International Journal of Digital Media and Interaction
Special Issue on Ubiquitous Music, Vol.3, No.5, (2020)

Second Wave Ubiquitous Music: Collaboration, Automation and Knowledge Transfer for Creativity (Editorial)

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Summary

This volume features a diversity of proposals gathered around the current efforts in ubiquitous music (or ubimus) research. Three papers provide contributions to timbre interaction involving lay participants. Two proposals target the development of network-based music making, one case features synchronous exchanges of visual code and another case proposes the implementation of musical robots within the context of the Internet of Musical Things. The volume wraps up with an interview on ecocomposition, one of the lines of research that has been nourished by ubimus initiatives.

Bessa et al. outline the strategies within the WYDIWYHE perspective (what you do is what you hear), a new strand of interaction design based on ecologically grounded creative practices. This approach involves the use of visual aids to represent actions targeting sonic results, while encompassing touching, seeing and listening. The authors propose six strategies within this framework: space-time proportionalities, flexible temporalities, isomorphisms, direct manipulations, semantic abstractions and the use of relational properties.

Messina et al. report on an intercontinental live-patching session based on the software Kiwi. This experience involved two groups from three different universities located in Brazil and France. According to the authors, this proposal has implications on the presence or absence of the human components in ubimus practices, on the patterns of territorialisation, on the operative actions and the related mnemonic-support processes within the group practice of live algorithms for music making.

Freitas et al. describe an exploratory study of the Sound Sphere Metaphor. A group of undergraduate music students with no prior training on audio tools was invited to engage in creative activities in everyday settings. Despite yielding successful sonic outcomes, the results of the study highlighted the need for improvements in the experimental procedures.

Targeting the infrastructure for ubimus activities, Camporez et al. suggest the use of sensors, actuators and connectivity for musical purposes within the context of the Internet of Musical Things (IoMusT). The paper discusses key concepts in ubimus for IoMusT-based activities, providing examples of the implementation and usage of musical robots (RoboMus). The authors focus on the development of robotic resources for synchronization. Their proposal features a mechanical delay-compensation system by means of a neural network. The authors also discuss the implementation of a precision time-protocol (PTP) and apply it in a clock for a musical robot.

Creative semantic anchoring or ASC is a metaphor for creative action that uses verbal strategies to ground aesthetic decision making. Creative semantic anchoring involves the verbal contextualization of sonic materials to facilitate aesthetic decisions involving the transfer of musical knowledge. Complementing previous proposals on ASC, Keller et al. present a study that applies semantic strategies for the selection of sound sources. The study focuses on the evaluation of emulations of everyday sounds using semantic descriptors. The stimuli consisted of excerpts of violin solo works, based on imitations of everyday events. Seeking to obtain a quantitative picture of the relevance of the descriptors, the experimenters gathered responses from 58 university students with basic or intermediate musical knowledge. The results highlight

ISSN: 2184-3120

the originality of the products and the subjects' familiarity with the sonic material. The descriptor *pleasant* – linked to strongly subjective aspects – and the descriptor *well-done* – targeting the technical aspects of the materials – also got consistent scores.

Carson furnishes a thorough interview with Damián Keller on the origins of the ecologically grounded perspectives on music making, including some of the recent developments within the ubimus field. The discussion unveils several aspects of the artistic and research projects that have not been previously addressed in the literature, encompassing topics such as ecocomposition, the function of everyday sounds in ubimus and the relationships between ecologically grounded music making and environmental activism.

Art, technology and reflection

Keller and Barreiro (2018) provide an overview of various trends within ubimus, highlighting two avenues of research that gathered increased attention during the last few years. They suggest that part of the ubimus research efforts have gone into the inclusion of a broader variety of participants in creative endeavors with a strong emphasis on untrained subjects and the participation of casual stakeholders. Casual participation presents very stringent demands, not only because of the lack of preparation for the musical activity - forfeiting domain-specific training or extended periods of familiarization with the materials - but also because of the peculiar and unpredictable characteristics of the settings where many ubimus activities take place, such as transitory or leisure environments not projected as artistic venues.

Another line of research has addressed the advancement of the extant musical knowledge based on the convergence of technological support, innovative artistic practices, complemented by the socially aware deployment of ubimus resources. This triad of technology, art and reflection is not exclusive of ubimus initiatives but points to potential crossovers with the related fields of ethnomusicology (Quiñones et al. 2013), sonic studies (Truax 1984), participatory design (Ehn 1988), computational creativity (McCormack and D'Inverno 2012) and the emergent ecological approaches to education and creativity (Malinin 2013; Pata 2009). Ubimus researcher Helena Lima has pioneered the development of a socially aware approach to music making, dialogics, involving intense collaborations and group-oriented activities. Mostly deployed in educational contexts, dialogics targets the creative engagement of participants in longitudinal and collective creative activities. The objectives of this approach entail the community-based construction of knowledge through reflective practices. The activities do not aim to yield genre-specific musical products but target self-reflection as a key component of the artistic engagements (Donald 2006).

Everyday music making

This volume provides a contribution to a decade-long effort toward the development of strategies for music making in everyday settings, targeting the inclusion of non-musicians as creative partners. These motivations are not new. They stem from a tradition of artistic practices that can be traced back to concepts such as that of furniture music – music that does not demand a special talent or specialized training to be experienced – proposed by composer Eric Satie at the beginning of the previous century. But a major difference of the proposals contained in this volume with the artistic trends that date back to the 20th century can be observed in the availability of a technological infrastructure that can be repurposed for creative endeavors. Furthermore, an expanded conception of music – from a static entity or a formal structure, to a dynamic self-organized process; and from an autonomous phenomenon to a socially constructed set of

relational properties firmly anchored in a specific material context – has led to the emergence of the multilayered research field called ubiquitous music (Keller et al. 2014a).

According to Keller and Lazzarini (2017a), the increased reliance of current musical practices on social interaction, everyday settings and open-ended, exploratory activities have underscored the limitations of the existing toolset for creativity support. Social interaction has been brought to the forefront through the anthropology-oriented initiatives pioneered by Blacking (1973). For Blacking, the study of music – rather than the study of a fixed representation of instrumental actions on a score, or the study of the sonic byproducts of music making collected in recordings – entails the documentation and analysis of the musical activity during the act. This view is later condensed by Small (1998) in his verbalization of the musical processes as the act of musicking. The verb 'musicking' emphasizes the dynamic properties of creating, deploying and listening to musical products. Small's proposal underscores the implicit hierarchies and contradictions of the stereotyped rituals of instrumental music, exemplified by the model of the orchestra, which enforce a separation between doers and receivers during the aesthetic decision-making processes.

Ubiquitous music (or ubimus) has been defined as the study of systems of (1) human agents and (2) material resources that (3) afford musical activities through (4) creative support tools. This four-component definition encompasses the human factors, the material resources and the properties that unfold during the creative activities, combined with the design strategies that foster creative outcomes – targeting both the processes and the byproducts of the activities. It is interesting to note that the emphasis on the creative aspects of music making was not a consensual feature of the initial ubimus initiatives. During a first exploratory phase (2007-2014), the ubimus definitions placed a strong emphasis on the technological infrastructure – highlighted by the adoption of the term ubiquitous – hinting at a subset of issues related to ubiquitous computing (Weiser 1991). This perspective shows some limitations when faced with the diversity of social and cognitive factors triggered by the deployment of musical activities in everyday settings. In particular, the support for casual participation presents challenges that go beyond the focus on the musical performance targeted by a currently hegemonic approach to musical interaction (for an example of the latter, see the concept of virtuosic performance[1] in Wessel and Wright 2002).

Distributed musical resources

Moving beyond the approaches centered on isolated tools, Lazzarini et al. (2015) propose the ubiquitous music ecosystem as a replacement for the fourth component of the ubimus definition (i.e., the creative support tools). The motivations are manifold. The implementation of isolated instruments or tools - as exemplified in NIME proposals - does not meet the demands for the relational and emergent characteristics of the casual participation and the opportunistic strategies observed in creative practices in everyday settings (cf. ubimus examples in Keller et al. 2013; Keller et al. 2015; Lima et al. 2017). While the adoption of traditional venues – such as the concert hall or the electroacoustic studio – ensures a material context and a set of social expectations geared toward professionally oriented music-making, casual participation in everyday musical activities exposes the stakeholders to acoustic and social factors that are seldom accounted for in the design of digital musical instruments. According to Keller and Lazzarini (2017a), ubimus support needs to be grounded on strategies that address not only the issues related to interaction and audio.

1 This view is found in the works targeting New Instruments for Musical Expression (NIME). Without dropping the emphasis on the implementation of isolated devices, this area has recently changed the word instruments for interfaces. As it will become clear in the discussion below, the undue focus of NIME on the device, the instrument or the interface does not necessarily help in the advancement of the support of creative practices.

It also needs to account for factors based on the relationships among the materials and among the agents, that emerge during the activity. Hence, a diversified perspective on ubimus ecologies is better equipped to tackle the dynamic processes that underlie everyday music making.

The present volume features proposals that contribute to the advancement of musical knowledge through the deployment of support technologies (Camporez et al.), through group-oriented artistic practices targeting an intermediate level of technical expertise (Messina et al.) and through new approaches to knowledge transfer adopting design strategies grounded on ecological cognition (Bessa et al., Freitas et al,, Keller et al.). These contributions provide a healthy complement to some of the recent advances of the ubimus field, especially regarding the application of semantic strategies for knowledge transfer (Keller and Feichas 2018; Stolfi et al. 2019), ecologically grounded improvisation (Aliel et al. 2015; Messina and Aliel 2019) and the proposals that target development of the internet of musical things (Keller et al. 2019; Keller and Lazzarini 2017; Turchet et al. 2018).

Let us take as an example the deployment of the Internet of Musical Things (IoMusT). Despite remaining mostly a theoretical construct, this proposal has gathered partial embodiments and contributions from various projects. According to Keller et al. (2019), there is a strong resemblance between the initial definitions of ubiquitous music and the recent conceptualizations of the IoMusT[2]. These two fields of study are complementary. While the development of the IoMusT targets the infrastructure needed for musical activities, current ubimus research focuses on the creative processes of music making linked to sustainability and more flexible forms of participation. Consequently, over the last decade ubimus has expanded its horizons to include aspects of music making that reach beyond the issues directly related to tool development and usage. Sometimes ubimus endeavours take advantage of local resources and available technologies through opportunistic design strategies involving repurposing. Hence, they do not necessarily demand new infrastructure (Flores et al. 2010; Keller et al. 2013). Other times ubimus projects call for custom, network-based professional audio technology aligned with the objectives of the IoMusT initiatives (Lazzarini and Timoney 2019; Zawacki and Johann 2012). Thus, Keller and coauthors envision a dynamic of mutual enrichment between ubimus and IoMusT. Ubimus experiences trigger the development of new IoMusT technology and as the IoMusT resources become available, they open fresh opportunities for applications in ubimus contexts. Given the potentially massive presence of the internet of things in everyday settings, the requirements and the affordances of the IoMusT components demand a careful consideration to clear the ground for an effective and, most importantly, ethical ubimus practice. Part of these issues are addressed by Camporez et al. in this volume.

Keller et al. (2019) describe the development of a metaphor for creative action involving the use of hand gestures, Handy. The Handy Metaphor relies on body movements, targeting the use of both hands to enhance the creative potential of IoMusT-based sonic resources. The authors gathered feedback on the control capabilities and on the limitations of two prototypes through informal sessions with artists and musicians. The two implementations were based on very different technological platforms but shared a common interaction method. Both prototypes use hands and torso movements to drive synchronous audio synthesis and processing algorithms. While one prototype replicates the parametric approach featured in the design of the electronic instrument Theremin, the other implementation targets an exploratory usage of the relationships between body movements and sonic outcomes. The results point to a good potential for deployment in public areas.

2 See Pimenta et al. (2009) for an early definition of ubimus that focuses mostly on the technological infrastructure for music making.

Another interesting strand of hardware development is proposed by Lazzarini and Timoney (2019). These leading ubimus researchers demonstrate the usefulness of an analogue-computing approach to electronic and computer music practices. They provide a general introduction to analogue technologies for music making, while tracing a historical parallel to the implementation of modular voltage-controlled synthesisers. The examples provided are relevant for the implementation of analogue audio signal-processing, pointing to practical applications in research and music production. Furthermore, their survey of state-of-the-art analogue computing highlights feasible candidate technologies that can be readily put to use in ubimus practices. Regarding the deployment challenges, the current quality of the analogue sonic renditions presents some constraints, including low signal-to-noise ratios and unreliable pitch/voltage stability. Synchronization may also be an issue to be addressed, which may seriously limit the scalability of these technologies. Assessing these issues and providing the necessary tools to correct eventual system malfunctions comprise key targets for future research.

Despite the current technical caveats, the ubimus perspectives on analogue computing may yield new possibilities for musicological endeavors. For instance, this technology may be used to reproduce some of the early electronic musical practices. This avenue of research addresses an important aspect of ubimus, centered around the sustainability of cultural endeavors (Bernardini and Vidolin 2005), while reducing the ecological footprint of the current creative practices (Pereira et al. 2018). Regarding programmability - also a cornerstone of ubimus practices (Keller et al. 2014b) - Lazzarini and Timoney's proposals give musicians and researchers flexible tools to manipulate sound through analogue means. This technology is not prescriptive in terms of musical genres or aesthetic approaches. Its open-endedness can be translated into components of digital-analogue devices for IoMusT usage both for professional practitioners (Turchet et al. 2018) and for everyday usage (Keller et al. 2019).

Human components of ubimus ecologies

Through the incorporation of the current perspectives on evolutionary theory, ubimus highlights the impact of the factors involved in hominid evolution on musical creative practice. Ubimus proposals have considered two approaches in this area: the social-brain hypothesis (Dunbar and Schultz 2007) and the niche-construction theory (Odling-Smee et al. 2003). The social-interaction mechanisms for survival comprise a central core of the first perspective. According to Dunbar and Schultz, the prediction of intentions has led to the development of the higher cognitive abilities of our species. Hominids that managed to predict the behaviors of other hominids had better chances to survive. Somewhat complementary, the approach proposed by Odling-Smee and coauthors explores the mutual relationship between the features of the local environment and the development of human cognition. As a response to uncertain environmental conditions, increasingly refined cognition mechanisms are adjusted to the characteristics of the local habitat. Simultaneously, the actions of the hominid groups shape the material resources to fit the group's needs. These processes of mutual determination trigger the formation of ecological niches. Thus, the ecological niches do not only shape the access to material resources, they also shape the behaviors of the hominid groups. The two evolutionary theories just described provide the overarching theoretical context for multiple design choices in ubimus research.

But what does a research program with music-making as its prime objective have to do with biology or evolution? The answers could fill an encyclopedia, but let us pick only a few major points featured by recent research. Evidence of music-making has been found in most Homo Sapiens populations (Honing et al. 2014); Furthermore, some researchers - based on archeological findings - believe that music-like behaviors

were also present in Homo Neanderthalensis (Mithen 2007). The pervasiveness of music making across cultures hints that the ability to make music may have been an evolutionary feature of the hominids.

Music-like behaviors have also been observed in other species (Patel 2014) - for instance, the drumming patterns produced by some chimpanzees (Arcadi et al. 2004; Babiszewska et al. 2015; Dufour et al. 2015). Other authors question essentialized visions of music as a phenomenon that is necessarily associated with human agency (Mori 2017). Whether the ability to make music is an adaptive evolutionary trait or just a byproduct of previously existing neural circuitry repurposed through exaptation is an interesting question, though this issue is removed from the focus of this volume (cf. Pinker 1997). Recently gathered neurological evidence points to a reconfiguration of the neural paths through music training (Herholz and Zatorre 2012). This observation reinforces the idea that performative activities – such as musicking – may have played a big role in shaping human cognition, maybe acting in tandem with the adoption of cooperative group strategies (Dunbar and Schultz 2007; Mithen 2007).

Various lines of investigation converge in musicking as a key element of socially grounded human cognition. Given the mounting evidence, it seems reasonable to push the definition of music a bit further. Current creative practices indicate that Varèse's notion of musical material as organized sound is aligned with genre-free approaches to creative music-making (see Keller and Budasz 2010 for examples of contrasting approaches to musical creation). The instrument, the note, the rhythm, the melody or the harmony are all concepts that stem from the acoustic-instrumental music tradition, strongly biased toward metric and pitch-centered forms of sonic organization. Hence, these concepts imply choices that restrict the creative strategies to a narrow set of options. Despite being applicable to music made with acoustic instruments, they present serious limitations when applied to music based on volatile, distributed, ametric or pitch-free resources. If musicking is to be taken seriously as a phenomenon to be grounded in evolutionary theories, and/or contextualized within a complex web of human and non-human agencies, then its mechanisms for knowledge transfer cannot be restricted to a single occurrence of a cultural manifestation within a narrow historical time-frame that entails multiple racial, geographical and economic biases. Messina and coauthors address several of these issues in their contribution to this volume.

Ecologically grounded creative practice

Three of the papers in this volume are based on ecologically grounded perspectives to interaction design and creative sound making. These include the development of two metaphors for creative action: Sound Sphere and Creative Semantic Anchoring (abbreviated ASC from the Portuguese initials). Bessa et al. outline a new ecologically based interaction approach to design (Keller and Lazzarini 2017), the WYDIWYHE perspective. This method targets the relationships between doing (touching), seeing and listening. It features at least six design strategies: space-time proportionalities, flexible temporalities, isomorphisms, direct manipulations, semantic abstractions and the exploration of relational properties.

1. Space-time proportionality is exemplified in SoundSphere by representations that explore direct proportionality between timing and the visual space. This strategy can be extended to other modalities, including the use of material resources (within the field of tangible interaction) or the support for gesture interaction.
2. The adoption of flexible temporalities allows for the coexistence of various forms of temporal organizations – leaving in the hands of the participants the choice of sonic resources and their temporal distribution. In the

case of SoundSphere, this freedom is guaranteed by the possibility of incorporating any kind of sonic material. However, there is no specific support for periodic events, as usually imposed by systems oriented toward the metric standard. So, SoundSphere's temporality tends to prioritize creative organizations based on the use of timbre, relegating rhythm or pitch to secondary functions.
3. Isomorphism is a complementary aspect to flexible temporalities and is exemplified by the structure of the metaphors that foster the distribution of sonic resources without imposing hierarchies. For instance, SoundSphere supports the application of various procedures to organize materials, including sound sketches (used for the initial attempts to establish sonic relationships) and modular structures (which can be freely combined or can adopt specific constraints). SoundSphere also supports processing techniques and the use of multimedia elements – a concrete example is described by Aliel et al. (2019). However, the latter aspects are best represented when longitudinal observations are undertaken. Therefore they were not explored in the two studies reported in this volume.
4. Direct manipulation provides support for interactions that resemble everyday behaviors while giving priority to action-perception relationships. This is a strong component of ecologically grounded creative practices. In SoundSphere, direct manipulation is used in the selection panel and in the event-insertion mechanism of the interaction panel.
5. Semantic abstraction entails accessing complex processes through the use of written or spoken language. This strategy enables timbre manipulation through the application of audio-operators associated with labels chosen by the users.
6. Relational properties emerge from the interaction between the stakeholders and the environment (Keller et al. 2015). These properties are strongly tied to the local resources. In transitional spaces, they may impact the level of cognitive effort and the creative profile of the sonic products fostering an increase in their originality (Keller et al. 2013).

The two articles targeting metaphors for creative action involve a loose meshwork of techniques that explore the semantic relationships between natural language and sonic organizational processes. Several design solutions based on the semantic descriptions of audio events and audio processes are covered by the paper Timbristic Interaction in Ubimus (Interação Timbrística em Ubimus). Freitas et al. point to timbre as a ubimus topic that presents complex challenges, especially when it encompasses lay-oriented interaction. Timbre parameterization cannot be handled by simplistic or arbitrary mapping strategies. Furthermore, semantic abstractions may not be amenable to untrained stakeholders. To deal with casual usage of elaborate parametric configurations, the authors put forth a two-tier approach to an ecology of metaphors for creative action.

Freitas et al. discuss a variety of approaches to timbre interaction, honing in on the demands for casual interaction (Borning and Travers 1991). Previous experiments with nonmusicians indicate that factors such as the time investment and the resource demands share a similar level of importance as the quality of the creative outcomes. Therefore, simplistic solutions enabled through arbitrary mappings or the uncritical adoption of acoustic-instrumental methods may not be applicable to timbre interaction involving lay participants. Timbre manipulations often happen in conjunction with other creative activities - including selection, mixing, editing or sharing of musical data. The experimenters asked a group of undergraduates to use - during creative open sessions - a tool ecology centered on the Sound Sphere Metaphor. Most participants successfully completed their tasks. However, a number of issues were raised regarding both the materials and the tool usage. The results indicated the need to improve the visual feedback on the sound-processing type applied on each sonic event.

The study reported by Bessa et al. indicates that the Sound Sphere ecology presents a good potential for timbre interaction in everyday and educational contexts. The application of a semantic strategy fosters the rapid transfer of highly technical and specialized knowledge without requiring long periods of domain-specific preparation or training. In line with the results obtained in previous ubimus experiments (Keller et al. 2013), the transitional spaces have a positive impact on the originality factor but this effect is not present in the assessments of relevance of the creative products. In line with the results obtained with other metaphors for creative action (such as time tagging, spatial tagging, graphic-procedural tagging, or the use of creative surrogates), most subjects labeled the activities with the Sound Sphere Metaphor as being fun and enjoyable. They also reported a high potential for collaboration.

Collaboration and temporality in ubimus

Aligned with the second component of the ubimus definition, two contributions in this volume target the development of practices based on distributed resources. Since the beginning of the field, this area has been approached by multiple initiatives (Brown et al. 2014; Miletto et al. 2011). An early question is whether the networked environments for music making should be modeled after the extant acoustic-instrumental practices or whether they require new forms of social engagement. Related to this issue, we should also ask if there are built-in limits in the remote participation of multiple stakeholders or if the extant limitations are only related to the temporary lack of technological support. A case in point is the recent confluence of multimodal resources contributing to the formation of a tactile internet (Maier et al. 2016). In theory, this technology allows for multimodal forms of interaction that can be engaged in real time within a maximum radius of 300 kilometers. The tactile internet should enable ubimus participants to share haptic and visual data, thus enhancing the quality of their engagement in synchronous musical activities. Furthermore, virtual reality and robotic resources may become accessible through the network, minimizing the boundaries between colocated and remote resources.

The increase in the speed, bandwidth and reliability of internet connectivity may impact positively the music practices that rely on synchronized timing, that depend on the immediate feedback from partners and on data-intensive cues. In particular the activities enabled by video-based scoring, haptic devices (Chafe 1993), smell-rendering devices (Kontukoski et al. 2015) and movement tracking (Rokeby 1986) may be further enhanced. But it is not yet clear if the tactile internet will provide support for key aspects of the creative cycle, such as the selection of massive audio resources or the ability to predict effective musical outcomes when the actual sonic resources are only partially known. These two issues may depend on creatively oriented strategies for design that do not rely exclusively on synchronous interaction. For instance, the current speed or the bandwidth of the internet is not a bottleneck for the musical activities that do not depend on acoustic musical instruments. Synchronization is a serious limitation in remote performances by acoustic ensembles (Barbosa 2010). But this caveat only applies to the acoustic-instrumental formats when 19th-century musical practices are adopted. If these issues are approached as musical opportunities rather than as technological caveats, then the requirements for tight synchronization are relaxed (Bhagwati 2013). Flexible approaches to the organization of musical time may be more effective than the solutions based on the adoption of new technologies for old musical genres.

Given these challenges, Camporez et alii's implementation and usage of robots may complement the existing initiatives to deploy ubimus resources through internet connectivity. The authors focus on the development of synchronization for robotic musical devices. Their proposal of a mechanical delay compensation though trained neural networks may push toward alternative solutions for device-

synchronization problems. The authors also discuss the implementation and usage of a precision time protocol (PTP) and apply it in a musical-robot clock system. According to the authors, the modified message format helps to compensate for the mechanical delays, bringing greater robustness to the platform. The physical wear of the mechanical components can interfere with delay timings. To handle this issue, the neural network can be retrained to learn the new configuration yielding an adjusted response. In addition, performance delays may occur due to the heating of the mechanical components. These variations may be predicted and corrected by the adaptive clock system.

Building upon a growing trend on systems based on browser platforms, Messina et al. report on the usage of intercontinental live-patching sessions based on the visual language Kiwi. This creative activity is closely related to live coding (Sorensen and Brown 2007) and belongs to a family of initiatives that we could describe as *network-based ubimus* that target the use of remote resources for collectively shared creative outcomes (Miletto et al. 2011). Kiwi (Paris et al. 2017) is a port of the well-established visual language Pure Data (Puckette 1997). The advantage of Kiwi over its predecessor is its design tailored for browser platforms. Thus, collaboration and online usage are built-in characteristics. Furthermore, the integration of web-based components is also facilitated. Kiwi patches were developed by the Live/Acc/Patch group and the University of Paris 8 music-technology undergraduate class, each group adopting specific patching strategies. This intercontinental patching experience features a combination of small elements that interact dynamically as autonomous structures. The issue of temporality gains a dimension that encourages open, collaborative and non-hierarchical approaches. In Kiwi, all the participants retain the same, unrestricted rights. From a software engineering perspective, this may be considered a downside. In addition, the operations on each patch do not leave genealogical traces, thus it is not possible to establish the authorship of a specific object or comment on a patch. Consequently, potential hierarchical barriers - such as instructor vs. student or group a against group b - are erased.

According to Messina et al., the group practices of live algorithms for music making has implications on the presence and/or absence of the human components in ubimus practices, on the patterns of territorialization, on the operative actions and on the required mnemonic-support. The live patching experience confirms the operativity of a common behavioral pattern in computer music practices: the development of new tools is intertwined with compositional and social issues that arise from musical creation. This approach could be expanded through two strategies. Firstly, to make up for Kiwi's technical limitations on signal processing and audio tools, it may be possible to integrate the Faust language when involving intermediate or advanced users (see Lazzarini et al. 2014 for a discussion of ubimus usage of Faust). Secondly, live patching may be combined with concert practices based on improvisation or based on open works. This second proposal is aligned with the recent developments in ubimus comprovisation (Aliel et al. 2015).

Surfing the second wave of ubimus proposals: Hints at future research avenues

The papers featured in this volume encompass a range of topics linked to several major lines of research that emerged during the second wave of ubimus initiatives. These include: (1) support strategies for knowledge transfer that may enable laypeople to access complex creative musical processes; (2) live patching as a ubimus-oriented activity that incorporates live coding without inheriting the aura of a practice "just for the specialist" (typical of its source of inspiration); (3) the use of robotics as a component of ubiquitous music ecosystems, potentially contributing to the deployment of an Internet of Musical Things; and (4) two examples of metaphors for creative action: Sound Sphere, highlighting its deployments in everyday settings and Creative Semantic Anchoring (ASC), targeting the incorporation of semantic strategies

for music creation and performance. These last two examples are inserted within a research field that has received an increased amount of attention in ubimus during the last few years - ecologically grounded creative practices. This perspective has been applied in formal educational contexts (Lima et al. 2012; Lima et al. 2017), everyday settings (Ferreira et al. 2016; Keller and Lima 2016), music theory (Keller and Lazzarini 2017), comprovisation (Aliel et al. 2015; Aliel et al. 2018) and multimedia art (Connors 2015; Gomes et al. 2014; Keller et al. 2014b). The volume closes with an interview by Tate Carson that documents the first initiatives in ecologically grounded creative practice and discusses some of the recent contributions to this field.

The five papers featured in this volume provide a sample of the diversity of applications that characterize ubimus initiatives. When placed within the context of the current definitions of ubimus, it becomes clear that the field has moved beyond an exclusively technological focus of a subcategory of ubiquitous computing towards a multidisciplinary endeavor. The political and ideological preoccupations addressed by Messina and partners are good counterparts to the educational and philosophical implications explored by Lima and coathors (2012) and (2017). The artistic and aesthetic consequences of the methods adopted in this paper are shared by the comprovisational proposals laid out by Aliel et al. (2015) and (2018). Furthermore, this proposal expands the ubimus practices based on browser platforms, pointing to issues that were not addressed by the initial ubimus projects (Miletto et al. 2011).

Knowledge transfer. The three proposals that build on ecological creative practice provide fresh perspectives for this expanding field. Until recently, semantic strategies were not considered tools of the trade in ecocomposition (see Carson for a historical context). The multimodal aspects of the eco-based practices have pushed for an integration of verbal elements in knowledge transfer. An initial hint was given by the implementation of creative surrogates, digital resources that represent the source materials to enable fast transfers among participants (Keller et al. 2015). C-surrogates incorporated labels, hence the usage of verbal commands is just a further refinement of this proposal. While the results obtained by Keller and coauthors place the emphasis on the relationship between the semantic content of the musical excerpts and the listeners previous experiences through the quality of familiarity, they also point to the possibility of using semantic strategies to assess the originality of the sonic products. The metaphors for creative action proposed by Bessa et al. and deployed by Freitas et al. indicate the applicability of this proposal. Nevertheless, further studies are necessary to establish the limitations of these methods. For instance, the study by Freitas et al. indicates a complex relationship between the sonic characteristics of the sound sources and the timbre parameters. While it may be possible to attach a consistent label to a timbral procedure, the sonic outcome is both dependent on the sound being processed and on the type of audio-processing in use. This means that simple recipes like “if you have this sound and you want this type of result, then you use this timbral operator” are not applicable. How can we enable reliable knowledge-transfer strategies for open-ended aesthetic decision-making? This issue will demand further iterations of design, implementation and assessment.

Live patching. Regarding the approaches to group creativity, if we place the ubimus patching experience within the context of the ongoing ubimus collaborative practices on browser platforms, some interesting aspects come to light. Temporality seems to be a common design quality that cuts across all ubimus online practices. The volatility of the resources provided by Kiwi seems to reduce the window for negotiations among the participants. Furthermore, the immediate sonic outcome of live patching implies a reliance on an existing code base. As new code is added, all errors are immediately reflected by the sonic outcome. The unrestricted access to the shared patches implies that all participants may modify the code simultaneously.

Destructive behaviors may sabotage the group's sonic outcomes. Hence, other means of negotiations may be necessary. For instance, opportunistic strategies involving chatting or voice exchanges through browser-ready tools could be employed to overcome eventual misunderstandings. This approach presupposes a shared natural language among all participants. This was not the case in the reported experience, which featured French components that did not speak Portuguese and Brazilians that did not know French.

Alternatively, destructive actions could be avoided through the implementation of selective sharing mechanisms. For instance, parts of the patches would be available for collective action while other parts would be reserved to individual actions or to a restricted group of individuals. In a sense, this approach is already adopted by ubimus comprovisational practices. Some resources are open to contingencies, while others are predetermined (Aliel et al. 2018). Complementarily, the dynamics of sharing could also be subjected to temporal constraints. For example, some resources could be persistent and accessible throughout the session while others remain accessible only within user-defined temporal windows. This temporal restriction would enable a more refined strategy of aesthetic decision-making. Persistent resources could ensure the structural stability of the sonic outcome, while volatile resources would still be available to enrich the experience through contingencies. This technique can be defined as *time-sensitive or volatile ubimus patching*.

Robotic musical things. The example we just discussed highlights the centrality of the resources' temporal qualities in ubimus activities. While a simplistic approach to musical interaction could adopt the computing labels of synchronous or asynchronous processes, second-wave ubimus designs demand a more subtle analysis. Ubiquitous music ecosystems involve material resources that encompass both the processes directly related to the sonic outcomes and the support mechanisms that enable decision-making but that do not impact the musical products directly. Consider, for instance, the design quality of volatility. Volatility may be tied to the social interactions fostered by the musical activity. Casual participation involves the engagement of stakeholders that may not be necessarily acquainted with the resources available for the activity. This limitation imposes very high demands on the usability of the support infrastructure, forcing the designs to target fast installation or configuration or preprocessing of resources. These requirements can be bypassed by interaction strategies that distribute the functionality among various groups of participants with specific profiles. By entering the creative cycle at different stages, these participants furnish pieces of knowledge that add value to the resources and enable a more intuitive interaction. For example, advanced users may provide complex parametric configurations that casual users can retrieve by means of meaningful semantic tokens (see Freitas et al.). Thus, the different levels of expertise are employed as assets for collaborative ubimus endeavors. Advanced users provide persistent resources. Subsequently. these resources are accessed by other participants through opportunistic usage.

One of the many forms of temporality that are relevant to ubimus design is synchronicity. Synchronization mechanisms are available for most studio-based audio processes, but support becomes much more rare when the musical resources are not colocated. As suggested by Turchet et al., among other authors, one of the requirements for effective IoMusT deployments is the existence of standard protocols that enable message exchanges among musical things. The contribution by Camporez et alii may be applied to a range of resources that demand synchronization, including haptic, visual and sonic rendering devices. The adaptation of the *Precision Time Protocol* described by Camporez and partners may fill part of this gap. The proposed mechanisms of compensation of temporal delays could ensure synchronization and recovery from flaws in transmission. The authors also comment on the issues related to human-robot interaction which have not been addressed by the projects targeting the deployment of the IoMusT. The caveats are non-

trivial. Let us take as an example a simple four-node network with two nodes involving human participants and with robot partners in the remaining nodes. For a synchronous session that includes free contributions from the human nodes, the minimum information that has to be shared is the synchronized sonic output from all the nodes. This implies that the transmission timing accuracy and the fluctuations should remain within sample-accurate delays. This is feasible for local setups, similar to those exemplified by the authors. But as soon as we access nodes through wide-area networks, the tendency is to degrade the performance to a range of a few milliseconds. This degradation could be avoided by the use of the tactile internet. Though there are still several challenges to be overcome to make this proposal deployable.

Another issue of concern is related to the concept of distributed creativity (Literat and Glaveanu 2018). Ubimus research has boosted the importance of distributed creativity through the incorporation of remote resources for musical activities and through the increased empowerment of lay participants in group-creative endeavors. While other approaches to music making rely on the creativity of the individual - including the virtuoso performer, the almighty director of the orchestra, the enlightened composer or the geeky studio technician - ubimus practices have given the casual participants (Pinheiro da Silva et al. 2013), the novices (Miletto et al. 2011) and the robots (Camporez et al. 2018) the center of the stage[3]. This raises the stakes. As discussed by Coelho de Souza and Faria (2011), autonomous machines may eventually provide high-quality aesthetic experiences which may be enjoyed only by other autonomous machines equipped with the right perceptual capabilities. Despite sounding strange, if we turn this claim around it becomes clear that we are quickly approaching a point of no return. The amount of sonic garbage produced by everyday appliances (with a special note on the mobile telephones) is becoming ever-present in homes, offices, terminals, streets and even hospitals! What does it take to reduce the amount of unwanted audio? It takes noise-cancelling headphones. But these headphones, as well as the usage of portable sonic devices with regular headphones, come at the price of almost complete auditory isolation from the environment. The risk of distributing the decisions on how our soundscape behaves to the mobile-telephone, the microwave or the refrigerator industries[4] is that we give up our right to choose our own soundscape. A similar problem is produced by the massive deployment of autonomous musical robots. If they are able to decide when and how to play music, how do we deal with the devices deployed in public spaces? Who decides how they behave? The robot factory? The government? A casual user? Furthermore, with the increased reliance on the robots' higher functionalities by the human participants in IoMusT-based activities there is the danger of a general decline of the human creative abilities[5]. As Carr (2013) suggested, "relying on computers to fly our planes, find our cancers, design our buildings, audit our businesses is all well and good, but what happens when machines fail and humans have become increasingly deskilled due to automation?" We may want to rethink what kind of sonic world we want to inhabit.

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3 To be accurate, ubimus has erased the symbolic hierarchy of stage vs. audience.
4 These are just the most pervasive items, with the popularization of the internet of things it is highly likely that all appliances will include sonic actuators and controllers.
5 This phenomenon has already been observed in several studies of mobile-telephone usage. The pure presence of the device has a negative impact on the subjects' cognitive capabilities.

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