Editorial: Ecologically grounded creative practices and ubiquitous music – interaction and environment

1. INTRODUCTION

This issue of *Organised Sound* includes articles on ubiquitous music and related concepts and practices. Ubiquitous music (ubimus)[1] is an approach to music-making which operates at the intersection between diverse technologies (often networked or otherwise modular) and social, interactive and enactive musical and/or sonic practices. Although ubimus may apply a variety of theories and methods, one well-established approach which we foregrounded in this issue's call involves ecological, embodied, embedded and distributed models of cognition and creativity, sometimes termed 4E cognition (Malinin 2019). In ubimus, this conceptual grounding is complemented by various enactive and socially engaged methods, including participatory, accessible, inclusive and community-oriented approaches to technological design.

The present issue comprises two parts. The first includes articles (Aliel et al; Koszolko and Studley; McConville; Brown et al.) which were explicitly submitted in response to a topic-specific call. The second includes off-theme articles from the journal's ongoing open call (Howe; Sanfilippo; Trillo and Poliks; Dean et al.), all of which nevertheless exhibit some conceptual or thematic compatibility with ubimus.

An ecological context for music can be traced to earlier work by Keller (2000) and was first explicitly applied to ubimus in an earlier *Organised Sound* article (Keller and Lazzarini 2017a), where it was presented as an alternative to 'instrumentally oriented and individualistic approaches' to composition. Thus, in the context of this connection of the ecological with the social, ubimus can be seen as sharing many of the same concerns as other recent special issues of this journal, in particular connecting with the subject matter of 'Socially Engaged Creative Practices' parts one and two (26/2 and 28/1), 'Collective and Networked Sound Practices' (26/3), and 'the Sonic and Electronic in Improvisation' (26/1), social and co-creative practices that incorporate open forms, and technological networks, engendering broader ecologies of actors and resources.

The 'ubiquity' of ubimus refers to a range of technologies, from DIY sensors to mobile and embedded devices, seen within the context of technology-driven music and sonic practices which empower and engage previously excluded social groups. Accordingly, ubimus can be seen as avoiding the symbolic weight of pre-internet, pre-mobility or other legacy acoustic-instrumental notions such as 'the instrument', 'the orchestra' or 'the score', with their implied division of labour between 'geniuses' and 'virtuosi' on one side and a passive and well-behaved audience, on the other side, or the implied vertical organisation of musical roles in synchronous music performance; cf. the oft-critiqued 'master/slave' terminology (Bhagwati 2013; Lewis 2000; Keller 2000). In short, it often questions existing approaches based on discourses of virtuosity and specialism (including the remnants of acoustic-instrumental perspectives) and seeks to embrace grassroots and participatory approaches to design and co-design.

Rather than a genre, a style or a particular artistic aesthetic, ubimus may be understood as a collection of frameworks that aim to expand musical thinking through creatively oriented practices. A first wave of ubimus proposals (2007–2014) was driven by several motivations: the expansion of musical deployments with a particular emphasis on the development of internet-based resources, the incorporation of everyday settings (such as various transitional spaces, network-based artistic venues and domestic contexts), and the inclusion of a wide range of participant profiles, highlighting the specific demands of support for casual interaction featuring subjects with heterogeneous characteristics (Keller et al. 2011; Lima, Keller, Pimenta, Lazzarini and Miletto 2012; Miletto, Pimenta, Bouchet, Sansonnet and Keller 2011).

This diverse body of initiatives has resulted in a somewhat relaxed and heterogenous approach to theoretical framing; perhaps even a patchwork of methods and concepts. One oft-stated goal is to avoid the biases present in some twentieth-century

[1]A discussion of the definitions of ubimus is beyond the scope of this editorial; see Keller, Flores, Pimenta, Capasso and Tinajero 2011; Pimenta, Keller, Flores, Lim and Lazzarini 2014; Lazzarini, Keller and Radivojević 2020; Zhao 2021) for various perspectives on this field.

music-theorising that places the author's aesthetic choices as the main target of the proposed creative methods; as aesthetic views may motivate and constrain many design decisions, consequently they may shape the adoption or the rejection of emergent technologies. Whilst this may be considered an obvious fact by most practitioners in the arts, surprisingly, it took the field of interaction design many decades to acknowledge the centrality of aesthetics (Löwgren 2009). Nevertheless, if a music-theoretic framework is restricted to a single genre, then it tends to lose relevance as a scaffold for design (Keller and Lazzarini 2017b). Consequently, ubimus frameworks often treat aesthetic biases as factors to be made explicit by the design process (Keller, Otero and Costalonga 2015), rather than as universal truths to be imposed upon the stakeholders. This is by no means a resolved issue. As suggested by Dourish and Bell (2011), infrastructures are shaped by permanent negotiations. Ubimus frameworks sometimes take this concept a step further to highlight the political implications of the incorporation of corporate designs and policies that target the monetisation of the digital commons (Messina et al. 2022).

Thus, the aesthetics of design are slowly being acknowledged as aspects to be considered from a politically aware, community-oriented and genre-neutral ubimus perspective. A concept gaining traction in second-wave ubimus initiatives (*c.*2014–present) is *aesthetic pliability* (Keller, Yaseen, Timoney, Chakraborty and Lazzarini 2023). Aesthetically pliable designs support culturally specific ways of music-making, without sacrificing replicability. This entails a delicate balance between using extant resources (which tend to push the design towards the adoption of standards that ensure deployability and reliable know-how) and fostering customisation and the usage of local resources (that highlight the original and unique qualities of these components). Standards may promote wider adoption, but may also tend to erase differences and may be incompatible with local needs. Customised resources may foster diversity, though at the price of reduced sustainability and deployability. We see the balancing of these competing dynamics as a key challenge for the field as it develops and diversifies.

2. ECOLOGICAL MODELS IN SECOND-WAVE UBIMUS: DISTRIBUTED CREATIVITY AND SOCIO-TECHNOLOGICAL ECOLOGIES

The articles featured in this thematic issue exemplify the expanded subject matter and methods of second-wave ubimus. As noted earlier, whilst a diverse body of artistic practices such as that found in ubimus has the potential to challenge any single theoretical framework, we can discern a common ground across themes of participatory and distributed models of creativity (Aliel et al, this issue; Koszolko and Studley, this issue), the foregrounding of networked communications (McConville, this issue), and strategies for, and situations of, co-creation (Koszolko and Studley, this issue; Brown, this issue). Seeking to unify these ideas, we argue that they can be broadly considered to be 'ecological' groupings, not simply in terms of the use of environmental materials (though this does occur in some cases), but also in terms of conceptualising musical and sonic activities,[2] their social context and the technologies which connect them, as exhibiting shared features and inter-dependencies (Keller and Lazzarini 2017a). We will now contextualise each of these main themes in terms of their relevance to ubimus.

Aliel and co-authors (this issue) propose an *ecological approach* to blended composition-improvisation (comprovisation) activities, exemplifying community-oriented *behavioural ecologies* (Keller and Lazzarini 2017a) that do not fit the clean categories of inherited acoustic-instrumental roles. These models and practices entail various questions as a search for new participatory roles. The piece which the article describes utilises spectrograms (of the unusual and ambiguous stellar object identified by NASA adjacent to black hole Markarian 355) as comprovisational scores alongside a system which itself integrates the visual with the auditory with a thematically similar indeterminacy and loose causal coupling through the use of imprecise computer vision processes (colour capture and motion tracking). Who is the composer, who is the performer, who is the audience, in activities that include casual participants, entail iterative cycles through extended periods of time, or that involve knowledge-sharing strategies that break established expectations? The result, in this case, is a participatory approach to activities broadly informed by sonification (e.g., the interpretation of spectrograms as graphic scores), in addition to the use of embodied-ecological models for relating sound materials and sounding activities (e.g., a double bass attempting to 'escape' a sound mass with a figurative gravitational attraction), and an engagement with the performance system as a (loose and somewhat error-prone) cybernetic-style system which was approached by the participants aiming at comparative equilibria. More broadly, we can consider the ecology of material resources employed in the creative activities from the perspective of their impact upon the technological support, in particular how resources respond in ways

---

[2]Ubimus frameworks tend to treat music as a multimodal experience, thus the emphasis is on the relational properties among modalities rather than a separation of aural from other senses.

which are unpredictable and volatile versus more stable and persistent scaffolding.

McConville (this issue) proposes a *networked approach* to music creation, production and distribution with multiple social implications. Based on previous ubimus initiatives (Ribeiro Netto et al. 2015; Zawacki and Johann 2014) and targeting an increased standardisation of network-based resources, several researchers have proposed the incorporation of the Internet of Things (IoT) to serve as a platform for ubimus activities (Turchet, Fischione, Essl, Keller and Barthet 2018). This thread is emerging as a highly contentious area of partially overlapped and sometimes incompatible frameworks.[3] Using IoT resources does not necessarily entail the uncritical adoption of extramusical concepts which may impose constraints on future music-making, reducing our ability to share or reinterpret the extant repertoire of cultural assets. The meaning of *internet* during the 1990s is definitely different from its current meaning. The same argument applies to *things*. There is a vast historical production based on the musical object that features a panoply of related concepts and typologies oriented towards a reification of musical assets. The outcomes of musical activities have often been treated as products (i.e., objects) rather than as cultural and community-oriented experiences. This is, of course, well aligned with the needs of twenty-first-century techno-capitalism, but is it compatible with the ethics implied by the conceptual grounding of ubimus frameworks and in particular with ecologically based creative practice? McConville's 'artist-as-subscription' model adopts a collective ubimus behavioural ecology inspired by open-source software projects. This community-oriented ubimus approach was initially investigated by Pimenta, Miletto, Keller and Flores (2012), highlighting its connections with participatory design as an extended application of the educational views of Paulo Freire (Lima et al. 2012). McConville's participatory and iterative approach implies a shift from considering the musical work as an object or a thing,[4] to support handling shared resources characterised by their temporal persistence. A ubimus technical term applicable to these shared entities is *the musical prototype* (Miletto et al. 2011). As discussed in the Introduction of this editorial, second-wave ubimus frameworks are converging towards the adoption of aesthetic pliability as a design target. This tendency implies avoiding genre-specific criteria, such as those adopted by the networked music performance genre (Mills 2019). And it also implies a very careful consideration of the basic components to be applied in ubimus-infrastructure developments. The *thing*, as an organisational unit of musical infrastructure, incorporates caveats present in lattice-based music (Wishart 1996) and in acousmatic-music concepts (Kane 2007). Furthermore, the reification of musical resources may facilitate the application of a techno-capitalist agenda enforced by the use of non-fungible tokens and related blockchain technologies (cf. Messina et al. 2022). In contrast, McConville aims to identify how internet platforms impact the procedural and structural aspects of music-making. According to the author, the use of volatile resources – exemplified by streamed recorded audio – is emerging as a dominant trend of musical sharing. By pointing to a growing artistic scene that applies this working method, he suggests that volatility may shape the expansion of music creation. This case underlines the ongoing discussion on the properties of shared resources, tackled by various ubimus projects (Miletto et al. 2011; Pimenta et al. 2012; Keller et al. 2014). Furthermore, it entails a reassessment of lightweight ubimus approaches as a complement to the standardisation of networked platforms.

Koszolko and Studley (this issue) propose *co-creation and gamification strategies* in support of audiences' participatory engagement with sound materials, avoiding the regimented division of composer–performer–audience often seen in legacy acoustic-instrumental forms of musical and sonic practices. A frequently encountered aspect of the acoustic-instrumental approach is the assignment of fixed behavioural roles, either as creators (composers and performers) or consumers (audience) of musical products. The strategy adopted by Koszolko and Studley, comparable to McConville and Aliel et al. approaches, see the incorporation of contingencies and local resources as tools for group-oriented creativity. Their proposals employ either sonic or visual volatile resources as knowledge-sharing channels, hinting that ecologically oriented creative processes may foster a fast circulation of volatile resources rather than enforcing a strict division of roles among stakeholders through the use of a fixed score. This view is also aligned with a move towards adaptive ecologies highlighted by Keller and Lazzarini (2017a). More broadly, ecologically oriented practitioners have actively searched for strategies to integrate timbre-oriented designs, as well as various sensory modalities and socialities in their creative endeavours. Multiple examples are available in the artistic literature. For instance, Basanta (2010) analyses the techniques applied in . . . *soretes de punta* to obtain realistic streams of impacts of raindrops by means of ecological models (Keller 1998; Keller and

---

[3]A special issue on ubimus and the implementation and usage of IoT resources featured in the journal *Digital Creativity* will cover some ground on this topic. Thus, we will not attempt an in-depth discussion of this aspect here.

[4]See also (Messina, Keller, Aliel, Gomez, Célio Filho and Simurra 2022).

Truax 1998). Nance (2007) documents the usage of *sonic scores* as a knowledge-sharing mechanism that constrains creative decisions without imposing pre-packaged musical outcomes. More recently, Connors and Denton's (2016) audiovisual installation *Flight Variant* uses audio recordings from and around Los Angeles airports as resources for ecological performativity. Furthermore, Connors (2015) has articulated and established ecological performativity, that is, the exploration of acoustic-instrumental improvisational techniques as a means to gather sonic materials for installation-based artworks.

The aforementioned hopefully makes clear the range of ways in which musical and sonic procedures, and their associated technological, creative and social genesis, can be considered under the rubric of 'ecologies', alongside the incorporation of materials derived directly from the local environment. A strict separation between 'musical' data and 'sonic' data is challenged by ecologically grounded creative practice (as it is by significant bodies of perceptual studies such as Bregman's (1990) auditory scene analysis). Ubimus practice does not enforce the adoption of 'musical' (as opposed to purely sonic) things, as has been argued in some IoT-oriented publications. In fact, ubimus does not abide by any typology that separates musical data from sounds or vice versa, and does not enforce boundaries between situated, extended or multimodal experiences. Hence, to talk about isolated musical things as building blocks of a tentative musical paradigm[5] is not consistent with the trends emerging in second-wave ubimus frameworks, with ecologically grounded creative practice or with the growing music literature based on ubimus research.

The connections between ubimus and the current conceptions of socially motivated and materially grounded interaction design underline a treatment of musical phenomena as *multimodal ecologies*, involving the meeting of people, technologies and situated resources that enable creative activities and experiences (Keller and Lazzarini 2017a; Lazzarini, Keller, Otero and Turchet 2020).[6] Brown et al. (this issue) survey sonic arts practices in regional Australia targeting the usage of creative technology ecosystems. This study – conducted during 2021 and 2022 – involved 11 interviews with practitioners from several Australian states. The authors situate the practices undertaken across Australia within ubimus, highlighting how the stakeholders manage the opportunities

and challenges of their local context. According to Brown et al., the role of culture in Australia is often examined through an economic lens under the guise of creative industries. This approach tends to discount the value of arts practices and overlooks the impact of the ecological situatedness and the well-being benefits afforded to ubimus amateur and hobbyist practitioners. Brown and co-authors bring forth another ubimus strategy: the development of communities of practice (e.g., DIY and maker communities (cf. Timoney, Lazzarini and Keller 2020)). This far-reaching and impactful thread not only fulfils the outcomes listed earlier, but also leads to innovations beyond the original scope of the DIY community. Arguably, community-oriented design is a strategy that cuts across several ubimus frameworks, highlighting the distributed notions of creativity of E4 cognition and the knowledge-sharing strategies encouraged by Freirean participatory design (Sepra, Portela, Costard and Batista 2020). Similarly, Koszolko and Studley's article explores strategies to foster performers and audiences to engage with live acts of co-creation based on environmental resources. Site-specific sampling enabled by mobile platforms is proposed as a way to expand participatory music performances. How can site-specific and sample-based participatory music-making be empowered through gamification strategies? By focusing on the unique qualities of location recordings, gamified performative music practices may expand the scope of audience participation in improvisation. Thus, according to Koszolko and Studley, ubimus playful experiences can offer new insights into the nature of audience engagement.

3. EMERGENT TRENDS IN UBIMUS, ECOLOGICALLY GROUNDED CREATIVE PRACTICE AND AN OUTLOOK FOR THE SONIC ARTS

The contents of this issue have given us the opportunity to interpret a diverse body of creative practices and models from the perspective of current ubimus theories. In addition to the articles from the original thematic call, we also have a selection of off-theme articles from the journal's ongoing open call. Howe (this issue) reflects on various techniques and models for structuring sound spectra in composition, proposing an integration of perceptual (and possibly ecological) and technological contexts for these compositional acts. There are some parallels with the heterogenous and integrationist tendencies reflected within ubimus practices and models in the common goal of handling musical parameters beyond the boundaries of the acoustic-instrumental approach. Sanfilippo (this issue) interrogates musical aesthetics

---

[5] To keep the terms aligned with what has been written about IoT developments in music, we employ the word *paradigm*. The limitations of this label are addressed in the last section.

[6] The discussion of the use of the term ecology in music-making falls beyond the scope of this issue and it has been the focus of extensive literature. Our usage is aligned to the proposals featured in (Lazzarini et al. 2020), highlighting the applied and integrated qualities of ubimus research.

from a systems approach, with a focus on classical cybernetics and its application in musical contexts. His approach furnishes a good complement to Aliel et al.'s treatment of comprovisational methods. Building on a materialist perspective and embodying parallels with recent ubimus work around computer music archaeologies (Lazzarini, Keller and Radivojević 2023), Trillo and Poliks (this issue) provide an example of a musical work which embodies practices and strategies tangentially similar to ubimus (involving the use of diverse creative strategies, participatory precursors, and heterogenous techniques applied to signal processing), contextualised via cultural theory and media arts discourses. Trillo and Poliks usage of participatory precursor, incorporating the products of GANs (generative adversarial networks) trained on sonic resources selected from an open call, could be framed as a ubimus-type ecology. Lastly, the treatment of timbre perception as related to creative strategies comes full-circle with Dean et al. (this issue), who investigate relationships between timbre characteristics via a network-based analysis, suggesting a connection between their findings and twentieth-century electroacoustic music literature and practices.[7]

Thus, the present issue suggests various ways in which ecological concepts come into play through diverse practices and models across the sonic arts field including, but not limited to, work which expressly engages with ubimus frameworks. These connections with sonic-arts perspectives indicates a potential for application of ubimus concepts in areas that have not yet employed ubimus techniques. For instance, Howe's article seeks to combine perceptual principles with the varied technological genesis of materials within a single framework. We have drawn parallels between Sanfilippo's systems/cybernetic approach and that of Aliel et al., and Trillo and Poliks have also used methods which may incorporate ubimus archaeologies. Furthermore, Dean et al. provide a network analysis which addresses the structures inherent within broader ecologies of timbral relationships in music, a view that resonates with the application of semantics and timbre-oriented design in ubimus.

The aforementioned exemplifies the ways in which ubiquitous music contributes to discussions within the sonic arts through diverse practices and involving contrasting settings. However, in doing so, we acknowledge that the proposed models may require further consideration of the cultural specificities of emergent technological resources and communities of practice (cf. Brown et al. this issue). The 4E cognition approach suggests that the selection of material resources and the characteristics of the environment constitute major factors in shaping musical experiences. Consequently, the design of technological infrastructure needs to take into account the local specificities. For instance, the application of large language models (LLMs), if not properly situated and specified, may induce a technocultural homogenisation of musical aesthetics based on common features of software and studio infrastructure (in each case through a normative emphasis on standardisation).

The preceding authors furnish various examples of musical processes and products that incorporate these ecologically oriented strategies to expand the creative potential of diverse communities. The opposite may also be true; variable levels of material resources, including the restriction of access to technologies in particular locations, may limit their adoption and usage (with the uneven geographies of internet access being one particularly salient example of something which acts as a constraint upon technologically mediated creativity). As we have noted earlier, standards, helpful as they are in ensuring broad adoption, and shared understanding, may also tend to erase differences and lack applicability to local contexts.

Given these tendencies, we may expect the emergence of two trends within our field: techniques which are generally applicable or culturally blind, but perhaps at the price of tending to increase the homogeneity of cultural production, and techniques that are sensitive to cultural traits which may help to incorporate local, or community-specific knowledge. A key challenge, in these cases, may be to delineate between the dialects and idiolects of diverse bodies of creative expression, informed by an understanding of the social and material contexts which shape them. The sonic arts have always had voices and fora which resist normative approaches (and *Organised Sound*, in its focus on the wide range of possibilities afforded by music technologies and diverse and novel forms of sonic practices exemplifies this). Hopefully, the contents of this issue have shed some light on the social and cultural implications of ubimus and related approaches. We look forward to exciting new developments as our ubimus and sonic arts communities incorporate new and diverse culturally situated practices from hitherto underrepresented practitioners and regions.

In this regard, it is fitting to close by expressing our thanks to the editor of *Organised Sound*, Leigh Landy, for his support of this issue throughout a lengthy process of development, from discussions around the initial call, through peer review and refinement, and, finally, in seeing it through to publication. Sincere thanks, also, to all

---

[7]The intersection between timbre studies and interaction design has recently emerged as a topic actively pursued through ubimus techniques (Chakraborty, Yaseen, Timoney, Lazzarini and Keller 2022). This thread is complemented by the investigations of an expanded approach to semantics that has also been applied in ubimus interaction strategies for audio processing (Simurra, Messina, Aliel and Keller 2023).

contributors, to the peer reviewers for their feedback on highly diverse topics and for doing so much to inform the collection, and to the wider ubimus community of researchers and practitioners for their contributions to shaping the original call.

Brian Bridges,[1] Victor Lazzarini[2] and Damián Keller[3]

[1]Ulster University, Derry~Londonderry, Northern Ireland, BT48 7JL, UK
Email: bd.bridges@ulster.ac.uk
[2]Maynooth University, Co. Kildare, Ireland
Email: victor.lazzarini@mu.ie
[3]Amazon Centre for Music Research, Federal University of Acre, Federal University of Paraíba, Brazil
Email: dkeller@ccrma.stanford.edu

REFERENCES

Basanta, A., 2010. Syntax as Sign: The Use of Ecological Models within a Semiotic Approach to Electroacoustic Composition. *Organised Sound*, **15**(2): 125–32.

Bhagwati, S. 2013. Notational Perspective and Composition. In V. Anderson (ed.) *Sound & Score: Essays on Sound, Score and Notation*. Leuven: Leuven University Press, 143–77.

Bregman, A. S. 1990. *Auditory Scene Analysis*. Cambridge, MA: MIT Press.

Chakraborty, S., Yaseen, A., Timoney, J., Lazzarini, V. and Keller, D. 2022. Adaptive Touchless Whole-Body Interaction for Casual Ubiquitous Musicalactivities. *Proceedings of the International Computer Music Conference* (ICMC2022), Limerick, Ireland, 3–9.

Connors, T. M. 2015, February. Audiovisual Installation as Ecological Performativity. *Proceedings of 21st International Symposium on Electronic Art* (ISEA 2015). Vancouver, Canada: ISEA.

Connors, T. M. and Denton, A. 2016. *Flight Variant*. *Proceedings of the The 22nd International Conference on Auditory Display* (ICAD), Canberra, Australia.

Dourish, P. and Bell, G. 2011. *Divining a Digital Future: Mess and Mythology in Ubiquitous Computing*. Cambridge, MA: MIT Press.

Kane, B. 2007. L'objet sonore maintenant: Pierre Schaeffer, Sounds Objects and the Phenomenological Reduction. *Organised Sound* **12**(1), 15–24.

Keller, D. 2000. Compositional Processes from an Ecological Perspective. *Leonardo Music Journal* **10**(1), 55–60.

Keller, D., Flores, L. V., Pimenta, M. S., Capasso, A. and Tinajero, P. 2011. Convergent Trends toward Ubiquitous Music. *Journal of New Music Research* **40**(3), 265–76.

Keller, D. and Lazzarini, V. 2017a. Ecologically Grounded Creative Practices in Ubiquitous Music. *Organised Sound* **22**(1), 61–72.

Keller, D. and Lazzarini, V. 2017b. Theoretical Approaches to Musical Creativity: The Ubimus Perspective. *Musica Theorica* **2**(1), 1–53.

Keller, D., Otero, N. and Costalonga, L. 2015. Aesthetic Heuristics in Ubimus. *Proceedings of the Electronic Visualisation and the Arts Conference* (EVA 2015), 64–71.

Keller, D., Timoney, J., Costalonga, L., Capasso, A., Tinajero, P., Lazzarini, V., Pimenta, M. S., Lima, M. H. and Johann, M. 2014. Ecologically Grounded Multimodal Design: The Palafito 1.0 Study. *Proceedings of the International Computer Music Conference* (ICMC 2014). Athens: ICMA.

Keller, D. and Truax, B. 1998. Ecologically Based Granular Synthesis. *Proceedings of the International Computer Music Conference*, 117–20.

Keller, D., Yaseen, A., Timoney, J., Chakraborty, S. and Lazzarini, V. 2023. Banging Interaction: A Ubimus-Design Strategy for the Musical Internet. *Future Internet* **15**(4), 125.

Lazzarini, V., Keller, D., Otero, N. and Turchet, L. 2020. *Ubiquitous Music Ecologies*. Abingdon: Routledge.

Lazzarini, V., Keller, D. and Radivojević, N., 2023. Issues of Ubiquitous Music Archaeology: Shared Knowledge, Simulation, Terseness, and Ambiguity in Early Computer Music. *Frontiers in Signal Processing*, **3**, 1132672. https://doi.org/10.3389/frsip.2023.1132672.

Lewis, G. E. 2000. Too Many Notes: Computers, Complexity and Culture in *Voyager*. *Leonardo Music Journal* **10**, 33–9.

Lima, M. H., Keller, D., Pimenta, M. S., Lazzarini, V. and Miletto, E. M. 2012. Creativity-Centred Design for Ubiquitous Musical Activities: Two Case Studies. *Journal of Music, Technology and Education* **5**(2), 195–222.

Löwgren, J., 2009. Toward an Articulation of Interaction Esthetics. *New Review of Hypermedia and Multimedia* **15**(2), 129–146.

Malinin, L. H. 2019. How Radical is Embodied Creativity? Implications of 4E Approaches for Creativity Research and Teaching. *Frontiers in Psychology* **10**, 2372.

Messina, M., Keller, D., Aliel, L., Gomez, C., Filho, M. C. and Simurra, I. 2022. The Internet of Musical Stuff (IoMuSt): Ubimus Perspectives on Artificial Scarcity, Virtual Communities and (de)Objectification. *INSAM Journal of Contemporary Music, Art and Technology* **9**, 26–50.

Miletto, E. M., Pimenta, M. S., Bouchet, F., Sansonnet, J. P. and Keller, D. 2011. Principles for Music Creation by Novices in Networked Music Environments. *Journal of New Music Research* **40**(3), 205–16.

Mills, R. 2019. *Tele-Improvisation: Intercultural Interaction in the Online Global Music Jam Session*. Cham, Switzerland: Springer, 21–57.

Nance, R. W. 2007. Compositional Explorations of Plastic Sound. PhD diss., De Montfort University, UK.

Pimenta, M., Keller, D., Flores, L. V., Lima, M. H., and Lazzarini, V. 2014. Methods in Creativity-Centred Design for Ubiquitous Musical Activities. In D. Keller, V. Lazzarini and M.S. Pimenta (eds.) *Ubiquitous Music*. Cham, Switzerland: Springer, 25–48.

Pimenta, M. S., Miletto, E. M., Keller, D. and Flores, L. V. 2012. Technological Support for Online Communities Focusing on Music Creation: Adopting Collaboration, Flexibility and Multiculturality from Brazilian Creativity Styles. In N. A. Azab (ed.) *Cases on Web 2.0 in Developing Countries: Studies on Implementation, Application and Use*, ch. 11. Vancouver: IGI Global Press.

Ribeiro Netto, A., Castheloge, L., Oliosi, A., Mateus, A., Costalonga, L. and Coura, D. 2015. Memories Tree: Multimedia Interactive Installation (Árvore das Memórias: Instalação Multimídia Interativa). In *Proceedings of the XV Brazilian Symposium on Computer Music (SBCM 2015)*. Campinas, SP: SBC, 76–82.

Serpa, B., Portela, I., Costard, M. and Batista, S. 2020. Political-Pedagogical Contributions to Participatory Design from Paulo Freire. *Proceedings of the 16th Participatory Design Conference 2020-Participation (s) Otherwise*, Vol. 2, 170–4. https://doi.org/10.1145/3384772.3385149.

Simurra, I., Messina, M., Aliel, L. and Keller, D., 2023. Radical Creative Semantic Anchoring: Creative-Action Metaphors and Timbral Interaction. *Organised Sound* **28**(1), 64–77.

Timoney, J., Lazzarini, V. and Keller, D. 2020. DIY Electronics for Ubiquitous Music Ecosystems. In: V. Lazzarini, D. Keller, N. Otero and L. Turchet (eds.) *Ubiquitous Music Ecologies*. London: Routledge, 57–76.

Turchet, L., Fischione, C., Essl, G., Keller, D. and Barthet, M. 2018. Internet of Musical Things: Vision and Challenges. *IEEE Access*, **6**, 61994–62017.

Wishart, T. 1996. *On Sonic Art*. Amsterdam: Harwood Academic.

Zawacki, L. F. and Johann, M. O. 2014. Analogue Audio Recording Using Remote Servers. In D. Keller, V. Lazzarini and M. S. Pimenta (eds.) *Ubiquitous Music*. Cham, Switzerland: Springer, 83–107.

Zhao, W. 2021. September. Ubiquitous Music-Making Systems: A Critical Overview of Current Practices. *Proceedings of the 16th International Audio Mostly Conference*, 204–7. https://doi.org/10.1145/3478384.3478391.

DISCOGRAPHY

Keller, D. 1998. *soretes de punta*. CD. *Harangue II*. Vancouver, BC: Earsay Productions.