Ecomprovisation: Project *Markarian 335*

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Through an ecological approach to creative practice (henceforth ecomprovisation), this project deals with the expansion of creative strategies applicable to everyday contexts. Within ubiquitous music (ubimus), we target the convergence of sonification methods with the application of ecological models within the context of comprovisation. These conceptual frameworks inform the technological and aesthetic approaches applied in the making of *Markarian 335*. We describe the creative procedures and the implications of the design choices involved in this artwork. The contributions and shortcomings of our ecomprovisational approach are situated within the context of the current efforts to foster expanded creative possibilities in ubimus endeavours.

1. INTRODUCTION

Since the publication of the first volume on ubiquitous music research (ubimus) (Keller, Lazzarini and Pimenta 2014), several new perspectives within this expanding field have widened the palette of possibilities for artistic endeavours. One promising trend involves the incorporation of improvisatory strategies to foster the exploration of sonic resources. This practice-led approach to music research was already present in various ubimus projects, gaining a specific conceptual and methodological foothold through the incorporation of ecological frameworks. How does ecological thinking impact the creative practices that target ubiquitous contexts? We tackle this question through a discussion of proposals within ecologically grounded creative practice, providing hands-on examples of the design and deployment of an artistic project using acoustic and computationally based sonic resources.

An aspect of ubimus research that received increased attention during the last few years involves the implementation of support for creative engagement by both musicians and participants who have no technical training. This is a particularly problematic issue because the majority of the extant research on musical interaction is limited to professional musicians and in some cases it centres on the virtuosic performer as the ideal model for interaction design (Wessel and Wright 2002). The undue stress on a genre-based understanding of virtuosism and on a culturally biased interpretation of expression[1] has erected serious barriers to the inclusion of untrained participants in music-making. Rather than adopting preconceived genres, while tailoring the design for the needs of a particular niche of musicians, ubimus approaches have strived to avoid the narrow focus of previous musical-interaction proposals while highlighting the need to let the participants determine when and how to deploy resources to attain their creative goals. Furthermore, the concept of *creative goal* has been put into question. When applied to artistic and educational activities, the utilitarian view of interaction as a problem-solving activity has shown serious limitations (Lima, Keller, Pimenta, Lazzarini and Miletto 2012). This is why ubimus methods tackle both the exploratory aspects of creative music-making and the demands of knowledge-sharing mechanisms in activities involving both trained and untrained participants.

Ecological thinking[2] has gained strength through ubimus deployments. Since the pioneering proposals dating from the late 1990s (Keller 1999, 2000), a healthy diversity of ecologically grounded frameworks has been applied to a wide range of artistic endeavours. Nance (2007) introduced eco-based strategies to the realm of acoustic-instrumental writing, hence expanding the palette of sonic resources through the inclusion of recorded instrumental sources. Connors (2015) proposed the concept of ecological performativity, adding another layer of techniques to eco-grounded installation art. Through a series of performance-oriented artworks, Aliel, Keller and Costa (2015) furnish the basis for a fusion between ecologically oriented improvisation and compositional approaches. Labelled *ecomprovisation*,[3] this practice-based thread applies ecological thinking to shape group behaviours targeting

[1]See Gurevich and Treviño (2007) for a critical discussion of the use of the label *expression* within the context of the conferences on New Instruments for Musical Expression.

[2]We use the terms *ecological*, *eco*, *ecologically grounded*, *eco-based* and derivatives to refer to the creative practices that are inspired by and engage with what has been termed the E4 perspective in cognition (ecological, embodied, embedded and enactive).

[3]Ecomprovisation features a fusion of comprovisational methods within the context of ecologically grounded creative practices. We acknowledge the possibility of exploring other forms of fusion of ecologically inspired improvisatory approaches within ubimus, such as exemplified by Connors (2015) and Stolfi, Milo and Barthet (2019).

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both synchronous- and asynchronous-distributed musical activities.

Another thread of developments has emerged from the application of ecological models to sound-making. According to Braun (2017: 89), sound-making should be studied in the context of and in relation to the other senses and modalities. He characterises sound studies as a field within the cultural and social sciences, highlighting its historical aspects. This proposal involves an interdisciplinary research agenda that emphasises cross-cultural components. From this perspective, Braun discusses the design and compositional projects of the late 1990s that have pushed the field towards multimodality. Keller and Truax (1998) implemented a set of techniques employing databases of granular sounds extracted from environmental sources and employed control functions modelled after the behaviours of real-world events. Artistic deployments of this approach can be heard in the eight-channel pieces *…soretes de punta* (1998) and *touch'n'go* (1999). As an example of a multimodal perspective on sound-making, Braun discusses Tyler Kinnear's analysis of *…soretes de punta*. He states that the compositional usage of synthesised water sounds highlights the variety of manipulations and interactions applicable to environmental sources in creative endeavours. According to Kinnear's analysis, the use of ecologically based granular synthesis lets the composer handle the identity of the sonic resources through operations on the acoustical parameters of water drops while targeting their interactions with various surfaces. Sounds derived from this referential identity serve as a creative palette for *…soretes de punta*. Despite the restricted materials, the manipulation of phase-synchronicities and decorrelations among streams expands the timbral profile of the sonic events and textures, thus enriching the sonic results (Rolfe and Keller 2000). Braun (2017: 85) concludes that as a transformative agent, the water stream functions as a thread between a baseline timbral identity – established through the spectral characteristic of the drop collisions – and the environmental sounds utilised in the piece.[4]

Braun's argument adds weight to the ecological methods of Opie and Brown (2006) and Gomes et al. (2014) that deal with the integration of perceptual modalities. Other examples of this approach are featured in Connors's two audiovisual installations, *From the Edge* and *Currents*, based on sounds collected through field recordings made at Newfoundland's East Coast in Canada. Connors uses Barad and Morton's ideas to articulate a compositional perspective that questions representationalism, adopting a midway position on how to deal with agency within a nature–culture continuum. These installations deploy live-streamed environmental datasets to re-enact various forms of agency. The datasets function as co-creative devices to explore the ecologically grounded performative dimensions of the artworks. The methods used by Opie, Gomes and Connors rely on the extraction of data from environmental phenomena. Rather than treating the usage of data as culturally neutral, they reinterpret the sources through situated sonification strategies. Consequently, these proposals differ from the standard usage of sonification as found in historical computer-music compositions such as Dodge's *Earth's Magnetic Field* (Dodge 1970).[5]

In line with the preceding discussion of sonic-oriented ecological perspectives, *model-based sonification* involves the creation of acoustic models that generate responses based on inputs from a user or from multiple users. This technique requires a computational model and complementary instructions to guide behaviours towards a sonic outcome. In contrast with the historical sonification approaches previously cited, ecological models involve an active engagement from the stakeholders. Local interactions with the participants become a crucial aspect of this artistic approach. The dynamics of the models are not fixed or strictly dependent on the initial conditions. They rely strongly on environmental factors which are prone to change during deployments. From an acoustic-instrumental perspective, this approach could be interpreted as a virtual musical instrument that can be played by the user to generate the respective sound (Hunt and Hermann 2004). Nevertheless, as entities dependent on mutual adaptations (which are very different from passive acoustic instruments), ecological models tend to be shaped by sonic ecologies (Keller 2012; O'Callaghan 2013). Given this functional context, acoustic-instrumental interaction becomes irrelevant.[6] To emulate real-world agent-object interactions that entail meaningful responses to actuation (usually yielding sounds and involving several temporal layers of events and featuring a range of variations dependent on the chosen modality), the data and the state of the ecosystem need to remain open to emergent processes.

[4]See also Basanta's (2010) analysis of this work. An informal discussion of the context of this piece can be found in Carson (2020). More background can be found in (Keller 1999, 2000; Keller and Berger 2001).

[5]See an in-depth discussion of the constraints and potentials of applying auditory-display methods in ubimus design in Lazzarini and Keller (2021).

[6]Examples of the acoustic-instrumental paradigm in musicology and in the proposals for 'new instruments for musical expression' are: the separation between the public, the composer and the performer; mastery of specific knowledge as a requirement for making music; the myth of the genius as a source of creativity incarnated by the virtuoso, conductor or composer (usually male, white and from a central country). See discussions in Bown, Eldridge and McCormack (2009), Keller (2000) and Simurra, Messina, Aliel and Keller (2023).

Furthermore, the application of ecological thinking to the realm of sonification may extend the usage of local resources in creative practice. The initial proposals in this field during the late 1990s involved the implementation of ecological models, the emulation of everyday events and targeted artistic experiences based on multimodality. More recently, Opie and Brown (2006), Hermann (2011) and Connors (2015) have independently developed techniques that extract information from local events fostering the explorations of sonic models based on human decision-making. How to deploy these resources in improvisation is an open issue partially addressed by recent artistic initiatives.

In this article, we document the artistic project *Markarian 335* (henceforth *M335*). The article targets interaction design and involves the implementation of computational tools, highlighting the application of sonification techniques aimed at improvisation. Based on an ecological approach to comprovisation, the *M335* project explores alternatives to expand the creative strategies applicable to everyday contexts. The section 2 of the article engages with the deployment of ecological frameworks within ubimus. We highlight the use of ecologically grounded audio-processing models and point to the potential impact of this perspective on sonification. Then we address the usage of auditory-display techniques as creative strategies for ubimus, indicating crossovers with the frameworks that target multimodal and behavioural ecologies (Keller and Lazzarini 2017). The section 3 is dedicated to the procedures employed in *M335*, highlighting the design of creativity-support strategies tailored for comprovisational practice. Finally, we deal with the contributions and shortcomings of each strategy to creative endeavours, situating the results within the current ubimus expanded field for novices and experts.

2. RELATED WORK: COMPROVISATIONAL APPROACHES

Comprovisation is an emerging artistic strategy that encompasses composition and musical improvisation. The term *comprovisation* does not have a consensual definition yet. Its origins go back to the improvisational proposals of the 1960s – including the output of artistic groups such as the *Scratch Orchestra* and *Musica Elettronica Viva* (Cardew 1969; Curran and Teitelbaum 1989). Current comprovisational approaches have also addressed aspects of interactive musical representations (Hannan 2006; Dudas 2010; Fujak 2011). Fujak (2011) argues that in the activities done by living beings, some scenarios can only be partially planned. A variety of uncontrolled factors can impact the environmental conditions, shaping the behaviours of the stakeholders. Thus, he proposes comprovisation as a metaphor for ways of living. In ecological parlance, interaction units are defined as *events* which occur in the context of habitats and ecologies (Keller 2000; Keller and Capasso 2006). When resources are deployed, the stakeholders engage in both planned actions and unpredictable behaviours. Plans are ways of projecting relationships between the extant resources, encompassing both material and cognitive activities, which may entail either teleological or exploratory strategies. In this article, we aim to construct a conceptual framework bridging comprovisation and ecologically grounded creative practicality within the ubimus context. To achieve this, we draw parallels with a conceptual tool introduced by Aliel, Keller and Ferraz (2018b) and Messina and Aliel (2019, 2023), the *Gelassenheit.*

Gelassenheit is a term coined by Heidegger (1966). Its literal translation is 'serenity' although Heidegger's formulation transcends the literal meaning of this word in English. He proposes two forms of thought: 1) calculative thinking, understood as a science-oriented artistic method involving measuring, collecting data and replicating results; and 2) its counterpart, meditative thinking, entailing an attitude open to unpredictable actions and unexpected outcomes, that is, 'an openness to mystery' (Heidegger 1966: 55). Heidegger proposes Gelassenheit as a stage to be achieved through innovative ways of thinking. From an ecologically oriented perspective and grounded on arguments by Donald (2006), Aliel, Keller and Costa (2018a) reframe this proposal as a process of adaptation and modification of self-reflective strategies in artistic practice. The absence of control encouraged by Gelassenheit factors tends to trigger unexpected results, setting an atypical frame for potential actions and forcing the stakeholders to adapt their behaviours to unfamiliar conditions. Thus, Gelassenheit may be viewed as a factor fostering evolutionary processes within highly compressed time frames.

Within the concept of Gelassenheit defined by Heidegger, encompassing calculative thinking and meditative thinking, we can hypothesise a method for comprovisation that engages in a dialogue with the ecological perspective through action plans (guideline plan and contingency plan) (Aliel 2022). From an ecological perspective, therefore, comprovisation may be defined as a way to handle creative actions that feature *guideline plans* (that constitute the core of compositional activities – calculative thinking) and *contingency plans* (involving elements of improvisation – meditative thinking), having a direct relation to the local environment as source material and involving experimentation within its sphere of practice. A guideline plan establishes rules of interaction that

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are persistent and depend on material factors such as mass, form and the dynamic properties of materials, acting upon specific structures and resources (such as place and stakeholders). A contingency plan may deal with the same targets as the guideline plans, though it also encompasses volatile resources and processes that lack predictability. A guideline plan includes rules, planned actions, algorithms and resources often obtained through asynchronous methods (and usually linked to pre-compositional activities). A contingency plan targets the unpredictable, the eventualities, the chaotic (involving deterministic but highly complex outcomes) and random events (encompassing either environmental factors or computational strategies), thus highlighting the creative role of both human and non-human errors.

Depending on emerging musical and social needs, comprovisational strategies can adapt. Given specific conditions, guideline and contingency plans may offer opportunities to level the collective access to the creative processes, avoiding preconceived notions of priority of one strategy over another, as suggested by the critical discussions on the application of hierarchical and centralised compositional methods by Bhagwati (2008), Keller (2000) and Lewis (2000). This flexibility tends to add weight to contingencies. Consequently, one of the challenges of ubimus design is to provide comprovisational guidelines that are effective both for persistent and volatile resources (Keller 2014), while encouraging the exploration of the creative potential of contingencies.

Some comprovisational plans may involve elements of intentionality of the stakeholders. A guideline plan may feature an explicit representation of expected outcomes. Contingency plans usually entail a lack of completeness and rest on implicit knowledge shared through cultural traces (non-idiomatic improvisation is a case in point). Sometimes, both plans may converge. For instance, the absence of rules implies a new rule that limits sharing explicit knowledge. This suggests the usage of tacit or informal knowledge as a way to establish criteria and order to the actions of the agents. At the other extreme, disruptive tendencies in comprovisation may involve an entity imposing a contingent plan opposed to the shared concepts obtained through previous interactions.

For the purpose of creating a new specific neologism related to comprovisation work aligned with ecological practices (guideline plans and contingency plans), we propose the inclusion of the letter 'e' into the context of comprovisation, resulting in 'ecomprovisation'. In this context, the 'e' combined with 'co' (eco) associates with 'comp' (composition) and 'provisation' (improvisation), thereby amalgamating three words into a fusion that aims to encompass the concept.

3. *M335* PROJECT

In this section, we tackle the analysis of an artistic work, *M335*. Our focus is on the possibilities of using action plans (guidelines and contingencies) for the creation of an ecomprovisation. We approach the discussion of *M335* from the perspective of a professional double bass player. Our analysis highlights technological advancements – involving the Handy S prototype – and approaches centred on musical aspects, such as the utilisation of extended techniques and graphical notations.

M335 is a piece for acoustic or electric bass, inspired by NASA's discovery of an unidentified object. The object was photographed while distancing from the black hole M335. It has not been catalogued and studies have not yet reached consensus on its composition or nature.[7] Einstein's general theory of relativity implies that nothing, not even light, can escape a black hole. The event that took place in M335 pointed at a new phenomenon that remains unexplained. We employ this premise as an artistic inspiration. Metaphorically, the double bass tries to 'escape' the sound mass generated by the machine. However, the sonic materials are mostly controlled by the actions exerted on the instrument. This struggle between acoustic and electronic sources fosters a process of sonic immersion involving cycles of feedback between the gestures and the sounds.

3.1. Tools and materials

The computational prototype features two objects from the Pure Data GEM[8] library, namely [pix_video] and [pix_data]. The [pix_video] object enables the use of a webcam connected to a computer. The [pix_data] object acquires the colour of a specified pixel in an image. This capture is defined by the RGB standard (red, green and blue). During the initial tests of a webcam attached to the double bass, we observed that colour-based capture does not necessarily yield a result directly connected to the musician's gestures. The capture process and subsequently the sound production were imperfect, even in single-colour conditions. In other words, it was not possible to repeat or refine the capture. After several tests, we concluded that colour-based capture did not contribute to the generation of musically replicable material.

However, during the testing process we also noted that the musician's movements of the double bass

[7]The news report can be seen at https://astronomynow.com/2015/10/28/black-hole-markarian335-has-major-flare/ (accessed 12 January 2024).

[8]GEM (Graphics Environment for Multimedia) is a set of externals developed for multidimensional matrix processing on Linux, Macintosh or Windows to create and manipulate video and graphics in OpenGL.

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produced sounds he considered more 'musical' despite their random qualities. Based on this premise, we proposed an indirect-capture process, allowing more freedom to move along *x*, *y* and *z* axes. Rather than emphasising mappings for each colour; the new approach focused on the relationship between light and darkness enabled by the movements. The musician moved the double bass, the webcam captured the light sources and sounds were produced. Darkness or low illumination yielded no capture and no sound. This approach provided a baseline control of sound 'on and off'.

Although we had a certain level of control, we considered incorporating randomness under unexpected conditions. In this context, the musician interacts with a sound (on or off) but has no control over other sonic characteristics, forcing them to adapt to the local conditions. Considering the object's ability to capture RGB, we altered the equation of the three colours (multiplications in some objects) to generate variations in duration, velocity and pitch.[9]

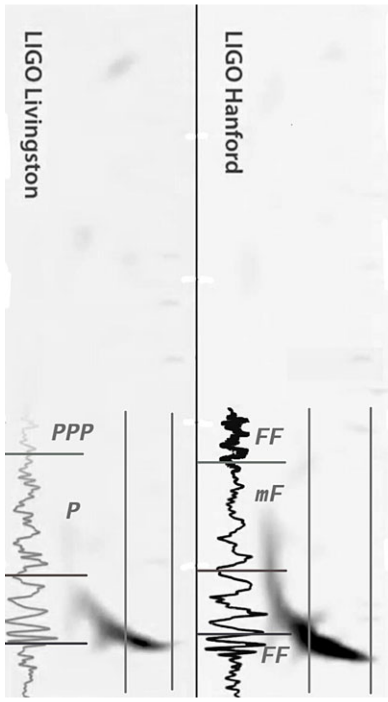

Figure 1. Spectrographic scores used in *M335*.

3.1.1. Graphics: target clear and accessible indications for interpretations and actions by the musicians/performers

We use spectrographic scores[10] to support the process of aesthetic decision-making (Figure 1). Our knowledge-sharing strategy features conceptual hints rather than rigid procedures. We use two graphs to trigger alternative sonic interpretations of data captured by the satellites LIGO Livingston and LIGO Hanford.[11] These sonic sources are colloquially termed 'black-hole sounds'.

To establish a connection between the spectrogram and instrumental actions, we subdivide each spectrum in three regions. These subdivisions (indicated by green, red and blue lines) are associated with the regions of the double bass's body and indicate where the left hand should be placed to handle pitch-oriented actions. To facilitate the comprehension by the performer, we have related the increase in intensity (displayed in the spectra) to dynamic references applicable to each segment. The double bassist can choose to play either the left side (LIGO Livingston) or the right side (LIGO Hanford). She can also switch sides at any time between LIGO Livingston or LIGO Hanford, or she may repeat the material indefinitely.

The spectrographic scores are read from top to bottom. Timbral variations are directly associated with bow movements. Thus, if a parameter value is large, the bow gesture will also be large. The wavy notation represents the intensity of the right hand (applied while bowing, pizzicato and so on). This parameter can be read from top to bottom or from bottom to top. Changes in the order during the performance are left to the discretion of the instrumentalist. There is no time restriction for repetitions, but there are restrictions on the dynamics and the strings choices. For instance, on the left side (LIGO Livingston), the strings E and A are indicated, while on the right side (LIGO Hanford), the strings D and G are indicated. As already mentioned, the choice of sides is free.

From a total of eight, four pages are used for each performance. Some pages permit a free choice of pitches, while others have guidelines indicating the pitches to be played or excluded. There are no time indications for page turns. Hence, the instrumentalist may choose to explore one or more pages before handling the complete set.

3.1.2. Extended techniques: furnish accessible and clear indications for interpretations and actions by the performers

Extended techniques based on explicit instructions are featured as part of the guidelines plan. Despite adopting a limited set of instrumental techniques,

[9]The Pure Data patch can be viewed at www.journals.cambridge.org/OSO.

[10]A spectrographic score is defined as a visual resource that features spectral information to convey musical knowledge. This knowledge-transfer strategy has also been adopted by other ubimus projects, see for instance Stolfi et al. (2019).

[11]The original spectrum can be seen at www.youtube.com/watch?v=dP6ZWew83_Q.

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Figure 2. *M335*'s performance.

we tailored the design for: 1) adaptation of sonic processing based on bow movements; and 2) adaptations tailored for the sonification model (more on this later). The variability is governed by rules of action and reaction that depend on the local context. Consequently, small-scale decisions play a decisive role. The implication is that a creative agent cannot expect to replicate previous results because there is no univocal relationship between the audio-processing techniques and the parameters driven by this form of performance.[12]

In the performance, we can observe the musician utilizing some of the proposed features, placing emphasis on the body movement gesture of the double bass to activate the webcam feature, employing extended techniques, and at times referring to the score to guide certain actions (Figure 2; Video Example 1).

3.1.3. Usage of the Handy S prototype in M335

The prototype Handy S was used to explore adaptive strategies (Keller, Aliel and Silva 2018): 1) parametrisation based on the capture of acoustic-instrumental gestures – a webcam is coupled to the instrument providing a gestural sonic interface that bypasses the typical process of acoustic-instrumental transduction; and 2) the generative sonic results are recycled as material for improvisation.

We conducted preliminary studies that led to the deployed version of *M335*, involving performers accustomed to improvisation practices who were familiar with contemporary musical repertoire. These studies pointed to strategies to attain greater control of the sonic outcomes: it was observed that some performers began to track the timing of the webcam 'errors'. Thus, they learned to anticipate when the system generates an update and employed these opportunities to try new behaviours leading to new sounds.

Another strategy involved learning that small changes of position in the x, y and z axes result in greater control of the outcomes. Instead of using manual gestures to trigger modifications (following their standard instrumental training), the performers tried moving the body of the instrument. Since the webcam is attached to the instrument, the movements of the double bass generated more precise sonic outcomes. We can interpret these strategies as human behaviours adapted to specific demands of the ubimus ecosystem. We believe these features were discovered because the musicians searched for apparent flaws in the system that allowed certain materials to be 'tamed', becoming more predictable and controllable.

4. *M335*: SUMMARY OF FINDINGS

M335 features two forms of auditory-display: action and feedback. The interaction model involves reading and interpreting a score and capturing visual data to transition from no sound to sound. The complete cycle involves events initiated by the instrumentalist, visual data captured by the webcam, and sonic outcomes that are not fully determined by the state of the system. While executing the score, the performer triggers multimodal events (Figure 3).[13] The spectrographic scores are used as a guide for the improvisational processes (see Opie and Brown 2006; Connors 2015 for related techniques). These processes do not imply a direct mapping between data and sonic outcome: they

[12]This touches upon issues of replicability in creative practice that have been a focus area of research in ubimus.

[13]In Figure 3, the items [pix_videos] and [pix_videos] refer to Pure Data objects.

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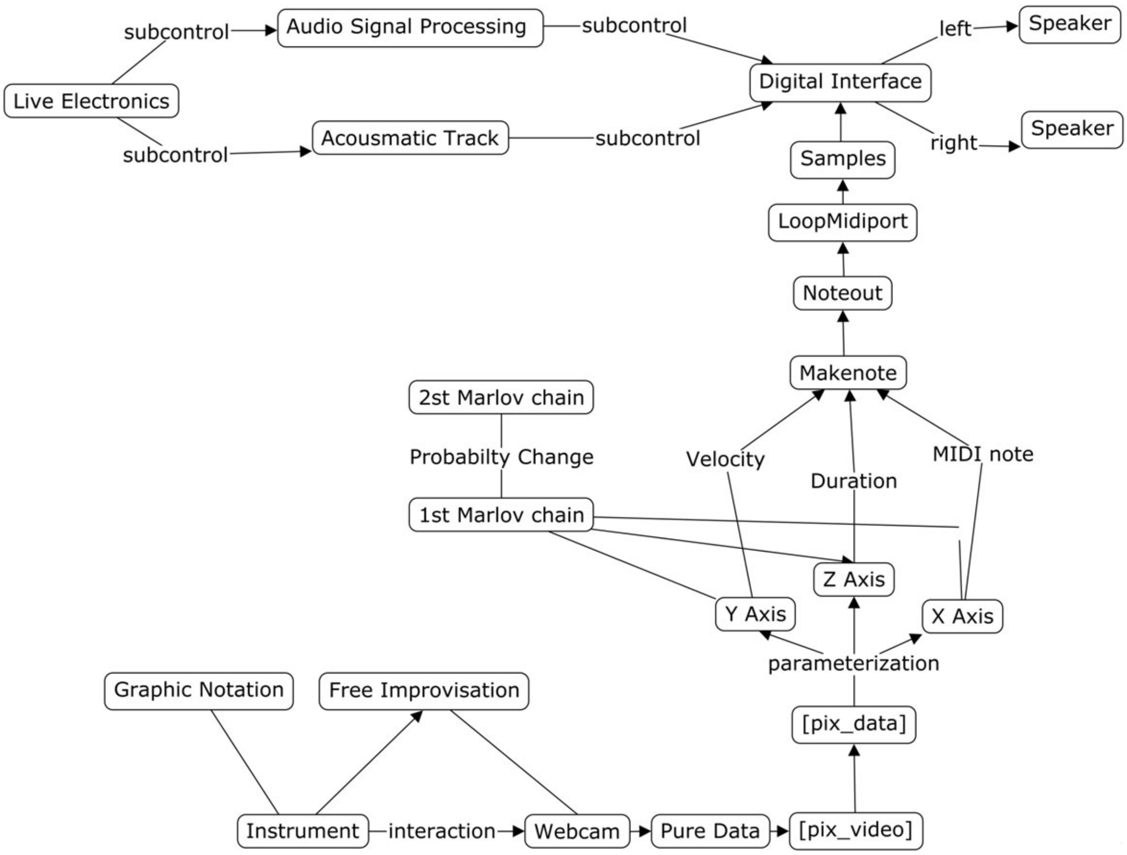

Figure 3. Diagram of the *M335* interaction model.

yield a new sonic layer that diverges from the acoustic-instrumental material. Furthermore, the player cannot intentionally replicate the processed material because the behaviours are shaped though sonic feedback. Instead of using only the sound of the instrument or applying extended techniques, our ecomprovisational approach promotes the empirical exploration of electroacoustic and acoustic sonic resources.

A second strategy aims to increase the creative relevance of the sonic sources. A fairly entropic level is fostered through a 'reversal' of roles. The musician (although still triggering audio processes) relies on events produced by the interactions with the Handy S prototype that may not necessarily involve instrumental sound. The instrumental gestures are captured by the webcam (Figure 4),[14] triggering processes that may diverge from what is expected by the instrumentalist. Consequently, electronic sounds become central. The outcomes are linked to the interactions between the instrumental sound and the movement-tracking system. Through this dual and synchronous interaction, the audioprocessing parameters introduce new and divergent material based on the double bass sounds.

As previously explained, the current prototype retains a certain level of randomness due to the low definition of the visual data and due to the automated 'choices' of data capture. These factors, rather than being treated as limitations, constitute a target of design for the *M335* ecomprovisational project. Although not planned as a design feature, during the sessions the musician pointed out that the projection of the hands of the performer influenced the way they were playing. At a later stage, this third strategy was integrated into the design (see Aliel 2017). Through the projection of the movements of the hands, the unintentional material is reframed, grounding the assessments of the contingencies on multimodal information and enhancing the immersion in the ecomprovisational experience.

From this perspective, we consider that the *M335* prototype follows the proposal by Boden and Edmonds (2009) to apply constraints to promote complex and creative results. These constraints serve

[14]We employed a Logitech webcam, Model C920, in our implementation. Its resolution capability extends up to 1920 ×1080 pixels with H.264 video compression.

Figure 4. A consumer-level camera was attached to the double bass to enable data capture and parametric control in *M335*.

to frame the performance leaving room for 'computational choices.'[15] Furthermore, a connection arises between Heidegger's calculative and meditative thinking, as presented earlier. While calculative thinking permeates the aesthetics and practice based on the acoustic instrument, expanded through the option to turn the electronic sounds on or off, meditative thinking is encouraged by fostering openness to the unexpected and adapting to the local conditions.

If we consider the application of Gelassenheit, we can suggest that the occurrence of unexpected conditions (almost with random characteristics) is not actually a problem. In general, this kind of event is common in ecological conditions (natural events that cannot be controlled by humans or computers). Thus, from this perspective, unexpected elements can bring unique benefits to the process and can be understood as events within the contingency plan. In other words, even a technological parametrisation error will be interpreted as a form of 'improvisation'. We term these conditions Gelassenheit events (Aliel 2022).

5. FINAL REMARKS AND FUTURE DEVELOPMENTS IN ECOMPROVISATION

Does ecomprovisation provide a path to deal with the demands of future ubimus initiatives? Let us take a moment to reflect on the proposals laid out in Keller, Messina and Oliveira, 2020a and Keller, Simurra and Messina, 2020b targeting second-wave ubimus endeavours. Second-wave ubimus may encompass everyday creative musical activities and collective asynchronous musical interaction. The constraints of casual interaction encouraged by ubimus initiatives include: 1) very limited time for preparations; 2) short-term engagements; 3) a wide diversity of stakeholder profiles; 4) unreliable network connectivity; and 5) unrestricted public exposure. While some of these caveats are addressed by the techniques discussed in this article, others constitute targets of future research. Despite envisaging professional-creativity support, some of the strategies implemented in *M335* could be adapted to address the needs of casual participation (Keller et al. 2018). In particular, the techniques developed for the creation of the artwork *M335* provide ways to extract knowledge from local resources that can enhance improvisational approaches. These approaches may potentially include strategies for everyday musical creativity for both trained and untrained participants in the future.

Potential future approaches include:

1. By using open graphic scores that present basic instructions for actions, the gap between learning and performing is reduced, allowing both groups to employ similar resources (see Aliel 2022).
2. Since the support involves coupling a technological object to an acoustic instrument, the process of gestural and sonic experimentation could eventually unfold similarly for both novices and more experienced participants, fostering knowledge exchanges through mimicking or imitation.
3. As unpredictable factors are an important feature of ecomprovisation, both groups need to deal with emergent properties by finding solutions or incorporating new actions into their palette of creative tools. This implies a pressure on the boundaries between everyday musical creativity and professionally oriented approaches. Ecomprovisation may furnish a bridge to explore both perspectives.
4. In line with the maker-oriented DIY ubimus proposals (Lazzarini, Keller, Otero and Turchet

[15]For example, given a set of numbers from 1 to 10 and (A > B), considering (B = 4) we have (A → 5, 6, 7, 8, 9, 10). The specific choice is left to the machine.

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2020), everyday objects could be repurposed through ecomprovisational strategies.[16] These techniques could bypass several of the financial barriers faced by potential participants in low-income regions. Owing to the scarcity of professional audiovisual equipment in peripheral countries, gear such as high-resolution video-cameras may be replaced by recycled consumer-level mobile telephones. Android systems, for example, offer a wide range of free or open-source software[17] that support synchronous streaming of audiovisual data to personal computers.

5. The incorporation of more refined movement-tracking algorithms (as exemplified by Chakraborty, Yaseen, Timoney, Lazzarini and Keller 2022) also opens interesting possibilities to release the interaction from the bounds of the acoustic instruments. Mid-air interaction techniques involve triggering a multiplicity of sources from a visual-tracking algorithm that supports adaptations to diverse body shapes and positions. No special-purpose equipment is necessary.

Finally, a note of caution is necessary regarding the support for distributed activities. Collective asynchronous musical activities bypass co-located face-to-face interactions. Consequently, they may reduce the social-bonding aspects fostered by co-located music-making. While several comprovisational proposals have targeted synchronous activities, open temporalities tend to be linked to non-hierarchical and asynchronous techniques. Ubimus ecomprovisational techniques could provide a way to deal with asynchronicity and quasi-synchronicity in comprovisation. On the one hand, group music-making lets the stakeholders build a shared knowledge pool that grounds consensual decisions. Alternatively, it fosters the coexistence of divergent worldviews. On the other hand, the participants' usage of the local resources encourages aesthetic diversity. Diversity within consensus and coexistence of opposed views seem to be attitudes encouraged by ubimus endeavours. Ecomprovisational strategies – as exemplified in *M335* – feature forms of interaction aligned with these goals.

SUPPLEMENTARY MATERIAL

To view supplementary material for this article, please visit https://doi.org/10.1017/S1355771823000651

[16]In some regions, even standard devices that are usually cheap and accessible – such as high-resolution webcams or MIDI-enabled gadgets – are prohibitively overpriced. For these contexts, DIY replacements may furnish affordable solutions.

[17]For instance, DroidCam.

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