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Waters, S. (2021). The Entanglements which make Instruments Musical: Rediscovering Sociality. *Journal of New Music Research*, 50(2), 133-146. <https://doi.org/10.1080/09298215.2021.1899247>

Published in:
Journal of New Music Research

Document Version:
Peer reviewed version

Queen's University Belfast - Research Portal:
[Link to publication record in Queen's University Belfast Research Portal](#)

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The Entanglements which make Instruments Musical: Rediscovering Sociality.

Simon Waters (Queen's University Belfast; Orpheus Instituut Gent)

A thing becomes a musical instrument by virtue of its use in a social context, a use of which its initial intended design (if it had one) forms only a part: sometimes a very small part.

Abstract

This paper draws on the notion of the 'performance ecosystem' (Waters, 2007), focusing on the social implications which flow from considering musical activity in such a manner. It suggests that instrument designers/makers working with digital technologies are typically over-concerned with reductive abstractions, and pay insufficient attention to the social contexts/constructs that characterise every level of musicking. It looks at the emergent, situated co-development of player, instrument and environment, suggesting that humans habitually use instruments to sense out, test and probe the possibilities of self-other relations in dynamic, mutually-engaging, and often playful and improvised behaviours¹.

This paper brings together two branches of my research, developed over some forty years as an improvising performer and composer: an engagement with musical instruments as 'things' bearing dense historical, cultural and potential knowledge, and an undimmed fascination with the moment of their use in musicking. In Waters (2007) I suggested that the notion of the performance ecosystem might be a useful manner of understanding the relations between performers, instruments and environments, intending such 'ecosystemic thought' as a tool for understanding *all* musical activity in a situated, holistic manner; as if all performers were and always had been in complex feedback loops with their instruments and environments, and could best be understood in that way, rather than being accounted for as separable parts of a system. Musical instruments were and always are parts of a larger *necessary* assemblage.² In a manner that rather too neatly illustrates one of the themes of this current paper – that what one 'designs' into something is not necessarily how it manifests in public life – the instances with which I illustrated the 2007 paper were taken by some to indicate that there were some musical situations and phenomena which were 'ecosystemic' and some which were not. Although by featuring the work of Agostino Di Scipio (2003) and Nic Collins (2006) I did perhaps encourage this reading, I was proposing ecosystemic thought as a tool for understanding the complex interconnectivities in *all* musical activity; not only that involving highly technologized situations or digital technologies.³ A subsequent observation made of the same paper was that it failed to address the social aspect of musical activity, and I hope to begin to correct something which was indeed left both assumed and implicit in that earlier writing here, as I believe it to be the key to a refocusing of attention from designing musical instruments to designing contexts for musicking.⁴ (Small, 1998)

I will proceed initially by suggesting that, despite the seeming differences between acoustic instruments and those involving digital technology, many of the concerns of those involved in digital instrument making can be usefully illuminated by being placed within a broad history of instrument use. As an example, one such insight might be that, within this broadened historical (and cultural) framework, the 'non-standard' instrument can be seen to be commonplace. It has been a pervasive anxiety among the new musical instrument making community⁵ that their instruments tend to be ephemeral and their repertoires strongly dependent on tacit knowledge within small communities of practice, but the nature of *much* musical activity can be best understood in this dispersed, distributed manner, despite the efforts of some musicology to persuade us of its teleological

¹ The entanglements (see e.g. Hodder, 2012) of the title are therefore the complex network of interrelations between objects, humans, environments, histories and ideas. Such co-dependencies may operate irrespective of physical or historical distance, and though pervasive may also be temporary or unpredictable.

² The term assemblage here points beyond the self-evidently problematic 'component' materiality of the instrument, via its ecosystemic interpenetrations, to Born's (2011) 'constellation of mediations', theorised as four autonomous but enmeshed planes of social mediation, allowing for a non-reductive account of 'music's plural socialities'.

³ Owen Green (2014) articulates this with characteristic elegance: 'a musical activity spreads out from its text, or software, to become embroiled in further flung social or musical networks, forming, in each instance, a particular musical assemblage... This embroilment is a feature of musical activity in general, but... work like Di Scipio's can serve to make these interconnections conspicuous.'

⁴ As ever, John Blacking, an early influence on my thought, was prescient here, his 1973 *How Musical is Man* – much quoted for the title of its first chapter, 'Humanly Organised Sound' – ends with the less well-known 'Soundly Organised Humanity'.

⁵ This topic is thus far most convincingly addressed by Goudard (2019).

continuities and inevitabilities. There is much to learn from old musical instruments, as these embody patterns of use, and ideologies of everything from acoustic fact to social cohesion, which often transcend (exceed) or ignore the conditions for which they might have initially been 'designed', but it is unlikely that we will learn much from them without placing them fully within their sociological contexts.

My working assumption here is going to be that it isn't useful to think of musical instruments as objects. As their status as 'musical' is dependent on their use in musicking, proceeding to design them as devices which are *then* placed into a musical context is likely to be less productive than studying how humans (plurally) conduct and organise themselves in musical activity. The notion of the 'performance ecosystem' was intended, in its refusal of the seemingly obvious distinctions between performer, instrument and environment, to focus attention on refining our accounts of what happens in the areas of ambiguity between these three 'categories'. Attending to such relational (emergent or enactive) interpenetrations and asymmetries is a key to refining our capacity for discrimination in self-other relations. It is therefore always at the very least implicitly social in motivation. And if one allows that environment, in the majority of musical activity, extends beyond a physical/acoustic phenomenology and incorporates other human participants, such research becomes explicitly socially situated: about musicking's social role. I will therefore look both at projects that explore 'ensembling' and those which, though apparently more 'solo' in orientation, cast light on the nature of the ambiguities to which I've referred above. My personal context as an academic working in a research centre focused on such projects⁶ has inevitably led to some partiality in the selection of examples, though all are works which have received international attention or exposure.

Terminology

Before embarking on this I will flag up two terminological issues which might otherwise cause confusion. I will not here enter into a detailed (though overdue) consideration of the term *agency*. On the few occasions in which it is used I trust it will be evident from the context which flavour of the term is intended. And I will, despite an instinctive dislike for them, occasionally employ the problematic terms *expressive/expressivity*, as these are widely used among the community of instrument builders and developers associated with conferences such as New Instruments of Musical Expression (NIME) and elsewhere.⁷ The cultural baggage associated with this is unavoidable, carrying the strong implication that the musical instrument is a conduit for some sort of supplementary expressive 'content' which, having been 'intended' by the performer, is somehow 'decoded' by the listener. I use the term to mean simply the transduction of physical action, often unmediated by conscious thought, into sound.⁸ Thus, no 'content' as such is transduced. Rather, the 'performer - instrument - environment' complex functions much in the manner of Bennett Hogg's (2011: 87) description of the violin as a 'lie detector', transducing only the trace and plausibility (perhaps even 'truth') of that action.⁹ Although of course framed by conscious thought at the level of 'intention to perform musicking', the player's moment-to-moment engagement with the instrument has to function 'as-if' unconscious or intuitive, because conscious linking of action to sound would simply not be fast enough for compelling musicking to occur.¹⁰ Here I am wilfully ignoring crucial issues of skill, history and prior experience for the sake of simplicity, but these will be revisited later in the course of writing.

Design

Those involved in musical instrument making (in the broadest sense) have much to learn from Lucy Suchman's useful distinction (1987, 2007) between 'plans' and 'situated actions', and in particular the manner in which one transmutes into the other. Suchman stresses that actions are *always* situated, and that perceiving and doing are not separate, but interdependent. Once design (as a field of abstract possibility) becomes situated, performances

⁶ SARC – the Sonic Arts Research Centre at Queen's University Belfast.

⁷ The NIME community has recently evidenced an impressive and increasing sense of self-critique, notably in its embracing of Hayes and Márquez-Borbón (2020), whose work corresponds strongly with my observations here.

⁸ Of course, the position of all listeners, including performer(s), with respect to the sound production and distribution/diffusion of sonic energy is a further environmental factor in the apprehension of the spectral qualities and morphology of that energy, hence my continuing interest in sonic proxemics (Waters, 2006, 1013, 2018). The relative localisation of sound/energy (intimate, local, environmental) is a key factor in establishing presence/co-presence, and it might be argued that the non-linearities in our sensitivity to frequency are in some sense a physical precondition for our capacity to discern sonic presence and proxemics.

⁹ To paraphrase Michael Edgerton, in an informal online review (12/12/2008), what is being communicated, if anything, rather than content, is communicability itself: the fact of another subjectivity, and by implication sociality and potentially community.

¹⁰ As Borgo (2018: 5) phrases it "our actions are either initiated from below the level of our conscious awareness or inflected by social dynamics of which we are seldom aware."

and repertoires emerge dynamically from that collision with lived reality. The human factors which appear to contribute particularly to the dynamism of such emerging behaviours include our varying capacities to distribute attention, and a huge propensity for improvisation. The fact that computers *require* a level of design (in the form of programming and 'interface design') to function usefully for humans has elevated the consideration of 'designed intent' to a point of near-ubiquity, and masked approaches beyond the human-computer interaction (HCI) paradigm which might have much to offer, particularly those which recognise the essentially improvisatory, contingent nature of much human conduct.

In their predisposition for human intervention, digital systems are probably most productively viewed as inevitable hybrids of physical and virtual realms, and it was this ethos that spawned the development of a number of intentionally hybrid physical/virtual instruments between 1999 and 2008 at the University of East Anglia,¹¹ documented in Waters (2003, 2007, 2009, 2013), Bowers & Hellström (2000), Bowers (2003), Bowers & Archer (2005), and Collins (2006). One of these, my own VPFI (Virtual/Physical Feedback Instrument) flute project grew from my exploration of and frustration with the historical role of the flute, exploiting the observation that it was precisely the difficulties and resistances of an instrument which gave its repertoire character and meaning.

One of the benefits of hybrid (physical/virtual) systems is their very impurity; their propensity to suggest or afford rich unforeseen behaviours which engage the player (and the listener) at a variety of levels: sonic, tactile, dynamic. And through our engagement with the unfamiliarities presented by such systems we become aware of the extent to which the bodily (and embodied knowledge) is implicated in our conduct with respect to, and understanding of, instruments in the broadest sense. (Waters, 2013: 125)

A performance ecosystem might therefore best be thought of not as something we make (or design), but something we 'find ourselves' in;¹² configurations of mutual interpenetrations between physical, social and historical/temporal context, and individual capacity. This very 'situatedness' alters the set of affordances in play to something neither pre-conceived nor entirely pre-conceivable. In such a manner (abstract) plans transmute into (concrete) actions in the messy lived world. Indeed, situatedness, in musicking, is mostly social.

Devices, objects, users.

The problem of how to make a compelling digital musical instrument has remained intractable to many in the design world partly because it's difficult to know what the problem is: In design terms, what we demand or expect from a musical instrument isn't easily specifiable. The HCI expert's approach – "All you need to do is decide what you want to do, break it down into its component functions, then we can make it happen," is potentially mutually incompatible with the musician's – "What I want to do is decided 'in the moment of doing'". It's less about 'knowing what' than 'knowing when'." The design approach here assumes the building of an object – a device – which will enable a user to carry out functions. But despite appearances, a musical instrument is not an object but a process; a dynamic system in a constant state of change, seasoning, adjustment and decay. This dynamic quality is sensed by players, who of course are not *users*, and who engage in active dialogue with and constant monitoring and recalibration of the state of their instrument.¹³ This 'processual' quality of instruments is something that has become particularly obvious in the digital age, where an instrument might be part physical and part virtual, but was just as true in earlier centuries in Western cultures, and is equally true in other cultures. And a performer always plays within an ecosystem which co-constitutes her activity. As Rodger, Stapleton et al. (unpublished) put it "The messy bi-directional influences between musicians and their socio-culturally situated contexts disrupts any neat mappings between musician's intentions and instrumental functions." Even more devastatingly, for a design ethos: "Musicians are too varying to allow for the characterisation of a prototypical user." (ibid)

As an exercise, it might be interesting to proceed with the problem of specifying what a musical instrument is and has to do, based on observations of acoustic instruments, to see where it takes us.

- a) Musical instruments should behave and respond *predictably enough* when we pick them up and do stuff - a detuned guitar, for example, still affords forms of musicking. Its physical potentials

¹¹ These funded by the AHRB (ARiADA – Applied Research in Aesthetics in the Digital Arts) and EPSRC (Interactivity, Ubiquitous Technology and Music Performance).

¹² Writer Alan Bennett chooses the same formulation to describe the act and process of writing: 'I don't put myself into my writing. I find myself there'.

¹³ A particularly poetic instance of the literal entanglement of player and instrument, demonstrated to me (07/04/2013) by Cassandre Barlosso-Bardin is that in which bagpipers playing instruments with single reeds habitually trap a strand of their own hair in the reed of the chanter, to facilitate its rapid speech and to prevent the reed sticking.

(affordances) including plucking and amplifying remain available and comprehensible without prior skill or knowledge (effectivities). Potentials which require prior experience such as the nature of proportional subdivisions required to alter pitch for each string remain in place, but other strongly culturally and historically framed expectations regarding pitch relationships among the strings will have been disrupted. Affordance of multiple (and unforeseen) modes of engagement seems to be an indigenous quality of the musical instrument.

- b) Musical instruments should be capable of transducing the *expressivity*, understood here essentially as physical energy, 'put into' them by humans, into sound in a plausible manner, and it's worth noting that a *good* musical instrument seems to be one which transduces the specific qualities of each player in a manner which amplifies or maximises small differences between them. Some aspects of expressivity seem to turn on the engagement between performers and musical instruments involving the exploration of behaviours adjacent to or transgressive of the perceived physical limits or capacities of either or both: the perceived systemic norms.
- c) Musical instruments are (in the most banal sense) *assemblages*: complex systems *usually* made up of a repertoire of changeable parts. Sometimes this is obvious, as in the inherent modularity of the drum kit; sometimes it is less clear to a non-specialist but just as significant to the patterns of resistance and affordance of an instrument, as in the different cambers of a guitar fingerboard, in changing the mouthpiece or lead pipe of a brass instrument or the head-joint of a flute, or the gauges or materials of strings or the bridge angle on a double bass. A musical instrument's patterns of resistance and affordance (and interpenetration with its environment - see below) should contribute to the transduction of energy in a manner sufficiently palpable to the player that this may be understood as simultaneously co-extensive with the body, *and* an entanglement with a separate agency or agencies – with something independent of the player.
- d) Musical instruments tend to have evolved with particular acoustic/environmental situations in mind, and their behaviour is therefore at least in part dependent on a systemic coupling *with* that environment. They are therefore assemblages within a further assemblage (instrument-environment). An instrument amplified by microphone(s), amplifiers and loudspeakers is therefore clearly a different 'instrument' from the same object used purely acoustically, as its affordances and behaviours are fundamentally altered.¹⁴
- e) Musical instruments are made with particular *social* situations and conducts in mind, and tend to be mutually constructed within the bounds of *that* environment too. They are therefore assemblages within a *further* assemblage (player-instrument-social expectation), which is contiguous with (indeed inseparable from) the previous one. The human voice provides a pertinent example, the entire meta-genre of pop growing from the amplified projection of *intimacy* made possible by the conjunction of voice and microphone diaphragm, writ large in social space.
- f) The combination of all of the abovementioned tendencies among a particular community at a particular historical moment tends to result in clustered, typical conduct(s)¹⁵ on the part of players which result in

¹⁴ Indeed, in contexts where microphones, amplifiers and loudspeakers are introduced, the assemblage of the musical instrument can become indistinguishable from the assemblage of the environment. My old German double-bass is set up with low-tension strings and low action, with an increased neck angle, to give an even response and long sustain when plucked. It is acoustically relatively quiet, but this doesn't matter as I rarely play it without amplification. This affords a combination of intimacy and clarity which couldn't be achieved by making the instrument acoustically louder. It also allows someone who doesn't practice sufficiently to play without pain. But the amplification is not scaleable. By using a small amplifier at low amplitude clarity and intimacy are optimised at the physical scale of the instrument. Increasing the amplitude further interferes with the acoustic modes of vibration of the instrument's body, reducing clarity and reinforcing unhelpful frequency peaks and troughs in the instrument's response. It might be argued that there are three socially distinct levels of amplified intervention which emerge at different historical moments and accumulate as technical potentials: the first is to make small sounds audible, or audible sounds somewhat louder; the second is where at which the dynamic range of reality is apparently increased, and third is where amplification habitually masks our engagement with the physical environment.

¹⁵ *Behaviours* are regarded as actions performed, and *conduct* as the relationship between those actions and expectations within a particular community of practice. Behaviour provides evidence of performance, while conduct is a judgement of the intelligibility/resolvability of that behaviour within the community's practices. It's worth noting that in this understanding of community, co-participants must be intelligible to each other – but they don't have to agree about things. This affords a sense of community dynamism which values non-conformity as potentially positively transformative.

repertoire (which I interpret as particular sets of conduct utilising all aspects of the current performance environment in an *idiomatic* manner). Of course, as human beings have an instinct for divergence from 'norms' of conduct (which is one of the things which keeps musicking a dynamic practice, rather than a static, specifiable set of behaviours) the demands of expressivity *may* be interpreted as requiring *atypical* conducts, which the musical instrument should thus also afford.

As we've moved down this list we've increasingly been forced to stray from problems of specifying a musical instrument into issues of *what musical activity is*. We've moved from thinking about *designing an object* to thinking about *making contexts of use*. We might now add that:

- g) Musical instruments are *typically* made to be played in ensemble with other musical instruments, of variously similar or contrasting sound qualities. Much solo instrumental repertoire can be seen as a paradoxical attempt to represent ensemble activity through the agency of a single player – the one-man band. Indeed, viewed in another manner, such solo repertoire is often an attempt to simulate sociality: to manifest apparent multiple agencies through skilfully apportioned (and carefully guided) attention.
- h) Musical instruments have typically been grouped in families of *similar* sound and behaviour by analogy with human family structures (or as a homology of human size differences), or in families of *dissimilar* sound and behaviour by analogy with extended social/working structures. Both groups afford coherent, imitative behaviours: structured pseudo-hierarchic behaviours in which 'roles' are relatively fixed (by convention - 'conduct', by sound/acoustics - materiality); or 'equitable' negotiated behaviours in which roles are dynamically reassigned (as in jazz and some improvised musics).

Moving away from the musical instrument as object.

Musical instruments on their own tell us very little. Indeed, without embedding in the activity which defines them as musical, it's difficult to think of them as 'instruments' of anything. In this respect organological study, ideologically preoccupied with classification, typology and 'norms' of use, can be seen to have been hugely unhelpful in its representation of the nature of human engagements with musical instruments, obscuring the messy, discontinuous and plural nature of their ontologies. Names and categories are localised, situated, temporary, and contingent on patterns of behaviour and use. 'Globalising' studies of these tend to misrepresent, as in Ireland, for example, where a distinction between 'fiddle' and violin sustains despite their paradoxical physical identity. A degree of ontological fixity does emerge with mass production in the early nineteenth century, but this is also an era of frenzied technical innovation. The transverse flute, although relatively unproblematically identifiable within the repertoire of western art music from 1680-1860, changes notably in physical form during that period. Paradoxically, the focus of much advertising of the nineteenth century was on convincing players that the instrument *hadn't* changed too much, framing technical innovations in terms of 'improving' or 'perfecting' because *players* were invested in particular sonic expectation and familiar playing techniques. This 'human inertia' in embodied knowledge, and resistance to changing familiar skill-sets and assumptions is a topic to which I'll return below.

From a historical perspective, it's worth noting that 'innovations' are often developments of instances from other practices, whether intimately connected with musicking, as in Johann Christoph Denner's development of the multi-register clarinet from an already familiar folk-instrument - the chalumeau, or in the more general but profound sense that developments in musical instruments are not isolated from other technological shifts. The 'valve' in all its many forms emerged in many areas of human activity related to metal tubes and plumbing, and was therefore quickly deployed for musical use in brass instruments. The breadth and distribution of working practices in the seventeenth to nineteenth centuries (e.g. through guilds, livery companies or more informal trade organisations – of turners, telescopic tube-makers, key makers, cabinet makers) led to quick adaptation of technical innovations between apparently different areas of making practice. This should caution us about being too *disciplinary* in our thinking with regard to musical instruments. Imitating skills from elsewhere may prove fruitful, and prevent our becoming trapped within an imaginatively constraining disciplinary language and discourse. This is not just a historical lesson. Philip Agre's (1997) notion of a 'critical technical practice' – devised as a critique of practices in AI, can have useful application in our current field of enquiry, suggesting, as it does, that a practice can only truly develop if it is open to the ideas of those working at or beyond the periphery of the discipline, where the habitual language and concepts which pervade that discipline are shown to

constrain it. In this regard Agre's observations¹⁶ are congruent with much of what goes on in 'artistic' practice-based research, and with what Suchman has recently (2018) characterised as 'border thinking': admitting inadmissible thought and language.

Musical instruments have tended to emerge through *irregular* distributed processes taking place over generations. These processes of accretion and filtering have immensely enriched them, but it is not clear that these are 'iterative' processes in the manner in which HCI rationalises them (as in the 'task-artefact cycle') or even constitute 'design' as such. As John Bowers notes¹⁷, iteration presupposes 'a rationalist notion of convergence to[wards] *an ideal*' which he goes on to note 'does not correspond to the exuberant explorative making that excites me', and Alice Eldridge draws attention to the shortened timeframe: 'we seem to have foreshortened the evolutionary cycle quite dramatically this century compared to last when we act as luthier, composer, performer and iterate annually rather than over years, decades, centuries, millennia' (ibid). Bowers develops his critique of the iterative process by suggesting that what is often required in developing an instrument is something more like 'extended thoughtful commitment' adding that this is 'to my mind more noble, and less like a logic of product design'.¹⁸ The designer who has perhaps contributed most significantly to a literature on the *feeling* – the (situated) extended thoughtful commitment - of musical activity is Kristina Andersen. In an essay co-authored with Joel Ryan entitled '821 words and 20 images' appended to her doctoral thesis ('Making Magic Machines') Andersen identifies the difficulties of abstraction.

As we become more virtual, more committed to digital media, we become more logical. Not logical as in clever or consequent, but logical as in not physical, logical as in calculating rather than thinking, identifying with symbol manipulation in its various modalities from algebra to ordinary language. (Ryan & Andersen, 2017: 2)

This is elaborated a few pages later: 'We fetishise machine precision, but it is nowhere as interesting as the mindful imprecision of the hand'. (ibid: 9)

Impermanence

Thinking of instruments as necessarily assemblages rather than objects, and setting aside the ontological fixity which as we've established was associated with the increasing industrialisation and standardisation of instrument production in the late eighteenth and nineteenth centuries, helps us to see that, in broader historical and cultural terms, the *non-standard instrument* can be seen to be typical of human/instrument entanglements. Thus, the anxiety expressed by some authors about the impermanence of digital instruments: their reliance on an intimate relationship with their player/inventors, and their dependence on temporary technological infrastructure (as a result of which concern has been expressed for their 'preservation') can be helpfully contextualised. Ephemerality and non-standardness can be regarded as typical of instrument making in many places, and at many times. Some instruments simply have specialised uses or short lives. Others are repurposed and gain entirely new functions. Early nineteenth century flutes made for wealthy London amateurs are transformed in the hands of Irish traditional musicians into idiomatic tools for an entirely distinct repertoire. One of the most remarkable qualities of musical instruments is their capacity to continually suggest or afford uses which might have been inconceivable in communities of practice within which they have been previously entangled, and this is true both historically and culturally. Conversely, some 'new' instruments and techniques prevail through their surrounding discourses (naming, genre-identification, etc.) rather than through physical continuities, as Rodgers (2011) makes clear.¹⁹

Materials

Ephemerality is a given. As Tim Ingold (2007) might have put it, all materials are processes: they just have different speeds of change and decay: different histories. Materials change, and the availability of materials also changes: boxwood and some of the tropical hardwoods used for nineteenth century wind instruments don't adapt well to central heating, or to the extremes of humidity and temperature associated with contemporary living and rapid air travel. The social and environmental impacts of using Brazilian rosewood, ivory, and other

¹⁶ These extend beyond a critique of dependence upon a particular understanding of how language works, through observations on AI's reliance on a particular set of assumptions about formalization and reasoning, to its conflation of representations and things.

¹⁷ In a recent Facebook discussion 08/11/19

¹⁸ It may be that iteration as a learning principle is not the problem, but that the discretized, goal-oriented version of it characteristic of HCI design processes obscures the flows and continuities which are a precondition for such extended thoughtful commitment.

¹⁹ I am most grateful to one of my anonymous reviewers for this line of thought, and for the introduction to the text in question.

such materials also change their desirability, status and value.²⁰ And material changes *can* afford radically new possibilities, not just of sound type/quality, but of repertoire and ‘role’. The contrabass has never been particularly standardised in size or shape, but the combination of new string technologies in the 1950s²¹ with amplification allowed players such as Scott La Faro to redefine the role of the bass in jazz, the resulting sustain, enhanced pitch definition and physical flexibility of the new string design allowing the instrument to sing, float, develop counter-melodies, articulate more rapidly, and project harmonics. Digital ‘materials’ change particularly fast, and therefore present particular challenges with regard to establishing *shareable*, mutually intelligible conduct and repertoire.

Legibility

Perhaps this relative *social* illegibility of digital instruments might still be an issue here.²² Acoustic instruments are configured around tactility not just for their players, but in their comprehensibility to listeners, who share common access to a repertoire of touch and resistance in relation to materials. Digital musical instruments tend (characteristically of modern western technology, which is celebratory of, and configured at least superficially around, individuals) to be comprehensible *primarily* to their players, in a manner unlike acoustic instruments, which draw on a repertoire of common experience of the material world. The relative illegibility referred to has unhelpfully led designers to focus on individuated devices for musical activity, often configured around exaggerated and inept readings of ‘gesture’, rather than addressing the more fundamental issue of how those with musical instruments habitually build successful *social* structures for interaction.²³ As Pickering (2013) observes, abstractions remove us unhelpfully from our entanglements with the environment, and a reductive notion of ‘gesture’ – which attempts to model but diverges significantly from the manner in which it is used in most performer’s vocabularies – is no exception. (This is fracture between the propositional logic of ‘machine precision’ contrasted above by Andersen with the speculative ‘mindful imprecision of the hand’). In general, what is revealed is the impoverished vocabulary of ‘gesture’ as understood by designers when compared with an understanding of movement activity as understood by a dancer or choreographer who has spent a lifetime working beyond such functional abstractions, refining and increasing the discriminatory capacities of the body.²⁴ One could make similar observations about so many other loci of so-called ‘tacit knowledge’: furniture-making, for example, or acoustic musical instrument making, where the bulk of knowledge is embodied. There still isn’t nearly enough acknowledgement of *performance* as a skill – distinct from technical facility on an instrument – or of the capacity of the skilful performer to animate and instantiate something in real-time: as a necessary *flow* of activity. Recently, however, performers have been less reticent about regarding what they do as a form of practice-based research which draws attention to the precisions and subtleties of their activity *in performing*. Flautist Richard Craig (2020) has produced valuable insights on how a score (a plan) is transformed into a musical experience (a situated action) through real and imagined dialogues between performer, composer, instrument, text and cultural context, and the research of guitarist Stefan Östersjö (2008) is an exemplary model for this mode of study: a critical *thinking-through-practice*. The dance-focused but inherently interdisciplinary phenomenological work of Maxine Sheets-Johnstone on the primacy and continuity of movement (e.g. Sheets-Johnstone, 2011) has been a key influence on this mode of research.

The study of instruments as if musicking was a social behaviour.

²⁰ Guitar manufacturers such as Taylor (www.taylorguitars.com/ebony project) have notably invested resources and research in experimenting with sustainable hardwoods, and others have followed pioneering German luthiers Gernot Wagner and Matthias Damman in using composite materials from the aerospace industry with appropriate lightness/stiffness in stringed instruments.

²¹ Thomastik-Infeld patented rope-core steel strings for stringed instruments in Infeld (1952). Thomastik’s Spirocore strings for double bass became available in 1961. LaFaro himself is documented as using a mixture of low-tension gut and steel strings on a bass set up with very low action, relying on microphones and amplification to compensate for the lower acoustic amplitude which resulted.

²² Bear in mind my earlier strictures, developed further below, about the inertia in human embodiment of knowledge and experience, despite which, the ‘swipe’, ‘double-click’, ‘scrolling’ and other types of conduct associated with touch-screen interaction have become consolidated in culture remarkably quickly. My generalisation regarding social legibility is also demonstrably less true in those areas of popular culture where *performer* legibility is less of an issue than surrounding discourses and behaviours associated with more pertinent social formations such as dancing and clubbing.

²³ This is not only a problem in musical instrument design. A similar awkwardness to that observed in the NIME community is evident in the community associated with the International Conference on Movement and Computing (MOCO).

²⁴ I learned this as an arrogant young electroacoustic composer – brought up on a discourse of ‘gesture’, ‘space’ and ‘transformation’ – and lucky enough to work with some of the world’s best choreographers. Turning up to a rehearsal with a notebook and a graphic score in order that I could make notes on what the choreography had missed in my management of gesture and form, I was both exhilarated and chastened to have the subtleties of my work simultaneously *explained to and redefined for me* by the experience of the dance.

The study and development of people and instruments *in performance*, and particularly in *ensemble* performance, is key to understanding how we might 'design' for such richly emergent scenarios as musicking. As an improvising double bass player, I am perpetually fascinated by what can be learned from the close observation of drummers. Drummers are *always* apportioning their attention *multiply* over their irregular assemblage of objects. They must think paradoxically in terms of *flow and feel* as much as of 'event triggering' or 'gesture', although at a more reductive level manifestly continuing to perform those latter functions. One of my current research students, a talented improvising drummer, describes the experience of playing as:

bodily exploration of movement on top of, across, and within, the interchangeable pathways of the drum kit. Physical restrictions considered, I tend to think of this style of playing as waves of circular phrasing moving above, around, and passing through the kit, the presence of which is felt both in the feet and the arms/hands, as well as the knees, chest, and stomach. (McAuley, unpubl)

The extent to which body movement shapes perception here is palpable. Another research student's²⁵ background as a jazz ensemble guitar player enables him to identify several key problems of his other complex, glitch 'instrument' – an assemblage of analogue and digital modular units (Benjolin, sampler, etc.). Most crucially the instrument doesn't easily afford the isolation of sonic behaviours which might enable the rapid, real-time reassignment of *roles* which is characteristic of jazz, improvised music, and even within the string quartet. The synthesiser instrument is demanding of both his manual *and* visual attention in simultaneous coordinated conduct in a manner which is unhelpful to musicking, colonising attention which is needed elsewhere, *between players* in the co-constitution of musical action. The allocation of *attention* (and the capacity to distribute or divide it appropriately – between objects and people, say, or between looking and listening – visual and aural judgement) turns out to be a key issue in performance.

Laptop orchestras have attempted to address this 'ensembling' issue in a variety of manners, typical approaches being the arbitrary assignment of frequency-bands within each group member typically operates, the mimicry of roles from jazz ensembles (bass, percussion, comping, lead), sonic feature distribution (drone, iterative or rhythmic activity, 'gesture-making', 'ticks') or distribution of a fixed number of interventions over a period of time. John Zorn's (1984) *Cobra* is prescient here and pervasive in its reach because ultimately it privileges social organisation over sonic organisation. The latter (organised sound) *results from* the former (soundly organised humans) as John Blacking might have observed.

The comprehensibility of ensembles using amplification is often improved by localising the amplification for each player and operating at amplitude levels which allow all contributors to hear each other with the enhanced position cues this affords. Given that, in a lap-top orchestra, 'who is responsible for what' is often a key issue – indeed the capacity for dynamic role reassignment characteristic of the sociality of ensemble music making is dependent on this – it is surprising that many performers opt for the complex sound reinforcement systems typical of large rock venues, necessitating additional foldback systems which cede autonomy for ensemble dynamics to an 'outsider'. When the outsider in question is regarded appropriately as an ensemble member such systems can work well, but within the economic ecologies within which much performance takes place this arrangement is uncommon. An instructive example of an ensemble *actively exploring* the offloading of some degree of autonomy occurs with Edinburgh-based trio *RawGreenRust*,²⁶ who cede some decision-making to an algorithmic agent which 'listens' to their contributions and intervenes to prevent playing which is too continuously of one character (too boring). The software (Green, 2012) mutes the output of any performer who is insufficiently dynamic in their own management of role reassignment, the evidence for such intervention being provided by feature analysis of each player's stream. This strategy can clearly work well in a committed ensemble with fixed personnel. In a recent performance at the Fruitmarket Gallery, Edinburgh, I was genuinely impressed by the sophistication and dynamism of the ensemble interplay, only to discover after the performance that the trio *had not used* the software in question. Clearly they had played *with* this 'fourth agent' sufficiently to embody its behaviours within their own conduct, and the result was impressively akin to the interplay between three acoustic musicians. Perhaps there is nothing mysterious about this process of skill acquisition. It's just about *putting in enough time* and is akin to the 'extended thoughtful commitment' identified earlier by Bowers as a pre-requisite for establishing contexts for musically rewarding activity.

The *deployment of mediating algorithms* (through machine listening or otherwise) is increasingly common, and, as this already impacts on social processes in most other areas of our lives – finance, social media, advertising – it is likely to become more of a focus of attention for digital musical instrument makers. In many current 'instrument-building' practices, maker/performers avail themselves of hybrids of physical materials and

²⁵ Shane Latimer.

²⁶ Jules Rawlinson, Owen Green and Dave Murray-Rust.

computation systems (physical models in computers), and the interactions between these, offering up a significant challenge to organology's position as the study of *material* objects. Though this usefully shifts the focus from designing devices to something more attentive to the processual and emergent, the difficulty remains that although machines may well learn fast and accumulate experience, the humans engaging with them still need time to adapt to and embody useful responses to this. This time-lag in engagement has recently been characterised as leading to 'naïve physics' – an example being the deployment of memory of embodied interaction with older media forms such as keyboards in the GUI of the iPhone (Ingrid Richardson, quoted in D'Errico, 2016: 192). My particular persistent inability in this respect is with graphic representations of rotary knobs in interfaces, which are 'turned' by dragging in a straight line up/down or left/right rather than by following the contour of the 'knob'. This inertia in embodied/cultural knowledge, based in prior interactions with the material world, is well-represented by neolithic ceramic water vessels, which retained the vestigial 'stitching' of their leather predecessors for some centuries after ceramic knowledge had become culturally widespread.

I'd like to continue by looking at a further series of instances²⁷ of situated musical activity in which the design aspect attends at least as much to social and organisational issues of activity as to technical and functional concerns with the instrument. Where the Edinburgh and lap-top orchestra examples used thus far have concerned themselves with the 'dance of agency' (Pickering, 1995, 2013) among/between groups of performers and their technologies, I will now look at a number of individual practices, selected because those involved are interested in enmeshing considerations involving 'individual' interactions *inevitably* into broader social ones. It might legitimately be observed that any and all musical activity could (and should) be considered through such social lenses. The projects described are also 'local' to me in various senses, this context allowing me to evaluate the primacy or otherwise of their conscious engagement with musical sociality. To various extents these are projects which explore the nature and limits of self-other relations as an intentional focus of their practice.

Line (Waters, 2018)²⁸ – one of my most recent projects, premiered at Turner Contemporary in Margate – is a hybrid virtual/physical system building on that described in Waters (2013), involving an alto flute partly driven by a loudspeaker in a 3D printed cone which replaces the cork in the flute. The loudspeaker plays both amplified sounds from the flute, including acoustic feedback, and material from a computer – which is fed both with the flute's own signal and fragmentary extracts of other musical material. So here we have an instrument, broadly conceived, operating within a physical environment with which it is intimately coupled, which has parts of its assemblage which are virtual physical objects, parts of its assemblage which are self-evaluative (in some instantiations it listens to itself and modifies its own behaviour) and parts which explicitly link it conceptually to (and incorporate sonically) the traces of historical music-making. The physical disposition of the technical infrastructure with regard to its audience – a single line of loudspeakers – is also specifically designed as a critique of ill-considered claims to 'immersivity'. It is simultaneously technical, social and sociological in conception. And, of course, albeit to a less obvious, and less deliberate extent, all musical instruments extend beyond their material limits – even those apparently bounded by physical entity.²⁹

Adam Pultz Melbye's (2020) Feedback Actuated Augmented Bass is a sophisticated attempt to address concerns of imbalance between human and instrument in solo improvisation³⁰. An on-board string-sensing, amplification and feedback-management system increases the autonomy of his instrument such that it sounds without his

²⁷ That individual instances can often be more instructive than 'statistical' surveys of 'utility' is given support thus by Cubitt (2013): "The unique instance can teach researchers as much as statistical samples or those abstractions that arrive either as axioms (there exists an X such that ...) or hypotheses, maps or diagrams. The word 'unique' requires stressing. *The core of the anecdote is not its typicality but its specificity*; its ur-text is Clifford Geertz's *Thick Description* (1973) but its history includes the tradition of close readings. The humanities have embraced study of individual poems, paintings, performances, or films as well as actions and historical situations. *Studying these unique instances is expanded by observations of the unique nature of moments of reception and use.*" [italics added]

²⁸ In *Line* – (<https://orpheusinstituut.be/en/projects/line>) as in other musical situations involving computers – digital technology distributes and augments human agency (in time, conceptually, in scale, geographically) in a manner beyond the prosthetics of conventional instruments.

²⁹ Hybrid physical/virtual instruments enhance a capacity to sidestep the 'fixities' of materiality, but they inevitably require (some aspects of) interactions with humans to be designed, rather than resulting entirely from *inherent* material or bodily constraints.

³⁰ In this respect, it manifests similar concerns to the Stefan Edwards's 2004 project, *Davros* described in Waters 2007, in which the composer/performer expressed a concern to avoid imprecise or 'flabby notions of interactivity' by setting up a situation in which he and the computer "could influence each other's behaviour, seeking to minimise the difference between us, while acknowledging that the 'relationship' isn't equal."

intervention³¹, but has a sensitivity calibrated such that it responds rapidly even to physical contact with its resonant body, and more emphatically to any interaction with the strings. Technically-impressive though the achievement is, its goal is primarily to address the paradox faced by the virtuoso improviser habituated to working in an ensemble, to sustain the 'dynamic, non-equilibrium' states which for him constitute good improvisation, but who wishes also to develop a viable solo practice.³² Melbye's approach is to focus on perceived asymmetries in agency between himself and his instrument, regarding himself as the 'precarious and metastable learning agent' (ibid) who must continually adapt to and learn from his environment (in this case primarily the instrument). It's a sort of modelling of empathy. It is significant for Melbye that the instrument he works on is already 'culturally highly-defined', having 'co-evolved with musical idioms, repertoires and techniques that can fundamentally be mastered'. He notes (ibid) that as 'the FAAB is in a constant state of mechanical excitement, what has traditionally been a largely monophonic instrument is now a potential continuous quadrophonic resonator'. As each string's resonance is co-dependent on the amplitude of adjacent strings (algorithmically-governed) the behaviours of the instrument are rich and complex, as are its affordances when bow and/or fingers are used.³³

Melbye notes that the relationship thus developed, because of the 'significant amplitude throughput', is far from merely sonic, but is 'intensely haptic and sensorimotor as well: When working around the threshold of feedback I sometimes feel the amplitude saturation of the sound before hearing it... This perceptual intermodality is a prerequisite for the intimate and embodied relationship between musician and instrument during performance' (ibid). To paraphrase Melbye, the feel of the instrument during performance is intimately tied to how the performer interacts with it, calling on 'sensory-motor functions that operate below the level of self-referential intentionality' (Gallagher 2005: 170). This correlates with observations from drummers such as McAuley (quoted above) who describes (ibid) 'the thinking mind as too slow to engage in improvisatory conduct' and his therefore not thinking in terms of 'technique', but simply following physical paths of least resistance around the drum kit, 'allowing the body to facilitate fluidity'. He draws parallels between drummers and dancers in their shared sense of functioning 'from an overall body perspective'.

Ricardo Jacinto's *hybrid* cello/distributed sound instrument, *Medusa* (Jacinto, 2014-) and its contiguous *Exploded Cello* project (2018) benefit similarly from their incorporation and expansion of a historically-developed instrument. The result is that, as Melbye (2020) describes in detail for his bass, new 'gestures' *do* emerge as part of the instrument's idiomatic *repertoire*, but crucially these 'gestures' were not arbitrarily imposed or chosen, but are responses to the affordances of the extension of the physical character of the instrument out into its environment, and to the result of transducing the energy from different parts of the instrument's structure, each with its own characteristic localised non-linearities. The decision to distribute these varied behaviours across spaces of performance and into the structures of the buildings housing them, emphasises and reifies the variety of materialities which are already present but implicit in the cello's structure and history, making them legible to the audience. Although much of Jacinto's work is solo, the architecturalisation of his instrument points to an explicit concern with the social use of space, which is unsurprising, as he is also an architect by profession. Jacinto's work explores and emphasises one approach to the 'making social' of the performing environment, by incorporating his audience, in a sense, within the instrument. As I have written elsewhere:

By implication the performance asks questions about territory, about public and private space. In exposing the relationship between one body and one instrument so ruthlessly, but incorporating the bodies of the audience within the result, Jacinto asks what are the limits of *his* body. Of course these limits are transcended here through technology, but, he asks us, isn't this what music always does? Isn't there always a transduction between my body, as a performer, and yours – as a listener, which is the condition of music. Some traces of my fingers, depressing this taut string, at this particular point, and in this particular way, resonate sympathetically within your autonomic nervous system. And as I move into the high register on the top string, something of the difficulty of doing so, of the sense that

³¹ Melbye attributes the ontological gap between solo and group improvisation in large measure to the conventional instrument's reliance on the energy supplied by the performer, hence his choice of a self-actuating feedback instrument as a means of flattening the hierarchic imbalance between instrument and player.

³² Of course, Melbye's work here, like much other solo practice, is in some sense always 'as if' socialising; a sustained investigation into self-other relations through musicking.

³³ Illustrated at <https://vimeo.com/428245351>, <https://vimeo.com/428243367> and <https://vimeo.com/428242004>

this is an acoustic and physical system approaching the upper limits of its viability, transgresses the merely physical boundaries between individuals, temporarily suspending them – touching you at a variety of distances – some intimate, some less so.

This permeability of boundaries between individuals echoes the permeability with which we began – between performer, instrument, and environment. The permeability that is the condition of music is also a condition of being human. In music-making human beings find a crucible for a non-appropriative acknowledgement of otherness – a suspension of the boundaries of the self. The qualities of empathy and inquisitiveness that make us human are enhanced. So it's no surprise that the 'exploded cello' has another life, away from its site-specific orientation, in improvised ensemble music, where groups of musicians negotiate and renegotiate boundaries and selfhoods on a moment-by-moment basis. (Waters, 2015)

My own *Proxemics: The World is a Deaf Machine* (2006) is another instance of work which manifests a concern with homologies between sonic, social and architectural space. This 'active sound installation' was commissioned by the Sainsbury Centre for Visual Arts to celebrate the completion of a new Ian Tyson sculpture, '*Proximity*', which visually links Denys Lasdun's iconic 'ziggurats' at the University of East Anglia to the Norman Foster SCVA building. The sound installation, a response both to Tyson's work, and to the architectural relationship between Foster and Lasdun, consisted of circle of eight extremely high quality studio monitors, mounted on plinths of four different heights designed both to 'modularise' and accommodate differences in human height, and to refer to Lasdun's stepped ziggurats within the SCVA's vast indoor space. These presented a loop of material which was calculated to produce standing waves - with nodal points which could be experienced by moving within the space. In addition, each visitor was given an iPod and open-backed headphones, which presented individual listeners with a further subset of audio material calculated to interfere with and 'complete' the audio experience from the loudspeakers. The piece therefore presented a physically fixed sonic structure within which each visitor could individually 'play' the space, completing and actively discovering the interactions between local (headphone) and global (fixed loudspeaker) material, and the nodal points of the (invisible) standing waves in the space. Each participant therefore controlled their own unique sonic perspective on the structure - in much the manner in which Tyson's three-dimensional steel work still affords and encourages multiple perspectives on 're-reading' the relationship between Foster's architecture and Lasdun's. Here 'performance' is offloaded to the participants, and the 'instrument' is distributed among them.³⁴

We have moved now from a consideration of what can be learned from solo practice, to 'distributed' performance, driven more by a need for plausible sociality, than for 'technological experiment', and such practices can be a key to understanding the problems with 'instrument design' conceived as an issue of individual 'interfacing'. The real 'design' effort is directed instead to affording plausible and engaging *social* structures. The instrument-in-itself is rather unimportant when the goal is actually supply, fluid social structures in which behaviour is improvised 'as musicking' using what is at-hand.

Paul Stapleton and Tom Davis's ongoing work with two-site networked improvised performance is unusual in successfully addressing this issue by exchanging physical and tactile data through a group of sound making objects. The performers, though in different locations, build sonic and social relationships not only through playing sounds together, but through a capacity for interaction (locally or remotely) with *shared* physical sounding objects. *Ambiguous Devices* was conceived from the first as 'a distributed musical ecosystem. a network of interconnected music-making machines, people and ideas' (Stapleton & Davis, unpublished). The results are both more sophisticated and more compelling than the earnest searchings associated with much 'network music' – in which participants' theoretically 'augmented' reality across a number of distributed performer and audience sites instead rather diminishes the experience of everyone involved through its awkward collage of screens, projections and ill-co-ordinated 'interactions'. As Stapleton and Davis note 'such performances commonly aim for the network to *disappear*, simulating the experience of making music in the same concert hall'. Their focus instead is on the questions of 'what types of *being present* might networked music interactions afford that are not available during other types of music making?' and 'How might physical presence be communicated be simultaneously communicated through and augmented by the body of an instrument or a player?' (ibid). Although their 'instrument' is a complex network, 'an amalgamation of digital,

³⁴ A more recent work (Waters, 2019) continues to explore this possibility by 'animating' the silent space of a historic library with local voices emanating from multiple hidden loudspeakers in such a manner that visitors feel allowed or encouraged to talk.

electronic³⁵, mechanical and acoustic objects – the overarching sound generation is through acoustic means and the interaction between the two nodes [performance sites] is primarily through (or via proximity to) the bodies of physical objects.’ (ibid) The project is a thoughtful counterbalance to Michel Waisvitz’s observation (Norman, Waisvitz & Ryan 1998) of a ‘loss of trust in hands and ears,’ and is in this regard as fundamentally about the careful apportioning and management of *attention* across a variety of sensory modes as it is about agency. Davis and Stapleton are in virtual tactile contact with each other’s instruments, affording unforeseen and playful bi-directional interventions which are made ‘in the time of the performance’, and read by an audience in that same time frame. Any latencies are masked by the physical inertia of the instruments involved, and read as part of the physical characteristics of such instruments.

That the tactile is the *correct* focus for such experimentation is emphasised by Stapleton’s subsequent hybrid virtual/physical performance experiments (Mehes et al 2017, Stapleton et al 2018) initially involving a simple physical string suspended between two piezo sensors. All physical (force) signal from input to the string is precisely mapped to a physically-modelled string coupled in a non-linear manner to a plate, the model simulating the sound of the string³⁶ and any interactions with it. The results are so physically plausible that it is almost impossible not to assume one is simply playing an amplified (physical) string. Having thus learned to simulate a physical system well, the player can be guided incrementally to explore changes to material properties that are not normally possible in the physical world.

Futures

I wrote earlier that mediating algorithms would become increasingly prevalent in musicking (and other) practices, but such interventions are not necessarily deliberately contrived as an adjunct to such activities. Sometimes they are forced on us by events. Writing this, as I am, during the first spread of the COVID virus, my capacities for interaction with friends and colleagues are now primarily mediated through software. Academic meetings, held on Microsoft Teams or Zoom, have become more audible and more efficient than their physical equivalents ever were in the reverberant Victorian spaces in which they had habitually been held, where moving a chair or coughing could eradicate a crucial sentence, and whispered parallel discussions proved hugely distracting. Colleagues have quickly devised new protocols, conducting parallel business (and sarcastic banter) through written comments, enriching but not deflecting the video-flow of business. And increasingly such tools (and protocols) become integrated into our other activity. Last night I had dinner online with seven friends and colleagues – all involved in some way in instrument design or performance – and as is becoming habitual we met through the same software infrastructure, designed essentially for orderly exchange. Doubtless influenced by Miguel’s (pre-distributed) ceviche, and good wine, exchange became less orderly, and at precisely the point at which it might have happened in a physical dinner party, Laurel produced a mandolin. Ten minutes ensued in which several otherwise capable musicians attempted, and failed dismally and hilariously, to replicate conventional musical ensembling. But the real musicking began when, abandoning attempts at precise coordination, participants began to video parts of the activity – from the sonic, visual and temporal perspective of each individual site – and to rebroadcast video fragments into the party. The resulting temporal cross-referencing and accumulation of events, however unsophisticated, was closer to ensemble music making than any of our earlier efforts. The key component in that musicking was the infrastructure we had ‘to hand’: iPhones and laptops equipped with software designed for business meetings, here repurposed as a highly resistant – but enjoyable – instrument-environment system.³⁷ Perhaps such messier ‘emergent’ organisational systems – improvised and shifting but metastable – also have something to teach us about organizing musical conduct.

And as we attempt to devise online delivery for courses in ensemble musical performance, some of the earlier strategies employed for entirely different reasons, such as the spate of YouTube videos in which all the parts of a piece of music are delivered by a single performer,³⁸ begin to look like potential models for new forms of non-

³⁵ e.g. sensors, microcontrollers, actuators.

³⁶ Technically what is simulated is actually the sound of the string-bridge-plate coupled together, listened to through the plate.

³⁷ This type of structure is eerily prefigured in the work *Radio Pieces* broadcast on Resonance FM in June 2002 by one of my research students, Stefan Edwards, described in Waters (2009): “listeners are encouraged to phone into a radio station while keeping their radios, tuned to the same station, as near to the telephone as possible. The resulting acoustic feedback from the open phone-lines, mixed and balanced by the composer at the radio station as it happens, animates this ‘central’ space with the influence of the distributed, external spaces occupied by the listeners, providing the ‘silent’ core with ‘content’ to broadcast.”³⁷ The social elements, distributedness and emergence, are as significant here as the sonic components. The ecosystem is both sonic and social.”

³⁸ Exemplified by Jacob Collier’s exuberant (2013) rendition of Stevie Wonder’s ‘Don’t You Worry ‘Bout A Thing’

real-time ensembling. It well may be that – despite my suggestion that attention be focused on musical situations rather than musical instruments – we will also have to transform our expectations about the nature of some of that activity.

Perhaps we only begin to realise what is crucial when it is taken away, and the current pandemic has forced a reconsideration of music's essential socialities in a manner without precedent. Perhaps, when Jacques Attali (1985) envisaged a fourth 'political economy' of music – composition – which followed on from accumulating logics of, in Simon Frith's more comprehensible (1987) terms, storage in the body (the inseparability of musical act from its initiating presence), storage in the text (the decoupling of performance codes and compositional speculation from their initiators) and storage in the recording (the decoupling of physical energy input from its habitual manifestation as sound) – he was more prescient than he realised. From a situation where music could only be instantiated 'here and now', via its reinstantiation at one remove through notation, and its multiple reinscription in the social fabric decoupled from its initial acoustic capture, we have reached a position in which each actor is responsible for consciously managing ('curating') the entire context of her sensible manifestation in the world, albeit virtual – (self-)consciously constructing the social environment in which nested versions of these 'earlier' musical modalities can be exchanged and understood.

But this apparent autonomy comes at a potential cost, distracting us from the essentially communal and collective core of musical activity. As Borgo (2018: 5) puts it: 'Pursuing an embodied, situated and distributed musicianship can help us explore musicking as a *mutually constitutive* process through which people, technologies and environments are dynamically involved in *configuring* one another'. As we enter a period where physical 'ensembling' is, at least temporarily, unavailable to us we will have to ensure that the technological infrastructure within which we are entangled, and which supports such activity virtually, does not filter our capacities for subtlety and suppleness in sense-making, reducing musicking to a series of banal propositional logics, or shambolic, uncritical 'jamming'. I hope the examples discussed above give some small cause for optimism.

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