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Technology and Contemporary Classical Music: Methodologies in Practice-Based Research

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Economic and Social Research Council

Technology and Contemporary Classical Music

Methodologies in Creative Practice Research

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Abstract

This position paper provides a distillation of the NCRM Innovation Forum, ‘Technology and Contemporary Classical Music: Methodologies in Creative Practice Research’, hosted by Cyborg Soloists in June 2023. It features contributions from a variety of creative practitioner-researchers to debate the current state and future of technologically focused, practice-based research in contemporary classical music. The position paper is purposefully polyphonic and pluralistic. By collating a range of perspectives, experiences and expertise, the paper seeks to provoke and delineate a space for further questioning, inquiry, and response. The paper will be of interest to those working within creative practice research, particularly in relation to music, music technologists and those interested in research methodologies more broadly.

Keywords: music, creative practice research, artistic research, practice-based research, practice as research, technology, methodologies, artificial intelligence, instruments, interfaces

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Contents

Introduction

In June 2023, Cyborg Soloists[1] hosted an NCRM Innovation Forum titled 'Technology and Contemporary Classical Music: Methodologies in Creative Practice Research.' This event brought together leading practitioner-researchers to discuss the current state and future of technologically-focused creative practice research in music, and to identify new methodologies tailored to this field.

This position paper provides a distillation of the discussions held at the forum, informed by the array of interests, experience and expertise present. It is structured under the following themes:

- Embodied Knowledge
- Methodologies & Criticality
- Impact

Rather than supply a definitive overview of these topics, the contributions seek to map out a terrain for further consideration, inquiry and response. As such, they may be useful for those working with creative practice research—particularly in relation to music—music technologists and those interested more broadly in research methodologies.

These contributions—and this paper as a whole—speak to a particular subdiscipline within the thriving and multifaceted wider field of creative practice research (Doğantan-Dack 2015; Pace 2016; Impett 2017, RMA Practice Research Study Group). Use of technology is central to this subdiscipline, but our focus is on its roles as a catalyst, resistor or active agent within the creative process, rather than being concerned with the technology itself. Practice research has established itself in recent decades as a rich and diverse field of inquiry both within the academy and beyond it (Bulley and Şahin 2021). Within the creative arts, a vibrant discourse regarding the function of creative practice in relation to research has emerged, in which definitions, methodologies and expected outcomes are contested. A corresponding profusion of terms exist which indicate slightly different approaches, but which are also sometimes used as synonyms for one another: these include artistic research, practice as research, practice-based research, practice through research, practice-led research, and so on. We use the phrase **creative practice research** here to cover these varied terms and definitions of practice engaging with research.

In our niche, creative practice research approaches are employed in combination with **new digital technologies**. In using this term, we refer broadly to an array of musical and non-musical technologies which have been in development over the last 50 years and are now readily accessible to creative practitioners. These might include digital instruments, artificial intelligence, motion sensors and augmented reality or virtual reality (AR/VR) technology, and

[1] Cyborg Soloists (https://www.cyborgsoloists.com/) is a UKRI Future Leaders Fellowship research project led by Dr Zubin Kanga (https://www.zubinkanga.com/) at Royal Holloway, University of London. The team is also made up of two current additional artist-researchers, Research Administrator and Events Coordinator Caitlin Rowley (https://catilinrowley.com/) and Postdoctoral Research Assistant Dr Jonathan Packham (https://jonathanpackham.com/), as well as former Postdoctoral Research Assistant Dr Mark Dyer (https://www.markdyercomposer.com/).

many more. Various forms of new digital technologies are now intrinsic to practices of contemporary classical music (Hepworth-Sawyer, Hodgson, Paterson and Toulson 2019; Bayle and Provenzano 2021). This enmeshment, whilst a divergent spectrum, forms the aesthetic backbone of creative practice and enables innovative forms of expression whilst problematising traditional practitioner roles, methods of praxis, and epistemologies. New dimensions and perspectives are added to the creative practice research agenda within music by engaging with new technologies, reinvigorating these research fields while extending them into new interdisciplinary areas.

The incorporation of new technologies distinguishes our field from the wider, well-established field of creative practice research, whose methodologies range across ethnography and autoethnography, analysis and performance studies. While some of these methodologies may still be useful in our field (and are mentioned in this paper), when researching creative works incorporating new technologies, it is important to acknowledge the value of specific interdisciplinary knowledge in implementing methodologies encompassing the full range of performance and compositional research. Specialised knowledge of the technologies combines with an examination of the particular roles that these technologies can play within creative processes. For instance, new digital instruments may have unique aspects that are distinct from traditional acoustic instruments (Magnusson 2017); AI raises questions about autonomy and authorship that are idiosyncratic and require at least cursory technical knowledge to discuss; and knowledge of other artistic disciplines is needed to analyse works integrating new audio-visual elements.

Interdisciplinarity is central to technologically-focused creative practice research as this is a field which crosses boundaries with a number of other disciplines including music engineering, human-computer interaction, instrument design, performance studies, distributed creativity studies and ethnomusicology, and has unique aspects that are worthy of deeper research. The clearest example of this is the rich field of research into music technology and human-computer interaction in music, focusing specifically on the engineering and hardware/software design aspects (Emmerson 2007; Tanaka 2009; Magnusson 2019; Cadoz and Wanderley 2000). Such research is often presented at the NIME (New Interfaces in Musical Expression) annual conference, an event of particular significance for creative practitioners not only because of the research presented, but also because of the development of innovations first presented at these conferences into widely available commercial musical products. Such innovations are grouped in this paper under the term **new instruments**, a broad term denoting new musical instruments, devices and interfaces created for the purpose of sound-making practices, as well as augmentations to or hybridisations of existing instruments. Either might involve digital or analogue technologies, as well as instrument-building and craft practices.

The figure of the ‘cyborg’ is regularly invoked in the context of human-computer interaction; it is, for Haraway, a ‘hybrid of machine and organism’ (1985, 65). Whilst our understanding of the cyborg owes its origins to Haraway’s work, so too does this report incorporate alternative conceptualisations of the relationship between humans and technology. Moreover, the range of topics and examples covered in this paper is not intended to provide an exhaustive survey or even introduction to the field. Rather, it is intended as a starting point for further research and

discussion of this emerging research area, and as point of reference those whose work intersects with our own, be they artists, researchers, industry professionals or wider audiences.

Embodied Knowledge

Obtained via prolonged training, practicing, habituating and cultural immersion, a musician possesses certain artistic and expressive knowledge. The musician communicates this embodied knowledge through the act of practice. The following contributions explore how engagements with various technologies highlight, extend or complicate this embodiment and communication. While Gorton and Hayden posit technology as a mediator of expressive knowledge, Benjamin highlights its entanglement within artistic agency. Redhead and Kanga provide examples of body-technology interactions that epitomise these conceptions.

Cyborg Musicality: Instrument-Body Hybridity, Agency and Technique (as Knowledge)

Mira Benjamin[2]

Cyborg musicality is found at the threshold between an embodied practitioner and the technologies that structure and orientate their practices. Positioned as research activities, these hybrid practices afford not only technological and artistic innovation, but also useful reflection on the epistemic dimensions of embodiment. Writing on practice research from the perspective of theatre studies, Spatz (2015, 13) contends that the 'cyborg' nature of technologically-focused practice 'does not (yet) entitle us to dissolve the conceptual differences between biology, ecology, and technology.' Spatz (1) draws a theoretical distinction between *technology* and *technique*, proposing technique as 'embodied knowledge that structures practice' and emphasising embodiment as 'first affordance' (Spatz 2020, 70). For Spatz (2015, 12), a positioning of the body as epistemologically prior to technology implies that 'technology can be defined as its effect upon embodied technique.'

The significance of the embodied perspective in a discourse surrounding hybrid musical practice lies in its reframing of agential relationships between practitioners and technologies—which may include mechanical, electronic or digital infrastructure, but also 'objects, implements, and instruments' (Grosz 1994, 80) and bodily artefacts, including language and writing (Ingold 2007).

Pickering (2010, 196) proposes that knowledge develops around the 'material agencies' of objects, forming 'zones of intersection where the non-human world enters constitutively into the becoming of the human world and vice versa.' Knorr Cetina (2001, 181) suggests that the nature of such 'materially defined' practice is to continually acquire new epistemic properties; thus Pickering's (190) 'dance of agency' may propel practice from habituated spaces of 'sedimented' technique (Spatz 2020, 6), towards 'multimodal participatory spaces' (Rebelo 2006, 29) in which received 'paradigms of control' (McLaughlin, Kanga & Benjamin 2021) are

[2] https://www.gold.ac.uk/music/staff/benjamin-mira/.

critiqued. Technologies, then, may be understood, in Ingold's (2010, 3–4) terms, as not only objects but as 'things'—spaces of creative entanglement where technical 'goings on become entwined.' Discussion of training and habituation in the use and application of technology may then be counter-stimulated by questions concerning the reflexive impact of technological materiality upon the knowledge objects that arise in practice.

Case Study: Sensor-Based Instruments

Zubin Kanga

The creation of new instruments, digital or otherwise, grows out of wider cultural affordances and desires. Gestural-based sensor instruments have grown out of a greater desire for bodily movement to be instrumentalised and sonified. They also bring the audience into this process, and the theatre of how gesture and sound relate is as much a consideration of design as the raw functionality. Practice-based research into the use of these technologies in new works can result in new approaches to composing and performing with these instruments and designing/engineering new instruments.

The MiMU sensor gloves are an instrument that combines gesture and movement sensors to facilitate control of sound. Kanga's practice-based research to produce his work *Steel on Bone* (2021) created a model for using the gloves as tools to digitally shape acoustic sounds from inside a piano. This piece combines the gloves' functionality with the theatricality of playing inside the piano with steel knitting needles, creating the impression of conjuring strange, new sounds from a familiar instrument through sonification of the performance gestures. Contrastingly, Kanga's collaboration with composer Neil Luck[3] and Deaf performance artist Chisato Minamimura[4] on *Whatever Weighs You Down* (2022) shaped the gloves' movements on Minamimura's movements, influenced by her experience in BSL and Sign Mime. The modelling of Minamimura's gestures allowed Luck and Kanga to move beyond the desire to push the instrument to its technical and virtuosic limits, exploring how the glove gestures and movements could have a quasi-semiotic function as well as a role in sonifying movement. In doing so, this case demonstrated how collaborations with disabled artists can facilitate new approaches to sensor-based instruments (explored in further detail in Kanga (2023)). This has similarities with a collaboration between Kanga and Amble Skuse[5], a disabled artist with movement impairments, who uses the MiMU gloves due to their accessibility as an instrument. This allows her to develop a sophisticated practice around the gloves that is transferred to Kanga and other performers through her compositions – the accessibility of the instruments facilitates a larger base of artist-users, and thus a wider range of potential modes of use as well as specialised expertise in the instruments developed by these composers and performers. Kanga's current collaboration with MiMU founder Tom Mitchell on the use of camera-based gesture control is a next step in this research. By combining open-source software for video-recognition of gestures with the MiMU software for mapping and control, a complex gestural instrument can be built virtually using a commonly available webcam, making these types of instruments increasingly accessible and versatile.

These case studies present new approaches to this existing digital instrument, as well as demonstrating what technical functions a next-generation instrument might improve upon. This work has generated research impact on artists, engineers and instrument makers. The artists involved in these projects—and others like them—play a key role in developing new and

[3] https://www.neilluck.com/.
[4] https://chisatominamimura.com/.
[5] https://ambleskuse.net/.

improved sensor-based instruments, complementing the research strengths and foci of engineers and instrument designers.

Interactions with Technology: Expertise, Affordance and Mediation

David Gorton[6] and Sam Hayden[7]

All music-making could be said to involve human interactions with, and mediation by, technology of one kind or another. Technologies in the broadest sense, including instruments and designated performance spaces, have been around for as long as people have created music. For musicians, an instrument like a flute is a piece of technology, as is a MIDI keyboard or a machine learning system. The difference between such old and new technologies is situated in the kinds of interaction and mediation of creativity that occur, and the ways these help to form cognitive and embodied understandings of making music.

A common expectation for professional training on an acoustic musical instrument—such as a flute—within the UK conservatoire sector is around five years of tertiary-level tuition undertaken if a student has already reached an advanced stage by the end of secondary education. Such a long-term regimen is only possible because the technological object—the flute—and its attendant repertoires and pedagogies exist in a relatively stable form, little altered across decades. While some of the newer technologies also have long-term, stable existences (for example, some electronic keyboards and music notation software have had sustained identities for thirty years or more), many do not. This raises questions regarding the nature of skill in their use. It is perhaps unlikely that a musician would expect to interact with new technology at a professional level without already having expertise in pre-existing technology, but the increasing speed of technological development will require a change in the versatility of expertise in both time and range. The transition from playing a modern flute to playing, for example, a baroque flute represents a significant adjustment, but it is one during which previous expertise remains relevant and useful. A musician working with new technologies requires a different order of transferable skills, needing quickly to adapt to new hardware, software, interfaces, and behaviours for which there may not be established performance practices and/or pedagogies.

In *The Craftsman*, Richard Sennett (2008) has observed that the development of computer-assisted design in architecture has resulted in a loss of the craft of drawing and sketching, with implications for how spaces are imagined by creators. Similar anxieties are voiced anecdotally about the effects of music notation and Digital Audio Workstation software on the act of musical composition. Yet interactions with such technologies can also be thought of as means for repositioning aspects of control and decision-making within the creative process, in a similar manner to how using a random number generator for creating pitch material is a matter of *choosing* a type of algorithmic control rather than relinquishing control entirely.

The language of affordances (Gibson 1966, 1979) is often used to consider the possibilities that different technologies bring to a creative situation (e.g. Windsor and de Bézenac 2012; Krueger

[6] https://www.ram.ac.uk/people/david-gorton/.
[7] https://samhaydencomposer.com/.

2014), which may be utilised by an individual musician in a way that is shaped by their ‘habitus’, a collective of their previous knowledge, experiences, aesthetic preferences, and so on (Clarke et al. 2017). Consequently, a musician’s artistic ‘voice’ may be considered as a complex entanglement of interconnections with other musicians, repertoires and notations, traditions and practices, and in which interactions with technology are central: often, but not exclusively, as a physical interaction with a musical instrument (Gorton and Östersjö 2019). Interactions with technology are thus dialogic in character, with technology shaping a musician’s conception of musical possibilities as much as being controlled by the musician.

The technological *mediation* of creative musical practices and developments in technologies have certainly afforded new means of musical expression. Technology itself changes and intervenes in creative processes. An historical example is the developments of composition and performance practices that mirrored the various expansions of the piano during the nineteenth century. The autonomous musical agents of AI arguably represent the latest paradigm shift in creative music technologies (Magnusson 2019), building on a history of algorithmic music, exemplified by stochasticism (Xenakis 2001), where computer programming increasingly intervenes in compositional decision-making. However, the relationship of such technological innovations with aesthetic innovation is less clear: where technological innovations *can* afford aesthetic innovations, the relationship is certainly not straightforwardly deterministic. Rapid developments in digital music technologies, driven in the main by university-based research and commercial tech-industrial imperatives, change both the conceptual and the aesthetic space of musicians. These spaces can take a while to settle, especially given the comparatively slow pace of the acquisition of performance skills and the very different context of, and historical agendas associated with, the conservatory. But such rapid changes in the creative possibilities of the digital mediation of music leave little room for establishing cultural consensus on the aesthetic value of their applications.

Vocality, Voice and Technology

Lauren Redhead[8]

Owing to its signifying quality, assumptions that it is indicative of the body, and its capacity to communicate inherent contradictions of the self/other, known/unknown, and familiar/uncanny, the voice is a separate case from other instruments (cf. Dolar, 2006 after Lacan). In a technological context, the voice is encountered beyond the body and yet is considered a constant signifier that is indicative of the body even in its absence. When technology and the voice intersect, the effect is often identified as uncanny. While technological mediation of the voice might be assumed to make the voice outside of the body strange, it is rather often technology that is made uncanny through the voice. Eldred (1997) posits that inflections of technology imbue many discussions of and encounters with the voice even when these are unnoticed, while Jarman (2011) describes technological mediation as a pathway to vocal identification, even of voices that represent others. While there is arguably no technological 'voice', in the intersection of the voice and technology, corollaries of the voice such as language are posited as somehow technological, while the 'vocality' of technologies may be revealed. This is especially true in non-phenomenological appearances of the voice (for example, where the voice is used as an input, filter or controller, but is not heard in performance). Rather, these situations draw attention to a phenomenology of technologies themselves. The contradictions that inhere in the aesthetic category of the voice therefore draw out similar contradictions in technological categories where the voice is encountered.

[8] https://laurenredhead.eu/biography/.

Methodologies & Criticality

Due to its origins within the broader field of creative practice research, technology-centred musical practice has often adopted similar methods and methodologies. However, the rate at which new digital technologies are developing—as well as their effect on society and culture more broadly—may necessitate a refinement or even complete revision of such methodologies to ensure both practice and research remain critical. Nickel and McLaughlin propose new perspectives on autoethnographic methods, whilst Howard and Laidlow suggest specific approaches for engaging with AI and machine learning in creative practice research. Hunt, Gioti and Dyer suggest various ways the practitioner's engagement with technology might remain critical—from creative tool to subversive exploration—with opportunities for self-critique. Lastly, McLaughlin highlights the obstacles in demonstrating 'rigour' in creative practice research compared to the STEM subjects that inform the field of music tech.

Autoethnography and Positionality: Perspectives of Technological and Cross-disciplinary Enquiries

Luke Nickel[9] and Scott McLaughlin[10]

In many cases, access to technology is granted as an asymmetric exchange where the price of admission is to give away parts of our identity. How we use technology contains the fingerprints of some part of our identities: through usage habits, embodied patterns/choreographies and data. Sometimes, these fingerprints are forcibly obtained, in terms of data capture on an individual level, but also sometimes on a colonial, cultural level when artefacts and spirits are captured against our collective will. Artists are in a position to problematise this relationship between humans<->data<->technology, and utilise technology to *demonstrate* their positional realities, *speculate* on future possibilities and *interface* with the world in accessible ways while changing both the technology and the world for the better.

The following artists, as well as many others, are using technology that is deeply intertwined with their own often intersecting positionalities to create original music that defies genre and unlocks new perspectives in both musicians and audiences alike.

- In their piece *Escape TERF Island* (2022),[11] CHAINES[12] *demonstrates* their positional reality as a non-binary trans person through the use of a synthesiser equipped with harsh, squishy, bodily sounds.
- Erin Gee[13] also *demonstrates* her position as a woman making electronic music by inhabiting the stereotypically high-femme genre of ASMR, redubbing her work as ASMR-tronica.

[9] https://lukenickel.com/.
[10] https://www.lutins.co.uk/.
[11] https://zubinkanga.bandcamp.com/album/machine-dreams/.
[12] https://www.chaines.co.uk/.
[13] https://eringee.net/.

- ℌEXOℜ𝔈SMOS[14] uses machine learning to *speculate* on a future where the 3ball music genre marries pre-Hispanic rhythm technology and modern western artificial intelligence, with the project *Nahuatl: Future* (2021), taking the form of a trained model for generative music making as well as an album that doubles as a sample pack.
- In her album *The Long Count* (2022), Debit[15] draws on recordings of ancient Mayan instruments to train a machine learning model that can generate new flute sounds to *speculate* on what ancient Mayan music might have sounded like.
- Megan Steinberg[16] uses innovative scoring methods and new digital instruments to *interface* with other disabled musicians (Morris 2022).

Just as artists use their unique positionalities to imagine new technological possibilities, when writing about our own and others' music involving technology, it is imperative that we explore methods and perspectives outside the dominant western classical analytical tradition. The following writers and projects employ forms of writing beyond the strictly analytical in order to expand our understanding of the relationship between music and technology, allowing for richer and more generative discussions to occur.

- *Hungry Listening* (2020), by Stó:lō scholar Dylan Robinson, uses speculative score-making and performance writing to demonstrate the unique reality of Indigenous music-making in colonised Kanata (Canada), often exploring the relationship that technology such as recording devices have had on colonisation.
- The position paper on Indigenous Protocol and Artificial Intelligence (Lewis 2020) uses workshops, speculative writing and stories to position the future of AI technology as intertwined with Indigenous values.
- In *Glitch Feminism: A Manifesto*, Legacy Russell (2020) uses the format of a manifesto to propose a new relationship between gender, technology and the body.

As academics and artists in practice research, we need to be more than simply users of technology. It is incumbent upon us to bring a critical approach to technology that avoids passive assumptions of the technology itself, the user, or the context in which it is used. Practice researchers are ideally situated to demonstrate, speculate and interface via our interaction with both academic audiences across disciplines, and artistic networks and audiences.

In recent years, auto-ethnography has emerged as a primary approach in music practice research because it is subject-centred and can be flexibly tailored towards the specifics of the underlying artistic project. Certainly auto-ethnography can be useful in our field of practice research at the intersection of music and technology, with its focus on individuals' perspectives, reflexivity, and ability to acknowledge the emotional aspects of challenges encountered in working with new technology and learning new skills. However, while widely used, auto-ethnography has not been theorised broadly in our field, and there is a paucity of examples

[14] https://hexorcismos.bandcamp.com/.
[15] https://www.deliabeatriz.com/.
[16] https://megansteinberg.com/.

where it is both done well and made visible across the great diversity of practice. This suggests that we could benefit from problematising the default adoption of auto-ethnography in our field, and question why it should be preferred over other methods. Alternatives available include methods drawn from the Social Sciences, such as Actor Network Theory (Latour et al.), approaches drawn from Philosophy (De Assis) or the Philosophy of Science, such as the epistemics of 'doing' (Rheinberger, Knorr Cetina, Pickering).

We believe that there would be immense value for practice researchers across all disciplines to be able to access training that engages more with the ways that positionality sits within ethnographic methods. In Music, much can be learned in this respect from sister disciplines such as Ethnomusicology, as well as from Anthropology and other Arts & Humanities disciplines. Understanding the range of methodological options from these fields—including their strengths and their limitations—would help Music Technology relate to existing discourses around the methodology of auto-ethnography from outside music to determine the most appropriate methodological options in this area.

How can Artistic Practice Research Critically Engage with Technology?

Using Technology as a Creative Tool

Edmund Hunt[17]

Artistic practice can suggest a multitude of possibilities for critical engagement with technology. Technology can both augment an artist's existing practice and contribute to the development of novel methodologies for artistic research. For creative practitioners, new developments in technology can afford increasing opportunities to question and re-imagine our assumptions regarding the roles of creators, performers, developers, and audiences. By enabling some of these categories to merge and overlap, technology can facilitate links between different fields, leading to work which is 'largely collaborative and inescapably multidisciplinary' (Impett and Parra Cancino 2019, 126). For composers, strategies such as computer-aided composition can be used to generate materials at a pre-compositional level (Vincenot 2016). Software such as OpenMusic, and more recent developments such as Sound Notation (Sköld 2023) have often facilitated creative strategies based on sonic analysis, leading to work in which the influence of technology is not always immediately apparent. Conversely, practices such as live coding demonstrate process-driven approaches involving technology, whereby the real-time creation and realisation of a score are integral elements of a performance (Magnusson 2011).

Critical and Subversive Approaches to Technology

Artemi-Maria Gioti[18]

Practice-based research can engage with technology in critical ways, investigating its contingent materiality and its embeddedness in social, cultural and historical contexts. Such critical investigations tend to view technology 'less as a source of solutions to given problems than as a way to challenge previously established solutions and previously recognized problems' (Di Scipio 1998, 32). They include, among other approaches, subversive explorations of Music Information Retrieval (MIR) tools (Bowers and Green 2018), (cyber)feminist critiques of the gender relations embedded in technologies (Schedel, Ho, and Blessing 2019; Alessandrini and Zhu 2021) and critical investigations of the contingent nature and cultural embeddedness of algorithms and data (Gioti, Einbond, and Born 2023). In these examples, technology is the object of both aesthetic exploration and critique, giving rise to questions such as:

- What are the distinctive qualities of technical critique produced through artistic/practice-based research as opposed to other forms of research?
- What role does the first-person perspective and the dissolution of the subject/object distinction that is characteristic of artistic research (Borgdorff 2006) play in this process?
- How is the relationship between the conceptual and the aesthetic, as well as between theory and practice, constituted in these approaches?

[17] https://www.edmundhunt.com/.
[18] https://www.artemigioti.com/.

How can Technology Enable Critical Engagement with Artistic Practice?

Mark Dyer

Notwithstanding the reductive bifurcation of ‘technology’ and the artistic subject—in reality inextricably entangled—our question of how technology can enable critical engagement with our artistic practice concerns *novel* technologies that present a distinct departure from the artist’s usual methods of working.

Such technologies have the potential to expose unique avenues for artistic enquiry as well as estrange aspects of an existing practice. A composer might utilise neural synthesis to generate unimagined sounds; a performer might use motion sensors to develop new instrumental gestures. The same composer might uncover, via deep learning representations, uncanny generalities of a corpus of work (their own or another’s, see Dyer 2023); through movement-to-sound mapping, the performer might discover bodily habits hitherto unnoticed. Such investigations are anthropological (Dyer 2022).[19]

The ‘technological other’ presents a ‘disorienting dimension’ (Aydin 2021, 315) that ‘intrudes’ upon (311) and makes unfathomable (306) both the artist and their practice. Following Heidegger’s (1977, 20–21) conception of *enframing*, of challenging forth and producing the real, such technologies have the capacity to ‘reveal’ truth aspects (12) of our practice. By engaging with technology—a mediating, material semiotic agent—the artistic practitioner is able to make strange and hence critically engage with the ways they work.

[19] An example of this is *ULTRACHUNK* (2018) by composer-performer Jennifer Walshe and computing artist Memo Atken. Extracts are available to view at https://www.memo.tv/works/ultrachunk/.

Artificial Intelligence in Musical Practice-based Research

Iterative, Collaborative Methodologies: PRiSM SampleRNN case study

Emily Howard[20]

The Royal Northern College of Music's Centre for Practice & Research in Science & Music (PRiSM)[21] brings together researchers across the creative arts and the sciences to address the mutual impact of new digital technology and what it means to be human and creative today.

This case study focuses on the Centre's reimplementation and ongoing refinement of PRiSM SampleRNN,[22] an open-access neural audio synthesis software coded by Christopher Melen, PRiSM Research Software Engineer (RSE) and released in June 2020. The initial coding phase (November 2019 – June 2020) revolved around collective artistic and computational experiments concerning the software's accessibility and potential strategies of facilitating artists' diverse creative needs. A collection of artistic outputs involving the technology, in turn, shaped subsequent refinements to the software by Melen following the software's release (Ma et al., forthcoming).

In part, this iterative approach is akin to how generative neural networks operate upon repeated learning processes, in that each iteration—or each complete learning sequence of the resource (data) available—can be referred to as an 'Epoch'. PRiSM's approach was not intentionally designed in this way, arising organically as a result of collaborating artists' requirements. Many of the works mentioned below are available to view on the PriSM website.[23]

PRiSM SampleRNN Iterations

Epoch 1 (2020-21): trial and error with Google Colab integration; possibilities of DIY toolkit or via the RSE-assisted training process, resulting in:

- Jennifer Walshe's[24] *Ireland: A Dataset* (2020)
- José del Avellanal Carreño's[25] s*peak, sing…* (2020) (PRiSM Blog 2021)
- Sam Salem's[26] *THIS IS FINE* (2021) (PRiSM Blog 2023)
- Emily Howard's *shield* (2021)

Ireland: A Dataset was the first performance to incorporate material generated using PRiSM SampleRNN. Working in Google Colab, Walshe used Irish traditional sean-nós singing to train the algorithm. Outputs were then learned by ear by the experimental vocal group tonnta for the performance. In writing *shield* for the Piatti string quartet, Howard's compositional process involved RSE-assisted training and a reworking of materials written for PRiSM SampleRNN dataset in response to hearing PRiSM SampleRNN's creation.

[20] https://www.emilyhoward.com/.
[21] PRiSM is funded by the Research England fund Expanding Excellence in England (E3).
[22] https://www.rncm.ac.uk/research/research-centres-rncm/prism/prism-collaborations/prism-samplernn/.
[23] https://www.rncm.ac.uk/research/research-centres-rncm/prism/prism-media/.
[24] https://milker.org/.
[25] https://www.josedelavellanal.com/.
[26] https://www.osamahsalem.co.uk/.

Epoch 2 (2021-22): software optimisation implemented to enhance training efficiency and to facilitate generation at higher sample rates (e.g. 44.1kHz or higher) and/or larger-scale datasets, which further streamlines the RSE-Assisted model. Projects include:

- Robert Laidlow's[27] *Silicon* (2022)
- Norrisette's[28] *Whale House* (2022)
- Megan Steinberg's *Outlier II* (2022)
- Chihiro Ono's[29] *simplexity2022* (2022)
- *The Wernicke's Area* (2022) by Emily Howard, Bofan Ma[30] and ANU Productions

Silicon features a live orchestra accompanied by sounds generated by PRiSM SampleRNN which was trained on over 2,500 hours of archive recordings of BBC Philharmonic's radio broadcasts. In *Outlier II*, Steinberg trained PRiSM SampleRNN with a collection of recordings of musicians rehearsing a melody generated by OpenAI's MuseNet, in order to articulate the process of generalisation AI undergoes and its impact on disabled, deaf and neurodivergent people (PRiSM Blog 2022). *The Wernicke's Area* is a mixed media installation that responds to the complexities of living with epilepsy. Informed by biographical and medical data, Ma's sound-design revolves around PRiSM SampleRNN-generated materials trained upon recordings of brain seizure activities, spoken voice and site-specific field recordings.

Epoch 3 (2022-23): developing beyond PRiSM SampleRNN. Through collaborations and ongoing conversations with artists in residence (e.g. George Lewis[31] (PRiSM Blog 2023) and Franziska Schroeder[32]) PRiSM began addressing challenges around improvisatory utilisation of machine learning and neural synthesis, whilst extrapolating to machine listening algorithms[33] and the field of music information retrieval (Porcaro 2023). Epoch 3 of PRiSM SampleRNN also marks Epoch 1 of other emerging PRiSM software tools.

Through RNCM's Centre for Practice & Research in Science & Music, the ongoing development of collaborative methods that enable new AI technologies to emerge in tandem with the creative outputs that make use of them is becoming 'business as usual' within the music conservatoire, impacting epochs of conservatoire-trained musicians. What further impacts will arise through the sustained development of this shared approach to technology and methodology? And what best practice might be developed to ensure space for subsequent deviations from the expected; for new organic approaches to arise?

[27] https://www.robertlaidlow.co.uk/.
[28] https://norrisette.bandcamp.com/track/whale-house/.
[29] https://www.chihiroono.com/.
[30] https://www.mabofan.com/.
[31] https://music.columbia.edu/bios/george-e-lewis/.
[32] https://pure.qub.ac.uk/en/persons/franziska-schroeder/.
[33] https://github.com/rncm-prism/PRiSM-MusicGestureRecognition/.

What is the Future of Artificial Intelligence in Creative Musical Practice?

Robert Laidlow

Much music-making using Artificial Intelligence (AI), and especially that which uses machine learning,[34] is currently explicitly and self-referentially 'about' AI. Take, for example, the recent proliferation of projects 'completing' unfinished canonical symphonic works. To make a twentieth-century parallel, early computer music which was similarly focussed on its method of production has not always stood the test of time: the majority of the music created by Berio, Maderna, Nono, and Cage at the Studio di Fonologia at RAI, for example, is very rarely heard today. However, the computing techniques they showcased have undeniably had a transformative effect on global music-making. So, what is the future of AI technology within creative musical practice beyond showcasing itself or recreating the past?

Here I offer two possible directions:

One concerns its future as a sandbox through which to create instrument-like algorithms, on which musicians might play any type of music (new or old). Machine learning's unprecedented powers to intuitively respond to its users are already creating bespoke digital instruments and assistants for artists (including myself), based on their practice, accessibility requirements, and taste (Fiebrink and Cook 2010; Morris 2022; Youth Music 2023; Laidlow 2023). This music need not be about AI, but AI is essential to its process. If instrument-like machine learning tools are made widely and freely accessible to the public, there may be a surge of interest in immersive, interactive, and intuitive music-making.

AI is also causing people to rethink their relationship with truth. Today, images, videos, music, and news stories cannot be relied upon to be authentic, or even created by a human. AI is a herald of the post-truth era, but it also seems likely that it will be critical in the artist's toolkit for examining and responding to issues of truth, authenticity, and reality. For example, large language models' ability to generate infinite parallel versions of the same story is something I have investigated in my own compositional work recently; the use of deepfake technology—already prevalent and contentious within the film industry—seems likely to be widely-deployed in questioning authenticity within dramatic works; and the blurring of 'real' and 'unreal' performers through virtual technology has been investigated by artists such as Holly Herndon[35] and Jennifer Walshe, and more widely through the virtual celebrities prevalent in K-Pop and experiences such as ABBA Voyage.

[34] Here, the term machine learning is broadly used to describe algorithms which are able to create models without following explicit instructions, or which are able to learn and extract rules from datasets autonomously.
[35] https://www.hollyherndon.com/.

Research Rigour

Scott McLaughlin

> ‘The extent to which the work demonstrates intellectual coherence and integrity, and adopts robust and appropriate concepts, analyses, sources, theories, and/or methodologies’ (REF 2020, 35).

The REF2021 definition of rigour is a useful generic starting point for UK academia since it is deliberately broad enough to cover all disciplines. That said, in the wider academic context, research rigour tends to be discussed in more positivistic terms (with a bias towards STEM subjects) that valorise the reproducibility of objective (i.e. universal) results. The tool for achieving this is usually the application of appropriate methods that are proven as reliable, guaranteeing a level of truth in the results. The rigour of such research is in choosing the right methods and applying them correctly.

In practice research, such a positivistic approach is very rarely applicable, so we need a different approach to rigour. However, there can be uncomfortable tensions when disciplines like score-based composition and acoustic performance overlap with music technology, which is a STEM discipline with roots in computation and electrical engineering that often assumes a normatively objective research epistemology (e.g. the majority of submissions to conferences such as NIME and ICMC).

As Bulley and Şahin (2021, 12) put it: ‘practice researchers often involve themselves in complex, changing, messy problems and situations [... with] first-hand experience, intuition, iteration and trial and error as key methods.’ The epistemology of practice research is subjective, situated with the practitioner and their context, and (in most cases) inherently unsuitable for methods designed for universally objective results. Practice researchers often begin-at and proceed-from a point of ‘not knowing what they are doing,’ where the research focus emerges through practice, ‘welcoming the opportunity for the ways of knowing that arise’ (12). As Michael Schwab (2015, 122) suggests, such experimentation ‘repositions theory: theory emerges from experimentation, rather than being tested by it.’

So if practice research cannot generally demonstrate rigour in the same way as STEM models, but the UK research establishment includes rigour as a key criterion, then what is rigour for us? I suggest that our research can be rigorous in two key aspects; in demonstrating a clear context for how we contribute to a field of knowledge, and the clarity of our communicating the key insights. The last of the three elements of the UK REF definition of research is that our insights are ‘effectively shared’ (2020, 49). If our ‘process of investigation’ is irredeemably messy by STEM standards, then our rigour is in clarity of sharing those insights, untangling the mess for others to gain from it effectively.

To consider the overlap with more objective epistemologies that structure fields such as music technology, it’s useful to return to the REF definition of rigour above. This definition is helpfully broad and avoids centering STEM objectivity, instead allowing methodological robustness and appropriateness to be defined relative to the researcher's field, becoming contingent on the

specific research aims. The project may then lean more or less towards different epistemologies: what role is practice and the practitioner playing in this particular project? what element is being researched through the practice? Returning to Bulley and Şahin (2021, 59), they emphasise that ‘[t]he process then is to try to work out what enquiry you can legitimately claim in that work, rather than having to change the work to fit within the system.’

Impact

The potential impacts of new digital technologies upon creative practice research and researchers are evident and varied. But what of the impacts of such technologies and research upon other stakeholders, including audiences and industry? Kanga and Laidlow offer examples of such impacts, using specific works as exemplars. Climent proposes a new conception for live, virtual works, in which the audience and performance venue are included within a stage-ecosystem.

Impacts upon the Music Technology Industry, Other Creative Practitioners and Audiences

Zubin Kanga and Robert Laidlow

There are numerous, varied impacts that the field of technology-focused contemporary music can have on other artists, on the music technology industry and on audiences. The music technology industry can benefit from the insights of new artistic research in expanding the possibilities of technologies created for commercial purposes for particular use cases. For example, Kanga's recent collaboration with composer Luke Nickel, *hhiiddeenn vvoorrttiicceess* (2022), uses haptic metronomes created by Soundbrenner. Soundbrenner's devices are commercially available and used by session musicians, but Nickel's collaboration with Kanga explored how the relationship between a musician and this technology can be expanded, subverted and flipped (Kanga 2022). Soundbrenner opened a beta version of their app, allowing for the haptic metronomes to be controlled independently—allowing Kanga to play constantly changing independent tempo curves in each hand, each corresponding to the movement of a rollercoaster shown on screen. Nickel also connected a Genki Wave motion controller to the system, facilitating moments where the metronome speeds were controlled by Kanga's hand movements—a flipping of the direction of control between body and device. As a result of this research project, the flexibilities Soundbrenner provided in this beta version of their app have now been implemented in their commercial app. In this way, an artistic research project discovered new ways that an existing technology could be used, opening up new avenues for experimental uses of this technology, without requiring a major redesign of the technology. This is just one example of the unique contribution that practice research can make to research with new technologies.

Other artists can be impacted by this research through the technical tools generated, as well as the works themselves which serve as examples for new music-technology interactions. For example, Kanga's collaboration with Philip Venables[36] on *Answer Machine Tape, 1987* (2022) uses a KeyScanner, an optical scanner that attaches to a piano, allowing it to function as a MIDI controller. This device was used to 'type' text live onto a screen, but the demonstration of the technology has led to increasing interest in this technology by other artists—with an increase in enquiries and orders received by its creator, Andrew McPherson[37]. These artists have been

[36] https://philipvenables.com/.
[37] https://www.imperial.ac.uk/people/andrew.mcpherson

introduced to a new compositional/performance tool, and provided with a model for its use. McPherson is an example of a researcher who has been impacted by this type or research – he points to the performances as impact of his own engineering research, as well as citing the collaboration with Kanga as being crucial to the development and fine-tuning of the KeyScanner for use in professional performance situations (McPherson 2023).

And what of the impact on audiences of this work? In other artforms, such as video games, audiences have come to expect and enjoy a high level of interactivity and immersion, leading to meaningful and memorable experiences. Classical music, on the other hand, often seems to be fixed in an historic model; audiences quietly sit, receiving the artistic vision of an author and interpreter without direct interaction. It could be stated that there is a disconnect between how audiences engage with much modern entertainment and how classical music is normally presented. The future of music is not in uncritically reflecting the form of other entertainment. However, there may be some value in pursuing within the concert hall the different kinds of experiences audiences are used to in other areas of their lives. Video games intended to create a profound artistic experience, for example, are not dependent on specific technology, but rather on the construction of a parallel reality that can involve co-operation, competition, narrative, success, failure, choice, and consequence. Laidlow's work with AI, *Silicon* (2022), allows audiences to examine the archives and history of the BBC Philharmonic in new ways, hearing these memories brought to life alongside the current orchestra. The work impacts on the audience's knowledge of how AI can be integrated into art, as well as demonstrating how new technologies can facilitate new perspectives on the history of an existing art form, and an historic ensemble.

There will always be an important place for the traditional model of audience-performer interaction, particularly in a world where that model is becoming rarer outside of music. However, the question of what perspective music performance can offer on such ideas, whether it is possible to construct similar realities in a concert setting, and how audiences might use music to reflect upon wider social trends, seems to become more acute by the year.

Co-presence and the ‘reality of the virtual’: Integrating the Audience into the Stage-Ecosystem in Live, Virtual Performance

Ricardo Climent[38]

Across 25 years of creating media projects mediated by computer technologies, I have gradually shifted how I envision the next generation of interactive entertainment and how audiences may engage with it. Central to this vision—something that preoccupies my artistic mind—is the concept of ‘co-presence’ (Fischer-Lichte 2008). More specifically, I am interested in how co-presence manifests at the intersection of the Real and the Virtual in a mediated musical performance. Scholar on the philosophy of computer games Olli Tapio Leino (2019) argues that Fischer-Lichte’s understanding of co-presence unnecessarily constrains performance, as audiences existing in the same space as performers contribute to the performance experience with every movement. But how does this performer-audience dualism manifest in computer-mediated spaces? How can an interactive system extend this concept to stage-space co-presence? And how might audiences perceive novel artistic innovations of this nature? To address these questions, I design complex, interactive media systems and ad-hoc narratives to explore different taxonomies of re-embodiment and representation of human-performers, musical instruments and the physical-space. However, most artistic outcomes facing these questions are constrained to the first-order doppelgänger design (Climent, Pilkington, Mesárošová 2016). The overall system scheme is still anchored to the idea that the exploration of the Virtual (performer, musical instrument or space) is as an extension of their real counterparts. But what if we reverse the whole paradigm? Audiences might understand the Virtual doppelgängers as the new-Real and anything else as non-Real by definition.

Slavoj Žižek's concept of the ‘Reality of the Virtual’, as outlined in his 2003 lecture of the same name (Wright 2004) has had a particular impact on my creative thinking and system design. Thinking of the Virtual as the new-Real has posed new questions regarding the development of live performance experiences. If—as Žižek proposes—the Virtual is the new-Real and what we deploy on stage is its surrogate, what is the nature of the so-called non-Virtual? Computer hackers are familiar with this quandary: what does it mean for a hacker to be AFK (away from keyboard)? Does their ontological reality reside in being-in-the-code, or is it being away from the computer screen? Translating this to a musical performance scenario, what is the ontological reality of the performer, musical instrument, stage and, ultimately, spectator? These questions have led me to shift my creative priorities towards dissolving the audience’s perception on what is real and what is not, while letting them freely navigate these two Žižekian non-realities. A logical development of this line of exploration may be towards constructing a higher form of co-presence, one that integrates audiences in the stage-ecosystem (that is, alongside performer, musical instrument and space). Considering the stage-ecosystem as a single embodied representation in constant flux prioritises physical, emotional and intellectual forms of experiential interaction, embracing the creative potential of dissolving the human-technology divide.

[38] https://research.manchester.ac.uk/en/persons/ricardo.climent/.

Conclusion

The contributions presented in this position paper represent summaries of the topics proposed and discussed by the authors in a single-day event. One of our aims was to identify common ground shared by these representatives of our field of creative practice research in technology-centred contemporary classical music, and three strands have emerged through these discussions and written contributions:

- A fruitful contestation of what ‘technology’ means within a creative, musical context.
- A desire for practice and inquiry to prioritise musical, artistic or aesthetic concerns over a narrow focus on technological innovation.
- A valuing of interdisciplinary collaboration as a means of combining the diverse expertise, resources and creativity that artists and technology creators/researchers can offer.

Despite these common values, creative practice research in technology-centred contemporary classical music is a diverse area of exploration. If the included contributions appear kaleidoscopic in their perspectives, tone and methodologies, this is because they necessarily reflect the vibrantly varied nature of the field they describe. With its unique position at the confluence of broader practice research in music and the creative arts on one hand, and innovations in music tech engineering on the other, our field treads a delicate line between the two. This balancing act—and the potential consequences of failing to maintain balance between the two aspects of our work—has implications on our contributions towards research assessment exercises, and suggests a real need for developing effective training frameworks (as suggested by Nickel and McLaughlin) and measuring their social and cultural impact.

We have found a common acknowledgement by those working within this field to navigate carefully a seemingly contradictory call to arms: to establish a common foundation for inquiry through the collaborative and iterative development of methods and methodologies, whilst ensuring the polyphonic richness of this field is not only maintained but multiplied.

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