# A Sustained Relationship with Large Instruments: a Case against the Convenient Interface

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## ABSTRACT
In recent decades, with the innovation in sensor technology, the trend towards smaller digital controllers for instruments has expanded. New generations of performance styles are growing that rely on compact instruments that can travel easily and are thus versatile. This article cites two interactive performance practices to illustrate how larger instruments change the nature of interaction and sonic outcomes of performance. Pressure-sensitive Floors, a wooden set of platforms for performing electronic music, are compared with a practice on the Renaissance violone with electronics. Large instruments offer unique additions to performance and music making that are not accessible in small instruments. They have their own specific affordances and limitations that affect the musical decisions of the performer and therefore contribute unique ways of conceptualising performance. The instruments in this paper have been chosen as the authors have a 'sustained relationship' with them and these practices merely act as examples of the embodied knowledge gained through staying committed to a particular large instrument. We demonstrate how with such a practice, the performance is recentered around human presence. This offers a deeper communication between performer and audience. It creates new avenues for the performance of contemporary music where the entire body is engaged in movement and sounding. We argue that overlooking large instruments in favour of their smaller counterparts would result in the loss of a unique aesthetic as well as conceptual and performance approaches.

## Author Keywords
Digital musical instruments; movement and computing; large instruments; whole-body movement

## CCS Concepts
• ***Human-centered Computing*** → *Interaction Design Theory, Concepts and Paradigms* • ***Human-centered computing***→ *User Interface Design* • ***General and reference*** → *Cross-Computing Tools and Techniques*; *Performance.*

## 1. INTRODUCTION
The size of a musical instrument is important. In acoustic instruments the size affects the timbre and register of the instrument, but also carries performance and compositional implications. Lia Mice and Andrew McPherson point out that, 'aesthetic features of large acoustic instruments shape the performer's choices while improvising, composing and performing repertoire' [1]. Furthermore they assert,

> 'Not only are musical gestures linked to musical intentions, they are also linked to cognitive processing of the sounds they create, and in this way physical interaction with instruments involving gesture/action consequences changes our performance gestures and choices, and therefore our thinking' [ibid.].

The size of an instrument shapes the way the performer conceptualises and expresses their musical language, shaping their cognition and thus their aesthetic choices. large instruments can facilitate specific musical sensibilities that their smaller counterparts cannot. Mice and McPherson argue that these are ideas worth considering and integrating into the design of DMIs, in order to access their full expressive potential and aesthetic affordances [ibid.]. This argument is particularly relevant in response to the current trends in DMI design that centre on the creation of small-scale interfaces that are convenient, lightweight and marketable.

Mice and McPherson also state that 'while large DMIs engage more with the body and are more physical and visible than their smaller counterparts, more research is required to fully understand ways in which their size influences DMI music and performance' [ibid.]. In this paper we address this gap by providing a critical assessment from the perspective of performing with and composing for large acoustic and digital instruments.

## 2. LARGE INSTRUMENT DESIGN

### 2.1 The Floors
The *Terpsichora* Pressure-Sensitive Floors (the Floors) are a new digital musical instrument which uses whole-body motion to control electronic music. The instrument continues the development of early models for pioneering dancer Philippa Cullen (1950-1975), expanding its use as an expressive and versatile instrument for musicians to play. Cullen, a prolific choreographer and dance artist working with sound, created a range of instruments in the early 1970s through collaborations with designers and technologists [2]. Cullen aimed to gain a new level of control of sound as a dancer, freeing her movements from the influence of sounds created by a separate performer. The original pressure-sensitive Floors, built in 1972, remain a distinct application of interaction design, as the movement of the entire body is required to control a single sensor underneath each Floor, a design choice continued in the newer *Terpsichora* Floors, which were initially built in 2015 and have been in constant development since, and will make the focus of the discussion in this paper.

The *Terpsichora* Floors are made of individual platforms that fit together and can be used in any number or combination. Since each platform is standalone, they can be spread out without limits. This modular nature of the instrument, along with its large size makes it flexible to the needs of differing performance methods (see Figure 1 for the layout of seven Floors in different sizes). The initial design for a dancer informed the large dimensions of the instrument (original Floors were equilateral triangles 1.4m on each side), which have since proven to be equally expressive and valuable for performing electronic music. As a musical instrument, the Floors can be placed closely together, so that the musician can control them simultaneously, engaging their entire body [3]. When spread apart across a space, they are also available to dancers without restricting the size of the stage [4].

In dance, experiencing the physicality of movement in an entire body is important, and it is this element which has given the design of the Floors a new point of interest for the musical performer on them.

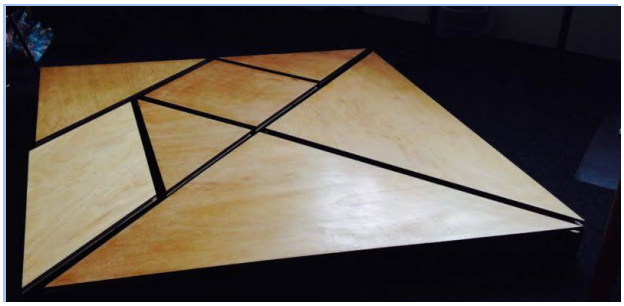

**Figure 1. Seven Floors laid out in a 2x2m square; the smallest floor is a 0.98 x 0.98x 1.4m triangle; the largest is a triangle of 1.4 x 1.4 x 1.98m length.**

The new Floors work as a MIDI controller by converting the control voltage signal into MIDI CC and MIDI pitch bend, interfacing with Max/MSP and Ableton Live. Most synthesiser controllers use many small sensors and control surfaces to allow for control of many parameters. By contrast, The Floors use few large interactive surfaces for fine control of many sonic parameters. On The Floors, data is not directly observed from the body, and the platforms do not require specific physical movements such as tapping or a particular gesture of a limb to be activated. Rather, they respond to changes in pressure, applied via body weight. The design and implementation in a DAW is combined with the development of a gestural vocabulary for performance on the new Floors. This vocabulary is used to increase the expressivity of performance, enabling the Floors to operate primarily as an expressive instrument, rather than a performance interface. The new instrument follows the original design principles: the sensors under the platforms send control voltages in response to movement using a load cell. Each of the Floors has one sensor underneath it.

Though usable individually, a single platform from the set does not constitute an instrument, since it does not allow for expressive performance and versatile control of sonic parameters. The performing musician needs to be able to change parameters of sound independently for the performance to be musically engaging for them, allowing enough expressivity to create musical change in fundamental elements of sound such as pulse, pitch, duration, and timbre. This means some of these parameters need to be mapped to separate Floors. Mapping gesture to sound in this instrument is a complex divergent mapping [5], a collection of simple 1-1 mappings that consider 'fundamental' elements of sound. This setup includes options of layered mapping enabled via a computer keyboard, facilitating the use of few sensors to achieve a large palette of sonic possibilities (see Figure 2).

**Figure 2. Floors and mouse/keyboard combination. Control voltages are sent from the Floors to a Teensy inside the controller box (middle), which sends MIDI CC and pitch bend to Max and Ableton. Layers of sound, channels, effects chains are mapped to MIDI CC, enabled via key mapping to keyboard on stand for performance. Mouse action mapped to additional overall volume control.**

Though 11 Floors exist, they are not all necessary for an instrumental approach to performing on them. The design and layout of the Floors in their current state, with keyboard mapping facilitating layers of complexity, means that the maximum number of floors that is required for its use as an instrument is the same as the maximum five points one can have access to at a time. This is due to the different ways pressure can be transferred from the body to the Floors, by spreading weight across the two feet, hands and bottom. These points (other than the knees, which are required for stability and movement in performance) offer spaces where the performer can shift their weight almost independently on each Floor. Performing on the instrument means changing the distribution of weight between platforms, and changing the number of contact points between the body and the instrument (from standing on one foot providing one contact point to kneeling providing four). Audiences can see this movement clearly and empathise with it. Much of the movements on the instrument are movements of the whole body, which many people share, more than the minute muscular movements a clarinet player would make for example, or the invisible air manipulation of horn players. Larger clear movement of the body in this instrument simultaneously suggests a sense of 'effort' and action from the body, which communicates an increased physicality to the action of making sound [6]. An example of this physicality is seen in Figure 3.

**Figure 3. Performer using four contact points, large movements of the body, and smaller gestures with each limb, simultaneously in performance.**

Where performance becomes complex is at the intersection of mappings, where smaller gestures, whilst the body is affecting five floors simultaneously, are used to control subtle sonic parameters.

The musician performing on the Floors has a task transparent to the audience: manipulating parameters of sound over a period of time, in a coherent and sonically-engaging manner. This task, shared broadly by any instrumental performance, is entirely visible to the audience in this form of practice. This visibility is a characteristic of both the Floors and the violone.

## 2.2 Violone and Electronics

The violone is the largest member of the viol family and is the precursor to the modern-day double bass. The instrument was not standardised in the Renaissance period so 'violone' can be the name of any instrument from a large bass viol type instrument to something more akin to a double bass. The author's instrument is closer to a bass viol, with 6 sheep gut strings tuned from bottom to top, D, G, C, E, A, D and moveable frets of the same material. The instrument is a contemporary version of an Ernst Busch instrument in Nürnberg from 1630, made by Melbourne Luthier, Ian Watchorn (see Figure 4).

**Figure 4. The author's violone, made by Melbourne based Luthier Ian Watchorn.**

The violone is an unwieldy instrument; it is large and bulky, the frets and gut strings are awkward to navigate and the bow technique is hard to master. The author's particular violone is played with a viol bow, made of horsehair and wood and held in a viol-bow 'underhand' style that requires the player to pull at the hair of the bow with their middle two fingers. Left hand technique on the violone requires the player to use the tips of their fingers and push the string down just before the fret, which, with such thick strings is not simple. Early bass specialist Peter McCarthy relayed a story about players of early bass instruments wearing leather gloves to hold down the strings; these were instruments with strings so thick and cumbersome they were not fit for bare human hands [McCarthy, personal communication]. Historically the violone was rarely performed solo, which makes it a somewhat overlooked instrument. However, it is a stunningly versatile and expressive instrument, with a distinctive tone.

Performing with the violone requires the whole body. The instrument is balanced near the player's hip, both the left and right hands keeping the instrument stable when played. The maximum stretch between the fingers is required to reach each fret in the lower registers of the instrument, with the author using double bass left hand technique and using the third and fourth fingers together on one fret. The distance between the first fret in the left hand and the bow placed on an adequate part of the string in the right hand is also the maximum length the arms can stretch. The instrument demands a kind of gymnastics of the player's body, stretched and twisted in an asymmetrical shape. Drawing sounds out of the instrument requires significant physical effort and can be fatiguing. This effort, stretching and twisting are characteristics it has in common with the Floors. Similarly, the small details afforded by the bow and fingerings link to the smaller gestures on the Floors, which coexist with the larger movements and shapes.

The author's current practice involves processing the violone with electronic augmentation; the instrument is fitted with a DPA microphone that is run through volume and reverb pedals, for nuanced control over volume and to provide a naturalistic reverberant sound for the instrument in different performance spaces. This signal goes into a mixer before it is sent back through the volume and reverb pedals. The violone is also fitted with a contact microphone that sits under one foot of the bridge. The contact microphone runs into an effects chain; reverb, distortion, octave pedal, a granular processing pedal and another volume pedal are used to switch back and forth between the more natural acoustic sound and the processed sound (see Figure 5). This electronic setup is often coupled with the collaging of the live processed violone and sliced up samples of the instrument, sometimes processed, further augmenting the instrument and its capabilities. These elements are also accompanied by field-recordings, samples of cymbals, drums and synthesisers [7].

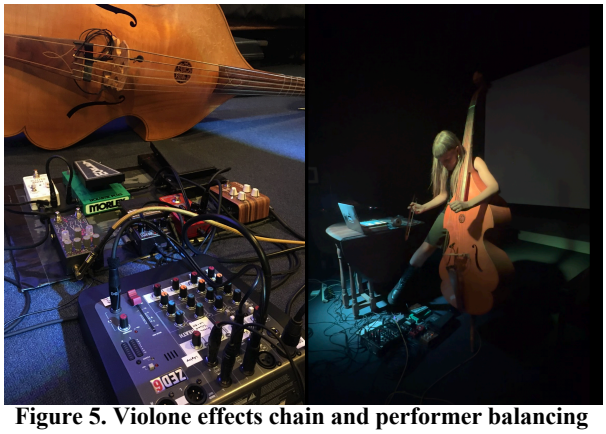

**Figure 5. Violone effects chain and performer balancing instrument on one leg while controlling effects.**

It would have been convenient to create this music on a laptop in live performance. However, the violone is the central point of the compositional approach. Interfacing with the violone and its characteristics in real-time is a core element of this embodied practice and key to its sonic outcomes. This has been tested in recent performances on a laptop, without the violone and effects chains. The result was a diminished and reductive version of the core of this instrumental practice. Not only is the instrument integral to the nature of the musical composition but it is also integral to the performance of the sonic work. Without it, the music loses its meaning, becoming decontextualized from the instrument itself and this embodied practice.

In the practice of both the violone and the Floors, the signal path could omit the large instrument itself. Yet a critical element of the embodied nature of performing, the instrumental facility of the player, and the unfolding of musical form, is lost if the large objects are removed from the process. This paper later examines how this physicality highlights the contribution large instruments offer as controllers for electronic music making.

## 2.3 Navigating a Complex Lineage in Design

Both of these large instruments have a playful relationship with the concept of lineage and design. They have been modified from their original designs, but both hold on to core defining features of the behaviour of the instruments. Decisions in directing the expansion of these practices in new ways is continually compared against the embodied feeling of working with the instruments and is assessed and adopted according to its relevance to this sense.

The lineage of the violone is visible in the design of the instrument. Upon viewing the violone, its presence as a large bass instrument is clear, even if the viewer may not know it is different to the double bass. The violone immediately signals to the viewer that it is a European musical string instrument. Yet it has characteristics different from the double bass. One may assume that the violone is similar enough to the double bass as to challenge why a violone required. Similarly, one might assume that the simple gestures on the Floors are accessible and



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are thus not cultivated techniques, and that since it operates as a MIDI controller, it is replaceable with any other interface.

DMIs are leaning towards smaller, more uniform models, with button grid controllers, gloves, rings, and handheld devices having a large presence in this sphere of practice. It seems that a gestural tradition is forming in electronic music, as it did with acoustical instruments. Yet this trend is dominated by the need for convenience rather than an object-person relationship between performer and instrument. Alongside the design of individual DMIs, standardised protocols such as MIDI and OSC have facilitated an expansion in connectivity and communication across instruments [8]. This standardising of protocol has also reinforced design of instruments and the ensuing music in relation to its architecture [9]; digital audio workstations, now almost ubiquitous and highly versatile, offer wide possibilities in the use of sound, but are complex to use when moving away from traditional musical structures [10]. The electronic nature of MIDI-based DMIs means that no particular physical design is strictly 'required' and any MIDI controller can in theory replace another. This facet creates an additional sense of 'indifference' to the physicality of the instrument, its design and care. When MIDI controllers are small, cheap and replaceable, there is an implied design view that if the controller stops working, another can be bought. Much of these controllers have been designed for gestures congruent with the design of MIDI architecture in the form of many buttons and sliders which enable triggering and shifting of values, left static at the new value until the slider or knob is moved.

Being pressure-sensitive, each of the Floors calibrate to send a low MIDI CC value (~10) when they are initially plugged in; the performer changes this value by their movement on a Floor. When the performer moves off the particular Floor, the sensor bounces back to its starting MIDI CC value. This behaviour and mapping is uncommon to controllers and would not suit the common use of DMIs. It is a technical choice rooted in a conceptual principle, informing a musical outcome. This principle is that the moment of interaction is required to continue to generate the sonic outcome. It is considered a core element of performing with the Floors and thus shapes the musical considerations of the instrument. This bounce-back design makes performing on the Floors more analogous to the feeling of performing on acoustic instruments. On an acoustic instrument one cannot place force on a string or surface, remove the effort by stopping the action but continue to create the same sound. Though the specifics of the connection between action (force) and sound are different across acoustic instrument types, the general principle is present in all of them. The specifics of the action-sound relationship give each acoustic instrument its unique voice, which is a difficult task in the performance of electronic music with controllers. The design principles of the Floors allow for a unique performance voice with the instrument, despite the fact that it has a wider timbral range and no acoustical action-sound constraints.

The appropriation of the violone as a controller for electronic music poses issues relating to the instrument's lineage. The violone is used both acoustically and as a signal for electronic manipulation, which highlights its idiosyncrasies and instabilities (such as the tuning of the gut strings). This recontextualisation of the lineage exists for the Floors too; the platforms make no sound on their own unlike the violone, and are difficult to control multiple sonic parameters with due to their size, making them unlikely candidates as an electronic music controller. Both practitioners in this paper are playing with an obscure tradition which could have been set aside for the sake of contemporary equivalents, yet they do not make that choice, preferring to create a contemporary practice informed by looking back. Both require specific technique, hidden behind the surface connections between the instrument and the outside world.

# 3. EMBODIED PRACTICE

## 3.1 Communicating Effort

These large instruments allow the communication of the physicality of effort in performance. This sense emerges in two ways on the Floors: through the body's navigation of different points of connection to the instrument (changing position and spreading across the instrument), and the physical effort of changing parameters simultaneously. The mapping of the parameters on the Floors means that individual elements can be controlled with each limb. When the author is performing and changing multiple parameters simultaneously, she needs to physically push down some of the Floors whilst her weight is on another. This sense of effort is directly and immediately visible to the audience (see Figure 3). Watching the performer navigate their body in dialogue with their musical impulse showcases the limitation of the body in performance. This is also achieved in the violone, especially in the interaction between body, instrument, electronics, and preparation objects [11]. In essence, the body navigation dialogue that these practices show is a magnification of all performance and body gestures, including the inner workings of performance with smaller instruments. Yet, these practices explicate this sense more clearly [12]. The full engagement of the body in performance communicates the motor functions of performing, leading the audience to speculate anew about the sound making process. Through the embodied sense of effort that these large instruments impart, they provide an avenue to connect to musical performance beyond idiomatic familiarity with the style of music itself.

This observation of physicality in both instruments, (see Figures 3 and 5), suggests that the sense of effort imparted to the audience is not achieved by the sound and timbre alone but rather by the relationship between instrument and player; both the violone and the Floors trigger and affect electronically produced sound and thus act as controllers. Yet their engaging element is equally present in performance using high sounds. To play higher registers on the violone, reaching towards the bridge, the player needs to hold the body of the instrument more closely, in a contorted shape, which reinforces the sense of physical exertion through extended shapes of a stretched body. This sense imparted with the violone is different from performance of similar pitches on a violin or a smaller instrument. Similarly on the Floors, playing soft, bell-like sounds, whilst the audience watches a physically demanding posture of a contorted body, imbibes the listening experience with an additional charge; these sounds are often associated with gentle movement and ease. In both of these cases, these high sounds are heard differently on such large instruments and the performer engages with their physicality in a new way [6][7]. Both of these practices, whilst subverting this sonic relationship between register and effort, impart a similar sense of effort in the performance using high sounds.

## 3.2 Physicality of Performance and Composition

The whole body is involved in creating and performing work with these instruments as a result of their size and design. This relationship between the body and the instrument dictates the working process, musical form, and the feeling of performance with the instrument.

To build complexity in a musical work on the Floors, each sound element's parameters, mapped to the set of five Floors, needs to be practised individually. As the layers of a work build up, controlling one element of an active sound will affect that of another mapped parameter, since they are all mapped to the same set of five sensors; thus only a small subset of possible gestures become available that can facilitate appropriate simultaneous changes to multiple parameters of sound. The relationship between mapping, movement and form becomes specific and in-built. The form of the work emerges as a navigation of movement across the instrument. The physical points of

the body connect and move and affect the sound; the audience then becomes more engaged with the musical process of enacting out the form and for the performer, this means a physical navigation of space and the body [6].

The physical demands of these instruments thus affect the compositional process and the resulting works made with them. In developing a piece on the Floors, the sonic possibilities of affecting any sound are explored through a rigorous process of practising movement and controlling the mapped parameters. It is through finding if gestures and postures on the body are available to sustain a particular sound that the possibilities within the mapping of sensor data are explored. Therefore, this practice considers action and sound first, and musical form as emergent from action. This model of using an electronic controller is an instrumentalist form of performing, cultivating technical and gestural virtuosity and versatility. This new instrumentalism breaks away from the dominant design of electronic music, which often considers form first and gesture as a sonification of the form.

The violone is a physically demanding instrument and requires the whole body of the performer to be involved in drawing sound from the instrument. As an acoustic instrument, every sound made on the violone needs to be created and sustained in that moment. The instrument also has to be supported when performing, so once one starts playing, the instrument cannot be put down without destroying the continuity of the performance; the performer is tied to the instrument throughout the performance. One of the author's interests is to augment the natural sound of the instrument through electronics and audio montage; to use the instrument as a starting point and extend its sound world through this processing. When the whole body is required by an instrument, live performance needs systems for the electronic elements to be performed. Given that it is difficult to put the instrument down during performance, the electronic elements have to be triggered with the feet, requiring the performer to stand on one leg, which is further physically demanding (see Figure 5). The pedal processing therefore becomes an extension of the violone and has its own boundaries. Though cumbersome and somewhat inconvenient, these elements again make for an idiosyncratic sonic expression, reiterating the case for artists and designers to embrace larger DMIs.

# 4. INSTRUMENTS IN THE WORLD

## 4.1 Living with the Instruments

To break through the barrier of an interface as an instrument, beyond the required mapping, sound design and engineering choices, there needs to be instrumental facility. It requires the development of a gestural vocabulary, with which the movement is used to control sound. Developing this language requires a daily commitment, over a long period of time, where all of the body is involved in relation to the instrument. This active choosing of the instrument creates a level of intimacy with it, which even without haptic feedback, connects the act of playing individual sounds to the intention of the performer. This intimacy is present between all musical instruments and their performers, including other bespoke new electronic and digital instruments that have a performance practice around them [13].

From an artist's perspective, years of playing a human-sized instrument results in that instrument being interwoven into one's cognition. The instrument not only affects the way the musician conceptualises musical expression, it also physically changes the musician's body. A long-standing relationship with an instrument, particularly that of large instruments, means the performer is shaped by that instrument both mentally and physically, while the instrument is moulded by the performer, becoming worn and reshaped from its use. The relationship is an intricately intimate connection between human and object that produces a unique way of music making. This relationship is difficult to cultivate with commercially produced DMIs that are designed for universal use and are easily replaceable and often require upgrading as technology is developed. The intimacy that develops between a musician and a one of a kind instrument means the instrument becomes irreplaceable, forming a precariously sustainable practice. The instrument becomes something that needs maintenance and repair, never replacing or 'upgrading'. The violone is on the extreme end of this replaceability continuum. It is near impossible to travel anywhere and hire a violone; if there were one available, chances are (as these instruments were not standardised) it would be vastly different from the performer's own instrument. The instrument's size is a significant factor in this scenario; as an obscure Renaissance instrument that is very large, few exist and even fewer are being produced. Due to its cumbersome nature, both in terms of size and playability, it is not a very popular instrument. Therefore, the specific relationship developed between the musician and their particular violone makes for a one of a kind sonic expression, producing music unlike any other. The creation of these large and unique instruments, acoustic and electronic, contributes to rare forms of music making.

The intimate performance using the entire body, on an object uniquely used for one purpose, has a specific sense of connection between body and sound that is cultivated, wholly embodied and translated to the audience. This choice is human-centered, reiterating through the developmental practice, stage presence, and sound-making process alike; the human body and its making of sound is the focus of these instruments [14].

## 4.2 Resistance to Uniformity

Both of these instruments are made and maintained for years, where technical design choices inform a conceptual resistance to uniformity. These instruments are inconveniently large and non-standard. They both stand against the obsolescence of materials but are endangered by external factors such as the development of commercial electronics or manufacturing and supply chains of rare materials (with the Floors, software updates can endanger the future of the instrument and access to gut strings is essential for the violone to remain operational). In both practices, the resistance to the standard form of the instrument is ever-present. In refining, developing new sections, solving technical problems, and continuing the practice of expressivity on these instruments, the case against a utilitarian approach to art-making is made. These two practices enshrine the instruments as art objects that are worthy of attention through the commitment to their development.

# 5. CONCLUSION

The Floors and the violone both operate as controllers and instruments. The Floors are structurally a MIDI controller, and the specificities of interaction with them turns them into an instrument. The violone is an instrument used in tandem as a controller for shaping electronic sounds. In both instruments, the method of control and the material controlled coalesce to create the outcomes outlined in this paper. These instruments resist the convenient, logical draw of stable and predictable interfacing, yet they are preserved as a life-long instrument worthy of development and growth, making the case for a deeper human presence in the performance of art music. It is a perverse pursuit of embodied sound-making, especially as both of these instruments can theoretically be replaced by a commercial controller. This paper has shown that something invaluable is gained from this contrary exercise; the particular gestural vocabulary for the player and the intrigue and connection for the audience. These instruments demonstrate that a different sonic aesthetic is obtained from committing to large instruments; one a highly resonant and expressive string instrument, the other a wooden electronic controller. These large interfaces, acoustic and electronic in nature, bring about a significant and unique contribution to contemporary musical practice. Rather than being a perfect interface, these instruments are objects we

navigate in order to discover new and unusual musical languages.

## 6. ACKNOWLEDGMENTS

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## 7. ETHICAL STANDARDS

This paper's materials exclusively use the personal performance practice of the authors with their instruments and others are not involved in the research. The Terpsichora floors have been built and maintained with financial assistance from the University of Adelaide, ArtsSA, and Monash University. The violone used in this study was built with financial support from the Ian Potter Cultural Trust. This paper's focus is on an individual instrument and its sustained relationship with the artist user and does not include in its scope room to examine the broader use of one instrument by many people. It considers a primary motivation around building a sustained relationship with one instrument as an act of preservation, and reducing the environmental impact of short-lived instruments. More broadly, this paper adheres to the NIME Principles & Codes of Practice on Ethical research [15].

## 8. REFERENCES

[1] L. Mice and A. McPherson. Embodied Cognition in Performers of Large Acoustic Instruments as a Method of Designing New Large Digital Musical Instruments. In Proceedings of the 14th International Symposium, CMMR, October 14-18, 2019, vol 12631. Springer, Cham, 577-590. https://doi: 10.1007/978-3-030-70210-6_37

[2] S. Jones. Philippa Cullen: Dancing the Music. Leonardo Music Journal, 2004, 14, 65–73. https://doi.org/10.1162/0961121043067307

[3] I. Sanadzadeh. The Terpsichora Pressure-Sensitive Floors. YouTube, September 29, 2022. [Video file]. https://www.youtube.com/watch?v=EbN7H2tqE6k

[4] I. Sanadzadeh. Utter: Stories Teaser 1. YouTube, July 20, 2021. [Video file]. Available: https://www.youtube.com/watch?v=TlMW5O-4fyw&t=1s

[5] A. Hunt and M.Wanderley. Mapping performer parameters to synthesis engines. Organised Sound, Cambridge University Press, 7:2, 97–108, doi: 10.1017/S1355771802002030

[6] I. Sanadzadeh. Axes. YouTube, Feb 21, 2022. [Video file]. Available: https://www.youtube.com/watch?v=nX4xboeNVKo

[7] C. Sobek. Excerpt 2 from concert at Monash University Sir Zelman Cowen School of Music and Performance. YouTube, Oct 5th, 2022. [Video file]. Available: https://www.youtube.com/watch?v=6HNwMleUXio&t=26s

[8] P. Manning. MIDI, In Electronic and Computer Music, Oxford University Press, Incorporated, New York. 2013, pp. 261-344

[9] P. Manning. The Expanding Perspective, In Electronic and Computer Music, Oxford University Press, Incorporated, New York. 2013, pp. 375-408

[10] M. Terren. Siliceous: Speculative Mimesis and the Grain of the Digital Audio Workstation, In Proceedings of the Australasian Computer Music Conference (Perth, Australia, 6-9 December, 2018). The Australasian Computer Music Association, Perth, WA, 2018, 101-105.

[11] C. Sobek. Excerpt from concert at Monash University Sir Zelman Cowen School of Music and Performance. YouTube, Oct 5th, 2022. [Video file]. Available: https://www.youtube.com/watch?v=u6KhljM1IEc

[12] S.M.A. Bin, N. Bryan-Kinns and A.P McPherson. Hands where we can see them! investigating the impact of gesture size on audience perception. In Proceedings of International Computer Music Conference, ICMC, Shanghai, 2017.

[13] U. Hansson. Úlfur Hansson: Segulharpa (Electromagnetic Harp). YouTube, Oct 9th, 2020. [Video file]. Available: https://www.youtube.com/watch?v=rXlZRGOuxvg

[14] V. Iyer. Improvisation, Action Understanding, and Music Cognition with and without Bodies. In George E. Lewis, and Benjamin Piekut (eds), The Oxford Handbook of Critical Improvisation Studies, Volume 1, Oxford Handbooks, 2016. https://doi.org/10.1093/oxfordhb/9780195370935.013.014.

[15] Morreale, Fabio, Gold, Nicolas, Chevalier, Cécile, & Masu, Raul. (2023). NIME Principles & Code of Practice on Ethical Research (1.1). Zenodo. https://doi.org/10.5281/zenodo.7545682