter will address the literature in more depth, looking at the practice(s) of music technology through a variety of lenses, not only bringing on board more detailed examinations of phronesis and craft, and also the aesthetic and even political implications raised by the study and practice of music technology.

Chapter 2 - Literature Review: You Can't Say Discourse Without Saying Disco

2.1: Introduction: Education and Implication

It is worth considering, then, what we are doing when we teach the subject of "music technology". There is a great deal of literature on what it means to be doing history, for example, or maths; Sennett and others have discussed craft practice, and Dunne experiential judgement. It still seems, however, that the subjects of vocational education (as opposed to vocational education itself) are not much theorised, and this may be because, as they are outside the academy, they in some way have a different (and more contingent) status. Music technologies may come and go but academic subjects are perceived to be forever, as well as being more prestigious (consider for example the discussion in Student Room (2007) on student and Russell Group university perceptions of "Mickey Mouse subjects").

Whatever the case may be, further education students spend two years (or more) in our hands learning about practical subjects such as music technology, or film and TV, or digital animation. While learning these kinds of subjects they study a broad and varied range of topics: among others acoustics, synthesis, digital audio, recording techniques, sound mixing, and a great many opportunities to create. My contention is that all of these parts come together in a blended practice which combines STEM, craft and aesthetics; however, even if they do not, they are conceptualised and timetabled by managers and taught by teachers as if they were parts of a single subject. In chapter 5 this thesis will return to investigate the nature of this subject/practice as conceived by its practitioners.

This chapter therefore consists of a comprehensive literature review focusing on the subject of music technology as a practice and unpicking the nature of STEM and creative practice from several points of view. Starting with the ideas of *praxis* (action), *phronesis* (judgement), and craft introduced in chapter 1, it identifies some lacunae in their direct application to the subject before also looking at the aesthetic, technical (STEM-like) and political aspects of "The Work of Art in the Age of Mechanical Reproduction" (Benjamin 2008). Sociomateriality, which will become important in the rest of this thesis, is introduced via the work of Devine (2019) to begin to address how we might understand the *stuff* of technology. "The *Techné* of the Kairos" returns to Dunne and his attempt to "rescue" *techné* via retrieving its experiential background.

All of these things bear directly or indirectly on music and music technology education. One can argue over the purpose of music education in general: is it aesthetic (The "Music Education is Aesthetic Education" view in Swanwick 1988) or an induction into a practice of "Musicing" (as proposed in Elliott 1995). To music technology education we can also ask: is it STEM education? Is it induction into a technological craft practice? And most pertinently to the background of this thesis, is it more than one of these things, and if so, how? The exploration of these questions will form a backdrop to what follows and will be directly related to my participants experiences in chapter 5.

2.2: Praxis and Practicality

Of the issues raised by the notion of a blended practice outlined in chapter 1, one of the most important for education is that of *what it means to know a thing*. Dunne's (1997) distinction between *techné* and phronesis illuminates the problem. In 1997 (loc 5240) he states:

> "*Techné*...enshrined the hallmarks of much of what we call a theoretical approach - a concern not so much with instances as with a knowledge that is explanatory, generalized, systematic, and transmissible, and is at the same time a source of reliable control over the facts that it brings within its ambit. And in explaining Phronesis, I shall be emphasising its experiential nature, the immediacy of its involvement in concrete situations, and the responsiveness and resourcefulness in these situations that come to it only from the character and dispositions of the person, formed in the course of his life history".

So, according to Dunne, *techné* seems to coincide with the nature of STEM knowledge laid out by Popper, in that it is knowledge of general principles which can be reliably applied to individual cases. The notion of phronesis is harder to pin down (evidenced by the fact that a large proportion of *Back to the Rough Ground* (Dunne 1997) is devoted to it). In Dunne's explication of phronesis it is worth remembering that it originally arose in Aristotle's Nicomachean Ethics, and was about the practical navigation of the moral and political realm in the Polis. In other words, it was culturally situated. By the end of *Back to the Rough Ground*, we have an account of phronesis and praxis that in its application to modern educational concerns is maybe more Dunne's than Aristotle's. Dunne's project is to provide a framework for conceptualising education and the practice of teaching which acknowledges that education is flexible and that attempting to provide a universal abstract framework that can be reliably applied to every situation with the expectation of the same result is misconceived and damaging. He argues at loc 5565 that this conception sets limits to the applicability

of *techné* and that education is outside those limits. Dunne was working against a political climate that seemed to prioritise behavioural objectives in education and promote a mechanistic model of teaching and learning, even down to classroom teaching method. Compare this with Swanwick's (1988) discussion of a similar issue (p127): "there remains a strong suspicion that the formulation of objectives *before the event* tends to drive out the magic of music and the spontaneity that enlivens human relationships. It is indeed an open question as to whether the *prediction* of objectives is essential or whether we should not rather be prepared to recognise achievement when it actually *occurs"* (author's italics). On p123 Swanwick conceptualises this distinction as the difference between instruction and encounter. For Dunne education is of necessity encounter: "If all this is true it is true willy-nilly. It is not something that happens by default in the case of the careless teacher, which another teacher can then obviate by taking the necessary technical steps" (loc 8304).

However we interpret phronesis in terms of general educational practice, its application to the practice, and educational induction into practice, of music technology needs some explication. Dunne cites (1997, loc 5374) Aristotle's distinction between phronesis as practical knowledge as opposed to *techné* as productive knowledge. So, for Dunne, *techné* is knowledge in which means are separated from ends (1997, loc 5534). I know how to do a thing, which I can then use to achieve a goal. In the case of making things (*poiesis*) the product is the goal. Phronesis on the other hand leads to *praxis*, action, which is an ongoing process. There is a moral dimension of phronesis conceived of as wise judgement in the public realm, which Dunne considers directly applicable to educational practice, but as mentioned in chapter 1 he also draws a parallel with the aesthetic realm, which is germane to the creative aspects of creative/technical disciplines. In part 1, chapter 2, he analyses R.G. Collingwood's book "*The Principles of Art*" and draws out Collingwood's alternatives to a technicist conception of art. Collingwood (and Dunne) depart from Aristotle here – as noted in loc 1422, for Aristotle art was specifically a kind of craft – and although Collingwood states (quoted in loc 1494) that craft is important in realising art, it is not definitive to art itself. At loc 1447 Dunne talks of the attempt to "articulate a mode of intentionality that is radically different from the technical one". This articulation is found in Collingwood's conception of art as emotional expression. For Collingwood such emotional expression is "*an activity for which there can be no technique*" (loc 1589, Dunne's italics) and at loc 1747 (in the context of politicised art) he is quoted as arguing that worthwhile art consists of the exploration and discovery of emotions, and that knowing what one's political emotions are beforehand to use art for the purpose of conversion stifles art. Shorn of its political concerns, Collingwood is edging here towards aesthetics as a form of praxis and this is highlighted by Dunne at loc 1848; "critical judgement as something exercised in the very activity, rather than as a higher type

of knowledge that can be brought to bear on it, is exactly what we shall find in Aristotle's notion of phronesis". I refer again to the quote from Brian Eno (Cunningham 1997) cited in chapter 1: "we don't have the canvas standing in front of any landscape, you are going to make the landscape here and now".

Collingwood's conception of art is, however, problematic, and these problems bear on the wider issue of phronesis in general both in education and in music technology. There is an implied social elitism in the notion of "knowledge like this which cannot be made accessible through general propositions or guaranteed by intellectual powers alone, knowledge that depends *rather on the kind of person one is*" (loc 1863). In isolation this would seem to preclude being able to learn how to be a better artist ("a person who is capable of producing bad art cannot, so far as he is capable of producing it, recognise it for what it is") and although Collingwood and Dunne attempt to address this issue ("there can be few, of course, whose consciousness is *entirely* corrupted and so the ability to recognise failure comes as the reward for previous successes") this does not seem entirely satisfactory. Worse, not just for a phronetic view of art but at a more basic level, Collingwood's view neglects the articulation and perception of a work of art. At loc 1871 Collingwood talks about the creation of a tune as being "already complete and perfect when it exists merely as a tune in [the artist's] head". There is a clear contrast here between this conception and critical incident 1 in chapter 1 above, in which the physical articulation of a piece via technical means was a key part of the compositional process. A similar view from Croce (1902, p50) is cited in Beardsley (1975): "When we have achieved the word within us, conceived definitely and vividly a figure or a statue, or found a musical motive, expression is born and complete; there is no need for anything else". Dunne recognises this as a problem, but he only sees it as a problem in that it does not allow communication (which the technical theory does). It seems strange, though, to claim that the concept of "music" is meaningful at all without a listener. From the Aristotelian perspective adopted in Dunne, the aesthetic (conceptual) work is pulled into the realm of praxis but the means of realising it are ultimately kept in the realm of poiesis. There is an assumption here that the production of art is separable from its conceptualisation. However, as this chapter will go on to claim, the means of articulation of an artistic conception (the means of artistic production if you will) are not neutral. Eno's making of the landscape is material as well as conceptual and so the characteristics of the stuff we work with cannot readily be disambiguated from its aesthetic conception.

There are other issues with the concept of phronesis in general. Since it is about conduct in the public realm *subject to the prevailing mores of the public realm* there is a danger that it might fall into what

could be termed “good chap-ism”. This danger is well articulated in the political realm in Blick and Hennessy (2019). The “Good Chap” principle of government is that “those who rise to high office will be ‘good chaps’, knowing what the unwritten rules are and wanting to adhere to them, even if doing so might frustrate the attainment of their policy objectives, party political goals, or personal ambitions”. The problem with unwritten rules is that they are unwritten. If they were not, in Dunne’s schema, we would be moving into the realm of *techné*. But this system can fail under pressure. Blick and Hennessy discuss the possibility that “the ‘good chap’ system was always flawed, that it was neither desirable nor as effective as was imagined, and any success that it appeared to attain owes much to a measure of fortune, that has now expired, exposing its fragility”. An educational example might be the repeated characterisation of Afro-Carribean children as “educationally sub-normal” first noted in Coard (1971). *Techné* based statistical accounts such as Teager (2022) suggest this is still an issue and no amount of wise action in the public realm seems able to stop it.

There is also an issue in that the public realm can become genuinely and sincerely divided on what constitutes moral action, or, in the case of other areas where phronesis is applicable, worthwhile praxis. Dunne’s answer has already been mentioned above (loc 8304); we are appealing to phronesis because *this is what happens anyway* and attempts to technicise a praxis are not only doomed to failure but will inevitably be damaging. At loc 2701 Dunne cites Hans-Georg Gadamer’s views on tradition which is held to be outside the realm of reason, and again reiterates that this is not a statement about desirability but rather one of what is: “What closes us into this circle - so that we can never get outside it, but can only try, in surrendering to it, to become more aware of it - is the fact that both our own anticipation of meaning and the meaning of the text already participate in the being of tradition”.

In the aesthetic realm, it is useful, following Dunne’s argument, to consider music making as a praxis; and insofar as music technology education is related to music education it is a perspective that has value. Elliott (1995) argues (against the then prevailing view amongst UK educationalists that “Music Education is Aesthetic Education” [MEAE]) that the purpose of music education is induction into a practice of “musicing” (broadly interpreted as including careful listening as well as performance). The idea that practitioners are embedded in a process whose goals (where they are anything more than nebulous ones like “provide a good live mix” or “write a good tune”) only emerge in process, and while, where there may be shortcuts that can be summed up as rules of procedure, they cannot be rigidly applied but always depend on context, seems to fit in well with the examples and critical incidents laid out in chapter 1. And yet, there is also a technical side to the discipline, where

generalised rules *can* be applied in specific cases that lead to predictable outcomes, so, for example, one can repeat an operation such as applying a voltage to a CV input on a synthesizer and it will have a predictable sonic result. This, according to Dunne, is the province of *techné*.

2.3: Craft and Creativity

As well as being a creative practice, music technology also requires the acquisition of technical skill, which as discussed in chapter 1 must then be applied in a creative and potentially even disruptive way. This is also (or perhaps especially) the province of vocational education. When we discuss "technical skill" what exactly do we mean, and when we teach it what exactly are we doing?

Sennett (2009) provides an extensive account of the development of craft skills, which have applicability here. In general, he lays out a path which, at the start, involve getting things to work, but which, once these skills are acquired, involves their application in higher level problem solving and even what he describes as ethical questions. (Sennett 2009, p20). Anyone who has learned a physical skill will see something in this account. Sennett also has a specific view of what he considers this kind of craft skill to be. On p 38-41 he discusses the need to train the hand in these initial stages, and specifically the impingement of CAD (Computer Aided Design) in the field of architecture which may be taken as in some respects an analogue of the use of technology in music making. So, on p39,

> "The smart machine can separate human mental understanding from repetitive, instructive, hands-on learning. When this occurs, conceptual human powers suffer".

Sennett admits that "the modern material world could not exist without the marvels of CAD" (p39) but then goes on to cite Turkle (1995) to argue that something has also been lost: that the ingrained knowledge gained by physically tracing and retracing a terrain by hand is not inculcated by the use of CAD. Renzo Piano's working procedure ("you start with sketching") is discussed and practical issues with the Peachtree Center in Atlanta, Georgia, are ascribed to the lack of this ingrained knowledge consequent from mentalized design. It is not the case here that Sennett is reflexively hostile to computers (indeed he discusses extensively the validity of Linux coding as a craft skill) and he also cites pre-CAD dependence on blueprints as part of the issue . He argues that blueprints started, and CAD extends, a problem of overdetermination: the overspecification of design prior to construction. (p 42 and 43). The question of relevance here is how Sennett's model relates to the practices involved in music technology, and induction into music technology practice, given our reliance on computers (especially in the last thirty years). Where Sennett discusses music making it is related to the playing

of stringed instruments, and the feedback between ear and fingertip, and especially the physical role of the hand when learning to play in tune and expressively (p157 and 159). This seems to align with Dunne's account of phronesis cited above ("critical judgement as something exercised in the very activity, rather than as a higher type of knowledge that can be brought to bear on it").

Whether this model of music making as a craft skill can be brought to bear on music technology is another matter. Frith (1986) notes the historical tension between perceived authenticity of expression and the use of technology. Part of the difficulty in unpicking these issues lies in the possibility mentioned in Chapter 1, that music technology is a portmanteau of several different skills drawn together under an umbrella, with the intention that they all might be useful in some aspect of the industry. For example, it seems easy to make the case that tape editing or live sound mixing are craft skills in Sennett's sense. They are partially physical skills (i.e. rely on a trained hand and ear), they require practice, and they involve the "awareness of physical material" and "corporeal anticipation" discussed by Sennet. On the other hand, the entry of MIDI notes via the click of a mouse seems far less so. Even here, however, it is possible to draw together elements that may fall under Sennett's criteria. It does not require craft skill to click in MIDI notes on a piano roll, but to characterise computer music arrangement in this way would be equivalent to characterising notation-based composition as "drawing dots and lines on a staff". In fact, "clicking notes in" is part of a larger process of musical arrangement incorporating, even at the simplest level of a drum loop, a surprising amount of subtlety and interpretation. In this kind of instance, the creation of a MIDI loop might involve changing the notes, perhaps even as the music is playing, making small tweaks, and listening at the same time. This is a continuous process which seems to avoid overdetermination (since design and construction are happening together) and demands the same kind of "focal awareness" that Sennett considers characteristic of a craft skill (2009, p174). Sennett quotes Michael Polyani's example of driving in a nail: "when we bring down a hammer, we do not feel that the handle has struck our palm but that its head has struck the nail". The "focal awareness" here is not in clicking on a screen but in directly affecting the feel and sound of a piece of music which is playing even as it is being composed. For example, in the loops shown below, notes and velocities were being moved around and altered even as the loop was played, in an iterative process, with the focus on listening throughout (note velocities in the MIDI protocol are a means of providing expression by providing a proxy of how hard a note is struck/plucked). After this kind of adjustment, the tune would be recognisably the same but with subtle alterations on emphasis and timing, providing the kind of expressive movement to the listener that under other circumstances would be created by the

musician's interpretive performance of a score (see figures 2.1 and 2.2). This kind of movement is usually referred to as "groove" in music software terminology (for example Ableton 2022).

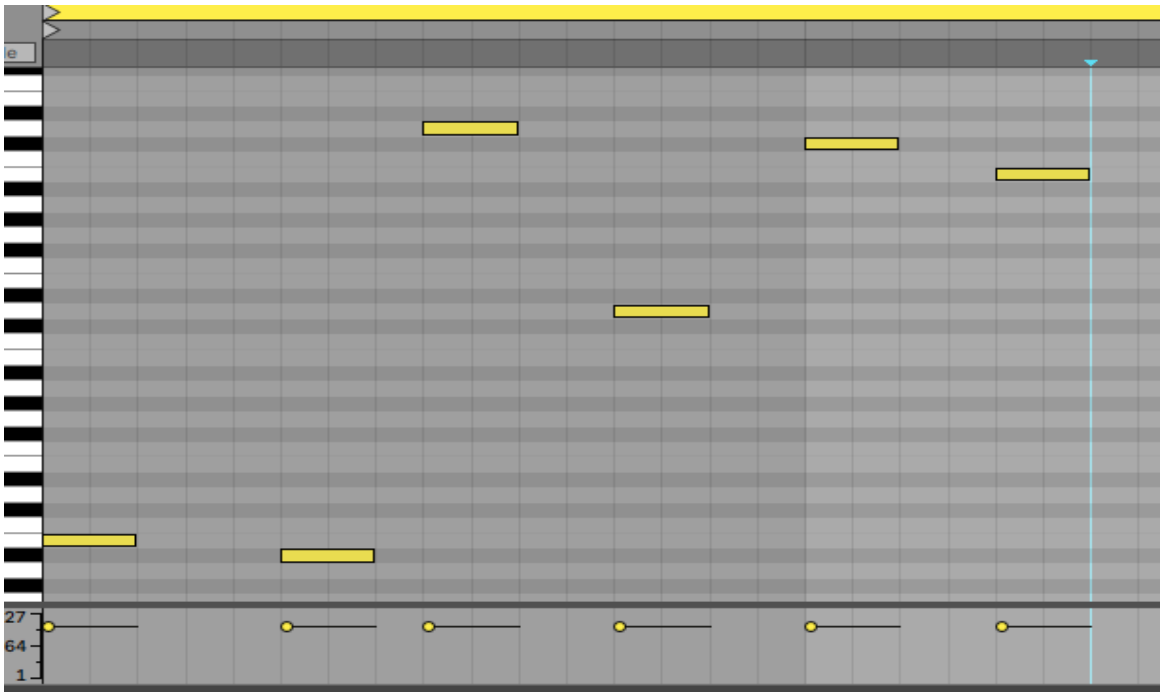


Figure 2.1: Part of a MIDI loop as originally pencilled in

The notes are fully quantised (starting and ending precisely on bar and note divisions) and velocities are uniform at 100. Image: author's own

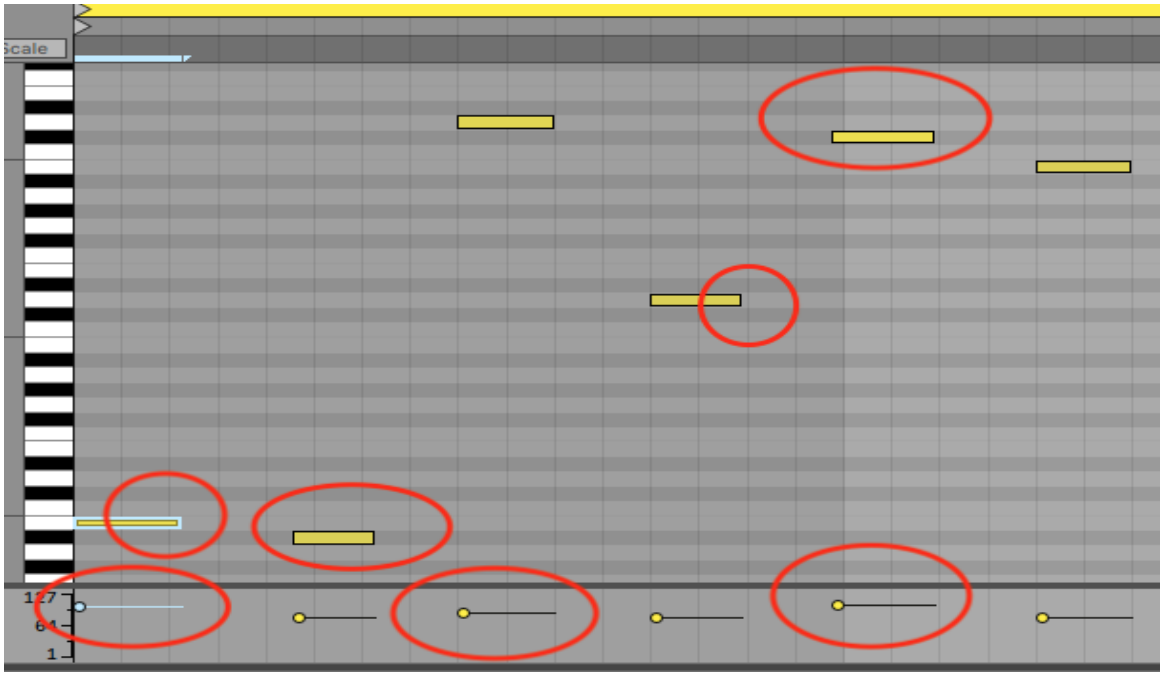


Figure 2.2: The same part after the iterative adjustment process described in the text.

Changes in note timing and velocity are circled red. Image: author's own

Comparing this with Sennett's description of glass blowing (2009, p174) we can recognise in the process above something akin to the "intelligent hand" where consciousness of the action of one's hand upon the controls is subsumed into considerations of (in this case) listening. This is even more true of other elements of electronic composition such as sound design, where controls (either software or hardware) might be continually tweaked while the operator's consciousness is fixed on the sound. In all these cases the sound (whether the apprehension of timbre involved in sound design, or the subtleties of rhythm and expression involved in creating a groove) is the focus of attention. It is also possible to recognise the "corporeal anticipation" detailed on p178, where via practice and familiarity it becomes possible to anticipate the effect of any given tweak of the controls, until what was trial and error becomes a fluid process. If this is the case then in education one would expect practice to have an effect on the quality and feel of compositions as students not only learn the basics of software ("getting things to work") but also how to "music" (in Elliott's (1995) coinage) via it.

There is also another aspect here which can only be described as *peril*. In the examples given here by Sennett each of them will fail to some degree or other if the process is not fluid. Across pp 173-177 the language is of glassblowing (pp173-175); musical performance (pp175-176) and even chopping meat (p177). What all of these have in common is a kind of commitment. Once the thing is done it is done, and if there was a mistake it cannot be corrected. In other areas of the book Sennett discusses brickmaking, pottery, and as mentioned above Linux coding, all of which have varying amounts of peril. All of these will eventually have to go out into the world as some kind of product, as will a piece of music created on a computer, but none are as capable of instant disaster as musical performance or glass blowing (use of music technology in performance is something of a special case which I address below). Moreover it does not seem to be the case that it is the use of a computer which is the defining factor: for example, in studio recordings the use of overdubs and multiple takes has taken the peril out of the equation since recording began; it has always been possible (although not necessarily economically feasible) in recorded music to discard a performance and go again since the days of wax cylinders, and these possibilities have become more and more flexible with the use of multitrack tape, punch in/punch out recording points, and the use of "comping" to create a composite performance consisting of the "best" fragments (Fig 2.3).

Selected vocals are in blue, discarded takes are in grey. The top line is made up of all the selected portions. Image: Author's own

Figure 2.3: Example of a "comped" vocal part

I must emphasise that this kind of reduction of peril takes place whether one is using tape, computers, or any other medium: it is the nature of recording that it can be revised.

A further consideration is the ongoing automation of tasks. Referring to the groove example above, it is also possible to extract or specify the groove of a recorded part, in other words to extract subtle timing and volume information, or use a preset, that can then be applied to a different part. Although this on the face of it requires less skill than creating a groove of one's own, it is also a defining feature of some older technologies (for example hardware samplers and grooveboxes) and has come to characterise particular genres. An example is the use of swing patterns (available as presets in the Akai MPC) in particular kinds of hip hop, as discussed for example in Scarth and Linn (2013). These grooves and patterns have come to characterise the genre. I would hesitate to say that just because they are presets, their application does not have the same craft-like character as that considered above: there will still be careful listening, and use of the intelligent hand, in the consideration of which groove is to be applied and how much. Indeed, in the case of hardware the operator is less prone to "mixing with the eyes".

2.3.1: Peril and Performance

The use of music technology in performance is another area where peril can be mitigated, but the use of technology can create perils of its own. Technological performance aids include microphones,

instrument and vocal amplification, and sound reinforcement in venues, as well as more visible considerations such as electronic instruments, use of laptop computers, and DJing. It may be useful to distinguish between technological mediation of performance such as sound mixing, and performance using technological means such as laptop performances. Certainly in education these would be separate projects and taught in different contexts.

Live sound mixing seems to be a different *kind* of thing from the use of electric or electronic instruments. The task of the live sound engineer is to optimise the sounds being created by musicians for the audience and the venue (or in the case of a monitor engineer, for the musicians). "The FOH (Front of House) engineer controls the audience's sound experience" (Berklee (no date)). Despite changes in mixing desk technology which enable a great deal of setup to be done beforehand it is still a skill that demands precisely the kind of use of the hand that Sennett considers characteristic of craft. Technological performance, on the other hand, has other considerations, and can range from performance using electronic instruments such as keyboards and amplified guitars (which would fall under Sennet's conception of craft in the same way as the cello he discusses), through use of performance software that permits on-the-fly changes in arrangement and sound design, via DJ performances to use of backing tracks. It is difficult to make a case for the performance (as opposed to the creation) of a backing track as a craft skill, whatever the arguments may be about its authenticity. However, the practitioners who do use backing tracks tend to use them as a backing for *something*, and that something is usually a vocal or instrumental performance that is a craft in its own right. The use of laptops and otherwise sequenced performances (including DJ performances) is slightly different; the role of the onstage musician or DJ here is to create a coherent experience using sections of music which are wholly or partly predetermined. There is still an element of needing to listen and change things on the go; and the direct apprehension of a controller by the hand is still present. While it is possible to "just press play" (Rolling Stone, 2012) the suggestion (from a leading DJ) that this is all that *anyone* does caused controversy (Kirn, 2012). The element of peril is still present – what if some element of this elaborate equipment goes wrong? – which in some sense makes it still "live performance". This kind of performance can be viewed as the preparation and live modulation of more or less self-sustaining musical processes (this is also discussed in the aesthetics section below). It is however a different kind of craft to that of "traditional" musicianship. Within this remit there are also performers who do not seek to mitigate peril and indeed try to do the opposite. There is something about peril which makes performance live and exciting, whether this is the exercise of virtuosity (either instrumental or technical) on the limit of what is feasible, or the performativity of live music creation. As Kirn says: "Part of the reason some of us seek out smaller

venues, crowded clubs, and experimental music haunts, is because we're excited to see stuff break. There's something thrilling about watching a set on the verge of a meltdown, about seeing someone try something that then really doesn't work – all for the chance to see someone produce something really new." (Fig 2.4).

Figure 2.4: Stage set up for electronic performance illustrating the potential for catastrophe.

Image: author's own.

However, in a situation where someone *does* "just press play" the craft may be elsewhere, in a vocal performance, the stagecraft of a frontperson, or the creative process. In the case of an elaborate audio-visual experience, the whole purpose of much of the technological operation is to mitigate peril in the interests of audience experience, and much craft will lie in the conception, assembly, and preparation of that experience rather than necessarily the performance itself.

2.4: Art and Artificiality

"If I pretended to compose music it would be cheating. I program arpeggiators". (Medlen, 2021)

The concern of this thesis is how technical and STEM-like skill *and* creativity work together in practice and in education. As noted above Sennett (2009) argues that at higher levels of craft questions of creativity and of art come into play. What does it mean to make – and teach – art in a technical environment? In fact, if we are to discuss creativity in this (and indeed other) areas, what is the *nature* of that creativity?

Sennett discusses and provides a model for the creativity of craft, but Dunne's discussion of Collingwood (1997, part 1.2) in relation to phronesis (which has already been considered earlier in this chapter) explicitly refutes the notion that art can be reduced only to craft, and I will discuss below whether or not art and craft are separable in the way that Collingwood wishes to claim. However at least some of what it means to be creative in this field is the artistic realisation of music or sound, and this in turn means that aesthetic merit must also be considered. In the example above (fig 2.1 and 2.2) the adjustment of notes and velocities has an aesthetic goal of "sounding right" that must be, like the ultimate shape of a vase or bowl in Sennett's glass blowing example, a matter of artistic judgment. Sennett himself may be read as a tracing of aesthetic and even moral threads in "mere" craftsmanship. For example, on p20 he discusses the "ethical problems of craftsmanship" and on p290, explaining why he has eschewed the word "creativity", explains "I have sought to draw craft and art together, because all techniques contain expressive implications". In this sense Sennett stands opposed to Collingwood (and by implication Dunne). For Collingwood the actual making of art is a poiesis which can be separated from its artistic conception, whereas for Sennett they are inseparable.

Sennett cites (p291) a pragmatist conception of aesthetics rooted in experience. As alluded to in the discussion of Dunne above, this is an aesthetic that can be related to praxis. In Dewey's *Art and Experience* (2005, originally published 1934) he insists from the first page that the aesthetic should not be separated from the everyday. "When artistic objects are separated from both conditions of origin and operation in experience, a wall is built around them that renders almost opaque their general significance…[the] task is to restore continuity". Or, more poetically, "Mountain peaks do not float unsupported, they do not even just rest upon the earth, they are the earth" (2005, p2). On p27 again, Dewey argues that although it is possible to distinguish between "fine art" and "useful or technological art" (craft, in Sennett's terms), this point of view is "extrinsic to the work of art itself".

Dewey distinguishes between the "artistic object" which is the physical painting, sculpture, etc and the "work of art". For Dewey "the work" is a dynamic process which has an effect, more akin to the way the term is used in physics than its more common usage in art as a noun, and the effect it has is

on the viewer (most of Dewey's examples are visual). *Work is done* on the experiencer via the artistic object: "By common consent, the Parthenon is a great work of art, but it has esthetic standing *only as the work becomes an experience for a human being"* (p2), and again (p168) the "work" is described as active and experienced, it is "what the product does, its working". "The *product* of art…is not the *work* of art. The work takes place when a human being cooperates with the product" (p222). For Dewey the felt presence of the thing is key, not just the thing. For Dewey, *contra* Collingwood, music demands a listener.

The nature of this experience, according to Dewey, must be coherent to be aesthetic: on pp 36-37 he draws the distinction between "experience" in the sense of mere exposure to things that happen, and "having an (aesthetic) experience". In chapter 3 he seems to struggle to define what an aesthetic experience is, although he talks of the unifying underlying quality which provides the difference between "experience" and "an experience"; he is able to hedge around it but not to pin it down. Indeed, Dewey analogises art as a language but one which cannot be translated without loss. "If all meanings could be adequately expressed by words, the arts of painting and music would not exist". So it seems impossible to specify the ingredients of aesthetic experience in order to reliably create a result. In this respect Dewey's account of art is phronetic rather than technical. The instructions on how to make a sound are not that sound. Attempts to transmit that experience in any way but undergoing it will not work. Although, for example, writers such as Toop (2019) and Demers (2015) have tried to capture a similar aesthetic to the music that they write about by literary means in their music writing, the provision of QR codes linking to sound files and a Spotify playlist by Toop indicate that they are well aware that this is not the *same* aesthetic experience.

Dewey is much clearer about the process of production. There must be intentionality (on p50 he discusses how, if an object previously thought to be made, were discovered to be accidental and natural, it would cease to be a work of art). Again, *contra* Collingwood, for Dewey the process is one of acting against a resistance – the transformation of obstacles into means or media, drawing by thoughtful action on past experience, transforms an activity into an act of expression (p63/64) and it is this which distinguishes between art and something accidentally or randomly expressive. For Dewey, AI could not produce art because there is no thoughtful action (Google engineers may disagree). Dewey sums this up in an early sentence "the intelligent mechanic is artistically engaged". For him Sennett's account of craft is equally an account of art.

Dewey's account therefore provides a coherent account of what art might be doing, which seems to fit in with the accounts of creators. From the point of view of someone creating pop music there are many positive aspects to his account – for example Dewey insists that the segregation of fine art into an abstract realm is false, and related to the elevation of museums, which themselves are monuments to "nationalism and imperialism". For Dewey, art of any kind needs to engage with its audience and the elevation of fine art above other art forms is also false. "All rankings of higher and lower are, ultimately, out of place and stupid".

There are however issues with Dewey's account from the point of view of a music technologist. In particular with reference to digitally reproduced music we have statements such as "an artist cannot work mechanically for mass production" (p8). Sennett (2009) on p291 tells us that Dewey fails to take into account the "disabling" effect of mass media, but he seems to share Sennett's pessimism. What Dewey means by this is not that there cannot be reproduced art – he discusses the "phonographic disk" - but that the process of making those reproductions is not an artistic one. This is not the only concern. His insistence on intentionality would struggle to account for generative music. He speaks of individual not communal experience. He does not discuss mediation. The aesthetic experience of Dewey seems to be mental not physical (although elsewhere he is very clear about the wholeness of the "live creature") and he does not speak of dancing. If a crowd dances to algorithmically generated techno is their aesthetic experience real? According to Dewey it seems not.

Mediation is a large part of what music technologists do. A mix engineer, for example, mediates between the on-stage artists and the crowd. They literally determine what, of the musicians, the crowd hears. Musicians themselves are sometimes surprisingly unconcerned with this: "those guys, they just play", said a mix engineer I interviewed (see chapter 5). For another of my interviewees, a professional musician, an emphasis on "nuance of sound" is somehow missing the point. But that is a mix engineer's entire job. Likewise electronic performance may be in part or in whole the live modulation - the mediation - of existing material, as mentioned above (and see the discussion of Subotnick and Thornton (1995) below).

Walter Benjamin, in "*The Work of Art in the Age of Mechanical Reproduction*" (2008; originally published 1936) addresses this kind of mediation when he is discussing film. For Benjamin, a film actor acts not to an audience but to camera (we could substitute to microphone in the studio) and the audience sees from the point of view of the same camera; but the camera is not transparent - it moves, takes different shots, has its own perspective. Benjamin presciently discusses art which can

"enter our homes with almost no effort on our part" and is designed to be consumed, not only communally, but in a state of distraction. To Benjamin, these are not flaws but changes in the nature of art, which it was politically urgent to comprehend (writing in the 1930s he was extremely worried that the Nazis had a better understanding of these new art forms that their opponents – for Benjamin, again *contra* Collingwood, it was important to politicise art). In music technology, as Benjamin would imply, sometimes the nature of the technology seems to demand the creation of an aesthetic that is explicitly different from that of traditional music. An example is the manifesto surrounding the Buchla modular synthesizer, where composers associated with the San Francisco Tape Music Centre were hostile to the "East Coast" idea of keyboard synthesizers; composers such as Morton Subotnick and Pauline Oliveros considered that use of electromechanical sequencers was a more appropriate way to control and create sound both in performance and in the studio (*I Dream of Wires*, 2014). These composers viewed their process as the creation of automated or semi-automated musical processes that could then be adjusted or modulated, to produce a new and experimental kind of performance that is an intentional rejection of traditional musicianship. This has already been referenced above; a modern instance taking this to its logical conclusion might be "Algorave"; coding music live in front of an audience using programmes such as Tidal and Supercollider, eschewing traditional musicianship in favour of an approach that looks a lot like live software engineering. (Resident Advisor, 2019)

Benjamin also addresses the issues raised by the artwork having potentially many copies, each if which can be considered equally real, in the context of film. The musical equivalent might be the vinyl disc, CD or digital file. For Dewey a phonographic disk is a "a vehicle for the effect and nothing more" and the original performance is the work of art. However for Benjamin

> "Reproductive technology….in making many copies of the reproduction, substitutes for its unique incidence a multiplicity of incidences. And in allowing the reproduction to come closer to whatever situation the person apprehending it is in, it actualises what is reproduced" (2008; p7).

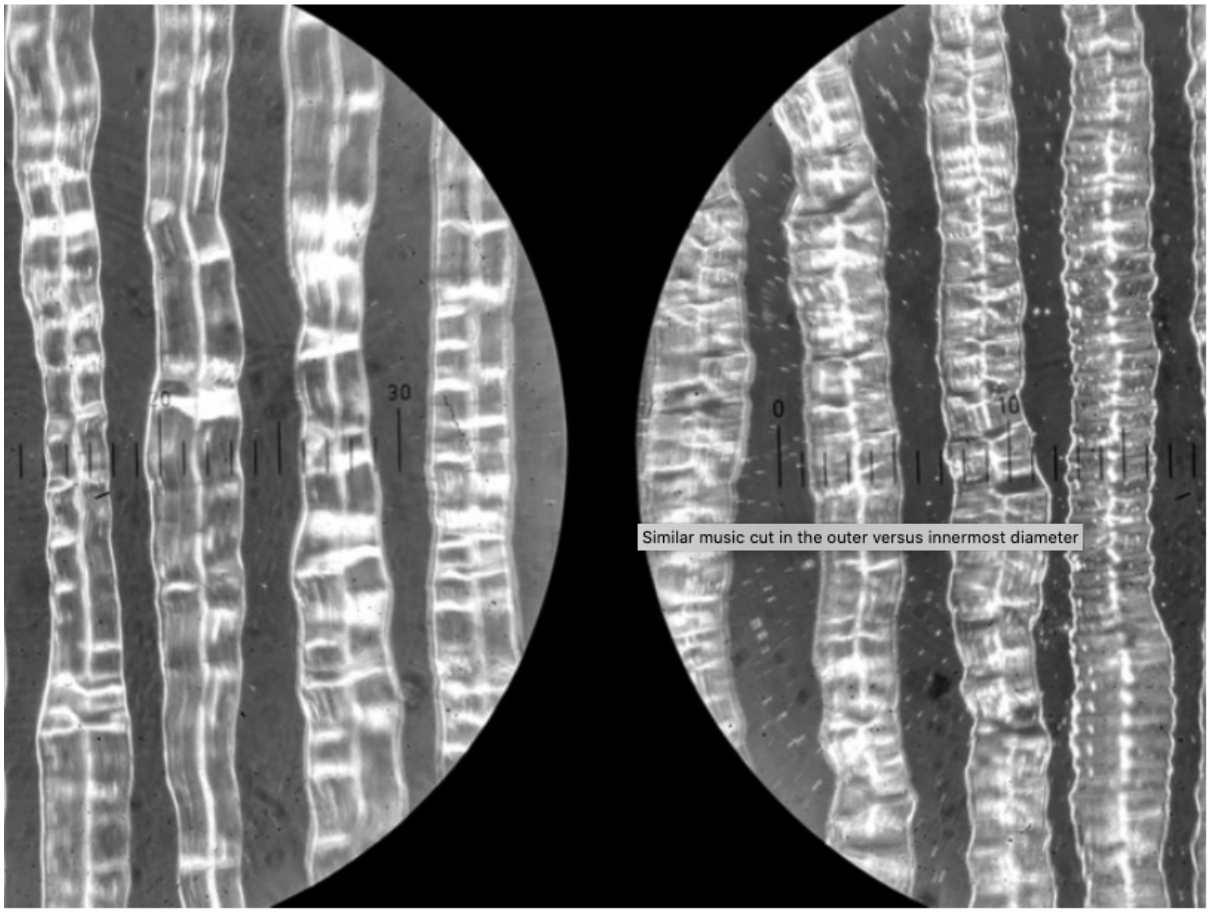
If there is no performance that was originally captured, but rather a composition that has gone straight from a piece of music software to a digital file, then the nature of a work of (musical) art seems closer to Benjamin's conception than to Dewey's, precisely because of the technology and mediation involved.

In “Club Cultures” (1995) the sociologist Sarah Thornton discusses “live cultures” where the claim to artistic merit, as per Dewey, is performance (the paradigmatic example is classical music, where a recording is always credited as of a specific performance in a specific time and place with a specific conductor) and “disc cultures” (where the music may be produced in the studio, by musicians playing at different times and places, who may have never even met each other; or on a computer with no original “performance” at all). In a full-fledged disc culture the recording is the original, if such a thing can be said to exist, and the performance is by a DJ who plays and manipulates the recorded material. From the accounts of Benjamin and Thornton it therefore seems that the phonographic disc and its modern equivalents are not neutral media, transparent vehicles as Dewey indicates, but part of an artistic process.

Kyle Devine, in “Decomposed” (2019), considers the conditions of production of mass-produced music. He cites the colonial conditions of shellac production, the petrochemical industry underlying vinyl, and the CO_2 burden of the so-called “cloud” (but in actual fact all too physical) server farms that host Spotify. Although his book is not about musicology as traditionally conceived, it is a valuable reminder that those materialities invisibly affect the aesthetic experience. He insists that music is not an aesthetic abstraction and that the substrate matters, and that musicology and aesthetics must somehow fold in these material considerations. For example, on p30 Devine discusses the relatively modern trend of format revivals such as the resurgence in vinyl. It is technically, measurably, not the case that vinyl has higher fidelity than CDs or even high bit rate MP3s, and yet people (including the author) will spend £20-£25 or more on a vinyl recording.

A revival of a measurably worse format does not fit with Dewey’s conception of aesthetic experience unless the format – the mass-produced object – is itself part of, or mediates, that experience. As a single straightforward example of how this might take place, dynamic range, the difference between the loud bits and the quiet bits, which is directly aesthetically experienced, is not purely aesthetically determined. Instead it needs to fall within various technical parameters, in order to tailor the music for the differing demands of the volume compensating algorithms of streaming suppliers, the material constraints of vinyl, or the listening conditions of club or concert venues. Artists and engineers are constrained to provide the artwork in a form which fits those parameters (known as a “deliverable” and discussed in more depth in chapters 5 and 6). Looking further into just one of these media, in vinyl mastering (the preparation of a master disc for subsequent albums to be pressed from), the nature of the medium even affects such apparently purely artistic decisions as track order.

As sound quality deteriorates towards the centre of a vinyl record due to the slower relative speed of central tracks to the needle, high frequencies in particular are distorted (fig 2.5).



Similar music cut in the outer versus innermost diameter

Figure 2.5: The difference in resolution between outer and inner grooves of a vinyl record.

Image from Gallindo (2022)

Many albums have a slow mellow track at the end of each side, and this is not purely an artistic decision, but a result of the need for more sonically detailed tracks to be in higher resolution parts of the record. The nature of the medium – the technology of a mass-produced product – informs the artistic result, with the long-term effect that this effect of a non-musical constraint now seems entirely natural and musically obvious as part of the "album" form.

Although this conclusion is in keeping with Benjamin's account it is also not entirely alien to Dewey: in his chapter on substance and form he says that "[to the artist] the art itself is exactly *what* it is because of *how* it is done" and "there is no distinction but perfect integration of manner and content". The difference between Benjamin and Dewey is that for Benjamin the existence and

process of reproduction is part of "how it is done" (and for Devine this even extends to the material conditions of production). The implication in education is that even if a student is working towards an apparently purely mediatory role such as live sound or mastering engineering, then aesthetic considerations and judgement are inevitably part of that work, whether or not they are foregrounded in a curriculum.

2.5: *Techné* and Technicality

As well as any craft and aesthetic dimensions that music technology may have, it is in the name that it is also a technology. When we teach it as a subject, we are considering craft and aesthetics, but we are also talking about wavelengths, frequencies, control voltages, MIDI protocol, formulae for reverberation times and acoustic resonance, patch cables and circuitry. And we treat these things as technical facts about the world. It is hard to avoid concluding that music technology, as the name suggests, is a *techné.*

As Dunne suggests, in a *techné* the account of *what it means to know a thing* is very different. For Dunne throughout most of *Back To The Rough Ground* the characteristic of a *techné* is that knowledge can be abstracted from the world, and can then be applied in more or less a predictable way (for example loc 5240: "*techné*...enshrined the hallmarks of much of what we call a theoretical approach - a concern not so much with particular instances as with a knowledge that is explanatory, generalized, systematic, and transmissible, and is at the same time a source of reliable control over the facts that it brings within its ambit"). There are plenty of examples in the use of music technology where this is extremely desirable. We do not (usually) want MIDI signals to send random notes; we do not wish sound levels to suddenly distort; if I send a control voltage to increment a filter, I want that to be by a predictable amount, and the same each time. In other words, I want to be able to apply procedural knowledge, to be secure in the anticipation that if I do X it will be followed by Y, all the time, every time. I may go further and wish to build things, whether software or hardware based; if I do that, I need those devices to behave predictably in the hands of musical creators. At this end of the discipline, we are dealing almost entirely with *poiesis* (making); this is music technology as engineering, a set of skills and attributes which I refer to as "STEM-like" in this thesis.

We can conceive of scientific - STEM-like - knowledge as making predictions about behaviour which are then tested by experiment as discussed in Chapter 1 (for example Popper 2002; originally published 1934). Again, I should emphasise that Popper did not consider this kind of knowledge to be positive, but rather provisional and liable to supersession (Popper repeatedly differentiates his own

epistemology from that of positivism; see for example 2002 locs 355, 383, 371, 392, etc). Popper's schema results in, at most, a reliable model. This is further discussed in Chapter 3.

There is, however, scope for interesting things to occur when the system does not behave as predicted, and this can be a path to new discoveries. This can be exemplified in the first example at the start of Chapter 1 (Day 2018). I had an idea about how a piece of equipment works, it turned out that there was also a way to get it to behave unexpectedly, certainly in a way that is not in the manual, but *is* a result of the way the device is built. Every individual component has behaved as predicted but it turns out that the complexity of both hardware and software can give rise to what are sometimes euphemistically called "undocumented behaviours". These are often by-products of other desirable features (in this case the wish to have two separate sequencer tracks), "spandrels" in biologist Stephen Jay Gould's memorable metaphor (Gould 2002 pp 1249-1259). In this metaphor the desire to build a bridge, for example, and the engineering solution – to use arches – results in roughly V-shaped areas of brickwork between the arches at the top, which are the spandrels. They are not part of the load bearing structure that keeps the bridge up, but they are unavoidably there, and may end up having unexpected effects both positive and negative. In this sense it is both possible and desirable to look at hardware and software systems as things where unexpected features may after all be experimentally discoverable. Exploration of equipment and what it can do is part and parcel of the acquisition of a craft skill. In my sequencing example above there was a creative disturbance but at the same time I also did, in fact, acquire the technical knowledge I was after. I now know more about how this device works. At the same time the exploration of equipment contains within it the possibility of the unexpected, and this can be identified with the kind of creative dislocation noted by Koestler, Meyer and for that matter Sennett.

However, in audio engineering texts such as Pohlman (2005), Everest (2001) and Brice (2001) we don't see statements about further experimentation ending to be done to establish, for example, the behaviour of digital to analogue converters. We *know how these work*. In engineering terms, we wish to create a system that we would expect to behave in a certain way. Although I may spend some time exploring a sound mixing desk, if acting as a sound engineer the skill of my trade is being able to alter sound in a desirable and predictable way, quickly and professionally (and potentially in the fraught and stressful context of live performance) and at that point I don't really want to make unexpected discoveries. I might, therefore, wish to teach a student about engineering concerns such as bit depth and sample rate as *facts about the world*.

There are several questions raised here from the point of view of music technology education. How far does the concept of making extend into everyday practice? How do practitioners understand and use "facts about the world"? Finally, bearing all of this in mind, how do we integrate this technicality seamlessly into the craft and creative aspects of the discipline? Again this integration is at the core of the thesis; how STEM and creativity *work together*.

2.6: Sound and Subversion

Part of what it means to educate is surely to empower (see for example Gibb 2015). We wish our students to have agency, to be equipped to realise the choices they make, and ultimately to have happy lives. These values are sometimes considered to be "liberatory". However, music and music technology have a profoundly ambiguous relationship with notions of liberation and democracy. Even in communal musical practices such as the Dagomba drumming referenced by Elliott (1995) there is a "master drummer" who has "cooled his heart", that is, who pays attention and acts strategically (pp63-64). Similarly, an improvisatory jazz ensemble has a band leader, and a gamelan has a *Kendang*. There is not equality in a musical ensemble.

Brandon Labelle (2018) alludes to this tension when he discusses a dual quality of sound in general. Although his main concern is *sonic agency* – sound as a liberatory force relating us to the "unseen, the non-represented or the not-yet-apparent" – he acknowledges that "sound is never far from noise, fragmentation, capture…the inherent potentiality of raising one's voice, shouting forth…[or] being overwhelmed and even silenced". The role of technology and of the amplifier in raising one voice above others is therefore called into question. How liberatory can technologically mediated music be?

Labelle discusses "echo and echoing" as an example of how this can take place. For him echo "return(s) to the dominant order and its master tongue its own performative grammars yet reshaped by an altogether different rhythm, an errant migrating repetition that may sound out alternative futures". We could equally easily be discussing sampling here. Groten (2020) discusses the democratising influence of the sample, in particular in "obsolescing the trained performer". At the same time he notes a commodification and commercialisation of "the sound object" that is inherent to sampling. The question of *who is in charge* of this commodification is illuminated by looking at Moraga (2020): on the one hand it is an examination of the BBD (bucket brigade delay), an analogue echo device, and contains enough information in the way of circuit diagrams for an engineer to build one, but it is also in substantial part essentially advertising copy for a range of pedals and devices manufactured by its corporate publisher. Thus, subversive sonic events such as the "People's

Microphone" discussed by Labelle (2018 p114) or underground psychedelic rock events in (then) Czechoslovakia (p54) are dependent on technological objects from the commercial sphere. To some extent one could argue that they have been repurposed, but the dominant dynamic is still that one group of people creates sound and another larger group listens. In fact, this is not necessarily undesirable. The possibility of surrender as a subversive act is discussed in Labelle (chapter 5) and the very nature of aesthetic experience as described by Dewey is that the listener is transformed by it. Labelle invites us to consider this in itself to be liberatory: "the extended and animate reach of sounded events are necessarily rapturous and disruptive" (p61). The educational equivalent of these considerations becomes apparent in the discussion in Chapter 5 of the "Calade ecosystem" and its extension into education by not only providing equipment but becoming an employer for graduates.

Various artists and other sonic actors have attempted to address this in different ways, all using the technological as a site of resistance. Labelle discusses the radical sound collective "Ultra-red" and the practice of recording – firstly as used by bathhouse workers during the AIDS crisis who protected themselves against police incursion by using sound recording as a kind of aural witness (audio rather than video to preserve anonymity) which were then in turn transformed into sound art pieces by the collective. He identifies this with "acousmatics", sound the source of which is not seen, which is technologically mediated, and which may reveal hidden hidden or hard to hear aspects of a soundscape (Ultra-red, forthcoming, cited in Labelle 2018). This concern with *paying attention* to the sonic rather than the visual is echoed in McLuhan (2001) who argued that electronic media favour the "inclusive and participational spoken word over the specialist written word". Other contemporary acts share this sensibility but not in a participatory way (for example avant-garde electronic group Autechre frequently play in "complete darkness" and ask for no photos - see for example Wredny 2016).

On p5 Labelle questions the very nature of the public sphere highlighting its increasing policing and criminalisation, and it is notable in this context that acousmatic sound can also be turned into means of control such as the "Mosquito" anti-loitering alarm, an apparently sourceless soundmaker, whose entire raison d'être is to prevent people deemed "undesirable" from exercising their right to exist in certain public spaces (Mosquito Loitering Solutions, no date). This example not only challenges Labelle's liberatory conception of acousmatics but also calls into question the very possibility of phronesis: what if the public realm is policed in such a way that wise action is rendered impossible?

Other attempts to subvert using sound are documented in Thornton (1995) and Gillett (2023). They chronicle attempts to not only take control of various sonic spaces but (at least initially) to do so in a democratised way: at least for some participants "faceless" DJs were an attempt to undermine the "star culture" inherent in one voice being amplified more than others. Similarly, Labelle discusses sound system culture and especially the role of Jamaican and reggae sound systems, and the technological role within them of "the electronic possibilities that led to the sound system, the sample, and the remix" (2018, p105). The anticolonial and antiauthoritarian associations attached to these systems were enthusiastically taken up by UK ravers (the author's experience of the Exodus sound system in Luton in the 1990s being a case in point: the borrowing of Bob Marley lyrics and a countercultural sensibility leaning heavily on Rastafarianism was intended as an act of subversion).

Finally, drawing on Jacques Attali, Labelle takes note of the tendency of music to "erupt, degrade and mutate under noise's continual pressure" subverting the demands of tonality and the centrality of melody which he identifies with systems of law and control. Again, these elements of noise can be technologically mediated such as those created by noise artist Merzbow, or the drone artists referenced in Demers (2014). Regardless of one's scepticism of the characterisations of specific musical forms as themselves politicised (see for example Shepherd et.al.1977) the intent of these artists to find alternative musical forms can be seen as liberatory.

It seems from these examples that the question of *who runs the machines* is critical. Agency can be enhanced or constrained according to dependencies which may not be obvious, and a microphone produced by a multinational corporation can be used in a democratising or controlling way. Furthermore, the difference between the two is not as simple as counting the number of voices it amplifies. It is inherent in technologically mediated sound that one sound source will be amplified; the implication is that others will be suppressed. The ambiguity is captured in Gustav Klutsis' constructivist designs for loudspeakers (Fig 2.6): part of an early Soviet art movement, they on the one hand suggest the stoking of revolutionary fervour, but on the other, via their centralised deployment as propaganda tools, they represent a nascent apparatus of control. Who is in charge of them? What will they say?

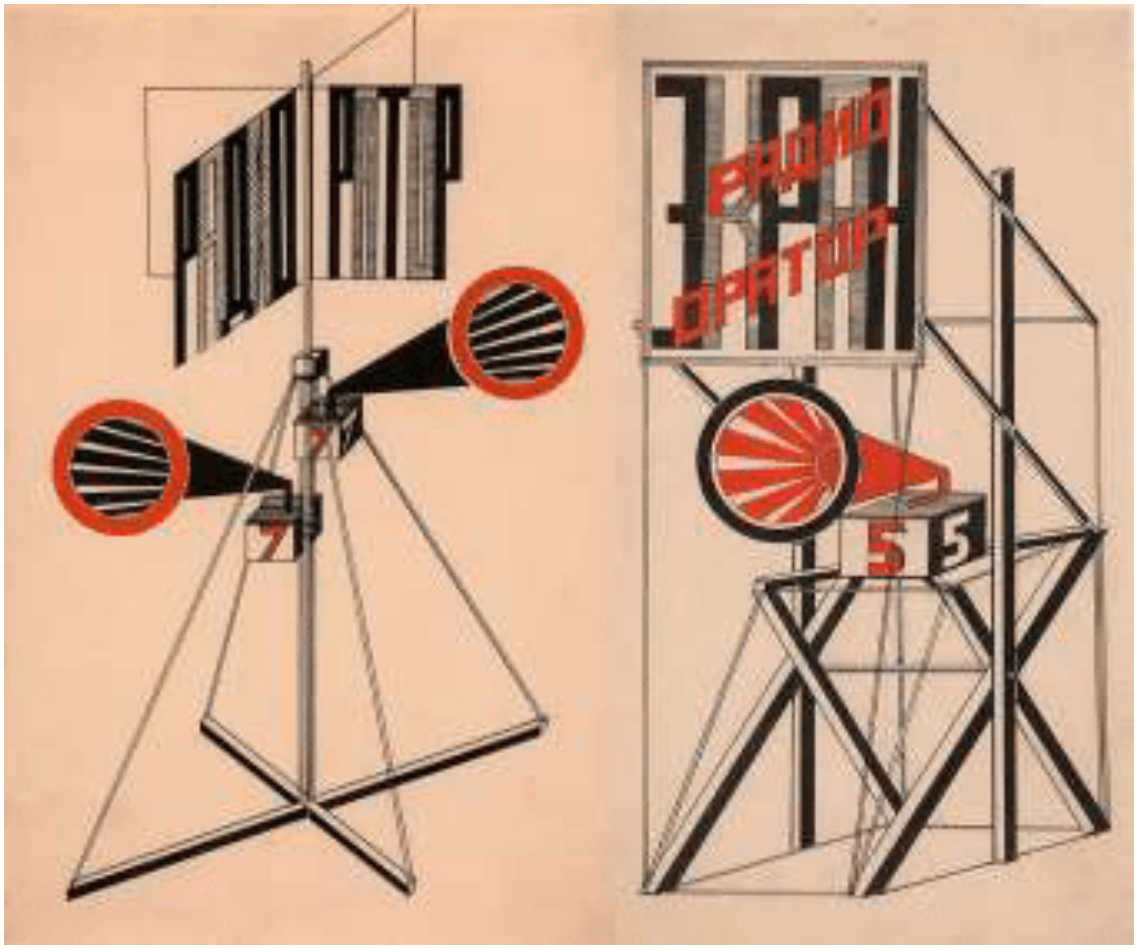


Figure 2.6: Design for Loudspeaker no. 7 and no. 5, Gustav Klutsis, 1922

Image from Savasir and Güleç (2020).

A good example of the use of technical means to take charge of one's own music making is the musical artist Brian Bamanya, who records as Afrorack (Afrorack 2022). This artist uses home-built synthesizer modules designed to highlight and foreground the conventions of African and specifically Ugandan music making. On his Bandcamp it states for example that "Bamanya uses a Euclidean rhythm sequencer to divide his CV signals into complex algorithmic patterns that mimic the polyrhythmic structures that exist in many East African musical forms". This kind of practice requires a deep commitment to audio engineering; and the same is true of sound system culture – the speaker stacks, altered delay effects, turntables and microphones which enable "the transformative and transportable properties of recorded electronic sound" (Labelle, 2018 p107) whether home built or corporate sourced, do not just self-assemble, and making the whole thing work together is not trivial. All of this is modulated by and in turn modulates an aesthetic commitment. Seizing the means of music production is, it seems, in itself a multifaceted practice.

2.7: The *Techné* of the Kairos

Is it possible to reconcile these different concerns or are they in fact characteristic of several different practices, some technical and some creative, which happen through historical accident to be combined into one portmanteau banner? I have briefly discussed the historically contingent nature of subject boundaries in chapter 1, but we should consider the possibility that there are ontological differences between subjects – and between aspects of music technology – which might be discerned analytically, and that the technical and creative elements are in fact quite separate. This is always an option that may come out in thematic analysis in later chapters.

In the curriculum, however, we talk about "Music Technology" as if it were one subject. The different approaches of two different exam boards have already been discussed; but it can also be seen that Pearson (2010) and UAL (no date), as well as demonstrating the difference between technicist and phronetic accounts of the curriculum, also (as one might expect) approach the nature of the subject in different ways. The Pearson specification of 2010 is atomised, dividing the overall subject into different modules which are intended to be internally consistent, such as Sound Creation and Manipulation (essentially sound design) or Acoustics and Digital Audio. There is no reason internal to this curriculum to teach these modules in the same way or seek any kind of unification. The UAL specification, on the other hand, is project based, loosely worded, and lends itself to assignments which demand a combination of technical and creative skill. As noted in chapter 1 both approaches have advantages; atomisation is not necessarily a mistake, and it is entirely possible to teach the Pearson specification via unified projects. Likewise, looking at the subject in a unified way does not necessarily involve discounting its internal *techné* or its creative and craft elements.

As touched on in chapter 1, Dunne (1997), starting at loc 2573, discusses the "*Techné* of the Kairos" which he defines as "a *techné* whose exercise is a praxis" (loc 5763). One example he gives is of playing an instrument but other examples given by Aristotle are warfare and navigation (all perilous occupations). The point is that there is such a thing as wise judgment informed and driven by technical knowledge; in order to navigate one must have knowledge of geometry and astronomy, for example, but must also be able to apply these things in a continuously changing and fluid environment. Even with modern equipment it is easy to find incidences where vessels have come to grief when something that "should be right" is mechanically carried out without taking local circumstances into account. This is part of a larger project of Dunne's: to rescue *techné* from the excesses of its own admirers. In chapter 10 (starting loc 3174) he discusses the ways in which the

"official" version of *techné* (his target) does not do justice to *techné* as practiced. Perhaps the most important of these is "experiential background". He quotes Aristotle as saying loc 7229 "men become builders by building and lyre-players by playing the lyre" but believes Aristotle (and by extension the "official" version of *techné*) allowed this consideration to be overshadowed. Later at loc 7268 *techné* is instead about "the bare knowledge". Purposiveness and character, which are conditions acquired by practice, are explicitly denied to *techné*. At loc 6437 we have "What is strikingly absent from Aristotle's treatment of *techné*……is in the first place, any account of what we might call 'creativity' and in the second place, any scope for what we would call 'experiment'"; and at loc 6444 "we do not get any sense of a making that is itself intelligent, endowed with know-how which is learned and actualised in the very process of making". According to Dunne this is because Aristotle was more interested in things than process, because he believed formal cause to be more important than material cause (loc 7397). But if the experiential background is recovered then technical knowledge may be able to merge with craft and creativity.

Consider this example from sound design. This is an aesthetically creative act, producing a new timbre for use in a piece of music.

Figure 2.7: Tweaking a filter.

Inage: author's own

In this picture I have set a low pass filter to around 200 Hz and tweaking a control to adjust the amount of harmonic resonance around the cutoff point. A low pass filter cuts off high frequencies

while letting through – passing – low ones. There is therefore already technical knowledge involved in knowing which knob to tweak. It is possible to learn the controls of any particular instance of "the synthesizer" by rote with no abstractions needed, but this will not help me if I need to use a different instrument with a different layout and analogous but different circuitry. It is therefore useful to have some kind of abstract schema of "the synthesizer" in mind because synthesizers, at some level, *are the same* – they form a class of instrument. Most of them will have control protocols in common, and most of those will have low pass filters, and in order to exercise control over the sound I need to know what a low pass filter does in order to predict the effect it will have on timbre.

However, it is also useful to have knowledge of *this particular* synthesizer; its individualities and peculiarities and how its particular controls react to the touch, because it is also true that all synthesizers are *not* the same, and not all low pass filters *sound* the same. In order to acquire that knowledge, I need to spend some time "messing about" with the instrument and trying things out. In other words, I need experiential knowledge as characterised by Dunne and Sennett. In the actual act of incrementing a filter, these two types of knowledge come together.

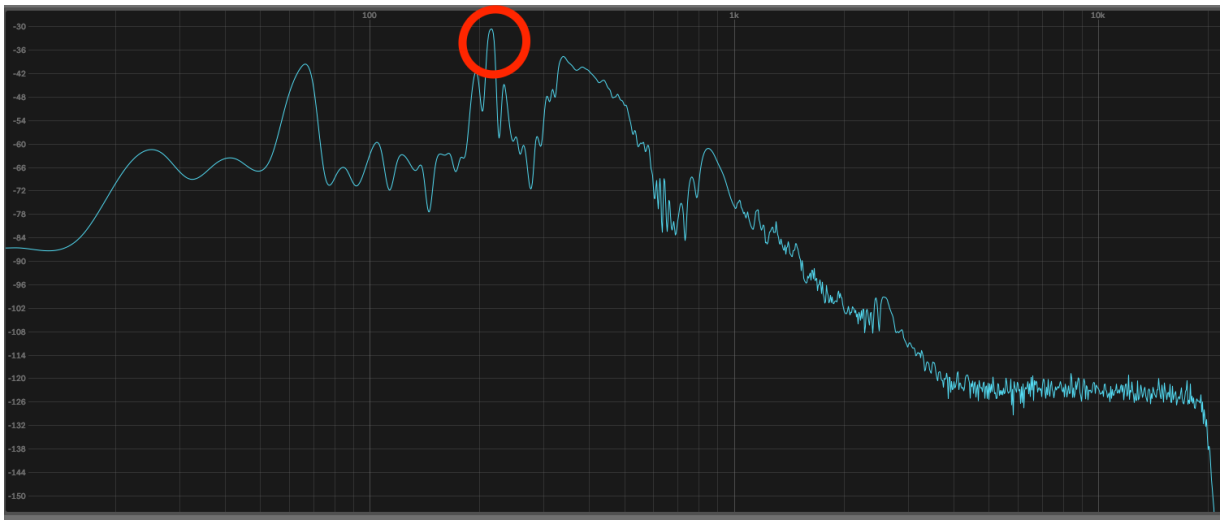


Figure 2.8: The frequency spectrum of the adjusted sound.

Image: author's own

In this diagram the filter's resonant peak is circled, and on the right are harmonics which are affected by the resonance control. The picture taken is a screenshot from a spectrum analysis tool embedded in a piece of recording software. I might, for example, use this tool to check where the sound will sit in an overall mix, or to troubleshoot unexpected or undesirable harmonics. This is a more or less technical process and I will need the kind of abstract knowledge of frequencies and amplitudes that might be discussed in Pohlmann (2005), Brice (2001), or Everest (2001). But, at the same time,

whether it is part of a piece of music or a stand-alone effect (such as a non-diegetic sound in a piece of film), it is also part of an aural experience to which the composer and the listener will assign an aesthetic outcome, and the nature of that outcome is not part of the technical recipe. Sound design is a skill that demands practice, acclimatisation, and the use of the hand – at the same time bringing to bear procedural knowledge of how to do a thing – and the thing that is done also has an aesthetic dimension. I will ultimately be using my aesthetic judgement to determine where the resonant peak sits.

2.8: Summary

A major concern of this chapter has been to draw out what the literature might say about music technology as a practice, and to draw out the implications of this both outside and inside education: if the avowed aim of vocational education is to induct students into a practice then clearly it is key to understand what that practice consists of. The chapter has therefore looked at accounts of music technology from the point of view of various theories of knowledge, action and craft, aesthetics, and empowerment. It seems a more complex picture than any single writer has addressed (and perhaps that applies to all practices).

What is, of course, missing from all of this is any account of *what the practitioners themselves*, whether educators or situated in the music and sound industry, have to say. This will be the major concern of chapter 5. Before we get there, however, we need an account of how these accounts were gathered and interpreted. The next chapter provides a methodological overview culminating in a path forward, and chapter 4 maps how that path was traversed. In chapter 5 we will return to the issues highlighted by this literature review when interpreting the practitioners' accounts.

Chapter 3 - Methodology, Epistemology and Ontology: The Real is Struggle

"After an hours long search that included a scientific paper that sourced a factoid to a book from the *For Dummies* series, I fell into an existential void and questioned the very nature of knowledge". (Yong 2022, p19)

3.1: Introduction

This chapter is an examination of methodology and method. The very notion of education is deeply tied in with questions of epistemology and ontology – what kind of knowledge are we trying to give to students? What does it mean for a student *to know a thing*? – and the same applies to research. In keeping with the overall concern of this thesis I have attempted to find something useful wherever it may be, and while I have tried to give a clear account of both commonalities and points of dissonance between positivist and interpretivist approaches, I have chosen to emphasise the former.

As discussed in the introduction to chapter 1, this is a thread – a *matter of concern* in the words of Bruno Latour (2007) – that runs all the way through the thesis. If I have spent an unusual amount of time, then, on a methodological overview, it is because of this; and rather than dismiss one viewpoint or the other I have tried to address what each of them say from the perspective of their own practitioners.

It may seem in keeping to adopt a positivist methodological stance for a technological subject, and this is not a concern to be casually dismissed. I have therefore sought to understand in some depth why so-called "positivism" seems so tempting, largely drawing largely on the philosophy of science of Karl Popper. I also discuss the real issues applying a positivist methodology to educational research. I therefore explore alternatives in various interpretivist methodologies drawing on Scott and Usher (1996) and their and Dunne's (1997) accounts of Gadamer, critical theory, and the "ideal speech condition".

A key section in this chapter is "The Presence of the Thing" (3.5) which highlights my concerns with methodologies that consider all meaning to reside in conversation or text. Many of the interpretivist methodologies above use this metaphor, yet as I have explored in chapter 2 there is something about the aesthetic practice of music technology that cannot be reduced to text. We have already encountered sociomateriality in the work of Kyle Devine (2019); it is now introduced and considered

more extensively. Using examples from the art world I examine in depth "the felt presence of the thing" and the obduracy of stuff.

Things (both technological and aesthetic) are an important aspect of music technology, and it seems strange to work on the assumption that they are nothing more than artefacts of "the social". In section 3.6 actor-network theory (ANT) is therefore proposed as a sociomaterial non-positivist approach that deals with the importance of things. The section begins with a consideration of Latour and Woolgar (1986), not just as an ur-text of ANT but also as a way of approaching STEM subjects from a humanities perspective, and continues to consider more recent views of ANT, notably Fenwick and Edwards (2010).

The issue of gathering and organising data is approached in section 3.7. In this section I consider Thematic Analysis (TA) as a way of understanding data. TA is a useful way of coming to grips with otherwise intractably large amounts of text and video but is not necessarily a methodological lens in itself (although it can be). A final section brings the chapter to a close with some thoughts and constraints in using TA along with ANT, which will be discussed in more depth in chapter 4.

The chapter below, then, is about *how to approach* the research question in a way that is sympathetic to the subject matter of how (and if) STEM and creativity work together in music technological practice and education.

3.2: The (Al)lure of Positivism

> "What good can come from philosophical thought that, contrary to every grain of Copernicus and Galileo, insists on the mentality of subjectivity? We really are too impressed with ourselves if we cannot conceive of a world without us." (Demers, *Drone and Apocalypse* (2014), p91)

There are things in the world which exist whether or not anyone is looking at them. These things are what we call real, and, because they exist independently of any observer, they can be studied in a neutral way. If I drop an egg on the floor and you, without knowing anything about me, also drop an egg on the floor, we will both end up with a broken egg. This will happen regardless of whether we believe in, or even know about, the theory of gravity. This is what we might call the folk ontology and epistemology of positivism. Things happen, and we can know they happen. It all seems very obvious and unproblematic.

Once you look at this harder you can discover some quite interesting things. You can measure how fast the egg falls. You can see if big eggs fall faster than small eggs. You can see if eggs fall faster or slower than ball bearings, or the same. At the end of it you can put together a mathematical model which you can use to predict what will happen to falling objects in a variety of circumstances. You can refine that model in the light of tests against those predictions. Maybe someone will have a conceptual leap and notice that the moon, which generally speaking seems to sit in the sky and not fall, also follows the maths of falling objects. All the material things we can see in the universe, at some level, can be mathematically modelled as a bunch of falling objects and their future trajectories calculated. Our simple set of observations has turned into something extremely powerful: a theory of gravity that ties all the objects in the universe together. If you don't believe it, then you or anyone else, whatever your background, values, or prejudices can throw a bunch of eggs about and measure the results and see if the maths predicts what is happening, and if you have done the maths right you will get the same answer. Our theory is therefore held to be reliable (because it works) and value neutral (because, in the words of a T-Shirt, it works whether you believe in it or not).

We can start to unpick this a little both in terms of ontology and epistemology. If we take the position that Newtonian gravity is "real", what are we to make of its replacement by the Einsteinian model? Is that "more real"? Are we in fact able to believe in the "reality" of these regularities at all since we cannot observe them directly, but only their effects? Is gravity real in the same sense that a chair is real? Popper (2002, first published 1934) suggests that the correct stance is to accept these kinds of propositions as only provisionally true, in the knowledge that they may be superseded by a better theory. Popper's epistemology is essentially what is outlined above - create a hypothesis to explain something about the world, test that hypothesis experimentally, and believe it provisionally until it fails experimental tests. It is noticeable that at this point we have departed from strict positivism in that we are not discovering absolute "truths". This is also a picture of a *social enterprise* where a theory must undergo attempts at replication by other workers and will not be accepted unless it is replicable. Although scientists are expected to strive for an ideal of honest self-assessment (see for example Feynman 1974), in practice over time the bias or otherwise of individuals is not a critical issue (not an issue, that is, for Popper's epistemology).

Although in Waring (chapter 3; p18; in Coe et. al.2017) this kind of process falls on the positivist side of the table, Popper emphatically rejects positivism (Popper 2002, loc 338) and argues that we replace it with a concept of provisional knowledge which is legitimated by meeting a falsifiability

criterion (loc 427): "*it must be possible for an empirical scientific system to be refuted by experience*" (author's italics). Popper is less concerned with how hypotheses are generated in the first place. How new hypotheses are invented "seems to me neither to call for logical analysis nor to be susceptible to it" (loc 270) - testability is all. Theories that do not make testable predictions (and are therefore unfalsifiable) are "not even wrong" (Peierls R; (1960); attributed to Wolfgang Pauli).

It is also noticeable that this epistemology can now become logically unmoored from realism, and although compatible with a realist perspective, we can also make sense of it as making statements about the accuracy of mathematical models in predicting instrumental measurements rather than proposing material truths about otherwise unobservable parts of the universe (these modifications of the stance are therefore described as instrumentalist ontologies, such as that formulated by Niels Bohr and cited for example in Faye 2016). In a paper on the reality of unobservables, Kukla and Walmsley (2004) argue that truth claims about unobservables are therefore not warranted.

Why would we want to follow such an austere view of research, which seems to discard so much of human experience, and which in the end maybe does not even promise knowledge of the universe in the sense that it is commonly understood? The answer lies in its promise of explanatory power and of reliability (or at the very least accurate modelling). An underlying framework of theory is favoured if it explains many things that seem disparate (such as the movement of a thrown egg, the moon, and distant galaxies) and if its predictions consistently work out. A realist interpretation would also state that this is predictive knowledge of actual things in an actual universe. For Popper and similar thinkers, the issue with other forms of enquiry is not that they have no value, but that as guides to conduct they can lead to (sometimes catastrophic) error: what is claimed to be illuminative does not illuminate if the model is unreliable, what is claimed to be liberatory will not lead to liberation if it is not grounded in "piecemeal"/"technological" rather than "utopian" social engineering (Popper 1983 pp304-318). This provides a mirror to Dunne's assertion (noted in chapter 2) that "if all this is true it is true willy-nilly" - both philosophers write of methodology as if they are making truth claims about an objective universe.

In the extreme case this leads to the characterisation of anything that is not empirically testable and measurable as not real, and certainly not knowledge. This view stems from genuine positivism: the idea that we can have positive knowledge of an external universe, and that this is all that is intelligible. In fact, Popper did not hold to this view – his underlying philosophy, which he termed "critical rationalism", is explicitly founded in metaphysics and ultimately morality (Popper (1983) pp.

33-45; Popper (2002) chapters 9, 10, 11). It is the extreme view which is the target of Dunne (1997) and Carr's (2005) writing (among others such as Braun and Clarke 2022) and it is important to note that "positivism" as defined in these works is not the same as STEM Practice (or even *techné*) as it is understood by its practitioners. As an aside, I have therefore become uncomfortable with the use of the term "positivism". Part of the background to this thesis (as discussed in chapter 1) is that STEM and humanities scholars may repeatedly misunderstand each other, and the use of this term may be part of this misunderstanding. Nonetheless, for clarity, and for consistency with other writers, I will continue to use the term as it is understood by scholars in educational research as a kind of shorthand, while noting Popper's objections.

Regardless of the extreme case there has nonetheless been, and continues to be, a great deal of debate about the value of the positivist account. An interpretivist critique, according to Usher (in Scott and Usher 1996), "challenges [the very assumption] that there are universal conditions of knowledge and criteria for deciding between theories" (p26). On the other hand, if one does not accept some kind of realist account of scientific success it is hard to explain how, for example, the laptop on which I am typing this works, without invoking an unlikely level of coincidence (this was formalised by Putnam (1979) as the "no miracles" argument).

Even at best, however, positivism seems unable to address large swathes of life. Leaving aside the question of whether these accounts can be relied upon at all, we also need to address the question of their use in educational research. The problem is that many of the things of interest are not susceptible to a positivist or even falsificationist approach. Let us take, for example, that Ofsted favourite, a good lesson. A teacher can have exactly the same lesson plan for two different cohorts of students that, if you look at their class profiles, will have a similar spread of prior knowledge, aptitude and needs. However, if she were to try to teach it identically at a granular level to both classes there is a real possibility that one lesson will go well, and one will go spectacularly wrong, because the complexity of a classroom will inevitably contain variables which cannot be planned for in advance. Maybe it is raining and students are distracted. Maybe a student has had a can of energy drink. Maybe a student or staff member has had an unusually bad (or good) day at home. What Swanwick (1988) describes as the *negotiated space of educational encounter* is not often susceptible to repeatable experiment, and the kind of knowledge a teacher has partly consists of a kind of nimbleness of foot in the face of an educational encounter that will be unpredictable and sometimes rapidly changing, that is, a phronesis rather than a *techné* of teaching. This is before we even get into the educational and ethical questions of what might count as "good". A great deal of what happens in

education is resistant to abstraction. In truth, we are interested in human life in all its chaos and joy, and the need to address human meaning is inseparable from educational goals.

3.3: Meaning and Encounter

It seems therefore that the toolbox of "positivism" may not be appropriate for a great many educational questions. If the starting point of this thesis is to look at practice in the field of music technology, the acquisition of this practice may not be the same process for all, and any common factors that we can begin to address in the curriculum are still at this point to be determined. Drawing on the narratives and experiences of my interviewees is more akin to the illumination of acts of communication. In positivist terms it is closer to the creation of theory (which as we recall Popper had little to say) rather than its testability. Further we will need to accept that we are not going to create the kind of abstract and overarching theory favoured by positivism.

The implication is that even if I accept that positivist ontology and epistemology are the most appropriate for describing material things in the "real" world, there is a corollary that if other methods prove more appropriate for a given piece of research, we are therefore researching different kinds of things in a different conception of the world. Scott and Usher (1996, p14) discuss this very issue: that the ontological assumptions of positivist epistemology, that the world has predictable regularities, may not be the case. The ontology they propose is therefore not one of separable things that are easily distinguished from the investigator, but one in which the social reality inhabited by the participants (including the researcher) is constructed by and inseparable from them. If as Coe claims "We cannot see the world outside of our place in it" (Coe 2017 in Coe et.al. 2017, p 18), a positivist account is therefore not only often not possible but is also undesirable, as the very act of abstraction will sideline important aspects of what we are looking at. For example, an attempt to isolate a variable will lead to a situation so artificial that any results that come from it will inevitably be distorted. "The social world does not consist of ready-made objects that are put into representation" (Game 1991; cited in Scott and Usher 1996).

If this is the case the question of what it means to know a thing in the social world is called into question. Usher (1996) cites Gadamer (1975, p18) as arguing that there is more to truth than scientific method, and that that human action needs to be interpreted within the context of human social practice. The describe this as hermeneutic or interpretive epistemology. As well as a claim about the social situation of enquiry, this is also a claim about meaningfulness that is very distinct

from the positivist implication that meaning is only to be found in empirically testable claims. All human communication, in this account, carries meaning and that meaning may be illuminated. Usher cites an apparently simple action such as raising one's arm. A positivist account might be able to address the movement of muscles and bones, and potentially also map the neural signals that initiate it. It is even possible that we might map the "neural correlates of consciousness" (Blackmore 2005) and determine that when the person raising their arm did so, regions of the brain were active that in other circumstances might indicate a desire to leave the room. But that is about as far as we can go. Without the context we do not know the full meaning :

> "The arm raising might mean different things in different contexts….so the meaning of the action is not exhausted by pointing to its 'underlying' intention…..We might want to specify how arm raising is culturally understood as a form of signalling, how it is associated with practices such as turn taking and so on. We could then go further and compare the meaning of arm raising in other societies" (Usher 1996 p 19).

Usher then goes on to discuss a far more complex practice – that of negotiating - and the beliefs and practices underlying it which in turn cannot be understood in isolation from the whole act of negotiation. (p20) This is of interest because the educational encounter is a matter of negotiation. On this kind of slippery ground where circumstances are not precise, mappable, and separable, understanding takes a different form.

At this point a positivist critique might dismiss what we are investigating as not "real" knowledge. It would be nice to know about such things but in practice it can't be done. And yet there is a discernible (if not easily measurable) difference between the experienced and inexperienced educator, and between a successful and an unsuccessful encounter, and the unavoidable implication is that we can gain a kind of knowledge and experience that can then be applied to improve our practice. The epistemological question in terms of the thesis is *what does it mean to know a thing* in this sense (in other words what kind of knowledge might answering the research question provide); and, following on from that, what methodology and method should we use to acquire this kind of knowledge?

Usher discusses a "double hermeneutic", where we are seeking to understand the interpretive frameworks by which others make sense of the world, but we can only do so within our own interpretive framework which needs to be taken into account. He cites Gadamer's argument that the

kind of objective stance sought by positivism is impossible in the social realm because the social situation of the researcher is inseparable from the wider realm she is investigating. Gadamer identifies this as "prejudice" but argues that it is inescapable. His response is to accept this and use it as part of the research method:

> "One's pre-understandings...are put at risk, tested and modified through the encounter with what one is trying to understand…..we should [therefore] use them as the essential starting point for acquiring knowledge".

He characterises this kind of work as a "fusion of horizons" (Usher 1996 p 21). In Gadamer's terminology "horizon" refers to one's standpoint and situatedness in one's own cultural tradition (it is notable that Gadamer often seems to use loaded words such as "prejudice", "authority" and "tradition" as a deliberate counter to enlightenment sentiment that these things are valueless or even damaging – see for example Dunne's account of Gadamer's view (1997) loc 2601). Our own horizon is inevitably partial and limited but can be extended by connecting with the horizons of others via "a learning experience involving dialogue" (Usher 1996 p22). In this view objectivity is the same as intersubjective agreement "where different and conflicting interpretations are harmonised". In this tradition, therefore, knowledge must be gained via dialogic means such as conversation, encounter, interview, and the researcher must be open to having their own horizon modified as a result of the dialogue. It is also worth noting at this point the implications for the idea of paradigms mentioned and critiqued in chapter one: If fusion of horizons is at all possible, then, whatever the situation in strict logic, in practice paradigms cannot be incommensurable. Part of the broader argument of this thesis can be characterised as a claim that the practice of music technology requires of its practitioners a fusion of horizons between STEM and artistic cultural traditions.

In keeping with this idea, Sennett (2009), as discussed in chapter 2, also discusses craft practice in terms of dialogue. Specifically, he discusses "dialogue with materials" (p7) and (as noted in chapter 2) states that as a craftsman engages more with their practice, they will struggle less with "getting things to work" and more with what he characterises as ethical problems. On p183 Sennett discusses the problem of "dead denotation", the writing of apparently informative instructions (he gives the cogent examples of software manuals) which are of no use without a great deal of already existing tacit knowledge. The problem, as Sennett identifies it, is a lack of expressive language which might work to help a neophyte come to grips with a problem or task. In a discussion of chicken recipes, he considers three ways ("sympathetic illustration" (p184), "scene narrative" (p187) and "instruction through

metaphors" (p189)) via which cultural practices of poiesis can be acquired. This can be seen as a useful set of examples of how a fusion of horizons may succeed or fail. In Sennett's example a cook trained in another tradition (or someone completely untrained) can come to an understanding of a craft, and in that understanding their own preconceptions will be tested. However, in Sennett's account the fusion of horizons is not something that is determined by only one actor – his aspiring chef is much more able to come to grips with expressive language than with dead denotation, and for Sennett this is a universal condition.

Conceptually there are similarities between modifying one's horizon in the light of encounter and modifying a theory in the light of experiment. In both cases there is an expectation of mental flexibility and willingness to let experience have its say. Popper's and Gadamer's accounts are in this sense both experiential. The difference is that for Popper the modifying experience is that of encounter with things in the world via experiment, whereas for Gadamer the guiding principle is of conversation. Dunne (1993) loc 2799 quotes Gadamer:

> "The whole point of conversation is that I both allow some play to my own thinking and, in doing so, expose it to the counterweight of the other's contribution, which may confirm me in it or force me to amend or abandon it".

Compare this with Popper (2002) loc 401:

> "But how is the system that represents our world of experience to be distinguished? The answer is: by the fact that it has been submitted to tests, and has stood up to tests…The theory of knowledge, whose task is the analysis of the method or procedure peculiar to empirical science, may accordingly be described as……a theory of what is usually called 'experience'".

Certainly, Popper and Gadamer have very different ontologies but both demand in their epistemology a reasonableness signified by an openness to another's horizon (Gadamer) or the construction of a theory that is open to falsification (Popper). The implication for both the classroom and the thesis is that this reasonableness should be part of academic and teaching practice. As discussed below in the section on ANT, any research is *risky* – the risk being that it might fail at any point (during the research, or after it if; it fails to be part of a fusion of horizons in the manner of dead denotation, or is falsified). In the classroom too, a teacher will strive for a fruitful encounter; or from another

perspective their idea that their lesson will be good might be falsified by experience. These are not weaknesses in Popper's or Gadamer's view; if we just ploughed ahead with a research outcome or a lesson regardless that would be the true point of failure.

3.4: Critical Theory

"Habermas (1972) argues that different knowledge/research traditions are linked with particular *social* interests" (Usher 1996 P 22).

According to Habermas neither "positivist" or "interpretivist" epistemologies are satisfactory because both are tied to political concerns that may be hidden or at least unnoticed by their practitioners. For example, the positivist tradition is linked to prediction and control. Thus, there is no such thing as a disinterested perspective (Usher, 1996 p23). In this instance the question arises as to how to reach some form of judgment as to which, and whose, knowledge claims are in some sense "better". For Habermas "truth" is to be found as a consensus agreement reached by a process of argumentation, critical discussion, and persuasion (Usher, 1996p24).. He argues that truth claims therefore depend on undistorted communication. This being the case Habermas argues that the key concern of critique must be emancipation, and that if this condition is not present then researchers should try to bring it about.

> "The condition ...is that dialogue must be free and unconstrained by structural/ideological inequalities. It is only in this context that a 'fusion of horizons' or an 'ideal speech situation' can be achieved" (Usher, ibid, p24)

Habermas' concern for emancipation therefore goes beyond questions of mere use value since research must involve praxis (action) in an emancipatory programme *as a precondition* for the ideal speech situation (providing a counterpoint to Popper's objection above – if for Popper a "correct" epistemology is a precondition for emancipation, for Habermas emancipation is a precondition for valid truth claims).

Habermas ties himself here to the use of linguistic communication, which he argues unavoidably places us in a structure which "binds us to the making, and proper meeting, of claims" (Dunne (1997) loc 4526). I have deep concerns regarding the commitment to a linguistic interpretation of communication, and indeed the applicability of the "ideal speech situation" to aesthetic experiences in general and musical (and indeed technological) experiences in particular. I have touched on this in

my literature review in my discussion of Labelle (chapter 2 section 6). Looking at this subject involves more than looking at people; music involves aesthetic objects which have action (Dewey's "product of art" does "the work of art" in conjunction with a human; one might analogise a "product of technology" that also does work). I will be exploring these objections and introducing Actor-Network Theory as a potential solution to them in sections 3.5 and 3.6 below. I have chosen to put them there because essentially they belong under method; I see ANT as a lens or sensibility that takes into account most or all of the methodological issues above whilst also being able to coherently account for "stuff" both technological and aesthetic. It also fulfils Habermas's need for praxis – ANT is as much (or more) an intervention as a mode of analysis (Fenwick and Edwards 2010)

3.5: The Presence of the Thing: Music, Technology, Methodology, and Method

The difficulty then with the accounts so far in this chapter of most interpretivist ontologies, and of critical theory, is that they are generally conceived in literature as the results of conversations, dialogue or dialectic, that is of knowledge and meaning that are essentially verbal. This is the case in sources that otherwise vary quite widely in their concerns. For example, in Scott and Usher (1996, p22) the model is of "dialogue", and Gadamer talks of "conversation". Discussing critical theory (p23) Habermas (1972) is quoted as characterising communicative transaction specifically as language use:

> "When one person says something to another that person explicitly makes the following claims:
> - That what is being said is intelligible or meaningful
> - That the propositional content of what is being said is true
> - That the speaker is justified in saying what he or she is saying
> - That the speaker is speaking sincerely
>
> On the basis of this, Habermas concludes that *undistorted communication is language use* where speakers can defend all four validity claims" (my italics).

Further down the page "for Habermas, truth is rational agreement *reached through critical discussion*". Coming from a different viewpoint, Connelly and Clandinin (1990) discuss narrative enquiry in terms of biography, field notes, conversation, and again dialogue. Again "truth" (or meaning or understanding) is focussed on the verbal. Although both Habermas and Connelly and

Clandinin have useful insights it seems to me that some important aspects of both truth (in either its artistic or positivist meanings) and situated meaning are being neglected. I have come to envisage these missing aspects as "the presence of the thing". By this I mean two related problems.

Firstly, in art and music a great deal of meaning - artistic meaning or artistic truth - is often transferred nonverbally. To return to the section on aesthetics in the literature review, Dewey (2005) takes a great deal of care to discuss "the expressive object" as something that can convey meaning – sometimes across centuries – without a code or convention.

> "There are other meanings which present themselves directly as possessions of objects which are experienced…..the work of art certainly does not have that (meaning) which is had by flags when they are used to signal another ship. But it does have that possessed by flags when they are used to decorate the deck of a ship for a dance" (p87).

Dewey's contention here can be summarised as a statement that there exists aesthetic truth and meaning which *has no propositional content.* For example, Demers (2015, p3) states (writing of drone music):

> "The discrepancy between the length of drone recordings…and the paucity of words we can use to describe this music make any attempt at interpretation suspect. No secret message, no code, nothing to interpret".

Benjamin's (2005) interpretation would take things even further in that the processes of mediation add an extra layer to the freight of nonverbal meaning - camera point of view for example is not a verbalised expression - and Devine's (2019) examination of the conditions of production of the artefacts of recorded music add another layer again. This is not to say that verbally conveyed meaning is not of importance in art, but it is clearly not the sole criterion. This can be illustrated by two relatively recent exhibitions: Parker (2022) and Riley (2019).

In Cornelia Parker's retrospective the signposted accompaniment that is now universal in art galleries has been co-opted by the artist to become part of the artwork. In a piece such as *Cold Dark Matter* (The "exploded shed") it absolutely matters that the shed did exist, was blown up, and was reconfigured/reinstalled by the artist in a way which "add(s) new layers of meaning". In the same way it matters whether a pile if rust in a glass case is the remains of a gun used in a crime, and that a ball

of rope is the same rope as was used to wrap a sculpture, was vandalised, and has been reconfigured with a "hidden weapon" inside. If we did not have the explanatory text, it would be a much less interesting ball of rope. If it turned out that it was a different rope, that there was no hidden weapon, the rust did not come from a gun, or that the shed was not in fact blown up, a viewer would undoubtedly be disappointed. These artworks would be different and far less interesting without the text, but at the same time the text accompanied by a mere picture of "*Cold Dark Matter*" (for example Tate Gallery 2022) is clearly not the same as seeing the exhibition. The thing itself carries artistic power and meaning beyond that conveyed by verbal dialogue.

The Bridget Riley retrospective at the Hayward Gallery (Riley 2019) is a contrasting example. Although the exhibition included a section on Riley's working methods (South Bank Centre 2019) this came at the end of the exhibition and was not necessary to appreciate the work. Riley and other op-art practitioners, inspired by Seurat, experimented with the direct effects of colour and form on the eye and mind. Standing in front or a Riley, colours and forms seem to dance and move in a way often described as hypnotic, and that is barely accessible by looking at a reproduction or print. The size of the originals and the way they fill an observer's field of vision are not easily reproducible.

In both these cases the presence of the thing is important. To fully grasp the "meaning" you have to be there. Furthermore, in Riley's work there is no "dialogue" unless the metaphor of dialogue is extended to include that which eschews and even obliterates language. This is not to claim that these artworks cannot be culturally situated – they can – but that a discussion of how artistic artefacts work needs to include both the nature of things and the existence of nonverbal meaning.

Those artistic artefacts include those involved in music. There has been a great deal of thought put into whether, and in what sense, musical communication can be analogised to linguistic communication (see for example the comparison of Schenkerian musical analysis to Chomsky's conception of language, and further discussion, in Sloboda (1985) chapter 2). Nonetheless it is clear that there is a difference between verbally discussing music and experiencing music. Sloboda also discusses the changes wrought in musical practice by varying forms of music notation but again not all aspects are linguistically intelligible. Elements such as harmony, melody and rhythm can be written down to an extent, but individual nuances of performance are much harder to capture and are generally abstracted away in the notation process (the reader is invited to experiment by playing a musical part to metronome via MIDI into music software, opening the score view, and comparing the resulting confusion to a "normal" musical score). The language of timbre and texture – a major part of

music production and electronic music creation and thus of music technology in general – is more or less unformalised; we are reduced to using broadly understood but vague terms such as “fat”, “heavy”, “warm”, or using STEM-like technical terms to describe, not the music, but the way we have set up equipment. In this case “the presence of the thing” should be identified with the listening experience. To be immersed in or subjected to a sonic or musical experience is to be pinned to the listening event; although recorded music has made that event (to some extent) replicable, anything short of undergoing the experience does not capture the most important thing about it. Indeed, this was Dewey’s point about all aesthetic experience as referenced in chapter 2.

Secondly, the importance of specific technological artefacts in music technology to the music created is clear. There is no technical reason why (for example) analogue synthesizers shouldn’t be precisely duplicable by digital sound, but the process is different. Recalling critical incident 1 in the first chapter, different processes create different results because any piece of equipment privileges one way of doing things over another - there are always easier and harder things to do. In some sense the style and form of music falls naturally out of the machinery and process used to compose it. This is true of any kind of music: for example, Bach’s “Well-Tempered Klavier” is (among other things) an explicit demonstration of how a new piece of equipment – the equal temperament keyboard – both makes possible and encourages the exploration of tonality. This kind of linkage between the aesthetic and the technical has again been discussed in some detail in chapter 2, in for example the discussion of the “phonographic disk”.

In discussing these kinds of relationships, it is difficult not to come to the conclusion that *stuff* has a reality, even an obduracy, of its own, that is not necessarily a straightforward projection of the intentionality or even the social world of its creators. This kind of obduracy has been experienced by anyone who has sworn at a printer. Again returning to chapter 1 (and the discussion of Sennett in chapter 2) and the repurposing of equipment (the example given of the Roland TR-808) it seems that features which were put into the original design with one intention were used for another unanticipated one that was nonetheless enabled by the design of the device. It is as if the stuff, once out in the world, had its own agenda. The apparent independent reality of stuff is well handled by “positivist” epistemology because the existence of an external reality with intelligible and measurable features is more or less a given in positivist ontology. As noted above, it is more problematic in interpretivist epistemology which traditionally mostly focussed on dialogue, conversation, negotiation, and social interaction, not on the way people work with things, and even more so with interpretivist ontology in which it seems hard to account for the non-mutable nature of stuff. In order

to address this, sociologists such as Devine (2019) have foregrounded "the material turn" or "the new materiality" in social sciences. Moreover, it seems clear that discussions of STEM and creativity cannot proceed without some acknowledgement of stuff, otherwise the STEM side is neglected or discounted. Any lens to view the data in this thesis will need to account for the interactions of stuff and people.

3.6: "The Things….Are Also People" (Adams, 1980)

In 1979 Bruno Latour and Steve Woolgar published *Laboratory Life,* an account of STEM practice (Latour and Woolgar 1986) that was to become contentious amongst STEM practitioners and philosophers of science. Derived from field notes at a life sciences facility it has been taken to show that scientific practice is unmoored from and has nothing more useful to say about the world than any other religion (as cited in Kukla and Walmsley 2004), or alternatively that its authors are obvious charlatans (Sokal and Bricmont 1999). In fact, it seems to say something more subtle and nuanced. It is worth exploring in some depth because, as an example of social scholarship that takes science seriously, it in some sense bridges a gap between the two. In this sense the concerns of *Laboratory Life* are mirrored in this thesis.

Latour and Woolgar's work is not just of interest in its serious study of STEM but also in that one of its authors went on to develop Actor-Network Theory (ANT) of which it is therefore in some sense a founding text.

Laboratory Life discusses what the authors call the construction of facts (in later editions they dropped the qualifier "social"). A central but unstated part of this account is an ontology whereby a scientific model of the world is inseparable from the world itself; it initially seems unclear whether Latour considers himself a realist ("Of course he believed in reality, he told the psychologist, convinced that the conversation was in jest" – Latour, quoted in Kofman 2018) or not ("the realist position…….centres on a tautological belief whereby the nature of independent objects can only be described in the terms which constitute them" – Latour and Woolgar, 1986, loc 3198). In fact, Latour's position is entirely understandable from an instrumentalist perspective – what we have access to are the results of measurements ("inscription devices" being what working scientists spend most of their time dealing with) and these are the constituents of "facts". Thus, according to Latour reality exists, but rather than pre-existing, it is constructed in a network by a **creative** act ("We do not

wish to say that facts do not exist nor that there is no such thing as reality. In this simple sense our position is not relativist. Our point is that "out-there-ness" is the consequence of scientific work rather than its cause" - Latour and Woolgar, 1986, loc. 3237). In the final chapter Latour uses the striking metaphor of Maxwell's Demon. In thermodynamics the Demon is a thought experiment - a device that can sort air molecules to create order from disorder at an energetic cost. Latour casts research into the same light as, not discovering a pre-existing order, but creating order as it goes, initially within its own network (1986, loc 4506). Putnam (1979)'s "no miracles" argument is that the utility of scientific discoveries in the non-scientific confirms the independent reality of scientific facts. For Latour and Woolgar, however, it is conceptualised as an extension of the network of the laboratory (in which network the fact is real) into the world in a way which anticipates "mobilisation" in Actor-Network Theory ("Proof of the statement necessitates the extension of the network" – Latour and Woolgar, 1986, loc 3271, and in detail loc 3262).

3.6.1: Tilley's Boomerang

A remarkable feature of such a contentious text is how far it can be compatible with traditional STEM accounts. Although Latour and Woolgar are looking for, and claim they have found, a mechanism by which facts come into being rather than being discovered (1986, loc 3419), they note in an afterword to the 1986 edition that

> "Perhaps the most interesting (philosophical) interpretation of our work is an attempt to enrol Laboratory Life as a confirmation (!) of the falsificationist theory of science. In this view, Laboratory Life constitutes "a striking corroboration" of Popperian philosophy of science (Tilley, 1981: 118)".

They call this "Tilley's boomerang". This cuts to the heart of the nature of STEM: Latour and Woolgar in the end wish to argue that science is not "special" and needs no special explanation for its efficacy. From this perspective incommensurability does not arise ("The full story will establish that there is a continuum between controversies in daily life and those occurring in the laboratory" - Latour and Woolgar, 1986, loc 3297). Tilley (and by extension Popperians) are taken to believe otherwise, but in this case a social science account is taken to by Tilley to confirm a falsificationist epistemology – again, incommensurability is called into question. The point here (and in this thesis) is not to argue for or against the special status of STEM but to tease out how STEM and creativity may work together in a particular field. For this purpose, *Laboratory Life* may serve as something as a model, not necessarily

in its method (see below) but in its elucidation of a perspective in which "positivist" and social science frameworks are not incommensurable *from either point of view*. If it does this by retaining some measure of creative ambiguity, that is also not entirely divorced from the perspective and subject of the thesis.

3.6.2: Actor-Network Theory

The appeal of Actor-Network Theory (henceforth, as it is conventionally referred to as, ANT) as a research perspective, besides the potential collapsing of incommensurability, is that it takes stuff and its obduracy seriously. Tara Fenwick and Richard Edwards (Actor-Network Theory in Education, 2010) lay down the groundwork for deploying several ANT and post-ANT perspectives. Although they caution against laying down definitions (it is in the nature of ANT that definitions are not, well, definitive) they lay out some features without which one wouldn't be doing ANT, but maybe something else. All of these starting points have implications and set up tensions which will need to be teased out. A precedent in the area is provided by Meynall's (2017) investigation of recording studio practice via ANT, although the method differs from this thesis in some important respects (see section 3.6.3 below). Meynall investigates the temporary alliances and networks required to both satisfy the aesthetic goals of musicians and to provide what I have characterised as a "deliverable" – a product that can be translated by a record label into networks of distribution and consumption. The use of technology to both create deliverables and ultimately retranslate them back into aesthetic experience is of great interest and is addressed in chapters 5 and 6.

To begin with, ANT is relational (p2). "No entity has an essential existence outside a given network". The relational nature of ANT has ontological implications (as existence, rather than simply meaning, derives from membership of a network). In ontological terms the relational nature of ANT means it is "democratic" in the sense that anything from a quark to a unicorn is "real" within its own network of relations (Harman, "The Importance of Bruno Latour for Philosophy", cited on p104 of Fenwick and Edwards 2010). As an example, in education the "teacheriness" of a teacher does not pre-exist, but is a product of her timetable, her training, the classroom she is situated in, the whiteboard, paper, pens, etc. As a corollary, distinctions (perhaps even between STEM and creative work) are "effects rather than foundational assumptions". This "democratic ontology" is prefigured and explored above in the account of *Laboratory Life.* In the craft practice of music technology, I will argue similarly that the "produceriness" of a producer is the result of a network of relationships, artistic production, equipment and so forth each of which has its own relations, perhaps the most important of which is *her role in the mobilisation of an aesthetic experience*.

Equally importantly from the perspective of this thesis, in the light of section 3.5 above, things – nonhuman actors – are accorded the same status as humans within a network. So a blackboard, a textbook, or an Akai MPC have (insofar as anything does) agency, or may be mobilised as part of a network that they are members of. Networks themselves become actors and can be discussed in this way. This aspect of ANT is attractive as it seems to take the "thingness" of things seriously without depending on a "positivist" ontology. One could account for Bridget Riley's art within ANT. "Things exert force themselves, they do not just respond" (p6).

In terms of action, "ANT focusses not on what things mean, but on what they do". This aspect is traceable to the anthropological field notes in Latour and Woolgar (1986). In keeping with this Fenwick and Edwards describe ANT itself as an action or intervention, or a sensibility, rather than analysis or theory to be applied (Fenwick and Edwards, 2010, preface, p ix). Thus ANT at least partially satisfies Habermas' demand for praxis – only partially, because it is also the case that in practice, from the examples in Fenwick and Edwards, it seems as if ANT often *is* used as an analytical tool, or perhaps more accurately sometimes strays into an analytical sensibility.

Finally, ANT "honours the mess". It specifically seeks to examine the local and capture the messiness of what "actually happens", and therefore takes Scott and Usher's (1996, p14 and cited above) warning against viewing the social world as orderly and predictable seriously. There is a tension here between "honouring the mess" and becoming so messy that any account reduces to "just one damn thing after another". At some level abstraction needs to happen for praxis to occur. Part of the concern of this thesis is to propose some commonalities in "music technology". If any findings are only applicable within a specific network there can be no implications for practice. At the same time, the messiness of life is important and vital elements may be missed if it is not captured. An example here is of Popper's and Latour's contrasting accounts of science as a process. Popper is not really interested in the individual and historic: he is interested in an abstracted logical process which enables coherent truth claims to be made. For Popper claims count as scientific only insofar as the processes of their production map onto that abstraction, no matter who makes them. For Latour science is whatever scientists actually do, and any logical abstraction they purport to adhere to must be investigated with appropriate scepticism (although such an abstraction has the potential to be a nonhuman element in a scientific network). In the same way looking at music technology and music technology education through an ANT lens must focus on what practitioners do, the workflows,

processes and events that make up the practice. Any commonalities are not a given, the likelihood of their existence needs to be demonstrated.

To end this section I would like to introduce some ANT terminology. An account of induction into practice is, in ANT terms, an account of *Enrolment* (initial recruitment), *Interessement* (binding to a role) and *Mobilisation* (being brought to bear as a representative of the network they have joined). All of these are aspects of *Translation.* I am hoping to find some commonalities as students and others are translated into the network(s) of music technology.

3.6.3: Bringing it All Together

The roots of *Laboratory Life* (and therefore of ANT) are in anthropology. However, in practice there are issues with the extensive immersion and field notes that are the usual methods employed, which mean they are not ideal methods for this research.

Firstly, there is the question of situation. Fairacres is a comparatively small college and since as a practitioner researcher I am unlikely to be able to spend an extensive amount of time in another institution, the only way to carry out standard ethnography would be in situ. This raises ethical concerns because the vast bulk of the students we deal with are under 18 (see more discussion of this in section 3.7). The issues of informed consent consequent to this preclude the kind of unstructured conversation and field note taking carried out by Latour and Woolgar. This means that, unlike *Laboratory Life*, the thesis will not be looking at detailed accounts in one institution.

Secondly and more importantly, such a method would not be appropriate for a search for commonalities. A site-specific investigation that is carried out once then "trashed" (Latour 1996 p131) can have little to say about implications for practice. However, ANT itself postulates networks within networks. For example, a network can become an actor either within another network or in a greater network. An ANT conception of music technology would therefore be looking at commonalities in *how a musikarbeiter might be mobilised by wider networks of STEM and creative practice inside and outside education*. This is in fact a reconceptualisation of the original research question in ANT terms. These networks are far larger than any given institution and therefore an investigation into this higher-level network needs to involve an examination of practice in more than one place. There is a tension here with ANT's commitment to the local as these networks are not in fact wholly local. The connections are not due to working in one institution but in a field or cluster of related fields, linked by factors such as professional connections, use of the same software, shared understandings of

technical terms, and the need to meet published technical standards. As an example, all of the practitioners interviewed are known to the author of this thesis via one route or other and linked by the production of this thesis itself. This wider network is not a given but glimpses of it may be revealed by commonalities of practice as discussed above, and more extensively in chapter 4. In this cross-institutional area of concern, the field notes approach is again not feasible nor necessarily desirable.

3.6.4: "Tell Me Stories"

I have therefore turned to another method of gathering the kind of fine-grained account that will lend itself to an ANT perspective, in that I will ask participants as far as they can to tell me stories of what they do (or have done), in other words, to talk me through histories, processes and workflows as narratives. Connelly and Clandinin (1990) suggest an outline for narrative enquiry and in particular the use of interviews (p5) and storytelling (p6). Although they point out the difficulty of reliable generalisation they discuss (citing a personal communication from Guba and Lincoln 1989) an alternative criterion of *transferability* which they consider to be more suitable or at least equivalent. Indeed, the considerations of "verisimilitude" and "transferability" may be considered as related, if not identical, to "credibility" in Latour and Woolgar (1986) and "mobilisation" in Fenwick and Edwards (2010), and answer the concern over implications for practice. Central to their view is a consideration of the pitfalls and traps involved and the need for an enquirer to take critique and potential critique seriously - "Our view is that every criticism is valid to some extent and contains the seed of an important point" (p10). It is important to remember the difference between telling stories and writing fiction.

In the same way as in Braun and Clarke's model of TA (below) and in Latour and Woolgar's (1986) account of science in action, the subjectivity of the enquirer must be taken into account. Connelly and Clandidnin are at therefore at pains to emphasise the intersubjective and collaborative nature of narrative enquiry.

3.7: Data Gathering and Thematic Analysis

The data gathered in this thesis have therefore been obtained by interviewing various industry workers, ranging from semi-amateur producers and performers to professionals for whom music production in some form or another is their living. It also includes education professionals. The steps

involved in deciding who to interview and the rationale for interviewing practitioners rather than, for example, students, will be covered in chapter 4. However even before this decision was made the question arose as to how to make sense of these interviews. There is a large amount of data (some 90,000 words of interview text and several hours of video recording) which needs to be organised in some way to make it tractable. The answer I came to is that some form of thematic analysis (TA) should be involved.

Again, the process of thematic analysis is discussed on more depth in chapter 4, but some important considerations are now in play: To begin with, thematic analysis is a wide-ranging suite of methods. At one end it is used in a very quantitative way in psychology studies. For example, Kahn (2011) adopts a methodology by which themes are abstracted from the data (for example pp76-77) but then participants' interactions with these themes are characterised as having positive or negative valence (pp78-79). In this way tables of quantitative data can be produced, and the results of the observations can be mathematised. Kahn's work is in experimental psychology and therefore he tends to lean into STEM methodology. In principle I have no quarrel with this but as part of the setup for such an analysis, various protocols like experimental controls need to be put in place, something which is not envisaged in this thesis and is impossible in many sociological studies. I would contend that unless a study fully complies with STEM method then what might be called the overquantification and mathematisation of the results is a bug rather than a feature. It is very easy to make thematic analysis *look like* STEM analysis – with all the intellectual prestige and even funding that implies – without it being so. This danger is identified by both STEM practitioners and social scientists who otherwise might not agree on much methodologically. For example, Braun and Clarke (2022) firmly place their method of thematic analysis in a "big Q" qualitative paradigm and warn against "positivism creep" (pp6-7). On the other hand, Hanlon (2013) drawing on the physicist Richard Feynman, describes a "cargo cult science" where "experiments" are done, and results are quantified, but are not repeatable and therefore are not falsifiable – something has been done that looks like STEM but is not. Some form of qualitative thematic analysis therefore suggests itself as an appropriate analytical tool. The apparent fact that thematic analysis is a flexible enough method to accommodate both STEM and humanities research also suggests that using it to understand data that will be interpreted with an ANT sensibility is not too far a stretch. In this sense TA as a method seems agnostic in terms of epistemology.

However, there *are* issues with thematic analysis as envisaged by Braun and Clarke ("reflexive TA") when looking at this subject. To begin with their characterisation of quantitative method and its

approach to ontology seems to rely on a concept of "positivism" that is a caricature of STEM thinking. This has been mentioned in the account of Popper's epistemology at the start of this chapter. Braun and Clarke for example claim that quantitative/positivist methods are characterised by an "unbiased observer" seeking "singular truth". In fact, as discussed, Popper's conception of science is a social enterprise which critically depends on subsequent experimenters attempting to knock down a result, and the more tests the result withstands the more reliable it is. Although observers might strive to be unbiased it is the repeated testing of a result which is held to count. Failures of science are ascribed in the field to repeat experiments not being done, results not being tested, or negative results being ignored (usually for reasons "outside the realm of STEM" such as finance, commercial interest and secrecy, institutional prestige, or publication bias in journals – Goldacre 2012). Similarly, far from being "singular truth", scientific results are provisional and are seen to be provisional in "positivist" accounts of science. However, there is also much to be drawn on from Braun and Clarke, in particular the stipulation that themes and codes are outputs that are emergent in the interaction of data and researcher. This contrasts with the possibility that themes and codes could be decided beforehand, and that the thematic analysis is therefore a kind of hypothesis testing of the codes. The data analysis will therefore use some aspects of reflexive TA.

3.8: Method: Conclusion

The above considerations have led me back to thematic analysis as a way of gathering data and generating themes and codes. However the idea of a disinterested observer is decried by Braun and Clarke (who as noted, strangely consider it part of a positivist stance – 2006, p6). The "stranger device" used by Latour and Woolgar in fact aspires to this unattainable ideal more than anything in STEM practice, and Latour in his postscript seems to accept Lynch's (1982) critique of it, even as a literary device, (loc 5220). Therefore, although Braun and Clarke are keen to stress that themes should not be borne in mind before an analysis, there is some subtlety here: Gadamer's discussion of "prejudice" above implies that a researcher will never be a blank slate. The key is that themes arise as an interaction, not that the researcher will have no prior idea of what they are. At the very least the framing of the research question and the literature review will suggest some of the initial codes, since the literature review itself is in some sense part of the data. This approach to themes and codes is discussed further in section 4.5.2 below.

Reflexive TA also throws up, as do many interpretivist ontologies, epistemologies and methods, an issue with *things.* In dealing with music technology, and indeed Sennett's considerations of

craftsmanship, things are important. The (realist) Samuel Johnson is alleged to have refuted the (idealist) Bishop Berkeley by kicking a rock (Boswell 1791), an argument known as "the appeal to the stone". Regardless of the logical validity of this refutation, any discussion of music technology needs to find a way of accounting for the "thing-ness" of rocks, synthesizers and sound waves, whatever the framework adopted. In terms of overall viewpoint, then, I will look at the themes and codes with an ANT sensibility. By this I mean paying attention to the way that connections are made. According to Latour (2007), "the social" is not a mysterious structure but a set of connections whose origin and nature *must be accounted for.* This means that the work involved in creating them by both human *and non-human* actors needs to be taken into account. My respondents are not all part of the same network but it is possible that in many cases *the same kind of work is being done*. By looking for commonalities in my coding I hope to avoid the trap of "one damn thing after another" while retaining an ANT (or probably more accurately a form of post-ANT) sensibility. By viewing these initial considerations several things become apparent.

Firstly, part of what the researcher brings to the dialogue as part of the ANT sensibility is a concern with what the interviewees actually do or did; although these events are not directly observed, their accounts of workflows, processes and histories (and what other parts of the conversation reveal around those) are the main focus. I will therefore be asking for histories and narratives of process.

Secondly, the contribution of non-human actors and their specific nature will be taken to be important. This includes aesthetic as well as the more obvious technical objects. There is a sense in which Dewey's conception of the "work of art" has a strong ANT sensibility already: art is worked on by a human and performs work on a human in turn. The influence of Dewey on Latour is touched on in Latour (2007).

In addition there are other constraints, but also advantages made apparent by resourcing, ethical considerations, and methodological concern. This is a perforce a small scale illuminative study with sample size constraints. Although for the purposes of this thesis the methodological stance is interpretivist, it is important to bear in mind (considering the nature of the thesis) the arguments and examples drawn out in the methodological considerations around *Laboratory Life* and ANT. In simpler terms, I doubt whether "interpretivism" and "positivism" are incompatible, and indeed whether "positivism" as characterised by, for example, Braun and Clarke (2022) is an intellectual position that anyone actually holds. Questions around "realism" and "instrumentalism" although interesting, and pertinent to the overall framing of the thesis, are less relevant when discussing "different kinds of

things in a different conception of the world" (above). Illuminative studies such as this one can be seen to have the same status as rational ways of generating theories in a more positivist environment. Theory generation is not bound by the same constraints as hypothesis testing even in a strict positivist methodology, and in ANT an illuminative study can still be used or mobilised. Therefore, even in strict positivist terms they have value.

This research method (conversational interview) has passed ethics review in line with BERA (2018). There were some criteria around consent that needed to be met: some of the practitioners involved are my friends and colleagues and two are line managed by me. I therefore had to make sure that I did not socially or professionally pressure them to take part. It is also part of the understanding for participants that they can withdraw at any time without consequence, and I had to make clear that this included social and professional consequence. Communication around this is in appendix 1 and is also discussed in chapter 4.

In summary therefore, due to the non (geographically) local nature of the network(s) I hope to elucidate, and the search for commonalities, I have adopted an approach asking for contributor narratives around process and action. I have conducted thematic analysis on the transcripts of these interviews in line with Nowell et al (2017) and Braun and Clarke (2006) and this will be examined more in chapter 4. As discussed in section 3.7, thematic analysis can be made to look "STEM-like" as it can be used to provide a numerical metric suggesting the measurement of a set of variables, and this is often not appropriate. Clarke (2021) for example warns about this in a valuable discussion of the language used to describe themes – "emergent themes" can be discussed but "themes which emerge" should be avoided as it implies themes are an "ontologically real things" which we are measuring or extracting in a detached way, as opposed to "being generated by the researcher through their interpretive engagement with the data". Notwithstanding the implication of ANT that data generated by interpretive engagement might then become "ontologically real" within a network of educational research, the intersubjectivity of the enterprise is noted and will be part of the overall account.

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Chapter 4 - Method and Analysis: Data Panik

4.1: Introduction

As a brief reminder my research question was: “How is music technology constituted in practice and presented in terms of curriculum and learning? How are people brought into this subject via education, and are inducted into practice beyond it, as they graduate and work in the sector? And in particular, how do “STEM” or “STEM-like” tools and practices interact with “creative” ones both inside and outside education?”

The data around this research question consists (as described in chapter 3) of interviews with participants in various areas of the music industry and music technology education sector. The interview questions were designed to elicit narratives as much as (or more than) opinions; in the nature of ANT is a concern with *what people did* as well as with *what they thought they were doing.* The intention is to understand how they were inducted into their positions in the industry or education as well as (in the case of educationalists) how they understand the induction of their students to take place. In other words the questions sought to bring out *the nature of their practice* and *the pathways into it*. The hope is to bring out commonalities, something that TA seems equipped to do. I discuss the questions in detail in sections 4.3.2 and 4.3.4

This chapter is mostly an account of how the data was gathered and the stages of analysis. Inevitably there is discussion of how a TA method can be melded with an ANT sensibility. In order to have a transparent process I have tried to keep this something of a “warts and all” account that accurately documents hesitations, changes of mind and problems that arose. I have kept the account more or less chronological, with one exception. Due to the expansion of the study from an MPhil to a PhD thesis in August and September of 2022 I had already gathered some interviews and already started some coding in the summer of 2022, and this had to be set aside for a new group of interviewees then taken up again in 2023. I have chosen to bracket the interviews and analysis together (so both sets of interviews, then all the coding runs for thematic analysis) but I will clearly flag what happened when.

The chapter therefore begins with an overview of the method and design (4.2). I looked at this at the end of chapter 3, but here I present a more detailed account. I discuss the interview technique, their length, and protocols, and why I chose the *kind* of participants that I did. I then follow with an account of the data collection for both groups of interviewees (4.3), including brief sketches of the

participants and laying out the “prompt” questions that I used. I also return to the ethics considerations laid out in 3.8.

Next (4.4) there is a discussion of TA protocols used in analysis, including concerns around reliability. As discussed in 3.3, criteria that might suit hypothesis testing are not appropriate here and instead I have drawn on Lincoln and Guba’s (1985, cited in Nowell et al 2017) ideas around ”trustworthiness”. I also discuss at this point how the codes will be organised into themes. This needs some explication as the codes are attempts at finding commonalities, but the themes are suggested by ANT and are more to do with action. The subsections of 4.4 are a more detailed account of the coding “runs”. This started off with a highlighter and Excel, but this soon became more or less intractable and point I started using NVivo to render the data intelligible. In the light of my own reservations about NVivo (because of the issues over positivism creep/“cargo cult science” noted in 3.7) and those of Adams and Thompson (2016) I have therefore also put in a note on the use of this software, and why I came to use it.

Finally I discuss how the themes of the analysis emerge (4.5), and state them (4.6). Nodes are discussed as *commonalities* which potential networks may share, and the themes are used to structure the discussion in chapter 5. In 4.7 I briefly sketch how some of the findings fit into them but bulk of this, and of this thesis, is in chapters 5 and 6 where I look at them in depth.

4.2: Architecture and Morality – Study Design and Ethics

I obtained the data analysed in this chapter by recorded interviews of 15 people. The first group of interviewees are practitioners in the music industry with roles that can all be characterised as both creative and technical, ranging from creative producers and electronic performing artists and DJs through to live sound engineers and technicians and one teacher working in music technology education. This was followed by a second group of people who are mostly music technology educators in some form (ranging from FE to HE and one educator situated outside either). The interviews were intended to average around 30 minutes, but participants have continued for more or less time, as the conversations have been allowed to continue naturally rather than being artificially kept short. In fact, the length of most interviews was considerably longer.

I made the decision early on to conduct the interviews remotely. There were two practical reasons: firstly, that several participants are some distance away from me, and secondly to facilitate video recording and transcription. The purpose of the video recording was twofold – as well as providing a

final reference point for any transcription ambiguities, I wanted to be able to retrieve emotional nuance – something said in a light-hearted way will carry different meaning to something said seriously (see Denscombe 2017 loc 7180). In order to attain some level of consistency I used the commercial platform Zoom throughout. Most educators and many outside education are familiar with the platform following the pandemic (see for example Walker et.al 2022) and in all cases access to it was not in practice problematic. I have at my disposal a variety of Zoom backgrounds including education settings and recording studios, and after some consideration I chose a blurred background as it seemed that any kind of educational or music technological background might act as a prompt for participants to answer in a certain way. Although, by the conversational nature of the interviews, participants will be nudged in particular directions, the nature of any such nudging needs to be transparent, and the effect of a zoom background is considerably less so than something that is recorded in a transcript.

Another aspect of study design is the nature of the participants. One possibility I considered early on was to carry out a number of student interviews, where my intention would be to investigate the curriculum based on how students reacted to various considerations around their own acquisition of practice. I eventually decided against this for a number of reasons (already touched on in 3.8):

Firstly, as discussed in 4.1, and students, by definition, have not been fully inducted into practice. Indeed, following Sennett (2009) this is a process that would be expected to take some time and task repetition. Similarly, the very nature of the practice and in particular any mixture of STEM and creative skills that it seems to offer may not yet be clear to students. On the other hand, industry practitioners are already involved in the practice and able to give rich accounts of how they came to be involved in it. An ANT account of enrolment, interessement and mobilisation will need to involve participants who have undergone these things.

A secondary consideration is that, following from the need for informed consent noted in 3.8, there are ethical issues with interviewing students under 18 in the kind of conversational way that is needed for any kind of ANT lens; essentially it is difficult to argue that a student under 18 can give informed consent to an open-ended procedure. To meet BERA requirements (BERA 2018) there would need to be a pre-approved and limited questionnaire approach for this kind of respondent which does not suit my intended methodology or method.

On the other hand, the choice of industry participants and educators allowed me to ask for stories of how they became who they are, and for my questions to act as prompts to more or less free ranging conversations which would allow participants to discuss topics of interest to them that I had not necessarily considered. It also allowed for the possibility of narratives of action, and this in turn opened up the possibility of ANT analysis. Notwithstanding Fenwick and Edwards' reluctance to rigidly or even provisionally define ANT – "It is extraordinarily difficult to write or talk about actor-network theory without either destroying or domesticating it" (2010, p1): if it can be said to be anything at all it is relational and dynamic (Fenwick and Edwards, ibid.). This has been discussed in chapter 3, along with the match of stories and narratives to an ANT approach. As the study moved from a two year M.Phil to a three year PhD, I realised that the number of interviewees was not enough for a full PhD thesis. I therefore called a halt and interviewed a second group. Most of this group were music technology educators. I did not just want to interview further education educators as that would preclude learning from other situations, so this group also contains higher education and other lecturers.

Most of the first group of participants were known to me at first or second hand via my own musical and educational work. As discussed in 3.8 this decision to focus on adult practitioners and educators led me to consider a range of rather different ethical considerations. For example, as a manager in education I might be held to be in a position of power over one or more participants. Additionally, participants known to me from other contexts might be concerned about social consequences if they declined to take part or gave answers I did not like. Various precautions around identifiability are also needed. In order to conform with these considerations, I proposed to send an initial email to specify the following:

Firstly, all participants were free to participate or not as they please and that they have a right to withdraw at any time in the research. I would ensure that no adverse consequences would be incurred (including social consequences such as changing of friendship status) if a participant did not wish to engage in the study or wished to withdraw at any stage. Two of the prospective participants are line managed by me in the workplace, in order to avoid any potential feelings of coercion it was made clear to them that their participation was entirely voluntary, and this research is not in any way related to the workplace except insofar as it draws upon on their specialist skills, and their accounts of experiences of becoming and being specialists in this field of practice. A written guarantee was provided to all participants in the research that no adverse consequences (for example HR procedures) would arise from any discussion of their practice.

Secondly, by the nature of the interviews, it is possible that participants will be identifiable from contextual information that they provide. Before any interview I asked participants in the research to choose their own pseudonyms in order to ensure anonymity in accordance with BERA 2018 guidelines. In fact, none of the participants did this and I have therefore anonymised them by assigning letters A, B etc.

In addition to this, participants were asked to fill out the University proforma (Appendix 1) again ensuring that informed consent was approved. In some cases, participants' gendered experience or experience as a person of colour revealed insights, and the use of these insights inevitably compromises anonymity albeit to a small extent. Once again participants have been reminded that they can withdraw consent for these parts (or other parts) of the material to be used at any time. This was submitted as part of the Ethics Committee referral on 5 March 2022 and final approval was on 11 March 2022. However, I also felt that the use of academic terminology and phrasing in an email to non-academics was potentially unclear and militated against informed consent, so, adapting the approach of Pitcher, Mitchell, and Hughes (2022), I appended a plain language summary was appended at each section of the email ("what this means"). The full text of the email and ethics application are also available in Appendix 1.

4.3: Gathering the Data

4.3.1: The First Set of Participants

As discussed above, at the time of the first interviews, I envisaged a two-year study with a focus on the views of industry participants. The first group of interviewees were therefore largely taken from people working in various forms of music technology outside education. This was because of the concern of this thesis with the nature of music technology practice as perceived by its participants and in particular the mixed nature of the field (with STEM and creative elements) as posited in chapter 1. Thus, this part of the data is related to how these practitioners acquired their practice, and their perceptions of the nature of it, not necessarily in educational context. For several of my participants, specialist 16-18 music technology courses in a FE context may not have been available in their own education, and if they were, may not have been the preferred study route. One teacher and one college technician were however included in this initial group as examples of industry workers; both undertake work outside of education and my intention was also to include education within the notion of "the music technology industry".

I chose these initial interviewees to try to represent a range of practices but with a weighting towards "creative producers". These are people whose primary technological activity is the creation and often performance of music using electronic (and usually digital) means – so performances might use laptops or similar equipment rather than "traditional" instruments. As wide a range of representatives of other skills as possible were also interviewed. In spite of my best efforts there is a skew towards male participants which is typical of the industry (Jones 2023), and there is certainly work to be done on the gendered nature of music technology as a subject. As touched on in the introduction to chapter 1 this has been noted in Green (1997) – "Girls are seen to avoid the manipulation of technology, but boys feature noticeably in the realm of technology, which is often, but not always, associated with popular music". Green goes on to note Caputo's (1994) contention that technology is seen as associated with value-laden "masculine" attributes such as rationality and by association with STEM-like thinking). However, while noting the effects of gender within music technology (and indeed STEM) practice they are not the main concern of this thesis.

The initial participants are listed here in order of interview date:

A is a creative producer/performer and vocalist who works and performs primarily using a laptop and dedicated controller hardware. They have released two albums as part of a previously signed act and two solo EP's and are touring nationally and internationally.

B is a creative producer/performer who primarily uses laptop for what they call "backing tracks" while they play bass and sing. They have been part of several signed acts and have released two solo albums.

C is a creative producer/performer who has collaborated with several other acts, they perform using a laptop and a series of hardware controllers.

D has a portfolio career including playing keyboards in a revived 80s band, recreating tracks for sync and advertising purposes, and music journalism.

E works as a technician in the music department of a college, and also operates as a small business/sole trader providing live sound for venues, acts, theatres and festivals.

F is a teacher of music technology who has also taken on sound design work for film and art installations.

G is a creative producer/performer who writes and performs using hardware (i.e. not using a computer except for recording purposes, although some of the hardware is digital)

4.3.2: Initial prompt questions

Again in keeping with the general approach I decided, after some discussion with my supervisor, on a series of questions which I hoped would prompt storytelling as well as eliciting views about technical and creative skill. I also wanted to use the narratives in these questions to be able to construct an ANT lensed account.

1. In your experience what is the relationship between technical and creative aspects of your work?
2. Tell me how you became a ...(teacher of music technology/sound production engineer/ producer etc?)
3. What were the critical turning points in your career for you and why?
4. What were your most memorable moments in your career and why are they so memorable for you?
5. What do you see as being the most important aspects of your professional practice? Your knowledge as a creative? Your technical knowledge? Practical knowledge? Theoretical knowledge? etc.
6. How did you get to be good at what you do? How do you make sure that you stay good at what you do?
7. What are your hopes and fears for the practice of ... in the future?

These questions can be thought of as attempting to elicit responses which would help me understand various aspects of the actor-networks of music technology. For specific questions their relevance in an ANT framework can be considered as:
Answers to 1 were often revealing about the participant's relationship with non-human actors, in particular music technological equipment as well as bodies of "theory" which are themselves taken as entities by more than one participant.
Answers to 2, 3 and 4 can be used to unpick how participants were enrolled into their networks and key incidents.

Answers to 5 relate to how a participant might be mobilised by their network, that is how they would act if they were to represent it. It is worth expanding on this concept – although to be "mobilised" by a network also means "to be made to do a thing" if my participants are mediators then they will not always be mobilised in the same way to do the same thing even by one network, and their range of things to do may be quite large. For example, a teacher may be mobilised by different parts of their network to act in different ways depending on class, timetable and in particular where they are in the curriculum depending on the time of year.
Answers to 6 will illuminate how participants maintain their position in a network. Latour (2007) argues that maintaining a network takes constant effort, ties dissolve easily especially in the absence of non-human actors and may be hard to maintain.
Answers to 7 invite participants to speculate as to where all this might lead – how the network might grow (or contract) and change.

I had intended to ask these to every participant, but it turned out in several cases that answering one question also answered another (for example "tell me how you became x" quite often involved telling me the stories of career turning points). Also, as interviews went on, I was able to use the previous answers as jump off points for exploration ("can you maybe give me an example of your workflow when you do x?"). Most participants also had their own concerns or agendas which seemed important enough to include. This means that the correspondences of questions to ANT concerns noted above are not (and never were) strict one to one correspondences, but a guide to how connections might be traced.

I will discuss the coding in a later section (4.4) but should note for reference that these participants responses were initially coded in an Excel sheet and later ported and expanded to a NVivo project entitled "Musikarbeiter".

4.3.3: The Second Set of Participants

At this point I depart from a strict chronological order. I did some preliminary coding over the summer of 2022 but set it aside to conduct more interviews after September 2023 as the project expanded in scope as I transferred to PhD. I will be looking at thematic analysis and how it was applied in section 4.4 and any discussion of coding protocols will make more sense after that point; I am therefore going to discuss all the participants at once then all the coding at once.

The second set of participants are mostly (but not all) music technology educators. One or two were professional connections but most of them replied to a LinkedIn post made in early 2023. One, who I have labelled H, was approached by me after an art event. I am extremely grateful to all of these participants for giving up their time and energy and essentially putting their trust in a complete stranger.

As well as any direct implications of the views of this educators' group on how STEM and creativity work in music technology *education*, Latour (2017, p31) notes the importance of group definers and spokespeople and I would expect educators to play a major role in this. In discussions with and amongst educators we often focus on how we can bring "industry priorities" or similar into education but – and this is something we often seem to forget – by (in ANT terms) mobilising their own networks of music technology and education into industry via the connections made by their students, we might expect educators to be also shaping the industry, and into what? By looking at music technology educators we are therefore also looking at (some of) the traces of how the future "industry music technologist" group will be created.

The music technology educators group also differs in other aspects of its makeup from the industry group. The educators by and large were an older cohort. This is what we might expect especially in further education since some industry experience is desirable, (which takes time), and HE because of the time taken to reach the level of professional qualification needed to achieve employment. It does mean that expectations of their own recruiters may have differed from those of a recruiter today. For example, with the participants involved in the industry I was able to achieve a reasonable gender balance but those directly involved in pedagogy are exclusively male.

The second group of participants were:

H is a sound designer working primarily in the field of live theatre and performance art, part of their practice is to provide live sound design.

J is a teacher and lecturer working primarily with higher education students

K is a teacher working for a private organisation, primarily with quite disengaged and disadvantaged students. They have a background in electronic music production but don't seem to consider themself to be massively technical.

M teaches music technology in FE and is interested in pedagogy. They started as a “conventional” musician but have since developed an interest and passion for modular synthesis.

N works in a Further Education college course leading music technology.

O works in a prestigious HE institution. They music technology and largely deal with STEM students who are required to take a module outside their main subject, in order to achieve their qualification.

P works for a major software company (anonymised as “Calade”) managing and supporting use of their software within education, and in addition works as a freelance sound designer for films. In the past they have worked as a post-production mix engineer in the film industry.

Q works for a technical company in the field of cinema and immersive sound. Their role is to help other producers understand how to work with these systems and standards. They have co production credits on various recordings.

4.3.4: Second set of Prompt Questions

For participants directly involved in education the questions were slightly altered to try to capture more of their teaching practice. Again, it should be noted that I did not always adhere completely to script – again, these are supposed to be prompts for a more free-ranging and revealing conversation.

1. Can you tell me who you are and what you do?
2. Tell me how you became a ...(teacher of music technology + sound production engineer/ producer etc?)
3. How do you understand the relationship between your educational work and industry practice?
4. In your experience what is the relationship between technical and creative aspects of your work?
5. What do you see as being the most important aspects of the practice you wish to teach to students? Creative (musical)? Technical knowledge? Hands on Practical knowledge? Theoretical (tech or music theory)? etc.
6. How do you think your students get good at what they do? How do they maintain being good at what they do?

7. Is there anything you would like to tell me that you think I haven't covered?

I hoped by these altered questions to get an idea of how educators acted as mediators to translate students into music technological networks. I also felt that although the responses to the final question for the first group (about hopes and fears for the future) were enlightening, it was a rather more closed question than I wanted and so I replaced it with a more open question about "is there anything we haven't covered".

These participants were interviewed between November 2022 and August 2023. The interviews and transcripts were this time imported directly into NVivo and can be found in the project Musikarbeiter 2, along with the first group. I will be discussing NVivo and its issues and my use of the transcription service in section 4.4.

Table 4.1 below is a summary of all the participants and their roles.

Table 4-1: Table of participants

Participant	Industry/artistic/educational role
A	Creative performer/producer/composer
B	Creative performer/producer/composer
C	Creative performer/producer/composer; "serial collaborator"
D	Freelance portfolio career: keyboard player and musical director; creates tracks for sync; journalist
E	Technician in music technology education; freelance live sound engineer
F	Music technology course leader in FE; sound designer/recording engineer/mixer for film and art projects
G	Creative performer/producer; hardware based composer
H	Live sound designer for theatre and performance art
J	Higher education teacher/lecturer
K	Teacher/lecturer often working with disengaged/disadvantaged students
M	Music course leader in further education; modular synthesis enthusiast
N	Music technology course leader in further education
O	Higher education teacher lecturer; teaches music technology as a humanity to STEM students
P	Works for major music software/hardware company; freelance sound designer
Q	Works for technical immersive sound company; liaises with other producers about immersive sound

4.4: Considerations Around data analysis

The first part of the data analysis was intended to be fairly "straightforward" TA insofar as TA is ever entirely straightforward. It does have the advantage that coding in TA seems tailor-made to highlight for the commonalites I was looking for.

As with all qualitative analysis it is important to establish authenticity and trustworthiness if other researchers are to accept it as useful. Some of the issues around reliability and reproducibility have been discussed in chapter 3. Thematic analysis has the advantage that there are clearly understood and widely accepted protocols which can be applied to a range of data collection methods including as in this case narrative interviews. I lay out two of them here:

Nowell et al (2017) suggest that although researchers often do not detail their analysis, it is considered by others good practice to do so (p1). "[many have argued] Researchers need to be clear about what they are doing, why they are doing it, and include a clear description of analysis methods" (p1) and again: "If readers are not clear about how researchers analysed their data or what assumptions informed their analysis, evaluating the trustworthiness of the research process is difficult" (p2). They provide a step by step procedure drawing on the trustworthiness criteria of credibility, transferability, dependability and confirmability laid out by Lincoln and Guba (1985, cited in Nowell et al 2017). It is important to note that both this procedure and the procedure laid out in Denscombe (2017) are not intended to be inflexible and are both recursive: so for example Nowell et al's method is designed for a group of researchers dealing with an extremely large data set and some parts of the procedure (such as researcher triangulation) will not be applicable to a single researcher. As long as there is a clear procedure for meeting the credibility criterion, and this is clear to readers who are therefore able to make judgements on it, the dependability criterion should be achievable: "When readers are able to examine the research process, they are better able to judge the dependability of the research" - Lincoln and Guba (1985), cited in Nowell et al (2017).

Initially I intended for this thesis to use a process derived from, but not identical to, that detailed in Nowell et.al; also drawing on Denscombe (2017) into account the feasibility of different kinds of checking bearing in mind the nature of my data. This procedure was intended to be recursive in the same way as suggested by these papers. In the initial stages much of the means of establishing trustworthiness are concerned with transparency of documentation. This is a rough outline of stages of the intended process (with a note of the chapters each stage would correlate with):

1. Establish initial themes via the literature review. These comprise the "lenses" through which I will initially look at the data and acknowledge that the observations will be theory laden initially.
    a. Documentation of initial themes

    b. Documentation of theoretical and reflective considerations which have led to those themes (chapter 2)
2. Immersion in the data (to be done prior to coding, see Braun and Clarke 2006).
    a. Transcribing and reading through transcripts
    b. Viewing of video data
    c. Documentation of initial reflections on emotional and contextual nuance
3. Generating codes
    a. Initial themes will inform first codes, this will be made explicit
    b. Documentation of codes including where they do not fit into initial themes.
4. Reviewing themes
    a. Analysis of initial themes to see if they still provide useful categorisation
    b. Search for emergent themes
5. Writing up results
    a. Detailed analysis and exposition of steps 2-4 (chapter 4)
    b. Discussion of themes (chapter 5)
    c. Thick descriptions of context
    d. Discussion of epistemological and methodological stance (chapter 3)

(Taken and modified from Nowell et.al. 2017).

This method has similarities with hypothesis testing in that the themes are brought in early and then checked against codes to see if they are still useful. This does have the advantage that it does not consider the researcher to be a tabula rasa; it is clear in real life that we bring our own horizon (in Gadamer's terms) to the research. However, it carries the risk (although not the inevitability) of falling into the trap of appearing STEM-like while not actually being STEM.

Braun and Clarke (2006) discuss an alternative schema where themes are emergent from codes rather than preceding them:

Table 4-2: Suggested process for reflexive thematic analysis.

(From Braun and Clarke 2006)

Phase:	Description of the process:

Familiarizing yourself with your data:	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
Generating initial codes	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme.
Reviewing themes	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic 'map' of the analysis.
Defining and naming themes	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
Producing the report	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

This seemed more in keeping with the bottom-up nature of ANT in that the themes were not assumed to be part of an overall structure. However, it also seems to carry an assumption of the researcher as tabula rasa – they "search for themes" – that is contrary to, for example, Gadamer's warning that we cannot escape our horizon. I do not in fact believe this is intended by Braun and Clarke who elsewhere (ironically in the context of positivism) decry the myth of the "neutral" researcher. If the viewpoints described in chapter 2 and 3 have any validity then codes addressing areas such as craft and aesthetics might well emerge from dialogue between researcher and data as well as from the preoccupations of the actors.

Themes, on the other hand, will need to reflect ANT considerations such as translation, mediation, and the mapping of networks (see part 4.xx) and the report will be ANT inflected. ANT will be brought to bear in parts 5 and 6.

It is worth noting that at this point this has become a kind of messy hybrid analysis. The analysis is influenced by but not the same as the reflexive Thematic Analysis of Braun and Clarke (2006, 2022). But the themes will be in keeping with an ANT sensibility. I will end up with something akin to the anecdotal overview of Molotch (2003). Molotch's conception of the "lash up", a concatenation of technical, human, infrastructural, financial and other actors creating a thing is repeatedly cited in Fenwick and Edwards (2010) as an illuminative ANT-type analysis. I hope to stick to the spirit of ANT by "honouring the mess" in this inevitably messy project.

4.4.1: The Initial Transcripts

With the initial interviews from my first seven participants, I felt it necessary to tidy up the data, as the conversational transcripts had a lot of filler words ("er…") and repetition. This involved some decision making as to what was important and what was not. For example, if I were to remove these, when does this impact on emotional or other nuance? For example, one participant might habitually use filler words as part of their normal conversation, but another may use them to indicate hesitation over an answer or careful thought. My decision in this case was to remove most filler words but annotate the transcripts for nuance. A sample of transcripts can be found in appendix 2. I also annotated a perceived character sketch about each participant with the start of the transcript in order to provide an overall emotional tone for the interview. For example, one participant was described as follows:

> "F has thought a lot about education and what it means to teach music technology. He is interested in pedagogy but also has enthusiasm for both music and tech. I say both, because I think even without one element he would still be interested in the other".

Another was described as:

> "B comes across as a whole quite lighthearted, there may be a hint of lack of self-confidence over tech – they are able to produce after all! They mention mental health troubles briefly but are generally quite upbeat. There is a sense in which 'not knowing' how to do things properly are important to them, something about how they see themself as someone who goes with their creative instinct".

It is fair to say that in some of these cases the character sketches are a result of greater knowledge – some of these participants have been known to me for some time whereas others were strangers before the interviews.

4.4.2: First Coding Run

I initially inductively generated qualitative parent and daughter codes from the interview material (fig 4.1, and "preliminary coding" below). Once again it is important to note the role of the researcher in this: codes may fit into more than one theme and an individual datum may be coded more than once. Nowell et al (2017), citing Starks and Trinidad (2007) point out the researcher's role in making judgments about coding, therefore I here use active voice to prompt and remind myself of my own theory laden-ness. Themes may seem, even to the author, to "suggest themselves" but in fact it is the author who is suggesting themes (Clarke 2001). The very language of establishment may be inappropriate – perhaps "themes are constructed" (after Latour) is more apt.

Since it is impossible to come to data with a tabula rasa, at least in the initial stages the codes were suggested to me by the considerations established in chapter 2. This is in keeping with Nowell et. al.'s approach (2017, p4). However, as the study continued codes and entire themes occurred which did not fit into this initial coding, as might be expected from Braun and Clarke (2006, cited in Nowell et.al. 2017 p6). Therefore initial parent codes were based around "art" (and aesthetic considerations), "craft" (and practice as well as formal music education and theory), "phronesis and praxis", "STEM" (including decision making, problem solving and making) and "unclassified" (including some statements about STEM and creative together and in opposition). However, it was also apparent than participants had interesting things to say about formal education, playfulness, curiosity, accessibility, and even mental health in the music industry. Also (as expected) several codes applied to more than one parent; for example, when B talked about the influence of a previous band on their technical/experimental musical approach, this would go under a theme of musicianship but also aesthetics and technology/creativity. I had created a spreadsheet to record the coding and themes, but it soon became clear that this was not going to be able to capture all of the coding (for example where a reference was coded more than twice there was no coherent way of recording it in Excel). At this point, therefore, I started to explore other methods in an attempt to capture the complexity of the interviews. This seemed especially important since I was attempting to "honour the mess" as an inherent part of the ANT analysis that I was increasingly favouring. I therefore decided to treat this as a preliminary coding run and to recode this and future interviews using NVivo software.

Notwithstanding the partial nature of this first run (which was subsequently to be made even more partial by the addition of a second set of interviews) some interesting things came out of it. In particular, although the initial plan of organising the data into themes based on chapter 2 provided some illumination, it became feasible to suggest other codes. One of them for example was play, and another was problem solving. Several participants spoke about playing around with things, whether those were musical ideas, physical objects, or computer programmes.

The first NVivo project "Musickarbeiter" was therefore based on and was initially grouped in the same nodes as the spreadsheet although I carried out another coding run resulting in a denser data set. An immediate advantage of NVivo is that statements can be multiply coded instead of just twice, and I took advantage of this. The initial Musikarbeiter NVivo project is therefore an expansion of the spreadsheet rather than an entirely separate run, as noted in section 4.4.3. In the end there were four NVivo runs as the interviews were recoded and gathered into themes culminating in NVivo project "Musikarbeiter 3". The annotated codebook from this final NVivo run is presented as table 4.2 in section 4.6

Interlude: A note on NVivo

I have a certain amount of trepidation using software for thematic coding. As with music technology itself, it both makes things considerably easier but also, as its own process, it has an effect on outcome. The biggest danger is also its biggest advantage, that in its speeding up of the coding process it can nudge researchers in the direction of a more superficial engagement with the data. It also makes it very easy to carry out a "counting" approach and fall into the trap of making an interpretive study "look like STEM" with all the issues noted in chapter 3. On the other hand, it was becoming increasingly clear to me that I had a very rich data set, and I was not going to able to adequately code it using the spreadsheet method. Finally, part of my own horizon as a researcher is that I consider myself an IT-literate person who is interested in using software as a tool to expand my capabilities.

Adams and Thompson (2016, p90) also note these and other concerns in their invaluable work on methods ("heuristics" in their terms) for interviewing digital objects. The importance of objects or non-human actors in any kind of use of an ANT lens is clearly discussed in Latour (2007) pp72, 73, 75-76, for it is by objects that ties and networks become durable. However, this consideration also applies to the academic networks and ties that go into making of this thesis. Adams and Thompson therefore look at the "affordances" offered by NVivo as a non-human actor. Affordances can be

described as the “invitational qualities of things” (Originally attributed to Gibson (Gibson, JJ (1979) *The Ecological Approach to Visual Perception;* Boston, MA: Houghton Mifflin), cited in Adams and Thompson 2016). “Knobs are for turning”, as Norman (Norman, D.A. (1988) *The Psychology of Everyday Things;* New York: Basic Books, cited in Adams and Thompson, 2016, p47) puts it, but also objects may invite us into a deeper (“co-constitutive, ecological, that precedes subject/object boundaries”, p48) relationship that Adams and Thompson identify as Gibson’s original intent.
On p91 Adams and Thompson identify the immediate menu of commands that NVivo affords (“Analyze, Query, Annotate”….) but also note “You may do everything you find here, but anything else may be difficult or impossible to do”. It may turn out for example be easy to sort text into nodal categories but more difficult to follow actors though a network. Affordances are not neutral.
Adams and Thompson also note using their heuristic 5 (“Discerning the Spectrum of Human-Technology-World Relations”) that NVivo falls into the area Researcher-> (NVivo-Research World) – a Hermeneutic relation. “The world as originally perceived appears translated into the language given by the technology” (p61). In the end Adams and Thompson conclude that “NVivo manufacturer QSR international’s claim that ‘NVivo doesn’t favour a particular methodology – it’s designed to facilitate common qualitative techniques no matter what method you use’ is simply false…in providing these amplified potentials, its users are shepherded along the limited trajectories of knowing and doing on offer by the software”.

However, while bearing the above in mind, I have still decided to use NVivo for my initial coding. NVivo has several advantages that contributed to my decision to use it. For example, it is specifically stated to support inductive as well as deductive coding (which it does seem to do, in spite of Adams and Thompson’s caveats). Furthermore, it is very easy to rearrange codes into new themes and cross reference text to more than one (or for that matter two, as per my Excel sheet) code (but not necessarily higher-level themes, as I discovered). If I was going to engage with the material to produce themes beyond those evidenced by chapter 2 this was vital. It is also possible to classify participants as “cases” to see if, for example, responses are significantly affected by gender or age.
As software it seems easy to understand, snippets of text (or any other material) can be coded into “nodes” which can be hierarchically arranged and rearranged. So, for example the procedures in Braun and Clarke (2006) p 90-91 are considerably simplified from an administrative point of view. Using the NVivo transcription service I was able to easily match transcripts to sections of video providing me with a quick way to track any nuance in a specific section. Finally, NVivo is available at no cost from my institution (although the transcription service is a paid extra).

4.4.3: Results of Initial Coding

The initial coding run expanded on the areas of the "excel sheet" version but due to the nature of NVivo I was able to use nested codes and cross coding (where parts of the interview fell into more than one area) to a greater extent. Being able to do this is one of the affordances offered by NVivo mentioned above. I also found it easier to expand on emergent codes ("nodes" in NVivo's parlance), such as play and problem solving, than in the initial Excel sheet. In the end I repeated and expanded the spreadsheet in the NVivo project "Musikarbeiter".

4.4.4: Second and Subsequent Coding Runs

For the second group of interviewees (between November 2022 and August 2023) the interviews and transcripts were imported directly into NVivo. After initial coding another run was made for all the participants as it seemed appropriate to again re-code the participants from the first group. More than one coding run is recommended by both Nowell et.al (2017) and Braun and Clarke (2006) in their schemata, and the fresh themes that were created from the data in the initial coding runs could now be considered in this one. I therefore looked at all of the interviews in the light of what I had seen so far. One of the outcomes was a subdivision of the codes relating to technical and creative networks working together. Other reasons for coding again are that from my initial interviews broader themes such as experimentation and play may be appropriate, and given my leaning towards ANT I would want to look at how networks are mobilised (or mobilise themselves). The differences can be seen by contrasting the NVivo sessions "Musikarbeiter" (which mirrored the Excel sheet) and "Musikarbeiter 2" which added a considerable number of new nodes. "Musikarbeiter 2" contains separate codes for "tech opening doors", "making things that do things", "expressive technology" etc. I have for example assigned much of participant P's communication relevant to this to "tech opening doors" - which is a double-edged sword as it seems clear that without being able to demonstrate technical background knowledge, those doors would have remained closed. Many workers in the field (including P in their role with a software provider) view their role as enabling, providing materials, training or software with the aim of allowing creatives to work more effectively.

A final coding run carried out in November 2023 resulted in "Musikarbeiter 2.1". No new codes were generated but several pieces of transcript were newly coded into existent nodes. By this stage I was thinking more in ANT terms and thinking about the nature of connections, and Musikarbeiter 2.1 has attempted to capture that.

4.5: My Themes and Where They Come From.

In this section I will address the question of how I intend this kind of "thematic" coding to work with an ANT sensibility. The danger here is in taking the themes, whatever lip service we pay to "emergent themes" instead of "themes which emerge" (Braun and Clarke 2021, cited in chapter 3) as some sort of social structuring principle of exactly the sort that according to Latour (2007) is antithetical to ANT. ANT is intended to build a picture of social structure from the ground up, as a consequence of the internal logic of practice(s), rather than as a mysterious thing that shapes them (see for example Latour 2007, p7).

The gist of Latour's approach is that that areas of sociological enquiry (such as law, science, or indeed music technology) are not "embedded in" the social which may partly explain them, but that the connections within their networks are what *makes up* the social. ANT is bottom up, tracing associations to explain/assemble the social; rather than top down, invoking the social to explain associations. For Latour sociology is done by the actors themselves in the construction of their networks, not by the sociologist (2007, p32). The implication for this thesis is that how the actors – including the non-human actors – mediate, translate and propagate through/in their networks must be of overriding concern when establishing themes. In fact, similarities and differences between these tracings will end up as the major concern of the analysis. It is for this reason that I have discussed the emergent codes in terms of *potential commonalities of how connections are made,* acknowledging the possibilities that many of these networks will work in similar ways.

This has established several points for consideration in the final establishment of themes
Firstly, Latour's carefully drawn distinction between mediators and intermediaries is useful. An intermediary in Latour's language is essentially a conduit which passes a signal ("meaning or force") through a network (or anywhere else) unaltered. Mediators transform, distort or modify the signal, they have in some sense an agenda. For Latour, intermediaries are expected to be quite rare. We may take the discussion of NVivo above as a case in point: it is a piece of software that sells itself as a transparent intermediary but, as Adams and Thompson show, it is in fact a mediator. Latour argues that whether something acts as an intermediary or a mediator depends only a little on its internal complexity (p39). Although NVivo is a non-human actor, this also applies to people, such as the participants I have interviewed. Almost all of them have undergone some form of music education and a number of them are music educators. Some workers on non-education fields are ex-students of others who still work in education. The mediatory role of the teachers and learners involved is therefore something that, far from being an adjunct to how STEM and creativity work together in an

abstract world, is a key to how this actually happens (if it happens, when it happens) in a series of physically sited situations. The role of educators as mediators is expected in a thesis such as this, and part of the opportunity offered by interviewing industry practitioners who are ex-students is to try to reach an understanding of how that mediation has played out.

Also, as the discussion around NVivo suggests, it is equally important from this viewpoint to examine the role of non-human actors. Many of the interviewees are especially keen to talk about music equipment. The Ableton Push, Korg Monotribe, binaural microphones, custom modular synthesizer, and hacked controllers mentioned in interviews were mentioned because they are important to the human actors concerned, and in turn the human actors are important to them. Somehow these individual sensibilities must be brought out and their importance respected instead of abstracted away. As I have previously mentioned if there is one thing that ANT practitioners and technologists share it is the conviction that the details of stuff are important.

A further consideration is that of "micro/macro". ANT appears to lend itself to small and local studies. However in his chapter "localising the global" Latour offers a rather different definition of macro – instead of being a larger overarching structure, for Latour "macro no longer describes a wider or larger site but another….equally micro place which is connected to many others". As a trivial example this thesis, tiny though it may be in terms of man hours of work by comparison with the work it tries to understand, is (by definition) highly connected within the actor network it describes. In the same way a common text, magazine article or music technological folk anecdote may be far more connected, and thus significant, than it seems. However, it is likely that some of the actor-networks detailed in this thesis will have no immediate connection with each other that I am able to trace except that they all partake in some sense of music technological practice. Although in ANT existence – ontology itself – may be taken as relational (as we recall from chapter 3 "No entity has an essential existence outside a given network" - Fenwick and Edwards 2010 p11), Latour paradoxically reminds us of the potential of those very things "outside the network" - or at least outside those elements of the network which have been traced. We do not know of everything that the actors have done but it may be possible to trace some outlines of where the "missing masses" (Latour 2007 p241) might be.

4.5.1: Working With Themes and NVivo

In keeping with the concerns over NVivo it is also worth noting issues that I struggled with. I found it very easy to aggregate large sections of information into hierarchical nodes. It was much less obvious how network type structures where a "daughter" node (as opposed to a quote, video/audio clip or

piece of information) falls into more than one parent might be created. For example, I might wish to place the "Film TV Tech" node into a "non-human actors" parent (since almost all the discussion in this section is about the use of technical objects: speakers, computer systems, "Connect A" etc) but also into a "Film and TV" parent and maybe a "collaboration" parent as well since they are also collaborative enterprises. In order to do this data can be gathered into "sets" (a node can belong to more than one set, but not more than one parent node). But "sets" do not seem intended as "theme nodes"! In fact I found it difficult to work in this way without in some sense feeling that I was using NVivo "wrongly". As an example, the way these nodes can be captured in "sets" can be either by separately aggregating all the information in daughter nodes (this losing the daughter node hierarchy) or not (thus missing most of the information). In fact, what are included in sets are shortcuts to the parent node that (unless they are also aggregated) specifically exclude material that is also in daughter nodes! In other words, only material that is in a parent node but not a daughter node is included, unless I took steps to include all the daughter nodes as well.

It is possible to switch between these modes but again the promise of transparency and ease is not entirely justified. Sometimes it seems I have swapped one kind of impenetrability – that of shelves of printed books with multicoloured bookmarks, accompanied by reams of notes which are themselves a barrier to access – with another, that of software, which seems at first glance easily accessible, but in fact has its own hurdles. Finally in spite of Zoom being able to produce timestamped transcripts these did not translate well into NVivo, meaning I would not be able to easily look at emotional nuance when carrying out any final analysis. I therefore decided to pay for the NVivo transcription service as it would provide timestamped transcriptions enabling me to click on a line and jump to the appropriate moment in the video. I am conscious of having a certain amount of privilege to be able to afford this. I also discovered another accessibility issue with NVivo, that being it is not possible to change the global font size in transcripts which raises concerns for researchers with less than perfect eyesight.

4.5.2: Working With Themes and ANT

Any themes I established would have to lend themselves to an ANT lens. Fenwick and Edwards state (2010 pp2-3) "distinctions, such as those between the social and the natural, the human and non-human, and between *the technical and the social*, are taken to be effects rather than foundational assumptions" (my italics). If I am looking at STEM like and creative networks in the field of music technology then the emphasis has shifted to how these networks are established then translated by the actors themselves, how they are able to mobilise and how they (so to speak) propagate. I must be

alert to the chains of local connections that shaped how my practitioners came to be as well as their own roles in enrolling others. This approach inevitably leads to some themes not being suitable.

Although, therefore, I have argued above the validity of looking via the various categories from chapter 2 and 3 (phronesis and praxis, craft, aesthetics, STEM, etc) for helping with initial codes, and although they provide valuable insight into commonalities, they are not my overarching themes. Translation in ANT is "the process…which generates ordering effects"(Law (1992) 'Notes on the theory of the actor-network: Ordering, Strategy and Heterogeneity', *Systematic Practice and Action Research*, vol 4, no 4:379-393, cited in Fenwick and Edwards 2010, p9). The purpose of the codes, therefore, is to attempt to understand *how these processes take place*. For example, when teachers or practitioners act in a craft-like way, then they are performing the work of connection via a particular process, which is not the same as (for example) a theory class, or a creative facilitation session. Thus the commonalities brought out by the coding account for *the kind of work done* by the actors in maintaining "music technology". Instead of providing or positing an overriding structure for these codes, I instead use them to understand how "music technology" and "music technology education" are (in Latour's terms) fabricated. With one exception (see below) the actors are not necessarily in one network (except that connected by this thesis) but rather will offer a series of examples in the way Molotch (2003) does. Identifying via commonalities *the ways in which connections are made* remains a valuable goal and indeed seems a useful one to educators who wish to make such connections (or enrol students into their networks).

I have also been influenced in my understanding of ANT and its application to music technology by the work of Adams and Thompson (2010). This work is primarily focussed on understanding non-human actors and is subtitled "Interviews With Digital Objects" (although there seems no *prima facie* reason why it cannot be applied to "analogue" objects such as the modular synthesizers that are a particular passion of one participant). It is worth mentioning Adams and Thompson's use of the word "interview" to mean "to catch insightful glances of it in action" rather than the sense in which I have interviewed my participants. Their heuristics offered useful models to analyse my material more widely. Adams and Thompson seem to break down their heuristics into data gathering and analytic techniques, though they never seem to quite say that, possibly because in ANT the boundary between the two is blurred or sometimes non-existent. Nonetheless the first four heuristics seem to lean towards observation/immersion (they are in the chapter titled "Attending to Objects, Attuning to Things) and the second four into analysis or consideration (chapter title: "Loosening the Meshwork, Analyzing Medialities and Materialities")

In particular, Heuristic One "gathering anecdotes" corresponds quite well to what I have done – my interviews are nothing if not anecdotal. This particular heuristic seems to lean towards the phenomenological, but some clues towards a more ANT based use of the technique seem possible. For example on p27: "the criterion for inclusion is simple – does this source reveal something about how a given technology is taken up, used, integrated, mobilised in professional practice or everyday life?". Adams and Thompson note on pp24-25 that this may include fictive anecdotes (and an example of a story from Latour about a seatbelt warning, which may or may not have taken place, but is nonetheless illuminative, is quoted on p24). A parallel may be drawn with the potentially self-mythologised account of the TR-808 from Roland (2020) cited in chapter 1. At least one of my participants has doubts about the veracity of this story but it nonetheless provides a useful account of repurposing. What this means is that the accounts of the participants should be taken seriously but also analysed more deeply. On p29 Adams and Thompson suggest an approach where "relational materialist approaches are scaffolded using human subjects as starting points. Rather than regarding the individual – or their story – as 'autonomous, unitary and coherent' [each is unfolded as] a network effect comprised of…social and material relations" (Mulcahy, D (2013) 'Turning around the question of 'transfer' in education: Tracing the Sociomaterial' *Educational Philosophy and Theory,* 45 (12) pp1276-1289, cited in Adams and Thompson 2010 p30). An anecdote gathering approach would seem, from an ANT perspective, to therefore mean looking at the anecdotes to elucidate the network effects involved. Heuristic Two "following the actors" is more explicitly ANT oriented. An immediate apparent difficulty is raised by Latour (2007 pp121-122)

> "How ridiculous is it to claim that inquirers (sic) should 'follow the actors themselves' when the actors to be followed swarm in all directions like a bee's nest disturbed by a wayward child? Which actor should be chosen? Which one should be followed and for how long? And if each actor is made of another bee's nest swarming in all directions and it goes on indefinitely, when the hell are we supposed to stop?"

There must come appoint at which we stop following connections, where we prune our portrayal of a network while acknowledging that there are connections that go beyond it. Thompson and Adams discuss this in terms of untangling practices (2010 p34) which is very much a concern of this thesis. In terms of analytic heuristics, Heuristic Seven "Unravelling Translations" again seems important, in particular the fourth question "how do different sociomaterial worlds come to be? What objects and/or practices work to connect or distance them?". Tracing the translations within music

technology practices and how these networks are presented as STEM-like or Art-like again cuts to the heart of this project.

I should note at this point a major caveat – Adams and Thompson's heuristics are specifically intended as ways of engaging with objects within sociomaterial networks, more precisely "digital objects" but perhaps also more broadly "non-human actors" (the difference between a digital and an analogue object in music technology can be somewhat blurred). Is it possible to stretch these heuristics to encompass the human actors who have in fact been interviewed (in a more literal sense)? I believe they can, providing that a key tenet of ANT – attending to non-human actors – is also adhered to. Non-human actors can extend considerably further than digital objects. The physical structure of a building, a textbook containing an account of musical or technical theory, a Google Classroom page with assignments and resources on it, a hardware/software hybrid performance controller with its affordances, a musical instrument, or an audio file might all be non-human actors. Latour tells us (2007, p63 and later) that non-human actors have a critical role in rendering the ties in a network durable. An account of a network will need to address both human and non-human actors. Latour also enjoins us to "write risky accounts" noting "we write texts, we don't look though some windowpane". The account that follows in chapter 5 will I hope be risky in that sense. It may not be "proper" ANT. It may fail (as Latour says is likely). But it may nonetheless be useful and do something, or more precisely in ANT terms make some other actor do something.

Bearing all this in mind the codes created from the interviews will be loosely grouped into accounts of process – themes – which are my "matters of concern", in the NVivo session "Musikarbeiter 3". This differs from "Musikarbeiter 2.1" precisely and only in this. Because codes are commonalities that may relate to more than one matter of concern, I have used the "sets" feature as noted in section 4.5.1. Sets have an advantage in that they are able to gather both codes and cases. Musikarbeiter 3 is summarised in the annotated codebook below.

Table 4-3: Annotated codebook from NVivo project "Musikarbeiter 3".

Node	Files	References	Reference Detail	Collected under theme(s)
accessibility	8	10	A, C (2), F, G, H, M, N, O (2)	Mobilising
AI	3	4	K, M, O (2)	Other
attitude and commitment	7	15	B (2), G, J, M (2), N (4), O (2), P (3)	Mobilising
flexibility	1	1	M	Mobilising

Node	Files	References	Reference Detail	Collected under theme(s)
autonomy	6	7	F, G (2), H, J, M, Q	Educators and educating Mobilising
backing tracks and legitimacy	2	2	B, D	Non-human actors
building tech skills	10	25	A (2), B, C (3), E (4), F (4), K, M (5), P, N (3), Q	Mobilising Non-human actors
creative and art and aesthetic	8	19	B (2), C, F (2), G (2), H, J (4), K (4), Q	Aesthetic mobilising Mobilising
building	2	2	H, O	Mobilising Non-human actors
creative constraint	5	7	C, G (2), H, Q, O (2)	Aesthetic mobilising Mobilising Non-human actors
critically aware	2	6	M, O (5)	Aesthetic mobilising Mobilising
emotion	3	4	A (2), O, Q	Aesthetic mobilising Mobilising
expression	2	4	H (3), O	Aesthetic mobilising Mobilising
flow state	2	5	B (3), G (2)	Aesthetic mobilising
judgement	4	10	C (3), F (4), H (2), J	Other
punk	1	1	D	Aesthetic mobilizing Mobilising
beginner's spirit	2	4	A (3), O (1)	Aesthetic mobilising
the human element of electronic music	5	10	B, G (5), K (2), O, Q	Aesthetic mobilising Non-human actors
thinking about form	1	7	H (7)	Aesthetic mobilising
thinking about sound	4	14	A, H (4), O (6), Q (3)	Aesthetic mobilising
nuance of sound is irritating	1	2	D (2)	Aesthetic mobilising
too formulaic	4	6	F (2), J, K, O (2)	Educators and educating
visuals	1	1	B	Aesthetic mobilising
deliverables	8	11	D, E, F, J (2), K, N, P (3), Q	Non-human actors
doing the job	1	3	P (3)	Mobilising
experiment +	8	16	B (3), C, F (2), H, J, K, M (4), Q (3)	Mobilising
experiment -	1	1	K	Mobilising
film tv tech	5	12	E, J (2), M, N (3), P (5)	Non-human actors
libraries and foley	1	1	P	Non-human actors
happy mistakes	5	8	B, G (3), M, O, Q	Mobilising
hard tech	4	7	E, M (2), O, P (3)	Non-human actors
higher education	3	3	F, J, O	Educators and educating
industry in education	6	16	E, F, J (7), K (2), N (3), M (2)	Educators and educating

Node	Files	References	Reference Detail	Collected under theme(s)
bad side effects	1	1	N	Educators and educating
IT	2	3	C (1), E (2)	Non-human actors
it's the money	5	9	F, G (3), H, N (3), Q	Mobilising
cost barriers	3	4	A, K (2), M	Mobilising
STEAM funding	5	6	E, J, K, M , N (2)	Mobilising
learning from mistakes	1	1	M	Educators and educating Mobilising
loops	3	5	C (2), D (2), K	Non-human actors
making connections	7	15	A, D (2), H, M (2), N, P (3), Q (5)	Mobilising
mentorship	3	4	P, F, E (2)	Mobilising
solo and collab	6	9	E (2), F, P	Mobilising
mental health	2	4	B (3), G	Other
musician	6	11	B (3), C, D, E (4), F, J	Educators and educating
formal music training	9	14	A, D (4), E (2), G, H, J, N, O (2), P	Educators and educating
influence	1	2	B (2)	Aesthetic mobilizing Mobilising
joy of music	4	5	B, C (2), D, H	Aesthetic mobilising
part of the culture	1	1	P	Mobilising Non-human actors
tacit knowledge	2	6	E (6), P	Mobilising Non-human actors
performance	1	3	H (3)	Aesthetic mobilising
play	9	30	A (2), B (2), C, F (4), G (8), J, K (4), M (7), Q	Educators and educating Mobilising
practical and craft	7	14	A (2), B (2), C, F (4), G (8), J, K (4), M (7), Q	Mobilising
practice	5	7	A, C, F (3), J, Q	Mobilising Non-human actors
preparation	2	2	E , P	Non-human actors
repurposing and abuse	2	6	H (3), O (3)	Non-human actors
problem solving	8	20	B, C, D (2), E (2), H, J (7), M (5), P	Educators and educating Mobilising Non-human actors
musical problem solving	1	4	D (4)	Mobilising
problem before theory	2	3	F (2), O	Mobilising
process and outcome	6	12	A (2), G (4), H, M, O, Q	Non-human actors
pushing the boundary	3	8	D (2), M (4), O (2)	Aesthetic mobilizing Mobilising
pushing creatively	4	11	A, D (2), H (5), O (3)	Aesthetic mobilizing Mobilising
pushing technically	4	8	A, O, M, H (5)	Aesthetic mobilising

Node	Files	References	Reference Detail	Collected under theme(s)
				Non-human actors
resistant to teaching	1	1	G	Educators and educating
self taught	7	18	B (2), C (4), E, F (3), G (4), K (3), M	Educators and educating
soft skills	2	4	P (2), J (2)	Mobilising
tech creative +	13	41	A (3), C, D, E, F (5), G, J (7), K, M (10), N (3), O (4), P, Q (3)	Educators and educating Mobilising Non-human actors
creativity needed for tech	3	6	E (3), H, M (2),	Aesthetic mobilising
expressive technology	1	6	H (6)	Aesthetic mobilising
joy of tech	5	11	C (2), F (5), H, M, O (2)	Mobilising Non-human actors
taking stuff apart	1	3	F (3)	Mobilising Non-human actors
making things that do things	3	12	D (3), H (6), M (3)	Mobilising Non-human actors
plan b	2	5	N (3), Q (2)	Mobilising
tech opening doors	13	39	A (3), B (4), C, F (2), G (2), H, J (8), K (5), M (2), N (4), O, P, Q (5)	Mobilising Non-human actors
tech serves creative	3	11	D (7), N, P (3)	Aesthetic mobilising
tech theory in practice	6	11	G (3), F, E, C, Q (3), O (2)	Educators and educating Mobilising
tech creative apart	10	16	A, E, F (2), G, J, K, N (2), O (2), P (2), Q (3)	Mobilising
it's destroyed my creativity	1	3	E (3)	Mobilising
tech transparent	4	7	C (2), J (2), M, Q (2)	Aesthetic mobilizing Mobilising
technical training	8	16	B, D, E, F (3), H, M (2), N (5), O (2)	Educators and educating
there should be a learning curve	3	3	K, M, O	Educators and educating Mobilising
trial and error	2	2	A, B	Mobilising
troubleshooting	3	3	O, P, Q	Non-human actors
tyranny of choice	2	3	F (2), G	Aesthetic mobilising
use your ears!	8	10	B, E, F, G, J (3), O, P, Q	Aesthetic mobilising
utopian	1	2	H (2)	Other
YouTube	2	3	C, K (2)	Educators and educating

In this codebook I have therefore mapped my codes onto themes that will be useful for an ANT lens, described in 4.6 below. Where a participant has said more than one thing that has been coded into a particular node, the number in brackets indicates how many entries there are in that node for that participant. This does however carry a caveat: In keeping with the discussion of qualitative analysis

above, raw numbers of comments are less important than content. Under one of the nodes one participant may have said several things but another may have said only one thing, but that one thing may have seemed highly significant. However, where a node has many entries that has sometimes been taken as a prompt to further investigation in chapter 5; for example "tech opening doors" was clearly of concern to a number of participants and is an important part of the discussions of gatekeeping and "human affordances". Nodes that were potentially of interest but did not fit into any theme were collected into "other" (as suggested by Braun and Clarke 2006).

The exception to this scheme (and therefore not gathered on this table) is the theme "The Fairacres College Network", which instead of using the nodes, gathered all of the accounts of participants E, F, N, P and Q, who are connected to the college.

4.6: The Themes

"Mobilising" (theme 1) is where I have gathered most of the accounts of translation, enrolment and mobilisation. If it seems a bit imprecise to gather them all under one banner it is because my concern is really into how networks have extended themselves in various different ways. So most of these accounts are accounts of extension, and of how actors themselves were enrolled or how they have enrolled others by accident or design (or in some cases where those enrolments have failed).

I have treated "Aesthetic Mobilising" (theme 2) as a special case. If we are to look at creativity as well as STEM-like activities, the initial coding seemed to reveal a set of tactics or ways in which people and things are recruited for aesthetic reasons. As noted in Dewey's (2005) account in chapter 2 these aesthetic links are hard to pin down precisely because they are hard or potentially impossible to verbalise. A musician/producer describes, in one example, being recruited into a band because the sound of the band seems somehow special in a way that they struggle to articulate. And yet any fellow musician will recognise the feeling of being moved by something in a mysterious manner and understand in principle (if not specifically) how that link was created.

I have in keeping with ANT concerns also separated passages where Non-Human Actors (theme 3) are discussed, whether these are hardware/software networking devices ("Connect A"), pieces of music hardware or instruments ("The Push") or ways in which non-human actors mediate links (such as the way a voice or instruments are affected by recording equipment and the ways in which that can have further effects down the line both technically and aesthetically). Part of chapter 5 will focus

specifically on these non-human actors and their mediation but in keeping with ANT sensibility they will always be borne in mind even in other sections.

"Educators and Educating" (theme 4) looks at all the accounts in which actors have been enrolled (or sometimes failed to be enrolled) into networks that they have identified as educative. Many of the coded passages in this set are from educators but not all: for example a producer's (who does not work in education) response to music theory lessons at school is encompassed here, as well as views on taught musicianship or even how STEM like and art-like skills might interact in a learning environment.

The final set is not by topic. An advantage of an insider account is that it is specifically situated around my own workplace. Two of my participants are ex-students working in the industry, one is an ex-student working in turn as an educator, and two are working at the college. This makes it possible to trace out a network of educators and industry workers specifically connected by links such that "X taught Y" (and all of the teasing out of connections that that simple phrase might entail). In this set the members are not nodes obtained by coding but "cases" in NVivo terms – that is participants (and their video interviews). I have called this set "The Fairacres College Network" (theme 5) and I hope in chapter 5 to be able to use it to show how these paths through a music technology network, suggested by my coding, are traced and maintained in space and time in a specific and extended instance.

4.7: Initial Findings

During these interviews I was struck by a number of observations – or perhaps I should say emergences – which convinced me I was on the right track with ANT, in that participants were talking about actions: what they had done, how they had felt compelled to do things, and how they made things (both technical and aesthetic) in turn. An important factor that many of the teachers, and also some industry participants, talked about was technology enabling or opening up possibilities. This has some bearing on questions of accessibility raised by the first group but was also about how learning to use advanced and even initially inaccessible technology was a key factor in what they did (in ANT terms they would be mobilised by their networks via a process of learning how to use technology).

> "Once again I am struck by how many of the respondents talk about their practice in terms of play and *doing*. "Mucking about with stuff", "taking shit apart for the fun of it" etc."

> "There is a commercial consideration involved in pushing out new technology that Q alludes to at the start of the interview but is not much approached by the others. A whole other network leaning in. There is a possibility here about the idea of creativity being necessarily informed by new technology that is capitalistic as well as the democratising effect being liberatory."

> "O teaches at (university) who already demand an extra subject module as part of the degree course, and music tech is one of those options. He sees it as a contrasting offer to STEM. This is in the interests of what I can only call a holistic education to counter the (unfair?) stereotype of STEM students as narrowly focussed and lacking people skills. I see this this is explicitly enrolling people who do not see themselves as creative into a creative network"

I also feel we are beginning to touch on one of the core concerns of this thesis: the use of technology to mobilise a particular kind of aesthetic, or indeed creativity in general. Most of this is of course the concern of the next chapter but there are some extracts from my notes:

> "I am struck by how much Q – who has essentially an engineering job title – is talking about his artistic passions and outlets for creativity and enjoyment of his work. More so than some of the actual artists in some cases. He seems led by an almost hedonistic conception of his work. He talks a lot about eliciting emotion via sound. His production work involves thinking about sound. There seems to be a difference between thinking sonically and thinking melodically/harmonically. He makes an interesting statement about how what's possible technically informs what is creatively possible : 'I can't even conceptualize what a new instrument in the 21st century would look or sound like, which is maybe, I don't know, a problem with my own imagination'"

> "H is very invested in tech in a kind of organic way. 'It's like an instrument. Like an instrument is a tool, but it also is more than a tool'. D, M, and H have all talked in various ways about building systems with the purpose of doing a thing"

The full analysis of these findings is the concern of chapter 5, where I will look at how the codes that emerge in data analysis illuminate the nature, movement, mobilisation and translation of the networks that make up the practice of music technology both inside and outside education.

Chapter 5 - Results: The Mobilisation of a Musikarbeiter

This chapter is structured around the themes stated at the end of chapter 4, exploring each one in depth with a consideration of how the commonalities suggested by the literature discussed in chapter 2, and by my coding, apply. Section 5.1 forms a general introduction and some illuminative examples. Section 5.2, "Ways of Translating", relates to theme 1 (mobilisation) and as befits such an overarching theme has several subsections, and will look at the way people bond with human actors (5.2.1), non-human actors (5.2.2), and finally touch on some of the ways non-human actors can be used to create agency (5.2.3). I will introduce the idea of "human affordances" as a way of reconceptualising Latour's (2007) explication of "plug-ins".

Section 5.3, "They're Making Art!" will look at the role of aesthetic experience (theme 2) in enrolment, mobilisation and extension of networks. I consider the aesthetic object as a specific type of non-human actor which is of great importance, capable of transforming those who it comes into contact with. The work of art that Dewey (2005) discusses and analogises to the conceptualisation of work in physics is therefore identified with the work of building and maintaining networks that is so crucial to Latour.

Some specific non-human actors, their roles, and the ways in which they bind or liberate are discussed in 5.4, "The Joy of Tech", which looks in more detail at an array of technical objects and highlights their role in creating and strengthening network bonds, as well as expanding on the possibilities for forging and creating agency that partnership with them represents (theme 3). I touch on the dangers of "lock-in", and consider the role of the "deliverable" as a technical non-human actor.

5.5, "Delivering the Musikarbeiter" examines the ways in which educators (theme 4) attempt to aid students in their enrolment into wider networks of technology, creativity, and employment, by helping them to develop the necessary "human affordances". They discuss various strategies for inculcating flexibility and autonomy, and again affirm the importance of aesthetic engagement.

Finally, 5.6, "The Fairacres College Network" (theme 5) will trace a network of educators and ex-students as an example of how the above can happen in practice.

5.1: Setting the Scene - Play and Performance, Critical Incidents.

In this chapter I will be heavily relying on the accounts of my participants. To help with anonymisation I will be using singular "they" in my discussion. There are one or two occasions where participants have mentioned their gendered experience or other factors (such as being a person of colour) that are important, and this may become apparent in the account, which will necessarily make that account less anonymous. I have sought and obtained permission where this is necessary. There is a fair amount of variety in their experiences and roles and there is no one term ("composer", "producer", "audio engineer") that accurately encompasses every single one of them, so in this chapter I will revert to Ralf Hutter's coinage (Kybernetisch 2017) discussed at the very start of this thesis of "musikarbeiter". I do not intend by this to beg my original question of the mechanisms by which "STEM-like" skills and creativity work together, instead that will become evident in the rich accounts of the participants.

Reading through the accounts it is illuminating, following the method of Latour and Woolgar (1986), to look at what the participants spend a lot of their time doing, or at least indicating they are doing. I am struck by how often they talk about messing around with things and exploring the technology. Consider these for example:

> "I would just mess around with it for hours making these kind of feedback noises" (F)

> "If you talk about (track)…there's a kind of scratchy sound…I was using a microphone with a foamy bit on it…and I just whacked it up really high and I'm striking it once and I thought that makes a cool sound….and I just went <wkch> and then I decided to just mess about with it" (B)

> "That stems from me, having spent a lot of time in in the late 90s kind of just playing with the early earliest versions of Logic [music software] and the environment and, and the manipulation of MIDI" (D)

> "It's good to have a good technical knowledge but it's good to keep a sense of you know childlike play about what you're doing and try not to get too bogged down in the theory of that." (G)

If actors in a network are to be seen as entities which *make other actors do things* (Latour 2007 p107) "not by transporting a force that would remain the same throughout but by generating *transformations manifested in the many other unexpected events* triggered in the other mediators that follow them along the line*"* then these look very much like instances of non-human actors making human actors *play* with them to create those very kinds of unexpected results. In the case of B we can further see a kind of unexpected affordance offered by the non-human actor: The "foamy bit" on the microphone, whose function (intended by the manufacturer) is to act as a windshield blocking off extraneous noise, instead invited them to *create* an unexpected noise by scratching it with their fingernail which in turn resulted in a snippet of recording which could be manipulated in music software and used in a percussive sound effect in a track. The actual track itself is not mentioned much in terms of a planned goal - indeed B says they work "unplanned" a great deal of the time.

A similar process is discussed by G:

> "I really enjoyed, you know, sort of recording just, you know, like recording, you know, fingers on glass and, you know, recording just little tunes with piano and piecing these kind of sonic universes together and just really got a lot out of and they were very structureless".

Again, non-human actors seem to offer affordances not necessarily intended by their designers. G for example is discussing working in a Pro Tools studio, a piece of software originally very much intended as a digital equivalent of a multitrack tape machine (Cook 2013). There is a link between this and the repurposing discussed in chapter 2. I am working towards the idea that *repurposing happens when a non-human actor offers an affordance not intended by its maker, which is then taken up.*

A related factor that many of the teachers and also some industry participants talked about was about technology as enabling creative possibilities. This has some bearing on questions of accessibility, but was also about how learning to use advanced and even initially inaccessible technology was a key factor in extending creativity. This seems true whether the affordances offered are intentional or accidental - so for example O discusses how the understanding of sample rates and the history of recording can contribute to a production aesthetic:

> "……some of them. It will. It will. Especially if they're more kind of that way inclined in terms the way their brains work, it will give them creative possibilities, you know, when they see

> that…….. you know, I we do talk about this notion of creating abuse. So as soon as there's something that you don't need any more…... you don't have to have tape hiss or tape compression or low bit rates. It becomes a fascination, doesn't it? So all this stuff, lo fi stuff with the hiss and the wobble and, you know, like the low sample rates of an old sampler. Yeah. So I encourage them to think in that way, you know, think about stuff that you like and how it's using, for example, the imperfections of certain media.".

Of recurring interest here is the idea of creating abuse, which links again with Sennett (2009) and repurposing. K again describes this tendency:

> "It's all about sort of using the understanding of technology, really. And how to select and combine sounds and play with sound to some extent, really. So that's where I come from".

And from M in a description of project-based pedagogy:

> "The real strength of being somebody who's involved with tech is taking the time to go out with the sound recording and making sure that they're then aware of what, you know, bit rate that they're confident knowing what their sampling rate's going to be, to make sure that it works in the project that if they're going to be time manipulating with it that they need to be aware of the (...) of the pitch and background noise".

In M's view, which slightly contrasts with that of B, a "correct" understanding of technology is important to open up possibilities. Breaking the rules is one thing but not knowing the rules is another. This also gels with industry participants' concerns whereby being able to display this "correct" understanding is key to their being able to find work in a creative area. P in an extremely revealing interview describes it as "part of the culture":

> "If you walk into a mix stage and you don't have technical knowledge…you're going to be laughed at just because it's…it's just you're expected to have studied it. You're expected to know it. And it's kind of that cultural thing".

For someone like this, technology is the sea that they swim in, and having background knowledge is key even when they are working on their "small" laptop setup, not just to ensure that file formats are correct but because otherwise they would be "laughed at". In Latour's terms, we might consider that

"cultural thing" as a network that has been constructed by a variety of human and non-human actors, and rather than being easily enrolled via play, interessement into the network (binding to a role) is routinely withheld, and only granted after a certain level of engagement with the non-human actors has been reached and demonstrated.

The difference between these modes of enrolment can be partially explained by the way in which participants are recompensed. Both B and P work as, effectively, freelancers for some of the time, but the difference is in the terms and conditions. When P freelances it is for large game and film organisations who are able to dictate certain expectations. This might be for a variety of reasons: a large number of people may need to work together on a mix stage without confusion, for example, or they may have clients with specific demands for "deliverables" (and I will discuss deliverables below in more detail). B is not free of deliverables which will have a technical dimension (sending tracks in a particular format to a mastering engineer for vinyl release for example) but is more deeply involved in sound and music composition (I have avoided using the word "creation" here because composition may be only part of "creativity") and ultimately, when writing music, is accountable to their listeners and their own aesthetic considerations. Their network therefore seems less demanding in terms of "correctness" and more inclined to reward play.

This is just one instance, or spectrum of instances, of how networks of practice are created, extended, and make use of non-human actors. There is more to say about this and about other ways of network propagation which I will deal with in the next section. In the light of Latour's conception of actors making other actors do things, one of the characteristics of this area (and other fields in creative media) is that human actors often actively seek enrolment. They want to know what to do in order to be firstly, subject to "interessement" and, ultimately, to be mobilised as representatives of the network. This powerful attractiveness of the group of networks loosely labelled "creative industries" is in itself a way of making people do things but also reminds us that an ANT lens is not simply a matter of power relations. P, for example, in spite of their "less playful" job, talks about enjoyment, seems happy to be working in the industry, and takes pleasure in their roles in the network. These roles, from their perspective, are things that they have achieved via study, work, and social relations, and are a matter of pride. At the same time, because of this, gatekeeping becomes one of the elements of the network ("to delineate a group, you have to have spokespersons who 'speak for' the group existence…..defining who they are, what they should be, what they have been. They are constantly at work, justifying the group existence, invoking rules and precedents, and….measuring up one definition against all the others. Groups are not silent things…." – Latour 2007 p31). As noted

briefly in chapter 3 educators are important to this gatekeeping role but as P's account shows they are not the only ones in it. Gatekeeping, of course, is a way of making actors do things – there are strictures they will have to conform to, or appear to conform to, in order to attain their desired roles.

I am therefore concerned with looking at the ways in which actors are enrolled into these various networks. At the same time bearing in mind the original research concern I will be looking at how these networks might seem "STEM-like" or "creative" to those involved in them.

Finally, a word of caution. The language of ANT can at times seem dystopian. Actors are "made to do" things, and one of the critiques of ANT is that it offers "no critical leverage, being content to only connive with those in power" (Latour 2007 p251). Similarly, the discussion of networks, gatekeeping, and later on "human affordances" seems to be vulnerable to Giroux's concern that "any vestige of critical education is replaced by training, containment and the promise of economic security" (Giroux, 2020). This is not my intent in using an ANT lens. Latour argues (2007 p252) that only by decomposing the social (rather than leaving it "unexplained and overpowering") can we begin to trace alternatives. Moreover, there is as we will see, more to networks than corporations, more to deliverables than technical specification, and human affordances in the form of technical skill and "trustworthiness" can also be leveraged to provide agency.

5.2: Theme 1 (Mobilising): Ways of Translation

If it is true that the networks of music technology are in some sense exclusive, that more actors want to be enrolled than actually are, and that gatekeeping is therefore an element, then it is worth looking at how actors are enrolled and how that can fail. One of last two heuristics from Adams and Thompson (2016) is that of tracing responses and passages. Critical questions include "How do human actors join with the things around them to co-respond to what is happening?"(p81) and "What kind of passages are being improvised as entities thread their way through the ways of others?" (p82). Another is unravelling translations, and critical questions include "What work is being done as actors join up, stay linked, or break apart? What kind of orderings and reorderings can be discerned?" (P74). The concern of both these heuristics is a concern with how networks change and extend (or contract) in time, and how their connectivity may alter. Ingold (Ingold T (2012) 'Looking for Lines in Nature' *Earthlines*, 3, pp48-51, cited in Adams and Thompson 2016), uses the term "meshworks" and talks about trails along which things *become.* In Adams and Thompson's words "Using the notion of

translation shifts the focus away from following the actors and instead probes the choreography of a particular practice" (2016 p78).

Looking at the gatekeeping issue from an FE point of view, then, there is an important sense in which students and potential human actors *have already been recruited*. At the simplest level, if they had not been, they would not have signed up for their course. It may be the case however that they may not have a clear idea of the nature of the network they have been recruited into. I will discuss educators and educating in section (5.5), but it certainly also seems to be the case (for examples, see below) that both educators and industry professionals talk about a notion of "professionalism" that is beyond the technical. This may seem obvious, but what is less so is that potential actors may therefore have a desire – to be "a producer" for example – but may not know what that means in practical terms. K for example discusses students who want to learn how to create a "beat" but are impatient with the technical knowledge that would potentially underlie that.

This section then will examine not only the ways in which networks enrol human actors but also the ways in which those actors themselves attain interessement. A key part of the "choreography of practice" here is that enrolment, interessement and mobilisation are not one way processes but are also driven by actors who already have tentative connections to networks and wish to stabilise them.

5.2.1: People and People

> "I'm always banging on about this, but it is the case, you know, when you're working with directors, you normally….if you're in a mix stage, you've got around seven, 5 to 7 other people in the room with you, you know, who worked on the productions. You'll probably have the video editor in there, you have the producer, you'll have the music editor, and you might even have certain members of the Foley team in there with you. You obviously have your mixers. It's really important to be good with people" (P)

In this account P identifies "being good with people" as a key trait which enables them to be an active member of their network. Professionalism for them involves more than technical competence. They often work in a busy environment and the importance of personal relationships in that environment is something they place high value on. This is also seen in similar accounts from Q and D:

> "I was then managing the relationship essentially with Ministry of Sound and DJs that were coming through the building to perform in immersive audio at Ministry of Sound. And that's how I kind of got my foot in the door at music at Dolby" (Q)

> "And then I've met various people along the way who have kind of realized that I'm kind of, you know, I care about outcomes and them putting their faith in me and me wanting to solve the problems that they put in front of me and making ridiculous ideas work." (D)

What these accounts have in common is an element of trust. When these actors were enrolled into these specific networks it is because they were identified by already mobilised actors as people who could be asked (or made in Latour's terms) to do things unproblematically. Placing themselves into this position was an active process that took work on their part. As P understands, this involves more than technical competence: it is necessary but not sufficient that a newly enrolled actor knows (or will know with a minimum of training) what to do in terms of the manipulation of things. In many cases more is required: the ability to work in a frictionless way with people who are not interchangeable (in all three cases well known musicians and film directors are involved) and may not themselves be unproblematic.

> "A mix is never done, and the director is never happy because it came back…. about five different times after we'd done all the deliverables and sent it off……and then it would come back like two weeks later and say, oh no, [director] wants to change this now" (P).

There is a considerable amount of work being done here by P in order to maintain their position. I should note that this director is not presented as an ogre who is difficult to work with. In fact, P describes this as one of their favourite projects. The point of their illustration is that productions are a complex process and a kind of cheerful adaptability is key: "The key is being professional, then technical knowledge".

This is identified by N (who works in education) as a potential problem for students:

> "…most of them are just in their own little insular world anyhow. Create hip hop beats essentially with headphones on……not thinking about actually, if I want to see it, I've got to work with other people".

If the goal is to be enrolled into and mobilised by a network, this is one of the points where mobilisation can fail even if other aspects are in place. This leaves a potential human actor in a difficult situation: they aspire to be part of a network, but entry to that network and mobilisation within it depends on conforming to expectations which they may not know exist. One of the ways around this is mentorship. A mentor can be explicitly identified as a human actor who has been mobilised by a network in order to enrol other actors. This is at first glance one of the roles of the music technology educator: what are we for if not to induct students into the norms of practice of the field? However, mentorship by definition involves the kind of one-to-one relationship that would be considered favouritism if it were to take place in a class. I am therefore using the term mentors in this sense for people who are not professional educators and do not have a duty of impartiality. Several of the participants tell stories of mentorship or of close connection:

> "He's got a big, big scope. And yeah, he kind of took me under his wing a little bit. You know, he taught me a lot about Audinal……he started to introduce me to more and more people." (P)

> "The tech guys at Glastonbury were amazing support. You know, they knew, I told them, I've never operated this desk, they gave me a lot of help" (E)

> "It's all to do with kind of meeting pivotal people…….so, you know, the entering of a significant kind of human being into my life, you know just ends up kind of driving me down this new avenue" (D)

F talks of not having mentorship and feeling that was a disadvantage: "It's the only short cut". The networks these actors are considering are often quite short lived, maybe the length of a musical project or film production: a period of months rather than years. Performance on those projects is key to membership of a more longer lasting network: one that might enable an actor to gain repeated employment. This kind of freelance role involves a second element of trust, not just that they will be able to work with the other human actors in a particular project but that they will be able to deal with stuff. Drawing a parallel with the scientists studied by Latour and Woolgar (1986 loc 4781) the capital of these freelance workers is therefore a kind of credibility that they will be able to collaborate with both human and non-human actors. This kind of credibility in turn makes them more connected in the network. It is in essence a bond with another actor or set of actors. Latour (2017 p176) urges us to avoid thinking of "macro" and "micro" in terms of "size" but instead looking at "connectedness".

Furthermore he urges us to look at the work that is being done by actors in order to attain and maintain the network (including their own positions in it). The constant work required to acquire and maintain credibility amongst other human actors is talked of as a trade off by F. For them the benefit of being mentored also has a price, that you might work in a secondary role in someone's studio for months or years with consequences for remuneration and autonomy in order to maintain the connections required. The work required to gain "sonic agency" may be long and hard.

Interlude: Human Affordances

On p207 (2007) Latour discusses a kind of modularity for human actors. A "complete" human actor is made of "plug-ins" (the metaphor is with browser plug-ins, which he considers a neutral term, but is perhaps confusing to an audio producer for whom the term "plug-ins" has a slightly different meaning). The "professionalism" required in a specific network is one of (or may be more than one of) these plug-ins. A specific technical competence may be another. A human actor, a "producer" for example, is thus according to Latour assembled in a network.

I would like here to compare the set of soft skills and competences displayed by a human actor with the affordances of a non-human actor. If I want to be enrolled into or mobilised by a network, I therefore would offer a specific set of "affordances". These might be entirely different to the set of "affordances" required in a non-professional role such as talking to my friends in a pub. However, I am not trying to deceive either group. The "human affordances" I might offer, fail to offer, or withhold, are elicited by the network. This seems in keeping with ANT's demand for equality of consideration between human and non-human actors. If things can offer affordances to people, there is a sense in which people can offer affordances – competencies/plug-ins/traits – to other people, and to things: a non-human actor might also elicit these affordances/require these plugins. I might have for example "good ears" but my mobilisation as a producer might fail if I am unable to operate the controls of a desk accurately ("good hands" perhaps), or work with another human actor who can. This becomes even more apparent in physical skills such as the playing of a musical instrument, which as Sennett (2009) reminds us are the result of a long process of psychomotor skill acquisition resulting in what might truly be described as plug-ins, a set of subprogrammes involving muscle memory and feedback that can be carried out almost unconsciously.

A parallel with musical artists is with musical collaboration. Connection building by working with other artists is valuable but there is a perceived trade off with autonomy. Those of the participants who

work as musical artists – that is as aesthetic creators, musical performers or producers – therefore have a varied attitude to collaboration. G describes what they see as a journey towards autonomy:

> "I think sometimes that sort of helps to have a little bit more of a sort of sense of self in the music and what you want to achieve……I think that kind of, you know, basically gave me a little bit of an advantage…. so I've always been playing in bands, but I think I really started to sort of take the idea of doing my own stuff seriously".

C, in contrast, is a serial collaborator who remixes, collaborates in performance, and is involved in a variety of side projects (and even their "main" identity can present onstage as anything from C solo to a five-piece band). B describes joining bands or choosing collaborative partners as aesthetically inspired. I will be looking in section 5.3 at the role of aesthetics in mobilising particular actors. As expected, those participants who are "creative producers" – in other words whose goal is not necessarily to gain employment but to gain a reputation for their music – lay a strong overt emphasis on this. Nonetheless as described below aesthetic considerations also extend into the "STEM-like" network of professional competency.

5.2.2: People and things

I will be considering some specific non-human actors in depth in section 5.4. In this part of the chapter, I want to look more at how the types of relationships human actors have with non-human actors affects their recruitment and participation in music technological networks, both in industry and in education. Latour argues that non-human actors play a crucial role in stabilising and making networks more durable. The responses of participants argue that it is not just relationships with particular things which they see as important (although they are) but the flexibility to form new relationships even in the face of obstacles. It is this relationship with things which has parallels with STEM, as this is often a relationship that involves problem solving and making predictions. Consider E, who works as a technician within education and a live sound engineer outside it, and says they can

> "walk into a room pretty much, and…know what it's going to sound like when you excite that room with volume".

E describes this as a kind of instinctive or tacit knowledge but spends some time in the interview describing the experiences – being a musician who plays several instruments, working as a guitar tech

then a live sound engineer, understanding and working with specific PA equipment and mixing desks – which have led them to the point where they can just "pretty much know" what will happen in a room. E is describing a relationship with materials which are obviously "things" (a room, a mixing desk, a set of microphones) as well as some less obvious but no less physical (the air in a room, pressure waves, the presence or absence of a crowd of people), which enable them to make predictions about "what will happen". They seem to be describing the kind of experiential knowledge highlighted by Dunne (1997) but later couch it in terms ("I can tell what's wrong") that could be mapped onto a STEM-like process in both Popper's (2002) (making falsifiable predictions) and Dewey's (2018) (applying careful thinking to resolve a perplexity) conceptions of science.

From an ANT perspective there are also other interesting factors at work. There are an array of human and non-human actors here (the musicians who E has as clients, the audience, and the room, technical equipment and physical processes involved) which will make E perform a set of actions which start before and will end after the actual performance: setting up and calibrating the sound equipment, adjusting values on the mixer, and even anticipating what is needed before the actual show:

> "in my preparation for shows and stuff, I will already be, shelving out roughly where I think it should be and turning on bands of that EQ I know that I might want to use for that guitar sound".

In turn their actions will make the musicians and audience do or not do things. Part of E's role is also to provide foldback (sound to onstage speakers so that musicians can hear what they are playing) to bands they work with. This demands a different set of requirements from the audience ("front of house") as onstage musicians are more concerned with making sure they are on time and in tune than with hearing a balanced sound:

> "Those kinda guys, they just play. They don't care what it sounds like out the front, they care what they sound like to themselves".

If the foldback sound is imprecise or problematic this will in turn make the musicians do things which may not be desirable to the audience. E and their equipment - as an actor-network of their own - have in fact not only been mobilised as the actor who directly conveys "the sound" from the band to

the audience but also as a critical player in a feedback mechanism - a part of the actor-network of musicians and vocalists who create “the sound” in the first place.

And yet, E does not see their role as creative. Instead, they consider it to be a kind of transparent conduit which enables bands to sound “how they are supposed to sound”. They even go so far as to say that as they have become more interested in their technical role it has “destroyed my creativity” (which at that point in the interview they identify solely with musical creativity). Looking at the video of the interview there is nuance (I would even suggest that E, who knows the concern of the thesis, is being a bit contrarian) but they are not the only interviewee to consider musicality to be the creative element and other more technical aspects to be a separate concern. This is a challenge to the main proposition of the thesis and will need to be addressed.

E elsewhere characterises their relationship with the things involved in their role as a problem solving one:

> “My skill, I think, over the years of doing this stuff is, is recognizing if something is wrong and then making it right”.

They are not the only participant to discuss problem solving in various ways and several of the educators identify it as a key skill to be nurtured in aspiring music technologists. Quite often solving a problem acts as a gateway into a network. D discusses this in a musical context:

> “I really, really like problem solving……like, you know, how do we perform song X, you know, with, with these four people”.

D is here discussing their work as a musical arranger and touring keyboard player. When they discuss people putting their faith in them above, they specifically refer to musical problem solving, the problem of

> “…making that music (that is, music recorded in the studio, with multiple layers of sound that are not necessarily replicable live by a group of musicians) performable by that group of people”.

Technology for D is a tool in this process. In terms of a network of performance D’s role is complementary to that of E: D ensures they deliver all that is needed to the engineer in terms of “the

sound". Indeed, D elsewhere expresses impatience with "the nuance of sound" (although they are aware others do not agree with this) which they see as "missing the point". However, they are keenly aware that their gateway into this role is a result of both musicality and technology. They talk about being "slightly obsessed" with Apple and the MIDI environment, and part of their skill set is to be able to set up a system so that "one small event happens and all of this can happen as a consequence". Once again STEM-like skills of problem solving and especially prediction seem to be at the heart of this relationship with the non-human actors involved, and are perceived by the participants as part of what brings them credibility – and therefore enables them to earn a living. However, for both of them those skills are directed towards aesthetic ends of "good music" or "good sound".

This separation of considerations is not always the case even with the participants above. Indeed, although D states their goals to be musical and fears "…the technical driving the musical instead of vice versa", they also talk of "becoming obsessional" about (music software) eMagic Logic and it being an "amazing toy". There is a sense in which D's concerns about music technology echo Adams and Thompson's over NVivo – there are to him some genuinely problematic pitfalls which challenge their conception of their role and maybe even their identity, but it is far too useful a tool to ignore, and also opens up previously unavailable possibilities ("making that music performable").

A perhaps paradigmatic example of opening possibilities is H's account. H works in a niche role as a "live sound designer" for avant-garde dance and theatre productions.

> "…my practice is really engaged with the technology as a medium. And part of that is because ……It's like an instrument is a tool, but it also is more than a tool."

H's starting position was an interest in the voice and how it can be manipulated live, and has led to the construction of custom hardware and software to enable him to create improvisational sound design:

> "For instance, I'm like, I can't use words, I'm just doing utterances. I'm just going like blehblehblehblehbleh, whatever. And I've programmed the joystick, you know, with, with audio programming to affect my voice in this specific way".

For H this engagement (and some ambivalence) towards technology is not just a tool but an *object of concern* (In Latourian terms) with which they engage, critique, and ultimately achieve agency through technological process itself.

> "I'm kind of giving myself agency within this kind of function, but that's the only thing that I can work in……part of the theatre shows which I'm involved with which tend to be kind of environmental theatre shows, this idea of technology as both kind of evil, you know, like Elon Musk-y sort of, like a like dominant kind of capitalist hegemonical kind of thing, and then the side of technology that's like…but it allows everyone to connect to each other. And so I guess I'm kind of interested by how I can use tools that are in some way elitist and academic in a way that is actually quite chaotic and grassroots-y and performance arty, and then also the other way around, like how can I bring performance artsy stuff and kind of chaotic stuff into theatre and concert music and kind of elitist art forms."

It is for example important to H that they do not just buy new "stuff" but repurpose obsolete hardware, both because it ties in with their environmental concerns but also as a kind of joy and artistic goal in itself:

> "I think I quite like the idea of reusing old stuff as well, like old, old technology. I think both for an environmental kind of stuff, but also just because there's something fun about it, about kind of using this stuff that's from some game that wouldn't run on any machines now……the controllers are still around and like I quite like the idea of instead of them just kind of ending up in a museum or in landfill or something, them being used to still to create something new."

This engagement with technology for its own sake forms a regular theme for many participants:

> "My favourite Christmas present I ever got ever was from my nan. She bought me a tool kit. And in there she bought me like a soldering iron. So all these little tools and craft knives and then all of these tweezers and bulbs, loads of batteries, bits of wiring. Solder, some motors just basically just made this entire tool kit." (F)

> “It's all miraculous to me really. How a little bit of, you know how a speaker……so getting something going from a SM57 [a type of microphone] to a speaker, and it sounds like the real…wow. Yeah. It's a wonder, isn't it?” (O)

> “I kind of had the time and the opportunity to kind of engage with more hardware synthesis and modular systems, just to stop myself from going completely insane” (M)

> “And these people were doing like very, very precise, like experiments and really precise things. And I just like, I love that idea of hearing something that doesn't exist and you make something that doesn't exist and you give it meaning through form.” (H)

This is not necessarily always foregrounded. Q works with immersive sound and part of their role is to induct other producers – who may be highly competent in stereo sound and have their own aesthetic programme – into how immersive sound works (“I do typically first projects basically, with notable artists, producers and everyone in between, to show them”). One might imagine therefore that their role is highly technical – to show producers how to set up a system then hand over to them – and indeed that is partly the case. Immersive sound mixing systems are an incredibly complex technical setup involving precise placement of speakers, several layers of sound handling software, and an in depth understanding of rendering formats. To Q however all this complexity has only one function: to render immersive mixing transparent as a process. It is clear from the interview (where they discuss Atmos, surround sound, stereo sound, the limitations of each, various soundbars and how they virtualise and so forth) that they are deeply technically informed, but to them

> “it's really, really easy. It's in the box. You toggle something to an object, you have a panner and you put it where you want it to be or you make it move in the way that you want it to move.”

They regard a large part of their work as “thinking about sound”. For someone like this, who has absorbed their technological environment in the sense that Sennett suggests a craftsman has their skill, they no longer need to think about the mechanics but are able to play with (and potentially repurpose) that environment. In this way the actor-network of Q and their studio are able to offer affordances – types of connection – to less technical musicians and composers.

This craftsmanlike way of repeating a procedure or using a piece of equipment can be seen in ANT terms as strengthening the connection between a human and a non-human actor (or actors) until they are able to be mobilised together as an actor-network. F discusses this in an educational context:

> "You know, every drum kit sounds differently. Only slightly tuning the drums to sounds different, you know…and then once you've done it 20 times, you start going, oh, yeah, yeah, that's the mistake I keep making. And that's why I have to keep EQing that kick so much. I suppose it's repetition…you get it all the time on telly, don't you? You're watching like Bake Off. Some of them that win go 'well I had to make 50 croissants before I got to this one that actually works'."

An interesting aspect here is that this procedure – micing and EQing drums – is *not* the same each time (EQ or equalisation is the boosting and cutting of various audio frequencies in a signal and a critical part of music production). This recalls critical incident 2 in chapter 1, but with an emphasis on task repetition – training the hand – as well as understanding principles of EQ. Indeed, the two are linked. J makes the same point

> "there's also a huge amount of factors…for example, what room are you in? What's the drum itself? What's the beater that's on it? Who's playing it? What mics have you got? … that's going to impact because you could have multiple different hits of a kick drum, with all those different factors, and the EQ will be different to make every one sound good."

This therefore demands that an aspiring producer learns not just an overall theoretical and technical knowledge but also the kind of flexibility and attention to the individual case that I identified in chapter 2 with Dunne's (1997) explication of "the *techné* of the Kairos" and which I am here recasting as the mobilisation of a human actor – the "producer" – whose "produceriness" exists in relation to the things and activities she is connected with, that is her software, her microphones, the drumkit, her relations with the human actors and their instruments, her actions as a recording or mix engineer and so forth. The analogy is with the "teacheriness" discussed by Fenwick and Edwards (2010, p17). Her ease of operation of, and practical understanding of the equipment in use, that is her connections with the non-human actors most closely connected to her in her role as producer, will form a key part of her ability to connect to a wider network of clients, collaborators, and sources of credibility, that is to mobilise.

C describes this in a different situation in a multilayered account of collaboration with another artist. They describe a software session being sent backwards and forwards with production and composition tweaks being made at both ends. In both these cases the other parties involved may not care about the details of production (as F points out "musicians don't usually have a favourite compressor"), but the actor-network that is "the producer" needs to be sensitive to genre and "the song". By this I do not just mean the human actor that is the affordance of the "producer" actor-network. Different genres, songs and clients might also demand different pieces of equipment (both in the sense that a client might have their own view of good practice and demand, for example, tape recording, or that a particular audio compressor might "work better" than another for a desired result, so even though a musician may not have a favourite compressor they will notice the difference in sound) so the whole network of human and non-human actors will be affected. The skilled navigation of this sea of possibilities and its accompanying manifold of relations with non-human actors is therefore a requirement for someone to mobilise as "a producer".

5.2.3: Democracy and Agency

"I make beats in bed and I don't need nobody else/I don't need your fancy studio, I'll do this shit myself" (Ghost Piss, 2020)

I would like to return to the metaphor of technology "opening doorways". I have discussed this in the context of gatekeeping (above) in connection with specific technical skills, but what I wish to address here is slightly different: the use of technological developments and their engagement with human actors to open up conceptual opportunities where they did not previously exist. An example might be H's use of technology (hacking controllers, programming patches, and physically building or altering controllers and devices) to create a role (improvisational live sound designer/technician) which might not have even existed previously, or to create their own pathways. For example, J states:

> "Maybe 20, 25 years (ago) if you couldn't play an instrument, music was quite a closed off thing. You couldn't really create music. You would either a musician, an instrumentalist or you were a recording engineer. And now, thanks to technology and digital audio workstations becoming more creative…you can have people that are fantastic producers and creators of music, media, whatever……pieces of work with incredible technical skill, but who actually can't read music or can't play in a traditional sense".

This perception of accessibility via technology was mentioned by almost every single one of my participants if asked to speak about their hopes and fears for the future.

> "You can just make things on your phone, you can make a whole album and record all the videos and edit it and everything on your phone. And I think that's great that's available to people" (A).

> "Suddenly my, my world opened up to me because I didn't have to be able to play drums. There was drum sounds that you could just program in……[it] made me want to write much more stuff using all the other sounds……yeah. It's limitless, isn't it, really?" (B).

Both B and A are, as it turns out, capable musicians in the traditional sense, but both found themselves able to expand artistically by the use of initially quite basic technology (in fact B claims not to be technologically adept: "'busses' - I don't even know what they are").

Q speaks of a similar moment of realisation:

> "we were both producing this death metal record and then hearing that back and just how, in my opinion, how awesome it sounded, I was just like, oh man, yeah, we can do this. This is amazing."

This kind of democratisation of accessibility therefore opens up the possibility that producers will be able to bypass at least some gatekeeping and find alternative routes to meet their aesthetic goals. However, this also raised fears amongst some of them that the hard-won agency they *had already gained* might be obsolesced by the deprecation of their skill sets in the manner that Groten (2020) argues that the sample obsolesces traditional musicianship:

> "I simultaneously love and loathe the fact that the technology around music production is so accessible and let me kind of expand a little bit. It genuinely is a big thing, so the fact that I can now produce stuff on my laptop and arguably create something that you can hear on radio……[but] everybody's doing it, and it makes the competition so much greater so being able to be heard because you got a million and one people in bedrooms doing what I do all trying to be heard, all producing this incredible sounding stuff in theory." (C)

For these creators, technological objects are therefore not only ways into networks of employment where they need to present affordances to gatekeepers, but partners in expanding their own artistic networks enabling them to produce recordings and obtain gigs or other opportunities. In network terms they are able to leverage technology to get other people to do things such as book them for shows or offer recording contracts. The distinction here is nuanced as promoters and label representatives are of course gatekeepers in their own networks, and as noted above the democratising effect of technology may paradoxically create additional barriers. Furthermore, as discussed in the introduction, it seems easy in ANT analysis to fall into a language of utilitarianism – networks "make actors do things" – in a way which may not be what Latour intended. On p63 (2007) he warns us that ANT is not an expression of the "market spirit" (but rather may be of use in explaining various inequalities). The matters of concern to creators like B and A are *not* necessarily primarily commercial (obtaining deals, playing gigs) but aesthetic. A gig is not just – or even primarily – a commercial event generating profit, but an aesthetic experience for both artist and audience. A record deal is not just a commercial transaction, but also a source of artistic validation and an opportunity to be heard. Therefore, for these creators an aesthetic impulse is mediated via a piece of technology into an expression of that impulse – an audio file, maybe, or a performance – that in turn as a non-human actor possesses its own momentum. There is a great deal more to say about this aesthetic extension of musical/technological actor-networks which I will address in the following section. However in both these cases, what technology offers them can be seen both in terms of more connectivity (<B plus laptop plus bass guitar plus software> is able to extend into more areas than just <B plus bass guitar>) and more complete mobilisation as representatives of their network (<A plus controller plus software> has autonomy and mobility that <A plus other musicians plus producer> would not). These are therefore the kind of considerations that make up the sort of agency discussed in section 2.5 of chapter 2 ("Sound and Subversion").

5.3: Theme 2 (Aesthetic Mobilisation): "They're Making Art!" – Aesthetics, Enrolment, and Interessement

> "It's aesthetics that we're doing a lot of the time when we're, we're messing around with frequencies and dynamics of sounds to get them to aesthetically blend. And yeah, it is art. There's art in every element, every choice, every decision." (F)

It is no surprise that technical and craft elements of production are only half the story. After all the concern of this thesis is the relationship between STEM-like technical skill – "the numbers and the

letters and the frequencies and all of those kinds of things" in F's words – and creativity. How do these two elements interact? F themselves has an ambiguous view. On the one hand

> "your ideal student kind of, and the ideal person in this field, is somebody that kind of has a foot in both camps……they appreciate and understand technology and science and engineering and what all the numbers mean. But at the same time, they need to have a good creative brain and also be interested in art and, and, and music as an art form"

but on the other, many students lean toward one end or the other and are still able to progress. Nonetheless to F "engineers and mix engineers, people that set up mics and arrangers, they all need to be sensitive to the song" in a way that musical artists do not necessarily have to be to the details of production. And this sensitivity in fact extends beyond music:

> "That sort of standard sort of Radio Four presenter voice…….that tone, the silky tone and the dynamics are just perfect. So, you know, it can send you off to sleep quite nicely as they read the shipping forecast. And just recording a voice in that way to get that tonally perfect is very artistic. It's an aesthetical thing."

This section will discuss the role of aesthetics and creativity in the mobilisation of a musikarbeiter.

Some of the clearest examples come from those of my participants who are musical artists as well as producers, educators, or any other role. By this I mean that they are, or have been in the past, involved in the release, performance or composition of original material. I will interpret the term "musical artist" quite broadly (so H as a live improviser, even though they are not making music, or K's past role as a remixer, even though they did not create the original song, would be included for example). My reading of Dewey (2005), Demers (2015) and Toop (2019) in chapter 2 led me to expect that the most important element of aesthetic experience is irreducibly non-verbal, and indeed some of the participants seem to struggle to put their aesthetic process into words.

> "I don't sort of remember how I've done it because I can, because it just comes out so quickly. I, I wouldn't be able to recreate a lot of the stuff because. Because there's been no planning involved." (B)

> “You get into this kind of Zen state where you're - you're not really aware that you're there, but the music becomes the real focal point.” (G)

Indeed, B’s creative flow is not always something they feel in control of:

> “It's not a choice. I don't think it's……it's just there in in me. Anyway, I. I want to turn it off sometimes cause it does my head in. I'll create all day long, If I could.”

It is nonetheless clear that however hard they are to articulate, these aesthetic considerations are important to this group when they look to extend their networks or are enrolled into other networks. In this sense gatekeeping works both ways: they will resist enrolment into networks where they perceive aesthetic differences and actively seek it where there is aesthetic convergence. B again:

> “I joined my first band, and (remember) how excited I felt by jamming with them. I basically went to three days of practice in a caravan in the middle of the countryside, and I'd heard their demo tape and I loved it. I absolutely loved it. And I remember saying to my mum and dad, like, this band are going to be…going to get somewhere. Might not be huge, but I just knew that they were going to be brilliant and…. There's something in the music that sort of speaks to you”

Although it is extremely hard to pin down what makes something “good” (and indeed educators such as F and K talk about how students often want a formula “but there is no formula”), there are principles and concerns behind the immediate creative flow that participants *are* more able to discuss. These elements and workflows form the scaffolding, or in ANT terms the web of connections, that enable someone to be mobilised as a musical artist. A, for example, returned frequently to a key principle for them that they describe as “beginner’s spirit”. They summarise this in a David Bowie quote:

> “One of my favourite quotes……Always step outside of your comfort zone so that if you feel that you're in water on your feet, some just barely touching the bottom, then that's where you're more likely to make something exciting.”.

This is a recurring theme in A's interview, and they even attribute it as a reason for changing DAW (DAW stands for Digital Audio Workstation and is an overarching term for software products which can record and sequence music and other audio):

> "I think the beginner's spirit is always interesting and I think that's why I chose to switch DAWs as well, because I think there was something interesting to be said and achieved if you don't really know what you're doing".

DAWs are expensive and complex to learn, and switching is not a trivial matter, but "beginner's spirit" is such an important consideration for A that they were prepared to accept other penalties such as delayed releases:

> "I wrote my…the EP that I released last year on Ableton (music software), and writing that EP took about six months. And even that was only four songs. And the reason it took so long was because I didn't understand the DAW".

At one point for them a complete technical understanding is equated with a creative limitation because it seems there is nowhere else to go:

> "I felt…limited by Logic (music software) because I understood it and I wanted to use something that I didn't understand at all that opened up and I thought, what the hell is this".

For A therefore engaging with new technical processes is a way to unlock aesthetic creativity.

Not knowing things, being unfamiliar with rules, is something that A sometimes has in common with D (although in other ways their approaches are very different). D describes it as an expression of punk:

> "I was too impatient as well to get musical ideas out there and kind of realized than to spend time worrying about what a knee on a compressor does. I think it's partly driven by the kind of music I was listening to as a teenager, you know, scratchy bands on John Peel who for whom the expression of their…of their art was more important than sheen that it had".

D's impatience with "nuance of sound" noted above is revealed as in fact an aesthetic position, intertwined with an appreciation of an anti-production artistic stance borne out of happenstance (the bands they like would, simply, not have had the time or money for more sophisticated production "sheen").

The notion of beginner's spirit or cleaving to punk production values ties in with a wider concern with artistic constraint. Pushing or rubbing up against constraints is another way that some music artists fruitfully interact with the non-human actors in their environment. These constraints may be self-imposed (for example in the case of A) as a deliberate part of the process, or may be a result of financial or other decisions made previously. G for example describes a "jarring element" between their creative ambitions and the limitations of the technology to hand but believes this to be sometimes a good thing:

> "You know, it's kind of…sometimes you can have a very basic bit of gear and you can get amazing things out of it. And I think that's really the trick is sort of, you know, kind of coming at it, using your human sense of error… and not being afraid that sometimes you're bound by those things and bound by the budget that you have".

In fact, for G people who "obsess too much with gear" are

> "missing the point…those people often make great sounding records sometimes or produce great sounding records."

There is nuance here in the interview: "Those people" make "great *sounding*" records but not necessarily great *records*. D similarly discusses how it is "It's very easy to make things sound superficially good ..... that passes for great music." This does not however mean that D and G are not technically engaged, or even that they do not strongly connect with specific non-human actors (the Korg Electribe in G's case and the Logic Environment View in D's) as will be discussed below (section 5.4). In spite of some similarities, they react creatively to their technological partners in slightly different ways: G is less likely to regard their device as just a tool than D is.

Lack of constraint can be paralysing:

> "You go what do you want to do? What inspires you?...they're just kind of stood at the junction of a thousand roads…and they just freeze". (F)

C (in a similar way to A's "beginner's spirit") even discusses setting deliberate constraints as a source of artistic engagement:

> "When I play live, I have kind of customised setup of controllers and all that kind of stuff…... I know when I hit this key on this keyboard, it'll do this thing, [but] the fun bit is where do I take this next. So the next gig, I'll go, well I'll try something different. I always try and bring something different to every single set I play, to keep things interesting for me and to keep the things interesting for the…Jack White said something similar where if you're playing keyboards, and you can get from the guitar to the keyboard [in] two steps, put the keyboard three steps away, just to give yourself that bit of a challenge to make things a bit more interesting."

It is clear from all my participants that aesthetic engagement is a vital part of the mobilisation process. As H says "I just…just loved music". However, it is also the case that technical process and aesthetic outcome are often linked in the way described in critical incident 1 of chapter 1. G's music sounds as it does because they use a specific device. H's artistic process is melded to their technological one. A specifically embraced new software and hardware because they wanted a different kind of outcome from their previous work. These participants display an awareness of both the kind of mediation that I discussed in connection with Benjamin (2008) and Latour (2007) in chapter 2, and of its potential.

Once embedded in a music technological network, some interviewees felt aesthetic creativity was less important (for example, E's statement that they have "lost their creativity", or P discussing that a great deal of their sound design work is via use of libraries rather than recording or creating sounds), but all of them came into their networks via an element of aesthetic recruitment. E and J discuss their instrument playing. F talks about playing around with tape recorders, making "radio shows" as a child, forming a band at an early age. K talks about being on the fringe of the 1990s UK electronic scene and wanting to get involved creatively. C discusses a deep engagement with local music making, starting as a guitar player. It is not just a matter of specific music making skills, but also critical engagement: an identification with the values of Punk in D's case, or B's statement that "There's something in the music that sort of speaks to you". O talks poetically about discussing John Cage with their students:

“The prepared piano…… making the altered sounds is like walking along the beach choosing particular shells”. Their students also engage on an aesthetic and critical level first of all:

> “they're quite serious about making pop music and they and they're quite clear that it is intended to have artistic merit.”

Finally, J discusses how an engagement with sound as an audience member is potentially a creative act, in a way which recalls LaBelle (2018) on listening as liberatory:

> “[in 40 Part Motet by Janet Cardiff] actually she hasn't written the music, it's 40 speakers…… And each speaker is one singer coming out of the speaker. And it's Thomas Tallis. It's a religious piece of music that's for 40 singers. It's an interesting one because what happens is if you were if it was a choir singing it, you wouldn't go up and put your ear right at the speaker. But because it's these speakers, people do that. Or when I went to see it, I saw at the Tate Modern and the tanks in the new building and the speakers were on a circle and everybody was in the middle of the circle. But then I wanted to listen to what was going on outside the ring of the speakers. And it's the same thing, someone's had an idea, they've not written the music. They've not performed the music, but they've had an interesting idea as to the way that they wanted to record it for an experience”.

5.4: Theme 3 (Non-Human Actors): The Joy of Tech

If aesthetic engagement provides an entry point for enrolment, non-human actors open (or consist of) paths. The above example shows how a deeply technologically engaged set up (40 speakers) provides an entry point for active creative engagement. O discusses how active *technological* listening opens up a pathway for students to achieve their aesthetic goals:

> “That means listening to the world and that... feeding that into what you [are] then creating. That means listening technically, so. Oh, it's…that's a funny noise. That's what overloading sounds like. Oh, that's a funny noise. I That's because it's too bassy. Oh, that's weird. Why does it sound weird in here? And it sounded alright on my headphones. Oh, okay. So that's about your monitoring and etc, etc….”

Similarly, J discusses a sudden moment of aural engagement with students resulting from their first experience with binaural recording (binaural recording uses a model of the human head as a recording device to create very precise illusions of position in sound - Ouzounian, 2020):

> "One of the bits of equipment that we've just recently got [is] the Neumann binaural, the heads, and you try and explain to students how with basically a stereo pair of microphones i.e. our ears, we can judge where things are…I sent a student out with a pair of headphones on that was obviously tied into the feed…I just had two buckets of water, I just stood in the room and I just poured the water or moved around…they can tell you exactly where you were…It's like it was just a great experience. The other one that freaked the students…the head was facing the student…I'm standing behind the head, but I'm technically standing in front of the student…they're listening to the mic and I start talking……it's like they really freaked out (because the sound seemed to be coming from behind them although they could see it was in front of them). Then they would look around to see what it was. And it's like the brain was going, 'this can't be right'".

This idea of technology providing entry points – opportunities for enrolment and interessement – is shared by many of the participants. Firstly, an understanding of a piece of technology can lock an actor into a role in a network. In many respects E's account is an example of how this can happen. At the beginning of their career, their musical training seemed the most important thing to them. At school they "failed everything…apart from I had an O-level in music grade A". However, this never led to a performance career. Instead, their aesthetic interest in music helped to win a high grade 'O' level, which helped with a job in a music shop, which led to working as a guitar technician for a well-known musician, which led to an interest in sound equipment, which led to their current live sound business as well as their role in education as a technician. By this stage E has been fully mobilised into an engineering role.

This would not have been possible without an array of non-human actors. An electric guitar is a surprisingly complex and delicate piece of equipment to set up and someone who has a link with it can find it solidified. E discusses how a specific guitar was key to their enrolment into the "guitar technician" position:

> "In the first year we were approached by [band's guitarist] at the time because he liked the look of the guitars, which was a brand called Shadow…and he came along and he wanted to

> try them out. So I basically set up a load of guitars, about six different guitars, all with crazy colours…that I thought that he might like….And so I ended up working for [band] for a year. That was a big turning point for me"

In E's account they "didn't really know what they were doing" at first but their experience with this specific musician cemented their place in the network of a touring rock band.

Something that is quite striking about participants' relationship with technology is that they often form ties with specific pieces of equipment. In the same way that the human actors they form ties with are not necessarily interchangeable, neither are the non-human actors. So, while an important part of E's role is to be able to operate almost any sound desk at short notice (as they discuss), in practice they refer to specific models (Behringer X32, the near identical in operation Midas M32, Soundcraft SI series). However they also express that part of the key to their facility with these systems is the technical underpinning provided by experience with older less flexible systems: "But I wouldn't have been able to, if I hadn't known about analogue equipment, I don't think".

P discusses a similar relationship with technology. Their primary source of income is their work with a large music software company which I am anonymising here as "Calade". The entry point for enrolment was an internship offered to students, which they had to compete for, and a prerequisite was knowledge of specific software, which I have anonymised as "Audinal". The role of this software as non-human actor is not simple. P originally intended to be a "producer" as an aesthetic but quite vaguely defined goal. Their engagement with the software was not initially motivated by a desire for interessement in the Calade actor-network, since this was not a possibility that they were aware of, but rather by an understanding that this software is used throughout the industry in a variety of places and would give them the opportunity to offer a "human affordance" (in my earlier coinage). They were not therefore made to learn it by the specific network of employment within Calade, but it is also the case that a *larger* Calade-related network of recording studios who use the software, salespeople and support staff who have caused those studios to prioritise that software, developers who keep it up to date and ensure it offers unique affordances, and recording engineers and audio technicians who have become used to it and don't want to change, exists, and that this network *did* make P learn the software in order to pass a more general gateway of "working in the industry". The situation becomes more complex because although a large part of P's work involves deep knowledge of Audinal it was not on its own enough – the original internship was in customer support and an accidental affordance provided by P's part time work in a call centre proved decisive.

I do not wish to over exaggerate this final factor. Many people could equally have applied with call centre experience but none of them would have even reached interview without the software qualifications P had gained. I have already discussed P's statements on credibility as a means of enrolment and in their case this credibility was enhanced by technical knowledge of Audinal, as well as their mobilisation in the in-company Calade network both as a trusted expert and as a mentee, which allowed them to find further work on film sound stages and as a freelance sound designer. In their role on film sets they discussed a related piece of hardware technology, anonymised as "Connect A". This is the non-human actor that is "part of the culture", which would get people laughed at if they were unfamiliar with it.

Connect A was (it has since been superseded by its successor, Connect B) also Calade-made and integrates "seamlessly" with Audinal. Its role was (perhaps fittingly in an ANT inflected analysis) to join together – to literally network – other pieces of audio and video hardware, and ensure the various clocks that they use for timing and triggering events stay synchronised. Again, it is clear that P's prior mobilisation as part of the Calade actor-network and subsequent familiarity with the company's hardware and software allowed them to offer (among other things) the affordance of *Connect A compatibility* which enabled them to find work as a mix technician and subsequently as a sound designer. It is noticeable that other knowledge of similar software and hardware would not have substituted. It is the Connect A, which is locked into Audinal software (its full name is "Audinal Connect A") not a similar product made by another manufacturer, that was "part of the culture".

Other participants have equally strong connections to particular types of non-human actor. D discusses at some length the linked pieces of software Mainstage and the Logic Environment View. Mainstage is essentially performance software that enables (typically) a keyboard player to change sounds, trigger loops, or bring in various effects via key presses (Apple Computer, no date [1]). Mainstage is a key tool for D which they conceptualise as something that can *make a chain of musical consequences happen:*

> "Mainstage just gives you a lot more just a load of flexibility…..You know what happens……if you press note B flat and what might actually emerge as a consequence of that".

D is here articulating a procedural *techné* of the type mentioned in chapter 2 – "we wish to create a system that we would expect to behave in a certain way" – but they have used their software to *build*

that system in an act of creative engineering which has at the same time granted them agency – they are in full control of what will happen if they press the note B flat.

Perhaps even more important to D is another digital object, the Logic Environment View. This is a kind of virtual network in which they can lay out the web of connections necessary to make their setup work.

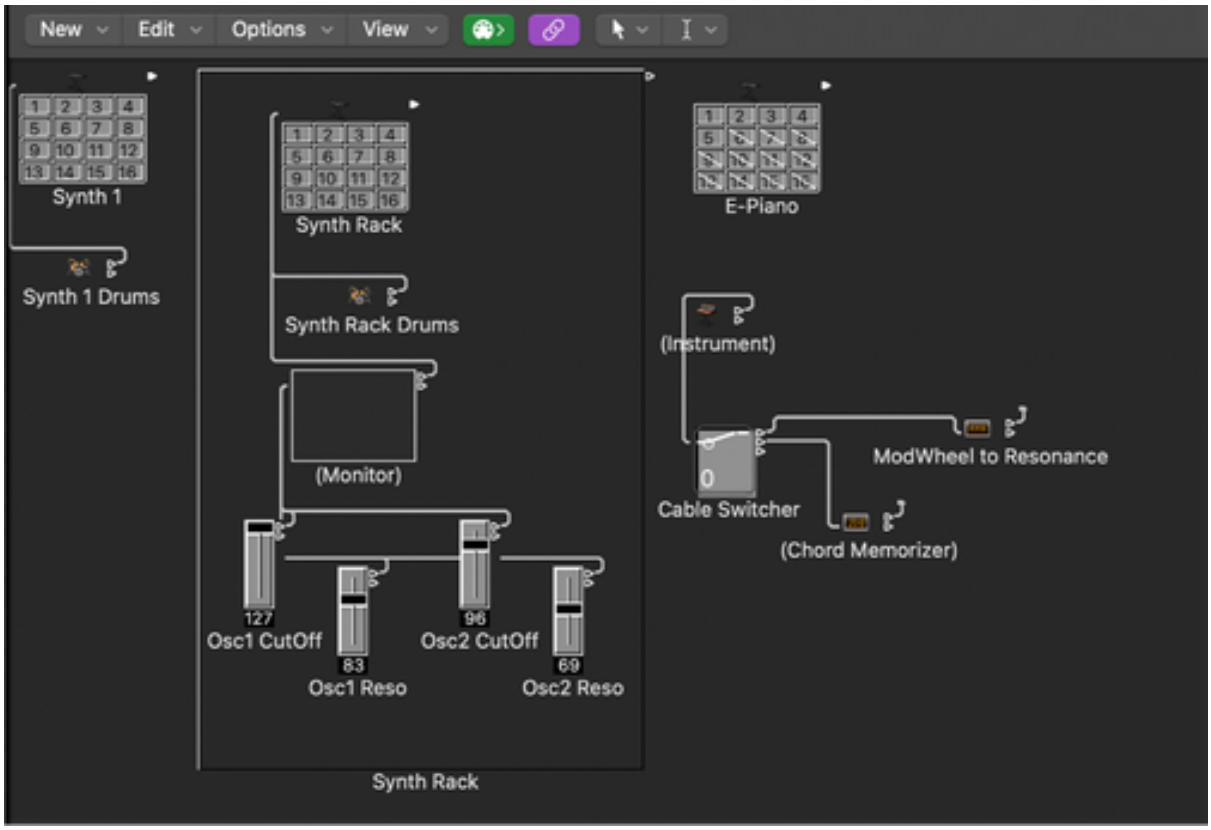

Figure 5.1: The Logic Environment View.

Image from Apple Computer (no date [2])

According to D, if Apple were to deprecate the environment view it would be "a disaster" for their practice, as their work with the band that they act as musical director for is dependent on it.

> "So yeah, with that band, it's all it's all happens via Logic and it still happens via the environment. I get the feeling that Logic are trying to kind of phase out the environment, which for me would be a kind of disaster for various reasons".

This particular aspect of their practice is therefore entirely tied up with this particular non-human actor. If it were to fail it would be a disaster not so much because there are no possible substitutes,

but more because of the accreted legacy files and setups they have accumulated which would need to be replaced by something done in an entirely new and unfamiliar way for them to regain the agency they would lose, and which is now revealed as constituted in a network consisting of Apple as well as the performers, venues and so forth which they are immediately linked to. I have discussed in the case of A the complexity of changing DAW, something that A was prepared to accept or even embrace for creative reasons. D, though, although they "like solving problems" (and would be fully capable of making the transition) does not relish the prospect of re-solving highly complex problems they have already solved previously.

This can be considered an example of "lock-in" between a human and non-human actor. On the one hand it creates a very stable connection and might provide an excellent example of the use of non-human actors to stabilise a network that is at the root of ANT. In the case of D, it is unlikely that another person, even if they were capable of assuming their musical role, would also have the understanding of this specific setup required to be able to fluently operate it. D's role is therefore stabilised. However, it also raises the question of what might happen when a non-human actor is deprecated and not replaced. In the case of P and Connect A, the successor hardware, Connect B, seamlessly slotted into its place in the network because it did essentially the same thing, and a non-specialist might struggle to tell the difference. But if the environment view were deprecated by Apple, D would either be tied to increasingly obsolete software meaning they as an actor-network would, over time, be able to offer fewer and fewer affordances; or part of their network would essentially collapse and need to be reconfigured in some as yet undiscovered way.

I have already discussed E's account of how a general knowledge of "sound desks" gained from analogue models and a basic understanding of how they work enable them to operate unfamiliar equipment on short notice. E is therefore *not* "locked in" to specific hardware. A middle case is G's experience as a music creator, which is tied to a specific piece of equipment, the Korg Electribe (Korg, no date). Electribe is a name given to a line of Korg "grooveboxes". A groovebox can be used to create or perform electronic music without needing to use a computer. In G's case they use a recent variant, the Electribe ESX-2. I have already discussed how G's understanding that the possibilities *and limitations* of this piece of equipment mould their production aesthetic, but it is also clear from the interview how much of their music making practice depends on this one tool. Although they do use computers this is typically just as a recording device, a digital version of a multitrack tape recorder, rather than for sequencing. It would not be so catastrophic for G if the Electribe were to cease to exist as it would for D if the environment view would be deprecated, as other grooveboxes from both Korg

and other manufacturers are readily available, but again, there is a significant amount of stored music and presets that would need to be either reformatted/recreated in a new device or abandoned.

Perhaps the ultimate expression of specific pieces of hardware for creation comes from M. M has a deep engagement with modular synthesis. Modular synthesizers are usually custom-built instruments created by buying and assembling “modules” which are single purpose units (oscillators, envelope generators and so on) made by a range of manufacturers but with a common connection standard and, typically, form factor (the most widely used of which is a standard called “Eurorack”) (James 2013).

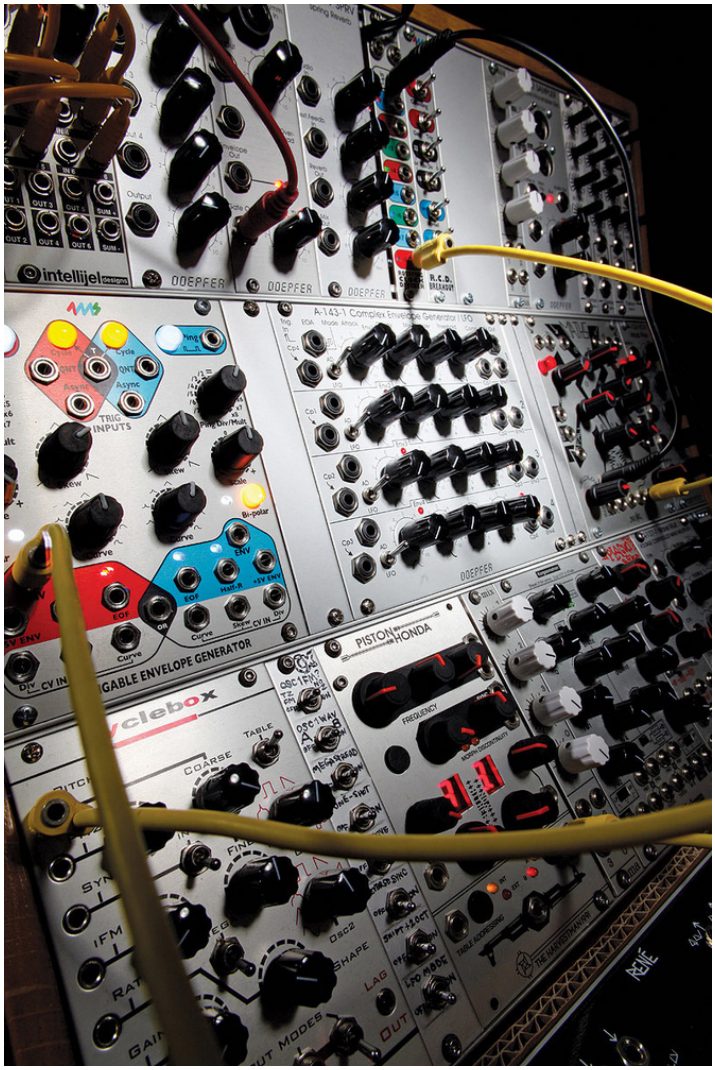

Figure 5.2: A medium sized modular synthesizer

Image from James (2013)

M describes their modular synthesizer as a single purpose unit meant to do a specific thing:

> "I built this and I designed it to do this one thing, which is generative kind of different sounds and like rhythms that I can kind of wind up or wind back, live, using pedals".

To M, as it is to H, pushing and customising the technology is part of the creative act, and even more than H (whose hacked controllers are quite flexible) building and using *this* modular synthesiser is a gateway to specific types of performance, while at the same time knowledge of *modular synthesizers in general* provides as yet unknown gateways into other options within creative technicality:

> "Okay, you've got on and off or you've got movement. And then…those two things are going to affect everything else on here. But what does it do? It again doesn't matter. I think the thing I've always really enjoyed about it is it is an exploratory thing".

M is able to avoid most of the disadvantages of lock-in in spite of the specificity of his modular synthesizer, as he built and configured it initially, and would be able to do so again if he wished. He shares with H a kind of meta-knowledge of how to create his own tools and in both cases, even though those tools are extremely specific and not readily exchangeable with other devices, they would be able to re-create them if necessary. Although D's use of the Logic Environment View to create setups is also a meta-knowledge in the sense that he uses it to build things rather than as a fixed entity, it is dependent on one specific piece of software which is subject to the whims of its manufacturer, whereas in M's case the whole of the Eurorack synthesizer standard, which is supported by multiple hardware manufacturers, would have to somehow cease to exist, and furthermore his existing hardware would need to malfunction, before he was caught in the same sort of disaster. The Eurorack network, then, is a much more stable one than the Environment View precisely because it has so many participants, both human and non-human, who rely on it and have a vested interest in its maintenance.

On the one hand, therefore, it seems that specific instances of mobilisation in specific networks use very definite non-human actors. Without these specific actors things would have been different. The networks might (or might not) have ended up in similar states but the meshwork – the version of a network discussed in Adams and Thompson (2016) that takes into account movement through time – would have been very different and different actors might have been enrolled. However, there is also a sense in which some of these non-human actors are substitutable. The Connect A was superseded by the Connect B without complication. G could find a substitute groovebox, although it would involve

some work. M's modular synthesizer exists in a more or less continuous state of evolution and modification. And the degree of substitutability depends on the degree of flexibility of other human actors (technical adaptability, meta-knowledge of the type shown by M) and non-human actors (in terms of ease of interface, for example Audinal working with Connect B in the same way as with Connect A; and the amount and ease of transfer of accreted projects such as sequences, DAW sessions or environment view setups). Part of what it means to mobilise as a Musikarbeiter is both to engage to a high degree with specific equipment, and to be able to adapt to new non-human actors in the manner of A to a new DAW or E moving from analogue to digital mixing desks. Ultimately D would need to adapt or lose their role if the Environment View were deprecated.

I have mostly considered non-human actors as tools but there is another category, that of product. I do not wish to solely use this term in the commercial sense of "bringing a product to market" but all of this engagement with people and things has the goal of creating sound in some form whether that be a live performance, a recording of a song which could then be played, or a soundtrack for a moving image. For recordings this is concretised as a "deliverable" which is almost always a digital audio file or set of audio files. In terms of live performance musicians and sound engineers also have things they need to provide: an electronic musician in performance, for example, needs to typically provide musical material encoded into a real time analogue signal, normally on a line level or XLR cable, to be converted into audio. The sound engineer needs to be able to pick this up, transfer it through the sound desk, and turn the electrical signal into audio in a way that engages an audience (by adjusting levels and applying EQ and compression where necessary, for example). This is expected to happen seamlessly and is helped to do so by the affordances of the equipment – for example the digital to analogue converters built into audio interfaces mean that musicians onstage do not have to think about the technical steps between the digital environment of their laptops and the analogue audio cables running to the sound desk, unless something goes wrong. The "deliverable" for live musicians and sound engineers is ultimately an aesthetically engaging live performance.

This ability to assume connections and specifications is not necessarily mirrored in recorded deliverables which often have to be strictly formatted. Apple Computer (2021) for example specifies a range of software tools to enable engineers to deliver audio files to the "Apple Digital Masters" standard, for example specifying PCM (Pulse Code Modulation) files initially recorded at minimum 24 bit depth, an aspect of analogue to digital conversion that a live performer might not be (or need to be) aware of. Deliverables are either specified by an actor in a connected network or as an accepted "industry standard" (in other words something that a large number of other networks also adhere to).

Deliverables are also directly affected by other non-human actors – the technical constraints of vinyl affecting the track order on a master tape or collection of audio files sent to a pressing plant that were discussed in chapter 2 are an example of this. Deliverables not only need to be correctly formatted but to meet a sometimes changing aesthetic standard ("then it would come back like two weeks later and say, oh no, [director] wants to change this now").

The creation of deliverables are therefore instances of other actor-networks *making producers do things* before translation of products between these networks can be accomplished. Deliverables can be highly complex: consider for example the list of deliverables for a film project in Hilton (2014). A large number of these deliverables are audio related (and in several cases the deliverable is in several parts, for example "each of 4 reels - 5.1 sfx/Foley/production M&E fully loaded mix for the reel" is in fact four separate mix files each of which is constituted from six separate audio files). Each of these deliverables in turn will have complex formatting expectations both in terms of digital format (as for the Apple masters) and loudness requirements, which may vary according to different national standards and for whether a file is for cinema or television (Simple DCP, No Date). In this way we can conceptualise a musikarbeiter's role as the production or modification of a non-human actor ("the deliverable") in such a way as it will offer affordances to wider networks of further production and distribution.

5.5: Theme 4 (Educators and Educating): Delivering the Musikarbeiter

As I have noted in the introduction to this chapter, educators often play a key role in the enrolment, interessement and mobilisation of musikarbeiter. We stand at the gates but our role is not to be gatekeepers in an exclusionary sense: instead we wish our students to succeed and go on to work in the industry in some way. Our success in these goals is measured in Further Education by a variety of tools including achievement statistics and the destinations of former students (which are held to be "positive" if they go into higher education or related work). Philosophers and educators such as Dunne (1997) and Carr (1995, 2005) have, as noted, questioned the value and appropriateness of these tools but regardless of their accuracy, the aim of our courses is for students to be properly equipped, that is to be able to offer appropriate human affordances, to be able to connect to one or more of the various non-educational networks that make up "the industry". The "deliverable" for educators is the musikarbeiter.

I have drawn on a range of examples of musikarbeiter outside of education partly to take account of the number of roles that are potentially available and therefore the flexibility that music educators have to provide. Even when a student graduates, they may not be clear about their preferred career path and may need to be able to offer human affordances to several other actor-networks whose requirements differ. It is noted in the section above that in many cases aesthetic compatibility is a key requirement for interessement but at the same time a budding musikarbeiter may have to offer a range of hard and soft skills including technical understanding and craft skills such as mixing.

> "There are conventions that you need to understand in the engineering side, there are numbers you need to understand. And there are, there are science and engineering terminology that you need to understand and you need to understand what's happening under the hood with all these devices and tools that you're using. But at the same time, you need to understand, be sympathetic to the genres of music" (F).

I have already noted F's statement that some students will lean more one way than the other, and they go on to consider how that affects their role:

> "Your ideal student kind of and the ideal person in this field is somebody that kind of has a foot in both camps perfectly…(but) that's your *ideal* person. But then there are very engineering specific jobs, (like) the development of software where you're just literally turning somebody else's ideas into a physical thing. So it's very much based around just the techie stuff. And the other way around. There are artists and musicians who haven't got a clue about what all the numbers and the buttons do, but they know what they want. But I suppose what we're doing and what I do in my job is trying to get people to understand both areas and be excited about those areas. By both sides of that equation."

Although, then, a graduate may eventually be mobilised into a highly specific role, an educator's concern is both to allow a student to develop their own strengths, and also to do so flexibly enough that they will not get "locked in" to their particular interests so far as to be unable to connect to other networks. In some sense the ideal musikarbeiter, precisely poised as half artist and half scientist, is a rare and maybe fictitious entity but from F's perspective a graduate will need to have some interest and knowledge in both directions even if they lean more towards one side. As was noted in the introduction to this chapter, N sees a related concern in getting students to collaborate with others:

> “You need to be networking with the performers…because you find a singer or an artist who you can work with and create something that's good that then gets you noticed. But most of them are just in their own little insular world….”

The educators I interviewed frequently talked about approaching this flexibility by means of problem solving. J:

> “Problem solving, [which] I think is something that the creative industries teaches better than I think most other areas, especially a technology based subject like sound production.”

This to J is a key skill precisely because it will provide their students with this kind of flexibility. Their end goal is for them to be able to problem solve autonomously, and, at some point, he will remove support and turn autonomy into an expectation:

> “[I] will say to the learners that if I look at your setup and I can tell from a glance what the problem is, and I know that I've also told you several times how to fix it, I'm not going to say anything. Like, you're going to have to figure it out.”

Eventually their students will need to work autonomously in a high stakes environment. J discusses an external recording session in a church at which they will not be present: “If there's a big problem, there's a phone number, but if there's not, you know, you need to figure it out.”

J works in higher education and may therefore put their students into a higher stakes situation that someone who teaches 16-18 year olds. M, who does teach the lower age group, discusses allowing their students to make mistakes in a low stakes environment so they can make errors without feeling “too uncomfortable”.

F talks about trying to present students with specific problems where “they will have to learn the theory” in order to carry out the practical element, and this mixture of theory and practical is a concern they share with M. M discusses a specific project at some length:

> “So we're doing a nature project at the moment, and one of the things was to turn an orchestra into animals and it's a case of saying like these all the different sections of an orchestra, what animals would you pick. And we had a nice conversation about that, we talk

about the different frequencies, ranges and things of that sort…now go online and try and find some animal sounds that work and they quickly run into a bit of a wall in terms of how far are they prepared to search for things, but also just the general quality of stuff. And so, in terms of teaching them, that's like, okay, well if you want that one thing, you're going to have to potentially go to a zoo and record it. Or you're going to have to spend some money to do that, find a high quality sample pack…that in itself is quite interesting just to get them to think creatively about and associating sounds with nature, then associating the orchestra itself with a piece of tech and then considering how are you going to ensure that what you're using is a good quality. *The main outcome for the session isn't to make an orchestra. The main outcome of the session is that they know how to import samples*." (my italics).

M is discussing using specific projects to inculcate higher level skills and theoretical knowledge. To put it another way the affordance of *knowing how to import samples* will in their judgement be a better one for a student to offer than *knowing how to make an orchestra with animal sounds* because it is more flexible and generalisable – that is, it offers potential connectivity to more networks. The ability to be flexible is a large part of the point, which M regards as future proofing their students:

> "While some things don't change…well, in 20 years when you're performing in augmented reality, you're performing in virtual environments like…how are you going to be able to react to that?"

K works with students ("all boys in fact") from "quite challenging backgrounds". When they arrive

> "They're kind of reluctant to sort of cross over and sort of work in a different way. They find a way of doing things and then they don't want to change it"

Nonetheless at the same time

> "They all want to create something. That's why they turn up. But they want to sort of create something and they want to get to the finishing line of being able to take something away, which. They're happy with in some way."

K is keen to develop some “nuts and bolts” – that is understanding of basic sound selection and audio and MIDI, so that they aren’t just creating one track but might be able to branch out in the future. He uses a specific device for this, the Ableton Push (fig 5.3).

> K: “I've been using the Push device quite a lot because…it's quite sort of tactile and they can actually get into this idea. [Instead of] just looking at a screen, they're actually twisting knobs and stuff…I think that young people like doing that.”
> TD: “How do they respond to the Push?”
> K: “They like it…being able to sort of navigate the screen a little bit and find the sounds. And it's because a little bit more visual in some ways. Like, they kind of like that aspect of it. And I think that you've because you've got this thing where you can use it as a drum pad, but you can also play chords on it. Yeah. Is sort of multi-functional in that way... and it lights up. Yeah.”

Figure 5.3: The Ableton Push controller.

Image from Ableton (2023)

In this way K ties the students to a specific object – the Ableton Push – in the same kind of relationship G has with their Electribe. The Push is described in Ableton (2023) as an instrument and is clearly conceptualised in such a way that the manipulation of it is a specific skill in the same way as

playing a keyboard. Playing one instrument does not necessarily mean you can transfer that skill to another (so a keyboard player might not be able to play, for example, a cello) but at the same time K is interested in using this device to help students gain

> "some understanding of MIDI and some understanding of audio and then…being able to select sound and edit sound and then combine different elements together really in terms of kind of finer sort of aspects of music production".

In the instrument analogy, playing piano does not help with the *mechanics* of playing a cello, but it will very likely create an understanding of how music works in terms of rhythm, harmony and melody which would be transferrable.

Some of my participants have discussed instances where pedagogy has failed. A, for example, felt alienated by the teaching of music theory. They describe their education as quite traditional:

> "I've never thought theory is important. And I think it's because at the school that I went to, we only learned classical music. And I just found that really oppressive. And, um, I just. I hated it … because it wasn't reflective of my culture or anything like that. And that just put me off theory. I have no interest in theory."

At the same time, they mention physics, rather than musical theory, in a Twitter post:

> "If I knew how much I'd be using the principles of physics as a producer I'd have paid more attention in science at school and might have actually enjoyed it….It was so abstract at school. There was no real-world application."

Although A has retained an interest in physics, the failures of pedagogy were similar – theoretical content was taught in an abstract way that they were unable to engage with. G similarly describes themselves as "stubborn with teaching" but then being able to engage with more theoretical elements once they were able to link them with their music making

> "…something clicked. Remember, it was I would think I was reading the Mike Senior book on mixing and, you know, talking about frequencies and things like that. And I remember experimenting….and just working out, oh, hang on. Like you've got a kick drum here. There's

> no there's no upper frequencies here necessarily. So, you know, removing with a filter, just removing those upper frequencies and then suddenly realizing that, whoa, suddenly everything comes alive"

N discusses a similar case:

> "We had a student who came in and said he did one year AS level music. And it was all, well, Bach and Beethoven, you know, no interest to him at all because he played guitar and he said in one week he learned more of use by starting to learn how to set up PA systems and stuff than an entire year doing an AS level and there was no, you know interest."

In 2024 this may seem a very obvious point but one still worth noting. The tying in of theory as an abstraction or development of practical knowledge works better for many or most students (according to my educators' and other participants' experience) than a more abstract "theory first" approach. From both of these participants' point of view there is (in Dunne's terms) a *techné* here which they consider worthwhile but were only able to approach via *praxis*. At the same time participants disagree about the importance of music theory to their practice. Those who have been formally trained such as D, J and E consider it a vital element. H, perhaps one of the most technically engaged of all my participants, refers often to his musical training. At the same time O is more ambivalent:

> "[The] music theory one's pretty tricky…it's sort of an ongoing conversation, really, or an ongoing problem shall we say……[what] is teachable, is structuring. So you could talk about music theory's really important. But if you are into techno, for example…in terms of harmony, isn't at all important, actually. And melody, not at all important, actually. So there the technical side is more important."

As a final part to this section, it is worth noting once again how important educators felt aesthetic recruitment was. I have discussed this earlier in the chapter regarding the nature of networks of music technology – that membership of them is seen as desirable and that part of educators' work is to enable students to overcome gatekeepers by offering "human affordances". At the same time educators are in a gatekeeping role ourselves: we do not want our students to graduate without them. In that sense the acquisition of these affordances is, for a student, a gate to which educators hold a key. However, for all this to be true students must be *already connected to these networks* via

another link, and that link is frequently aesthetic. Bluntly, music technology students love music and educators are aware of this. As K said, “They all want to create something”. Of all my participants only F talks of discovering technology – “taking shit apart” – before music and even then, the two are closely related – one of the first things they “took apart” was a tape recorder. Many of them discover a joy in technology for its own sake but music is the way in. They are similarly concerned with developing student creativity. For F everything is about “the song”. Teachers are for an ostensibly technical subject concerned to a perhaps surprising extent with students’ self-expression:

> “But much more important to me is that they are expressing themselves creatively……I always say to them, you know, if you're from, I don't know, Tunisia. Where is that in your EDM piece? You know, because I can hear a million copies of so and so. But…there might be something much more personal that you can express.” (O)

> “One of the things is to actually stand by their choices and be like, look, this is, I'm really happy with that mix. That's the aesthetic that we were going for” (J)

Technology then offers two simultaneous options from an educator’s perspective, both as an affordance by which graduates can gain fulfilling roles in “the industry” (although not necessarily “creative” ones if seen in the narrow sense of music composition or performance) but also as a means to offer students the opportunity to advance their aesthetic expression.

5.6: Theme 5 (The Fairacres College Network): Musikarbeiter in Action

As a final element to this chapter, I wish to look at how all this works in a real educational network. This is based around Fairacres College and several of my participants are connected to it.

F is the Music Technology course leader at the college. They have been in post for over 20 years

E works as a technician. It is their job to keep “A vast amount of Apple computers and five recording studios” working properly. F and E co-built the studios.

N studied under F, completing a HND course. They now operate as a course leader (that is in a similar role to F) in a neighbouring college.

P is a successful graduate of the college. They now work for the major music software house which I have anonymised here as “Calade”, who manufacture music software (also anonymised as “Audinal”) and as a freelance sound designer for films and games. They have also worked as a mix engineer in film. As part of their role for Calade they are in regular contact with the college, which is a Calade training centre.

Q is another graduate of the college who works for Dolby, training other producers to work with Dolby Atmos, an immersive and cinematic sound mixing software. I have not anonymised this company as he is one of several people who have worked in this role.

This college network provides many of the examples for chapter 5 above. For example, Q was recruited into the college music technology course, and subsequently the wider array of networks of music technology, by his interest in playing bass in a metal band. Tracing how this happened through time might sketch out a “meshwork” (Ingold 2012) showing, not just a slice of a network at a point in time, but an idea of how one might evolve.

I will (slightly arbitrarily, because the college existed before this point, and had a music course) start with the recruitment of F and E to Fairacres College. F discusses aesthetic engagement with technology coupled with aesthetic *disengagement* with a slightly different pathway:

> “In the first year of the degree I worked out that if I wanted to be a guitar maker, I'd basically be stuck in a shed somewhere smoking roll-ups and smelling of patchouli oil for the rest of my life because the guitar workshop, the place where I was, was just full of guys with beards… listening to folk music and carving headstocks and mandolins endlessly, smoking roll-ups and listening to Caravan or the Incredible String Band…relentless folk and psychedelic stuff and smoking roll-ups all day. And I decided that there's more music out there. I'm really into electronic music and all these other forms of music as well, not just folk and this stuff. And so I actually changed tack on my course and. Changed units, so I was doing more sort of production and engineering based stuff. So I'd end up getting to use the studios and then they had an Audinal system there. So I'd just lock myself in there…every lunchtime, basically.”

It is also noticeable that the non-human actor Audinal was an important part of F’s enrolment – they had not just become a “technologist” but also part of the wider Calade network described earlier in

the chapter. F has since become a Audinal trainer and Audinal will continue to be a key non-human actor throughout this account. F had therefore become linked with this software for originally aesthetic reasons (a desire to move into a different area musically) but now had a valuable technical affordance to offer: that of *Audinal Expert.*

F was recruited to Fairacres College as a teacher shortly after completing their degree. They were originally recruited as a technician, but immediately they joined they were offered the opportunity to teach on an expanding course, as a Popular Music course had split into a technical and performance pathway. As the course expanded, F's engagement in their teaching role meant there was a vacant role for a technician which E took up. E again was originally recruited into a technological network via aesthetic means: their musical training and love of performance led to work as a guitar technician and finally as a live sound engineer. During that time and since they have become more and more interested in the technical side of their role. I quoted them earlier as claiming that the technical side had "killed their creativity" but a close reading of the interview shows a shift in interest and it might be more accurate to say that the energy they once put into what they regard as their "creativity" (music composition and performance) was redirected as they became more interested in the technical side of things. At the same time, they were able to offer more human affordances (skill with specific "industry standard" mixing desks, ability to "walk into a room" and know what it will sound like) which link to audio engineering rather than performance opportunities. One of the ways they have gained these affordances is "building the studios" along with F. E has been able to use these developing skills to obtain more work outside college recently, and expects this to continue. F and E are in frequent informal discussion about various aspects of music technology, often relating to the college recording studios, but also live sound.

By the early 2000s F was fully mobilised as a music technology teacher and a key part of an actor-network consisting of themself, E, a small suite of recording studios and practice rooms, and various pieces of equipment including microphones, four track cassette recorders, mixing desks, and computer rooms. This was (and is) embedded within the wider network of Fairacres College, its various marketing and recruitment arms, its management structure, buildings, infrastructure and so on, which it depends on to bring in vital elements such as students, new equipment, electrical power, and staff.

At this point N came to study at the college. They were a more mature student and studied first on an evening class then a Higher National Diploma (HND). Their background was in business and in performance:

> "I actually did HND business studies and had a job planning out multi-million pound projects. But then I developed RSI, repetitive strain injury, so I liked music [but] with RSI, can't play the instruments and I wasn't any good anyway. But anyway, so I thought, well, I'll do music production…..And I did like an evening course at Fairacres College, and then I did the HND there and then my degree. There was [a job] as a technician going. I 'd already part qualified then as a teacher, doing hourly paid work. So I took the job as a full time technician at a different college and after a couple of years went to full time teaching."

N again briefly mentions aesthetics ("I liked music…") as a motivating factor but was not initially attracted to production for its own sake. N has been trained in Audinal by F, and his own college in turn also offers Audinal training. N discusses the importance of upskilling, displaying the technical flexibility that educators are concerned about, in a changing technological environment:

> "The technical side has gone in part because you don't need to know about MIDI and doing Sysex messages because it's all in the box…but I suspect because of T levels, because of the growth in TV and film, that may well change…so you've had to like upskill, because half the stuff like Dante [a connection protocol] in the studio didn't exist even a few years ago…but if you want a career in studios or in live sound, you pretty much got to know it. Microphones used to be, you know, with an XLR lead. Now you get radio mics and wireless mics."

Between N graduating and P and Q joining Fairacres College, the music technology actor-network gained a major new feature in that it became able to offer manufacturer approved Audinal qualifications. F took a course to enable them to become an official trainer and in the process of this developed a close relationship with a Calade representative which would be critical for the future pathway of P. P joined the college as a Level 2 student (that is a student who joined at 16 but without GCSEs: "And I never got my English"). P studied at the college for four years (Level 2, Level 3 and one year of HND) before successfully taking part in a competition for a paid internship at Calade. As described above, they were able to gain the internship due to the Audinal knowledge they had gained at college, as well as other qualities (P themselves, as mentioned in section 2.2, places a very strong emphasis on coming across as cheerful and professional and having a "can-do" approach). P also

believes that their perseverance in understanding digital audio theory was useful. Their description of working as a mix engineer on film sets reads as being in a fast-moving environment with a lot of moving parts involving deployment of both theoretical and practical knowledge. Part of P's development of these skills involved being mentored by the same Calade representative that F worked with.

Much more so than N, P can still be considered an active member of the college network. In their role working for Calade they have been mobilised as a Calade representative and liaise frequently with Fairacres College in this role. They sometimes come back and visit the college and talk to newer students at careers events. As part of this network then, they form the link between Calade and Fairacres College once provided by their mentor, who has since moved on and whose job they now do. The college therefore fulfilled its role in allowing P to offer an affordance ("Audinal competency") to the Calade network which helped them to be enrolled, and in turn their role at Calade allows the Calade network to mobilise the entire Fairacres College music technology department as an actor-network that disseminates their software (by making students learn it). The binding of students to Audinal in turn helps Calade to maintain their own wider network. P also provides an example of how a student who was at one point considered non-academic was able to gain entry into a range of technical roles involving deep understanding of both hardware and software via practical learning, both in Fairacres College and beyond it.

It is worth noting that P's mobilisation by Calade and their link back to the college is not their only role. Via their Calade work they have also been able to use their connections gained at Calade, Audinal and other skills to work as a mix engineer at a large film studio, and this is where much of their worldview of can-do professionalism comes from. They still work as a freelance sound designer and in this role do not always necessarily use Calade software. They have therefore been able to translate a software-specific affordance (or plug-in in Latour's terms) to a more generalised "sound design" affordance that enables their deployment elsewhere. Once again, a specific non-human actor has then been used to leverage flexibility.

If P has been mobilised by Calade, Q has been mobilised by Dolby. The pattern of aesthetic recruitment is once again noticeable: Q was originally motivated by wanting to produce their own material. This was as an instrument player in a band and continued to determine a large part of their direction throughout their time at Fairacres College and even beyond. As already quoted above:

> "…. Hearing our album back in full, after we'd finished producing it together when he was basically finishing Fairacres and I was at uni. So he was in F's class at tech and I was doing production … and we were both producing this death metal record and then hearing that back and just how, in my opinion, how awesome it sounded, I was just like, oh man, yeah, we can do this. This is amazing."

Q discusses a decision point where they realised that their band was too "obscure and heavy" to make a living out of and began to consider alternatives. It was clearly still important to them to be able to gain some aesthetic fulfilment (or not "sell their soul" in their terms):

> "If I'm honest, it's kind of much like a compromise around not selling your soul for what you're going to do to make a living as an adult. I kind of realized that being a bass player (there were) three options basically… you could become a session musician and go and record bass on other people's records. You could be essentially like a cruise ship wedding band kind (of thing)…not what I wanted to do either. Or you could be in a band and be an artist. And that was obviously what I wanted to do. (But) that obviously has a lingering doubt in your mind. And so I figured, well, you know what? I should probably figure out something else I can do within this realm that I feel really passionate about, that I can get fully involved in and want to do it."

Q's recruitment to Dolby was not, however, initially musical, but as

> "an internship in commercial partnerships, which was essentially we're trying to get, you know, BT or Sky or whoever onboard broadcasting Atmos. And we need a young tech person that we can not pay too much money to come and sell this equipment".

Again, the ability to generalise technical skills was important: Q would not have had familiarity with this equipment at the start as it was essentially new, but was able to offer an affordance of being a "tech person". By their account, being able to then turn this internship into a "music position" was a result of their own action within the Dolby network and their translation of their position as a "tech person" into being a music/audio tech person. Q has therefore been able to leverage their technical skill into agency by autonomous use of the technology. The route to doing this was being able to work with specifically music-based customers, in particular at a large club event which Q describes as a turning point:

> "When I had finished working with a trance artist called…and he worked with me for about 2 to 3 weeks to prepare an entire six-hour Dolby Atmos trance set for [large nightclub]. And we did that. And I then engineered the …we pulled it through and just seeing the reaction of like his fans that have listened to him for 30 years since the OG Ibiza days he's going, oh my fucking God, I've never experienced anything like this. This was absolutely incredible."

If P's work with Calade has in some sense closed the loop and brought them back into being an active member of the college network, albeit as a mobilised representative for Calade, Q has to a lesser extent also been reintegrated into the Fairacres College network, as the college used a connection with them to sign a trademark agreement with Dolby and create an Atmos mixing facility. They are in less regular contact with Fairacres College than P and are a more tenuously connected part of the network but are still there.

Finally, it is noticeable that both P and Q retain their connection to Fairacres College via the non-human actors of Audinal and Dolby Atmos. There are other ex-students who stay in touch with Fairacres College and maintain friendships but are not tied into the network of college operation: they are not actors within the Music Technology department in the same way that P and Q are. They do not have the same commonality of non-human actors – of stuff and technology and software – maintaining the connections and consequently the full work of translation back into the college network has not been done.

5.7: Summary

In this chapter I have shown how my themes, taken from an ANT sensibility, illuminate my research question of

> "How is music technology constituted in practice and presented in terms of curriculum and learning? How are people brought into this subject via education, and are inducted into practice beyond it, as they graduate and work in the sector?"

and

> "How do "STEM" or "STEM-like" tools and practices interact with "creative" ones both inside and outside education?"

I have looked at participants' accounts of how they are, or have been, mobilised whether as part of corporate actor networks such as Calade, educational institutions, or in their own actor-network as an independent producer/performer. Rephrasing the question in ANT terms I have tried to show:

> "how all the various actor-networks of music technology that the participants are members of work to extend themselves and interact" (6.4).

Looking at the second part of the question I have as part of this process reconceptualised both "STEM-like" and "creative" skills as *human affordances*. It is important to remember that these are not just skills offers to corporate actors who may provide employment: phronetic attributes such as "trustworthiness" as well as aesthetic judgement and technical competencies such as troubleshooting are also important to how independents perform on stage, for example. In terms of STEM and creativity there are also multiple levels of engagement: technical skills and in particular those relating to specific non-human actors may be important in binding to roles, but at the same time the ability to abstract principles and reapply them to other circumstances allows agency when those bindings need to be loosened. Similarly "creative" skills may be needed throughout a project but participants (such as E at his mixing desk) may not see those skills as creative. "Creativity" in the form of the exercise of aesthetic judgement is typically most visible at the beginning and end of a process of mobilisation, starting with aesthetic recruitment and ending with the presentation of "the deliverable".

In terms of education my participants presented a variety of accounts of how they were inducted and how they inducted others. Some of them have thought deeply about aspects of pedagogy and in particular the realisation that technical and creative skills on their own are not enough: Students should be able to work independently both technically and personally.

The relation of an ANT lens to the original research question, and of the findings to the themes, is discussed in more detail in chapter 6.

Chapter 6 – Interpretation: What Does Anything Mean? Basically (The Chameleons, 1985)

This chapter provides an overview of the thesis. In a sense, then, it will duplicate (but perhaps distil is a better term) what has gone before. The first two sections re-examine the nature of the research problem in the light of ANT. In the first section "The Problem Reproblematised" I take an overview of the research problem originally posited in chapter 1, and specifically what that problem means in the light of an ANT lens, as well as the broader concern of achieving a rapprochement between STEM ("positivist") and humanities ("postmodernist") accounts. I raise the possibility of this ANT account being an intervention as suggested by Fenwick and Edwards (2010). Section 6.2 "Why'd You Have to Go and Make Things so Complicated?" also offers a recap and a reminder of how the ANT lens I have used to look at the data works out in practice. Sections 6.3 "What did the Literature Say?" and 6.4 "What did the Participants Say?" address the findings of the thesis as they relate to music technological practice. 6.3 re-examines the literature review in chapter 2 and summarises how I consider the various writers and theorists relate to this practice in the light of the interviews. 6.4 is in some sense the most important part of the chapter, as it highlights and emphasises what I regard as important commonalities in ways of doing the work of fabricating "music technology" from chapter 5. 6.4 is divided into Aesthetic Recruitment (6.4.1), Technical Interessement (6.4.2), Human Affordances (6.4.3), and Creativity and Deliverables (6.4.4).

6.1: The Problem Reproblematised

> "In this universe, people who are interested in the souls of machines are…isolated in their own separate world. I would like to try to bring that isolation to an end" (Latour 1996)

At the close of chapter 1, I stated that I would examine and tease out the nature of music technological practice with the aim of abstracting a useful framework for curriculum intent. It is certainly the case that I have spent a great deal of time teasing out the nature of the practice. In chapter 5 and section 6.2 below I have discussed the existence of commonalities amongst the various practitioners who I have interviewed. These commonalities are what might form the basis for a useful curriculum framework. Some may be of different uses in different parts of a student's journey.

I also suggested in chapter 1 that music technology is "a mixed practice" but it has become clear that the nature of that mixture is not the same for everyone, from B who "doesn't even know what [buses]

are" (but who is nonetheless able to compose, produce and perform with software) to F's "ideal student" (who perhaps will develop into H whose technical practice forms part of their artistic one) through to E who has become so interested in their technical skill that it has "destroyed their creativity", via P and Q who have so internalised their connection with technology (and the non-human actors they are linked to) that they regard it as transparent and "a part of the culture". F illuminatingly describes this as a "spectrum" and it is also the case from these accounts that people do not necessarily stay in one place on it – Q and J both, for example, describe journeys from being musicians into more technical roles; but Q as mentioned above, having internalised their technical skill, feels they have moved back to a more musical, or at least sound oriented path. Human actors are changed by their exposure to both other human and non-human actors and are translated into other roles in a mediated way.

The second impetus behind this thesis was more than to map a particular curricular area. I was originally motivated by a feeling of dislocation between sciences and humanities. That feeling has only been amplified by the research I have done towards this thesis. I have read accounts of "positivism" that STEM practitioners would not recognise and revisited accounts of "postmodernism" that bear little resemblance to humanities in practice. Even the use of ANT, chosen partly because of its attitude of respect towards its participants and refusal to dismiss "stuff" as some kind of social fiction, is, Latour feels, misunderstood. In Reassembling the Social (p89-91) he discusses the reaction to Latour and Woolgar (1986):

> "There was not the slightest doubt that the products of these artificial and costly sites were the most ascertained, objective, and certified results obtained by collective human ingenuity. That is why it was with great enthusiasm that we began using the expression 'construction of facts' to describe the striking phenomenon of artificiality and reality marching in step……Unfortunately the excitation quickly went sour when we realised that for other colleagues in the social and natural sciences the word 'construction' meant something entirely different…to say something was 'constructed' in their minds meant it was not true".

Again, Latour displays a slightly gleeful disingenuousness. This account is perhaps slightly at odds with his statement (which he surely cannot have expected to be welcomed by STEM practitioners) that "Epistemology….is an area whose total extinction is overdue" (1986 p280).

Nonetheless if ANT is “a way to intervene, not a theory of how to think” (Fenwick and Edwards, 2010.) then part of my desired intervention is some form of reconciliation. This is not a case of battling for equal funding as STEAM advocates suggest nor is it a suggestion that STEM, humanities and arts are “the same thing”. However, I am exploring an area of ground where they converge and which I believe is neglected in simplistic statements about the curriculum such as “STEM subjects have a positive impact on the economy and society……increasing the number of young people that study science subjects is important if we are to address the STEM skills shortage and support the UK economy to grow.” (Education Hub 2021) or indeed the equally simplistic backlash evidenced in Jenkins (2006). This is an area where students and practitioners routinely and seamlessly use STEM-like skills to solve aesthetic problems, and creative skills to translate themselves into “technical” networks of software and hardware. Because these areas are “vocational” they do not tend to have courses in prestigious universities. O is an interesting exception as they work in a Russell Group university and have a specific remit to deliver music technology as a cultural “minor” to STEM students, based on feedback from the University careers service that “Graduates…. are considered very good at their subjects, but rather narrow”. In O’s university music technology is regarded as one of the humanities.

It is therefore my hope that other actors in the education network may see these vocational, blended subjects (other candidates might be 3D animation, with its mix of art and software expertise, or the technical cinematography and camera operation which Benjamin (2008) showed was also an artistic practice) as part of a curricular continuum that should not be walled apart, and even that academics on both sides of what were once called the “science wars” (for example Parsons 2003) might see something valuable in each other’s positions.

6.2: “Why'd You Have to Go and Make Things so Complicated?” (Lavigne, 2002)

As Fenwick and Edwards (2010) promised us, looking at things via an ANT lens has left things a bit messy. In fact, that was the whole point! However my ultimate goal was to provide a set of commonalities between these individual processes which might be useful to educators trying to frame a curriculum.

A potential critique of this thesis from an ANT point of view is that I have not (with the exception of the Fairacres College Network) traced a network in a way that a good ANT study might (Latour 2007). Instead, I have looked at a number of fractions of different networks, forged by my participants. Some

of those may be interconnected. For example some of my participants who are performers have at some point played on the same bills as each other. Others (D for example who has no personal connection with any other participant except via me, or many of the educators who work in separate institutions and do not know each other) are not. In what sense then does this thesis have an ANT lens? I have taken a lead from the final chapters of Latour (2007). In it he looks beyond the mapping of immediate connections, to a larger goal. "The new associations do not form a liveable assemblage……once the task of exploring the multiplicity of assemblages is completed, another question can be raised: What are the *assemblies* of these *assemblages*?" (pp259-260). There is an ambiguity here because if anything an ANT can be considered a fact, it is that the task of exploring the multiplicity of assemblages can *never* be completed. Nonetheless at some point I believe one must ask about commonalities between networks if ANT is to start to move beyond local cartography.

If Latour is correct, then any such commonalities are not the result of a mysterious "the social" but are the result of further networks whose detailed exploration is mostly beyond the reach of this (or any limited) thesis. There is for example a network of journals, conferences, papers, teacher training institutions, Department for Education strictures, Ofsted guidelines, exam board stipulations and so forth which guide the way teachers think about educating their students (which are of relevance to the discussion in chapter 1 of the apparently differing educational philosophies behind the QCF BTEC and UAL specifications, and how in turn they placed a different value on different types of taught content). Another such network is characterised by connections with the commercial entity Calade and an associated array of musicians, studio engineers, producers, and educators, to which one might add filmmakers, sound designers, immersive mixers, as well as non-human actors such as Audinal, Connect A/Connect B, and various audio interfaces and live and mixing consoles all of which work together. Calade (in common with other large IT systems suppliers such as Apple) describe their mission as providing an "ecosystem" which is vast in scope, and which privileges some ways of working and even thinking above others. Even something as basic as a content browser may vary considerably. Calade's browser, with its extensive tagging and preview system and ability to work across large libraries and multiple drives, lends itself to large scale operations whereas another hardware/software commercial network, Ableton's, simpler browser may work better to quickly drag and drop content into audio software on a laptop (Ableton 2022). I cannot help but be reminded of Adams and Thompson's (2016) comments on NVivo "you may do everything you find here, but anything else may be difficult or impossible to do". Educators such as K are conscious of a social network producing creative expectations involving non-human deliverables such as "beats" amongst their disadvantaged students, much as O is conscious of a different one amongst their more privileged

STEM students. K uses a non-human actor, the Push, as an educative tool but this non-human actor is in itself a mobilised node of the Ableton network, who also have an interest in selling more Pushes. The Push offers very different compositional affordances from Calade software, in the same way that the Korg SQ-1 in chapter 1 enables different outcomes from writing staff notation or inserting MIDI notes into a virtual piano roll. This in turn might make it more attractive to students and staff who have been aesthetically recruited via particular forms of music which have historically used similar workflows. Tracing every one of these connections is an endless task.

Latour (2017, p241) discusses these many possibilities that lie "outside the network". He calls them "plasma" and analogises them to the "missing mass" of cosmology. Although he describes them as "simply unconnected", there is always going to be some kind of selection by the writer in an ANT study – after all as noted in chapter 4 themes and connections "are emergent" in dialogue between the researcher and the material, rather than "emerge naturally" as an ineluctable feature (Clarke 2021). The implication is therefore that with a different researcher different connections might emerge. A connection which is not mapped in a particular study, or indeed in all the studies that have been done so far, is therefore not the same as a connection that does not exist. It may remain to be discovered, or it may be perfectly well known outside of academia.

If we are to take Latour's metaphor seriously, we should note that the cosmological missing mass is believed by astronomers to exist *because it has noticeable effects*, or more accurately because there is a discrepancy in the mapped universe compared with theoretical expectations, which astronomers have labelled "missing mass", and of which they are able to trace some kind of shape (Coble et.al. 2024). In the same way the commonalities mapped in my participants' individual networks might enable the reader to get some idea of the shape of other, potentially unmapped networks, and their effect on music technology education, and even to suggest features to look for in related educational networks. Latour (2017, p176) states of these apparently broader networks "Macro no longer describes a wider or larger site but another……equally micro place which is connected to many others". By examining several micro sites some picture of that more connected place may emerge.

6.3 What did the Literature Say?

6.3.1 Overview

In my literature review (chapter 2) I set out to explore some perspectives which might help with the task of understanding how music technology practice(s) are constructed or might be constructed. This section was revisited in chapter 5 as various elements of practice were illuminated by these different perspectives from the literature. I was looking particularly to see how "STEM" and "Creativity" (which I am putting in inverted commas here because both, it turns out, are more complicated than that) might be working together in these practices and therefore I wanted to look in the literature at how these areas might interact, in other words, how the dichotomies in the title of this thesis might be collapsed. I have therefore attempted in this literature review to reconcile what seems to be something of a false conflict. Near the end of chapter 2 I discussed the blurring of purely technical considerations into the aesthetic with the example of adjusting a filter on a synthesizer as part of a sound design process and suggested that the particularisation of abstract knowledge directed towards a goal was not so simply separated from the practical and aesthetic "wise judgement in the public realm" identified by Dunne (1997) as *Phronesis.*

6.3.2 The Literature and the Themes

In chapter 2, in order to try to unpick how STEM-like and creative practices might work together, I examined ideas of *techné,* phronesis and praxis following the views of educational philosopher Joseph Dunne (1997, 2005). Dunne (1997) ascribes a specific set of characteristics to *techné* which, we may recall, he characterised as:

> "…knowledge in which means are separated from ends - I know how to do a thing, which I can then use to achieve a goal. In the case of making things (poiesis) the product is the goal. Phronesis on the other hand leads to praxis which is an ongoing process". (1997 loc 5534, and chapter 2).

In education, the application of *techné* ("this set of steps is how to deliver a good lesson") may indeed be perilous. In the music technological practices examined here, phronesis and praxis permeate most of the accounts as a constant background hum. Musikarbeiter are working towards aesthetic outcomes that are not set as fixed goals: the nature of the deliverable may be technically specified but its content must also be engaging. However, the eschewal of *techné* in an actual technological field seems strange, and the ability to work from abstract principles is also important. In the actual

interviews people seem to move fluidly between technological abstraction and the application of aesthetic and technological judgement, and educators are keen to push their students towards this state using a variety of methods (theme 4, discussed above in 5.5 and below in 7.1). I suggested a resolution to at least some of the issues in Dunne's explication of "the *techné* of the Kairos", which he characterised as "a *techné* whose exercise is a praxis", and in many areas this seems to fit. Phronetic concerns such as *trustworthiness* also seem key to the mobilisation of musikarbeiter and music educators (theme 1, 5.2.1 in particular, and theme 4, 5.5). What seems missing from Dunne's account however is the ability of technical knowledge to provide agency and open doors (discussed below).

I also looked at ideas of craft and craftsmanship informed by Richard Sennett (2009), examining use of technology "in the moment" in performance, as well as in the more deliberative environment of production. Sennett (2009) places a great deal of emphasis on training the hand and discusses the problems associated with computer aids such as CAD in architecture (pp39-45, discussed in chapter 2.2). I have tried to fold Sennett's insights into the discussions of working with non-human actors (theme 3) especially in sections 5.2.2 and 5.4. The fluid use of software towards aesthetic goals discussed in these sections (and also as a desirable "human affordance") has some factors in common with craft skills, and I have argued in chapter 2 that a deeper look at the use of both MIDI sequencing and performance reveals traces of the "intelligent hand" and of the element of peril discussed by Sennett in conjunction with glass blowing (for example). In cases where the element of peril is missing (I identified recording as a practice which aims towards the elimination of peril), whether it is in a digital realm makes little difference, and the accounts of my participants seem to reveal more craft in the praxis of recording than the "lack of peril" inherent in the nature of recording itself would indicate. It is unclear where the theoretical abstraction and the psychomotor skills begin and end – micing up a kick drum might require formulae *and* tape measures *and* ears *and* hands and the result might be both a development of abstract knowledge *and* craft skill *and* lest we forget, a deliverable in the shape of a recording which will go on to have its own constraints in terms of required technical parameters. Sennett's insights into craft skills have been valuable in my framing of my participants' responses and in particular understanding the flexibility required to abstract and particularise this kind of understanding: how "micing up a drum kit" might relate to "micing up *this* drum kit which I have not seen before" or how "understanding this piece of software" can relate to "using *that* piece of software which I have not previously used".

Another valuable insight from Sennett is his refusal to separate craft from art (2009, p290, cited in chapter 2). This was a point on which he was closely aligned with Dewey (2005). Dewey has a lot to

say about the nature or artistic experience which he identifies with what I have called “the felt presence of the thing” (theme 2). The existence and importance of “the thing” on both its creative and STEM sense was one of the reasons I turned to ANT analysis. “The song” after all is a non-human actor as much as “the deliverable” is. His description “the *work* of art” as taking place when the art and a human cooperate also seems prescient of ANT (and Latour (2017) discusses Dewey’s influence on his own political thought). I also found Dewey’s insight that there is something in aesthetic experience that cannot be captured by text (“If all meanings could be adequately expressed by words, the arts of painting and music would not exist”) valuable in not only understanding aesthetic recruitment but also in critiquing textual modes of analysis such as those of Gadamer and Habermas. My participants in section 5.3 struggled to pin down even their own aesthetic judgement, describing “flow states” and how it is “not a choice”, looking at ways to achieve aesthetic satisfaction (“beginner’s spirit”), and working from “knowing when it is wrong”. However, to fully encompass the aesthetic and creative elements of this practice I felt the need to go beyond both craft and Dewey’s view of intentionality. Recalcitrant actors kept making themselves known: as seen in the work of Benjamin (2008), Thornton (1995) and Devine (2019), the mediation and incursion into artistic process of the materialities of production, inextricably tied into *technés* required to create deliverables (such as vinyl mastering) challenge Dewey’s views of mass production, and the existence of technologically mediated modes of production and performance such as DJing and generative music challenge his ideas of intentionality. My participants all describe technologically mediated processes, culminating in “the deliverable” (section 5.4 and 6.4.4 below), a non-human actant with aesthetic and technological characteristics whose history of mediation by other non-human actors is an inextricable part of its existence.

I examined a liberatory perspective drawing primarily on Labelle (2018), Thornton (1995) and Gillett (2023) as especially relevant to music, sound, and music technology, concluding that control of the technology was important in establishing agency. Again, this seemed to be drawn out by my participants but the relationship may be more complicated. In the discussion around theme 1 I have looked for insight into the paradoxical idea that abstracted technical knowledge may help with providing agency but it often does so by making a musikarbeiter *of use* to a commercial actor-network. The complex relationship between agency and gatekeeping is discussed in “Interlude: Human affordances” (chapter 5) and below in 6.4.3.

It might be easy to stop at this point and argue that everything is reconciled. However it is also critical to take account of different skills and sensibilities involved in various parts of the practice.

Differentiation is also important – it is not the purpose of this thesis to claim "everything is the same really", but to examine how these methodologically different elements, which are routinely considered so incompatible as to make it logistically difficult to study both post-16, come together in the lived experience of my participants. The fact that a practice can combine different elements does not mean the elements are identical, even if they are "inextricably linked" as I proposed in chapter 1. The job of this thesis and of chapter 5 is to unpick *how* they are linked in acquisition and execution. Theme 5 (5.6) begins to map the complex ways that people move through a specific network, are translated, start on one path and move to another, are mobilised or even demobilised, undergo binding to roles then unbind themselves (or are unbound) and move to new ones, as they leverage their technical, craft and/or creative understanding, or as their aesthetic interests, skills and understanding, or personal interactions change.

6.4: What Did the Participants Say?

If the problem is to discover how music technology is constructed in practice and how it might be in education, the research method was to talk to people who actually do it. This involved, in the end, fifteen participants, including a range of industry professionals, self-employed producer/performers, and education professionals (again from a range of backgrounds), mostly in Further Education, but some from universities and one externally situated. In chapter 5 I was able to discuss what they said and did in terms of five themes: "Mobilising"; "Aesthetic Mobilising" (which seemed significant enough to be addressed separately), "Non-Human Actors" (an area which seems in this practice to be especially associated with "STEM-like" thinking), "Educators and Educating" (how educators view their task of inducting students into practice), and "The Fairacres College Network" which combines all of these elements in the cartography of its network.

The first thing to note is that the sample size is quite small (as discussed in chapter 3) and this is perforce an illuminative study which suggests rather than prescribes actions. At the same time the transcripts and data are extremely rich. There are over 90,000 words of transcript alone – more than the length of this thesis – so inevitably some areas which might be of interest (for example gendered experiences of music technology, musicians' mental health, and the legitimacy and perception of "backing tracks") are not discussed here.

Looking at the interviews through ANT suggests some commonalities in how all the various actor-networks of music technology, that the participants are members of, work to extend themselves and

interact. It is possible to create a kind of narrative of *becoming,* drawing on ideas in Adams and Thompson (2016)'s "Heuristic 7: Unravelling Translations". Actor networks above all *act*, they do things, and this is a temporal process. They grow and shift, human and non-human actors join and leave, and are inducted in. It is possible therefore to put together a kind of a story of how induction into practice works (or mostly works, or might work). The following sections are therefore in a narrative order rather than in the original order of my themes.

6.4.1: Aesthetic Recruitment

A key element, maybe the key element, in the stories of how the participants came to work in some way with music technology is aesthetics. The first part of the story therefore relates to aesthetic mobilisation (theme 2).

Many of the participants found it hard to pin down exactly why they were attracted to music and what the aesthetic appeal is – "It's not a choice" (B). Time and time again they tell stories of being interested in music from an early age, in some cases it being "all I was good at" (E). For many of them this aesthetic is quite specific to particular musical forms, especially at the early stages, and for several this is still true. B, A, D and C in their different ways have commitments to particular sensibilities, be they D's desire to use musical problem solving (quoting one of his influences, Captain Beefheart) to help "break the catatonic state", or C's love of hip hop and sample-based workflows.

Music educators discuss their own musical background in particular genres and even in some cases even to "not liking" the music their students produce. Teachers are not supposed to demonstrate preferences (in the name of equity), so take pains to mask that fact from the students. In keeping with Dewey very few of them were able to say *why* they liked specific things; D explains with great fluency things they don't like and things they fear (overproduced music, oversimplistic loop based music) but when describing their own aesthetic recruitment ("scratchy bands on John Peel") relies on a commonality of experience: that I have also heard those bands and understand what he means. Their attempt to pin it down ("the expression of their art was more important than the sheen that it had") is more akin to a political manifesto than an aesthetic statement, something they share with A (who does not wish to engage with music theory because they sense it as oppressive).

Regardless of the universal difficulty in pinning down the nature of the aesthetic experience that has moved them, they have nonetheless been moved by it. They have *felt the presence of the thing* and have been forever changed. In this way the network of music production in its broader sense, with its

human actors of producers, mix engineers, musicians, performers, producers, hardware and software manufacturers, marketers, and distributors, and its non-human actors of amplifiers, instruments, recording studios, deliverables, items of software and hardware, retail outlets, venues, audio files, CDs, and vinyl discs has already reached out and touched them. It has enrolled them and changed them. They have been subject to interessement as consumers – critical consumers in fact – but not yet as musikarbeiter.

6.4.2: Technical Interessement

For those who pursue this route, aesthetic recruitment has had a second result. They have been made by this network not just to *like and buy* but to *want to make*. Some of them, like F, with their joy in taking things apart and building things, seem to have been destined for this route from early on. Others fell on it as a way of making music more easily (such as B) or even as a diversion from their original intention of or interest in musicianship (Q, E, J). Some came from another direction: K originally worked in A&R (artists and repertoire, part of music management) and seems pleased that they have found a way to make music when they were outside the traditional pathway of learning an instrument.

Mobilisation is the hoped-for result, but it is a lengthy process and there are stages on the way. We have in fact a whole group of people – music educators – whose job description is to translate eager students into some aspect of the music production industry.

I am struck by how often significant moments of contact are associated with quite specific non-human actors (theme 3 - 5.4 and 5.2.2.). Whether a student learns Audinal or some other software first may have a defining influence on their future career. Using an Ableton Push might open a door into composition for one of K's students that would otherwise remain closed.

The same is true of other participants – recall A who learned an entire new DAW in order to tap into "beginner's spirit", C's concern with recovering some element of peril, G who engages with their Electribe in the way a guitarist might with their guitar, or H's deep engagement with technical practice as part of, not separate from, his aesthetic concerns. These participants have also often thought about process and the appropriate use of technology within that process, and in this way their use of technology and aesthetic concerns modulate each other. Recall the technical/aesthetic manifesto quoted in chapter 2: "If I pretended to compose music it would be cheating. I program

arpeggiators" (Medlen, 2021). In the same way D or M in their different ways have thought about the role of technology in their artistic process.

While students and other practitioners, then, are still highly motivated by their individual aesthetic concerns, and are focussed on learning specific skills that will help them realise those concerns, non-human actors help to tie them to particular roles and skillsets. There is a potential pitfall that this can happen to the extent that lock-in – overspecialisation to the point of inflexibility should the environment change – can become a problem. Lock-in is a very one-sided relationship, in which an aspiring musikarbeiter may be fully mobilised by a network, but is left vulnerable should their connections with that network be suddenly dissolved (by the loss of binding non-human actors via software or hardware deprecation or for that matter by non-technological factors such as loss of employment). The network on the other hand wholly benefits by having a fully mobilised human actor who is unlikely to leave. As a potential counterbalance, contact with these non-human actors frequently involves "STEM-Like" thinking (as discussed in chapter 5), and recalling D, M and H's engagement with the Logic Environment View, modular synthesis, and hacked game controllers respectively, and also the discussion around sound systems in Labelle (2018) in chapter 2, this "STEM-like" technical understanding of abstracted underlying principles (5.2.2.) seems an important ingredient in achieving the flexibility needed to avoid lock-in and acquire agency (5.2.3).

6.4.3: Human Affordances

Part of the explanation for the initial specificity of non-human actors is that, because the aspiring musikarbeiter already *wants to make*, entry into the network is subject to gatekeeping. In the accounts in 5.2, the general discussion of theme 1, what might be termed sub-networks – recording studios, record labels, software houses – are able to demand *human affordances* such as specific software skills.

Latour has termed these as "plug ins" but I want here to capture the sense that these are *handles that can be offered* to gatekeepers which serve a dual purpose. Firstly, they *invite* actor-networks to grasp them in order to achieve a goal – often a deliverable – but at the same time, in order for a network to grasp such a handle, they must *open the gate*. This strategy only works from the gatekeepers' perspective because enrolment has already been made desirable. I gave the example of the Calade network. This network has already done a great deal of work that has primed it to be an object of desire. It has produced music and media software, liaised with recording studios, done all the *work of connecting* to achieve lock-in (which, remember, is beneficial from its point of view) and

be perceived as an industry standard which is both prestigious and hard to move away from, both due its interoperability with a large user base and the necessity for replacing a quantity of expensive hardware and software. In other words, the array of human and non-human actors in this network have achieved great stability (and the non-human actors have played a major role in this). Since Calade is in this position it can be quite demanding about who it enrols, and hold such things as competitions for internships. In the end the musikarbeiter who was successful needed to offer not just proprietary software skills but also affordances of customer service experience.

Again, however, it is also the case that gatekeepers demand flexibility, in particular the flexibility to rapidly adapt to the exigencies of their particular network. This ability to rapidly and cheerfully adapt forms a particular human affordance seen as "professionalism" and both STEM-like problem solving skills (5.2.2) and a kind of phronesis (5.2.1) are components. A similar affordance is *trustworthiness*: the perceived ability to present a "deliverable" without disruption. This again may involve quite deep technical knowledge and creative skill but also the adaptability that comes with not being locked in.

6.4.4: Creativity and Deliverables

How does "creativity" come in? Somehow all of this is a creative act and musikarbeiter and educators are in practice aware of this. An initial reading might see musikarbeiter lured in by aesthetic commitment but then tied into a purely technical role. Indeed, this is implied by E's account. However, it is worth recalling that E at this point in the interview associated creativity purely with musical performance and composition. If instead we take Dewey's dictum, echoed by Sennett, that "the intelligent mechanic is artistically engaged" then E's account of mixing as a praxis, with its reliance on experiential wisdom ("I can walk into a room and know what it will sound like") is surely a creative practice in its own right.

It is possible to outline a cycle of aesthetic recruitment – technical skill – aesthetic outcome. The array of deliverables discussed in 5.4, which are couched in very technical terms such as bit depth and sample rate, and which are required to be precisely formatted before they can be translated into other networks of distribution and consumption, *are also aesthetic objects*. When we talk about delivering commercial items for consumption it is easy to become disillusioned and fall into a kind of despondency, but it is also true that what a deliverable will become as it is translated and mediated is *the thing* - the aesthetic object - that others will *enter the felt presence of* and be transformed in turn. As one might expect from ANT, the translation of a "deliverable" into an aesthetic object requires work. For example, Harper (2010) discusses how "systems" constitute – bring into being – musical

objects (p66). And as Latour implies, this is work in the physics sense and has an energy cost, as discussed in Devine (2019): fossil fuels are burned, containers of electrical goods are shipped round the world, servers hum, trucks full of vinyl trundle down highways, electrons are moved in wires, speakers shunt air molecules around.

Latour (2017) discusses the difference between an actant and an actor. An actant is a kind of raw thing that can be expressed in different ways – Latour gives an example from politics of "Imperialism strives for unilateralism" and "The United States wishes to withdraw from the UN" (with some other versions) as being different expressions of the same political actant. In the same way a deliverable is a non-human actant that may be "an audio file of 96KHz and 24 bits, 4minutes 37 seconds long, with LUFS of -12", "an Apple Digital Master", "Check out my new track", and "Oh my God this tune has changed my life" at the same time.

Chapter 7 - Conclusion: Implications for Practice

The goal of this short and final chapter is to explicitly relate these findings back to education. Education has of course been implicit all along, in that we have been exploring the terms and conditions of induction into practice which educators are part of and try to engage their students with. The first part (7.1) is based largely on the educators' own responses as laid out in chapter 5 and especially 5.5. The second part (7.2) attempts to map out some of what Latour called matters of concern towards a curriculum. The chapter (and the thesis) concludes with a short paragraph on the nature of vocational music technology education.

7.1: What Did the Educators Say?

Educators have to bear all of the above in mind. They are keen to ensure that their students original aesthetic motivation is present and harnessed: "I think it's just more important to like music." (M). They search for moments where significant contact can be made: "I'm standing behind the [binaural] head, but I'm technically standing in front of the student…they're listening to the mic and I start talking…it's like they really freaked out" (J). And they seek to deliver up to date technical skills: "Dante [connection protocol] in the studio, as mentioned earlier, that didn't exist even a few years ago, it's only recently come in. But if you want a career in studios or in live sound, you pretty much got to know it." (N)

A major matter of concern, reflected in educators' responses, is to enable students to become autonomous. There are two reasons for this. One is to avoid what might be termed premature lock-in. I have alluded to this above in chapters 5 and 6. Revisiting the comment that learning Audinal as opposed to other software might define a career, we can see that this can work well or badly. If a student only knows Audinal but is attracted to an environment where it is not used, they may find the door barred instead of opened. They risk, in other words, offering the wrong affordance to the wrong network. As educators we are caught in a balance where we need to teach specific skills in enough depth to be useful (for example a full knowledge of all the audio editing tools in a piece of software) but at the same time students need to be able to *rapidly and flexibly apply those skills elsewhere*. We hope that by training the hand in one set of operations, or by teaching underlying principles in a more theoretical way, or by setting assignments that foreground problem solving, students will be able to abstract enough of the principles at work that they will be able to also undertake similar (but not identical operations) such as micing a different kit or using different software (in the way E can with mixing desks). We also hope they might learn how they might abstract principles themselves if they

need to - in other words that they may fully master a *techné* not as a set of givens, as implied by Dunne, but as a process. N addressed this precise concern in the same sentence as their quote about Dante above: "Part of what they should do to be independent is *learn to teach themselves because* Dante didn't exist even a few years ago" – if, once they have graduated, students encounter a new thing, they need to be able to learn it on their own. There is a level at which all synthesizers are the same, and a level at which they are not the same.

The second is that this kind of adaptability *is in itself an affordance*. P as has been noted speaks eloquently of this as cheerful professionalism and a can-do attitude. This is also expressed as *enjoying problem solving* – figuring out how a new thing works has helped both D and C for example. J's leaving of their students to carry out an important recording on their own has the same end. This exercise was not intended to simply apply their skills to unfamiliar hardware, but to enable them to become used to utilising those skills, and solving any issues that arose, without relying on outside agencies. Where educators have discussed frustration, it is most often with the difficulty of bringing students to this more autonomous creative space. M has thought deeply about pedagogy and works towards inducting their students into this deeper, more thoughtful layer of practice where a musikarbeiter can adapt and potentially even creatively abuse equipment (in the way Sennett describes) by *providing safe spaces for them to fail*.

7.2: Conclusions

I am reaching the end point of this journey. I have tried, in the spirit of Latour, to conduct a social/educational overview without making too many assumptions about the nature of society, education or indeed music, but inevitably I came to the research with some ideas, taken from my own experience, of a blended practice of music technology that might serve as an example of something that doesn't quite fit into curricular ideas of "STEM" or "Humanities" or "Art", a recalcitrant thing in the world forged in practice by people whose main concern is making things and doing things. Some of their matters of concern are aesthetic – creating great music. Some are commercial – selling products (whether technical or musical). Some are technical – working with and improving equipment, or making sure that all of it works together as a network rather than falling apart. P's day job for example can be seen as a form of maintenance of the Calade network that in turn makes a whole series of films and pieces of music possible.

I believe I have found some commonalities in all of these networks, informed by my literature review and above all the interviews. In discussion I have been led to understand that at some point any thesis

will be remembered by a simplified overview, so here is mine. I therefore wish to distil this down into three affordances, that are advantageous if a musikarbeiter is to be mobilised, and maybe to achieve agency. In an educators' terms, these are the matters of concern suggested by this thesis.

7.2.1: Skills

A great deal of what has been written down can be described as skills. Operating a mixing desk, positioning a microphone, sequencing MIDI into music software, understanding and using the controls of a synthesizer are all skills. There are technical and craft elements to all of these – competently mixing a track is a skill that goes beyond knowing what the faders and knobs do, but knowing what they do is a vital prerequisite to mixing a track.

It is also the case that these skills must ultimately be able to be applied flexibly. Musikarbeiter may be asked, or impelled for their own reasons, to work with different hardware and different software in different environments. This has elements in common with phronesis (Dunne 1997) but as we noted in chapter 1 Dunne considers phronesis to be dynamic not rule based. These skills however are both dynamic *and* rule based. There is also an element of *techné* in that students may need to abstract principles of operation from one device and apply it to another – there is, after all, a technical level at which all mixing desks do the same thing – but in turn that *techné* is fully interlinked with the experiential background highlighted by Dunne. Indeed, at a high level, musikarbeiter are themselves able to configure or build equipment to provide the technical predictability they will need.

In educational terms, then, skill acquisition is important, but the matter of concern is to move beyond "just" skills teaching. The technical understanding needed to achieve flexibility, avoid pitfalls such as premature lock-in, and offer affordances to networks of music technology is not just procedural. It has elements of, but is not identical to, Sennett's higher levels of skill – elements of it because it involves moving beyond the problems of "getting things to work" but not identical because certainly some parts of it would not be considered a craft in Sennett's sense. Educators in my interviews have discussed various ways of inducting students into this, including providing safe spaces to fail, creating assignments where students are forced to problem solve or understand abstractions, introducing ways to "abuse" (in Sennett's sense) equipment, and introducing them to novel non-human actors which they will need to interact with to meet their aesthetic goals.

7.2.2: Creativity

It should not be forgotten that both the initial impetus and motivation of a musikarbeiter, and the output of the network of which they are a part, is aesthetic. I have specifically looked at music producers and educators, and it seems to be the case that they are recruited by a transformative aesthetic experience or set of experiences, that mostly takes place before any formal training, and are motivated to create transformative aesthetic experiences in their turn. Their technical skills are likely to be turned one way or another to this goal. An example of how the technical and creative are bound together can be found in the *deliverable:* a tightly technically specified non-human actant whose efficacy as an aesthetic object *depends* on those technical specifications. Although a musikarbeiter might lean towards creative or technical ends ultimately the deliverable is an actant both of whose expressions need to be apprehended.

Many of my participants have thought about their process and have tried to match their technology with their aesthetic outcome. This can be as sophisticated as H's deep integration of the two, but none of the application of skills is purely mechanical: to take the example of mixing again, *competently* mixing a track is one thing but *artistically* mixing a track is another. The intelligent hand, after all, is artistically engaged.

The matter of concern for educators, this suggests, is to ensure that students are not only equipped to carry out these creative goals, but that the connection between the technical things they are doing and the art - or deliverable - they want to make is clear. When students come to us it is not just to acquire technical skill but to be inducted into a technological practice of "musicing" (in Elliott's (1995) terms – I am again following Elliott's spelling in this discussion). The ways in which they do that may be quite diverse and will often (as mentioned at the end of 7.2.1) involve introduction to non-human actors (MIDI controllers such as the Push, Software such as Audinal or Ableton Live, hardware or software synthesizers) which they may bond with.

Paradoxically an educator's role may also be to *loosen* these bonds in order to stretch students' practice of musicing, by suggesting or setting as assignment tasks the use of alternative processes. This may also stretch them aesthetically by introducing them to new ways of musicing: a student with a primary interest in electronic music could be asked to record or mix a band (or vice versa). A student may discover an enjoyment of cinematic sound effects via an engagement with the process of making them. This acquisition of aesthetic flexibility may also open up doorways or encourage them to take up opportunities that they would otherwise miss.

7.2.3: Autonomy

The flexibilities addressed under "skills" and "creativity" are part of what I mean by autonomy but interviewees such as P and Q go further. There is an expectation in their areas of the industry that they can be "trusted to get the job done". This involves being both technically trustworthy – having an understanding of the operation of their equipment – and also being able to work without micromanagement. This is what J hoped to impart to their students in their recording session. These are often addressed in the curriculum as "soft skills" – turning up on time for example – but there is more to them than this. Turning up on time is of no use if one can't then do the work. The same applies to producer/performers such as B, A or C: for a performance to be a success they need to be there, on time, with their equipment, and an understanding of how it works (or at the very least common things that might go wrong and how to fix them).

They are also not just expected to have a sound that will work but one that is *engaging*. P, for example, discusses how a particular director trusts them to carry out an engaging piece of sound design, and the producer/performers need to not just play a gig where nothing goes wrong but to play a *good* gig – hitting that hard to define mark of aesthetic experience – at least most of the time or they will not be re-booked. E's freelance employment depends on producing a mix that "sounds right" to an audience. Trust in aesthetic judgement is therefore also part of the trustworthiness that is a musikarbeiter's currency.

I have put these criteria of trustworthiness under the heading of "autonomy" to try to capture the feeling, not only that a musikarbeiter will be expected to get the job done, but that "the job" itself demands the use of independent aesthetic and technical judgement. A band does not micromanage a mix engineer. The matter of concern for educators is therefore the inculcation of autonomy. The technical competence covered by 7.2.1. and the nurturing and extension of creative judgement in 7.2.2. are vital components of it. A student is unlikely to be truly autonomous unless they are confident in their technical understanding and aesthetic judgement.

Autonomy or trustworthiness is perhaps the hardest of the three matters of concern to pin down in educational terms. The provision already mentioned of safe spaces to fail, and also paradoxically the expectation that students will be able to operate on their own in high stress environments, both have the same impetus – the idea that students will at some point have to do things on their own – and might even work at opposite ends of the same programme. It seems easy to forget amidst the teaching of technical and creative criteria but is perhaps the most important outcome.

7.3: A Final Word.

I have tried through all of this to both map and suggest ways forward. Vocational education in particular takes things as they are found in the world rather than tries to squeeze them into curricular schemata. Music technology was not created because someone thought it was a good idea to mix science and art for philosophical reasons. It arose out of a mesh of commercial opportunities, technical advances and artistic creativity that (as Devine or Thornton have shown) is deeply embedded in historical networks of creation and distribution, of recalcitrant stuff that needs to be engineered as well as transformative aesthetic experience. It is here, and it is a glorious dirty mixture.

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Appendix 1: Ethics Application, Emails to Participants and Proforma.

Appendix 1.1: Ethics Application.

University of Sunderland

Application 006704

Section A: Applicant details

Date application started:
Thu 26 March 2020 at 11:42

First name:
Tim

Last name:
Day

Email:
Timothy.Day@research.sunderland.ac.uk

Programme name:
SUNCETT - Customised MPhil

Module name:
SUNCETT - Customised MPhil

Last updated:
05/08/2022

Department:
School of Education

Applying as:
Student

Research project title:
Musikarbeiter - Collapsing dichotomies and divisions between STEM and creative frameworks in Music Technology education

Similar applications:
- not entered -

Supervisor

1. Supervisor

Name	Email
Prof Margaret Gregson	maggie.gregson@sunderland.ac.uk

Risk Assessment

Suitability

Adheres to BPS Code of Human Research Ethics (2021)?
No

Takes place outside UK?
No

Involves NHS?
No

Healthcare research?
No

ESRC funded?
No

Involves adults who lack the capacity to consent?
No

Led by another UK institution?
No

Involves human tissue?
No

Clinical trial?
No

Social care research?
No

Risk Assessment

Does the study involve participants who are potentially or in any way vulnerable or who may have any difficulty giving meaningful consent to their participation or the use of their information?
No

Are participants to be involved in the study without their knowledge and consent (e.g. through internet-mediated research, or via covert observation of people in public places)?
No

Will the study require the co-operation of a gatekeeper for initial access to the groups or individuals to be recruited?
No

Does the research methodology involve the use of deception or activities which are conducted without participants' full and informed consent at the time the study is carried out?
No

Are there any significant concerns regarding the design of the research project?
No

Does the research involve any of the following groups?

a. children under 18 years of age?
b. vulnerable adults (eg people with learning or communication difficulties)
c. individuals who have a dependent or subordinate relationships to researchers
d. people in custody (eg young offenders or people in prisons)
e. individuals unable to give consent
f. individuals involved in illegal activities
g. therapeutic interventions

Yes

If the proposed research relates to the provision of social or human services is it feasible and/or appropriate that service users or service user representatives should be in some way involved in or consulted?
No

Are there payments to researchers/participants that may have an impact on the objectivity of the research?
No

Will financial inducements (other than reasonable expenses and compensation for time) be offered to participants?
No

Could the study induce unacceptable psychological stress or anxiety or cause harm or negative consequences beyond the risks encountered in normal life? Will the study involve prolonged or repetitive testing?
No

Will the study involve discussion of sensitive topics? For example (but not limited to): sexual activity, illegal behaviour, experience of violence or abuse, drug use, etc.)
No

Are drugs, placebos or other substances to be administered to the study participants or will the study involve invasive, intrusive or potentially harmful procedures of any kind?
No

Will research involve the sharing of data or confidential information beyond the initial consent given?
No

Is there ambiguity about whether the information/data you are collecting is considered to be public?
No

Will the research involve administrative or secure data that requires permission from the appropriate authorities before use?
No

Will the research involve the use of visual/vocal methods that potentially pose an issue regarding confidentiality and anonymity?
No

The Data Protection Act 2018 will apply to any data-processing activities entailed by this research. Is there any cause for uncertainty as to whether the research will fully comply with the requirements of the Act?
No

Are there any particular groups who are likely to be harmed by dissemination of the results of this project?
No

Do you have any doubts or concerns regarding your (or your colleagues) physical or psychological wellbeing during the research period?
No

Will the research involve accessing security-sensitive material, such as material related to terrorism or to violent extremism of any kind, including, but not limited to, Islamist extremism and far-right extremism?
No

Summary

This study proposes that STEM and creative practice need not be in opposition but in some cases (in particular technical creative media such as music technology) can form an indivisible whole.
The study examines the acquisition of practice in a music technology cohort, teasing apart and paying attention to the application of STEM problem solving methodologies (hypothesis testing) to creative problems (sound design, composition). Drawing on the practice of students and staff, it shows how STEM problem solving techniques can be an inextricable part of creative endeavour. The roles of playing with and "misusing" technology are discussed with reference to Dunne's (1995) declaration that a living practice must be extended by its insiders in ways that sometimes seem "dramatic or even subversive"
Approximately 6 practitioners for several areas of music technology will be interviewed and asked to provide their stories of how they acquired and continue to carry out their practice, The interviews will undergo thematic analysis

Section B: Basic information

Proposed project duration

Start date (of data collection):
Fri 1 April 2022

Anticipated end date (of project)
Sat 31 December 2022

Indicators of risk

Involves potentially vulnerable participants?
No
Involves potentially highly sensitive topics?
No

Section C: Summary of research

1. Aims & Objectives

This study examines the connections between STEM and creative practice and pedagogy with special reference to music technology

2. Methodology

Approximately 6 practitioners from various areas of the industry will be interviewed and the interviews video recorded and transcribed. It is likely that some or all of the interviews will be remote via Zoom or equivalent. After consulting my supervisor, the interviews will have a minimum of structure and interviewees encouraged to provide narratives of their process working in the field as well as acquisition of practice. The interviews are anticipated to be roughly 30 minutes long.
The interviews will then undergo thematic analysis in order to draw out and elicit any relevant or emergent themes relating to the practice of music technology that may then illuminate our own practice as teachers.
Illustrative questions are:
- In your experience what is the relationship between tecnical and creative aspects of your work?
- Tell me how you became a ...(teacher of music technology/sound production engineer/ producer etc?)
- What were the critical turning points in your career for you and why?
- What were your most memorable moments in your career and why are they so memorable for you?
- What do you see as being the most important aspects of your professional practice? Your knowledge as a creative? Your technical knowledge? Practical knowledge? Theoretical knowledge? etc.
- How did you get to be good at what you do? How do you make sure that you stay good at what you do?
- What are your hopes and fears for the practice of ... in the future?

3. Personal Safety

Raises personal safety issues?

No

Section D: About the participants

1. Potential Participants

Practitioners will be identified from a range of people working in the industry, who are known to me in connection with my own musical practice.

2. Recruiting Potential Participants

They will be recruited initially by email.
Participants will be told that this is work towards a research project investigating the nature of music technology practice, and that it will involve a half hour remote interview.
I will make clear in my initial email that:
All participants are free to participate or not as they please and that they have a right to withdraw at any time in the research. I will ensure that there no adverse consequences will incur (including social consequences such as changing of friendship status) if a participant does not wish to engage in the study or wishes to withdraw at any stage.

3. Consent

Will informed consent be obtained from the participants? (i.e. the proposed process) Yes

I confirm that I will be using the University of Sunderland consent template in my research and that I will follow both the University of Sunderland and BERA 2018 Ethical Guidelines throughout this study. I confirm that all data will be collected, stored and retrieved in accordance with GDPR 2018. Although data from the research are likely to be quoted, all interviews and transcripts will be treated in accordance with GDPR 2018 and BERA 2018 ethical guidelines paragraphs 40-51

I will make clear in my initial email that:
All participants are free to participate or not as they please and that they have a right to withdraw at any time in the research. I will ensure that there no adverse consequences will incur (including social consequences such as changing of friendship status) if a participant does not wish to engage in the study or wishes to withdraw at any stage.

By the nature of the interviews, it is possible that participants will be identifiable from contextual information that they provide. Before any interview I will ask participants in the research to choose their own pseudonyms in order to ensure anonymity in accordance with BERA 2018 guidelines paragraph 50 participants full confidentiality will be ensured (including 'fictionalising'/''generalising' of information surrounding the interview) or anywhere in between where there is any risk of a participant being identified in the data by their job role, context, location etc.,

Two of the prospective participants are line managed by me in the workplace, in order to avoid any potential feelings of coercion it will made very clear to them that their participation is entirely voluntary and this research is not in any way related to the workplace except insofar as it draws upon on their specialist skills in the workplace and their accounts of experiences of becoming and being specialists in this field of practice.

A written guarantee will be provided to all participants in the research that no adverse consequences (for example HR procedures) would arise from any discussion of their practice.

4. Payment

Will financial/in kind payments be offered to participants? No

5. Potential Harm to Participants

What is the potential for physical and/or psychological harm/distress to the participants?

No physical or psychological harm is anticipated.

How will this be managed to ensure appropriate protection and well-being of the participants?

Not applicable

Section E: About the data

1. Data Confidentiality Measures

I will be complying with GDPR 2018 and BERA ethical guidelines chapters 40-51

2. Data Storage

I will be complying with GDPR 2018 and BERA ethical guidelines chapters 40 and 49

Section F: Supporting documentation

Information & Consent

Participant information sheets relevant to project?
Yes

Document 1012204 (Version 1) Consent and participation document	All versions
Document 1019323 (Version 1)	All versions

Consent forms relevant to project?
Yes

Document 1012205 (Version 2) Consent and participation document	All versions

Additional Documentation

External Documentation

All participants will be using forms based on the template provided by University of Sunderland.

Section G: Declaration

Signed by:
Tim Day
Date signed:
Thu 10 March 2022 at 17:54

Offical notes

Appendix 1.2: Text of Email Sent to Participants

Dear xxx

I'm sending you this email to ask you to participate in my PhD research project. This is a project investigating the nature of music technology practice

> What this means: I am trying to find out your view of what you do (so it might be creative production/techy or electronic performance/audio engineering or anything related) and how you got to where you are, with a view to taking those insights back into educational practice (in other words using what I have learned to make us better at teaching the subject)

What I would like to do: Interview you for approximately 30 minutes over Zoom or similar. This interview would be recorded and transcribed. There may be a follow up after I have written up my findings to ensure I have represented what you have said accurately. I am looking to interview maybe 10 people and gather all their experiences.

The project has been approved by an ethics review following BERA 2018 guidelines.
This is the relevant paragraph that has been approved relating to informed consent:

"All participants are free to participate or not as they please and that they have a right to withdraw at any time in the research. I will ensure that there no adverse consequences will incur (including social consequences such as changing of friendship status) if a participant does not wish to engage in the study or wishes to withdraw at any stage.

By the nature of the interviews, it is possible that participants will be identifiable from contextual information that they provide. Before any interview I will ask participants in the research to choose their own pseudonyms in order to ensure anonymity in accordance with BERA 2018 guidelines paragraph 50. Participants' full confidentiality will be ensured (including 'fictionalising'/''generalising' of information surrounding the interview) or anywhere in between where there is any risk of a participant being identified in the data by their job role, context, location etc".

What this means:

- You are free to say yes or no, or pull out out at any time, you in no way need to participate and I do not feel there is any obligation on you to do so. I won't be upset if you say no or change your mind.
- Full confidentiality will be assured including "fictionalisation" or "generalisation" of information around the interview so you cannot be identified in the data.
- You will be invited to choose your own pseudonym in order to ensure anonymity
- If it is important to you not to be anonymous, for example there is an experience you would like to be attributed to your own name, that is also an option.

My zoom link is:

Hope to speak to you soon!

Tim

Appendix 1.3: University of Sunderland Proformas

Consent Form

Study title: Musikarbeiter - Collapsing dichotomies and divisions between STEM and creative frameworks in the Practice of Music Technology

Participant code: _____

I am over the age of 18 / aged 16-18 (please circle)	
I have read and understood the attached study information and, by signing below, I consent to participate in this study	
I understand that I have the right to withdraw from the study without giving a reason at any time during the study itself.	
I understand that I also have the right to change my mind about participating in the study for a short period after the study has concluded.	

Signed: _____

Print name: _____

(Your name, along with your participant code is important to help match your data from two or more questionnaires. It will not be used for any purpose other than this.)

Date: _____

Witnessed by: _____

Print name: _____

Date: _____

University of Sunderland

PARTICIPANT INFORMATION SHEET

Study Title Musikarbeiter - Collapsing dichotomies and divisions between STEM and creative frameworks in the Practice of Music Technology

What is the purpose of the study? To collect and analyse accounts of the experiences of music technology staff and industry practitioners in relation to being and becoming a specialist in this field of practice

Who can take part in the study? Teachers, technical staff and industry practitioners working in the field of music technology.

Do I have to take part?

Participation is entirely voluntary. If you change your mind about taking part in the study, **you can withdraw at any point during the session without giving a reason and without penalty**.

What will happen to me if I take part? You may be asked to give recorded interviews, take part in a focus group, and/or answer questionnaires. All of these will be anonymised.

What are the possible disadvantages and risks of taking part? None.

What are the possible benefits of taking part? There are no financial benefits

What if something goes wrong?

If you change your mind about participation, please contact me by email to cancel your participation. If you feel unhappy about the conduct of the study, please also contact me immediately or the Chairperson of the University of Sunderland Research Ethics Group, whose contact details are given below.

Will my taking part in this study be kept confidential?

Yes

What will happen to the results of the research study?

The results may also be presented at academic conferences and/or written up in the form of a thesis and offered for publication in peer reviewed academic journals.

Who is organising and funding the research?

Organised by author as part of University of Sunderland SUNCETT-MPhil funded by ETF

Who has reviewed the study?

The University of Sunderland Research Ethics Group has reviewed and approved the study.

Contact for further information

Doctor John Fulton (Chair of the University of Sunderland Research Ethics Group, University of Sunderland) Email: john.fulton@sunderland.ac.uk
Phone: 0191 515 2529

Appendix 2: Sample Transcripts

Appendix 2.1: Transcript of part of interview with participant B

56
00:05:57.390 --> 00:06:08.340
B: i've never plan anything I sit at the computer and and i'll open up a project and i'll choose a random bpm and then.

57
00:06:09.090 --> 00:06:21.810
B: i'll probably just put like a bass drum down so just tapping the keyboard just dum dum dum dum and then loop that and then I just mess around with different sounds and if something.

58
00:06:22.770 --> 00:06:36.090
B: If I hear something I like I just put that down, maybe over four bars and then a layer up another one, and just see what comes out it literally is just seeing what what happens so I never know when I sit in front of the computer.

59
00:06:36.690 --> 00:06:47.970
B: How it's going to turn out so never know what I don't I say probably 90% of the time it's completely unplanned trying to think when I have planned something.

60
00:06:48.780 --> 00:06:56.010
B: I might have been bored sitting in my car or something and before i'm about to teach the ukulele, which is what I do for my job.

61
00:06:56.430 --> 00:07:10.710
B: I might pick up a ukulele and just start strumming something, and if something cool comes out of my get home and then put that onto and or interpret that in some way on to logic, but that's that's still not really planned.

laughter

62

00:07:11.790 --> 00:07:12.390

Tim Day: I guess not.

63

00:07:12.690 --> 00:07:13.110

yeah.

Appendix 2.2 Transcript of part of interview with participant D

44

00:04:14.640 --> 00:04:22.200

Tim Day: And you can you can give a particular example, if you like, in you know I mean I know you use logic I don't know if you use mainstage or something else on stage for.

45

00:04:22.230 --> 00:04:29.580

D: Well yeah I mean we yes, I mean in that in that set, yes, with <band> we use we use Logic and.

46

00:04:30.810 --> 00:04:45.180

D: You know, and that stems from me, having spent a lot of time in in the late 90s kind of just playing with the early earliest versions of logic and the environment and and the manipulation of MIDI and realizing.

47

00:04:46.230 --> 00:04:55.860

D: You know what can be achieved we've kind of you know it's almost like one small event happens and all of this (expansive hand gesture) can happen as a consequence, so.

48

00:04:57.480 --> 00:05:08.550
D: So yeah with with <band> it's all with that band it's all it's all happens via logic and it still happens why the environment, I get the feeling that logic are trying to kind of phase out the environment.

49
00:05:09.330 --> 00:05:22.920
D: which, for me, would be a kind of disaster, for various reasons, but mainstage as well in every other band that I play, and when I play keyboards mainstage and really getting.

50
00:05:24.330 --> 00:05:27.180
D: Really pushing mainstage to its limit really.

51
00:05:29.760 --> 00:05:33.060
D: You know mainstage looks like a very.

52
00:05:34.710 --> 00:05:42.840
D: Very simple piece of software until you kind of burrow into it and it's incredibly powerful and that's part of the joy of.

53
00:05:43.920 --> 00:05:47.610
D: you know, working with.

54
00:05:50.250 --> 00:05:54.240
D: Using that technology in the in these bands is is yeah finding out.

55
00:05:55.560 --> 00:06:02.460
D: finding out what its limits are and whether you can, Oh, you know it's it's basically I love problem solving.