

NIME Identity from the Performer’s Perspective

Fabio Morreale
Centre for Digital Music
Queen Mary University of
London, UK
f.morreale@qmul.ac.uk

Andrew P. McPherson
Centre for Digital Music
Queen Mary University of
London, UK
a.mcpherson@qmul.ac.uk

Marcelo M. Wanderley
Schulich School of Music
McGill University
Montreal, Canada
marcelo.wanderley@mcgill.ca

ABSTRACT

The term ‘NIME’ - New Interfaces for Musical Expression - has come to signify both technical and cultural characteristics. Not all new musical instruments are NIMEs, and not all NIMEs are defined as such for the sole ephemeral condition of being new. So, what are the typical characteristics of NIMEs and what are their roles in performers’ practice? Is there a typical NIME repertoire? This paper aims to address these questions with a bottom up approach. We reflect on the answers of 78 NIME performers to an online questionnaire discussing their performance experience with NIMEs. The results of our investigation explore the role of NIMEs in the performers’ practice and identify the values that are common among performers. We find that most NIMEs are viewed as exploratory tools created by and for performers, and that they are constantly in development and almost in no occasions in a finite state. The findings of our survey also reflect upon virtuosity with NIMEs, whose peculiar performance practice results in learning trajectories that often do not lead to the development of virtuosity as it is commonly understood in traditional performance.

Author Keywords

Artistic practice, virtuosity, DMI performance

CCS Concepts

•Applied computing → Sound and music computing;
Performing arts;

1. INTRODUCTION

The NIME community describes itself as a hub that allows “researchers and musicians from all over the world to share their knowledge and late-breaking work on new musical interface design”¹. This description identifies an academic and an artistic side, which have always been in balance throughout the various editions of NIME, the artistic productions being as prolific as the academic discussion. However, it seems that the *identities* of the two sides might not have grown at the same rate.

On the academic side, a large number of self-reflective papers contributed to the maturity of NIME as a research

¹<http://www.nime.org>

community [4, 5, 9, 10, 23, 30, 33]. One can arguably be able to identify a *NIME paper* as such. On the artistic side, however, identifying the characteristics of *NIME practice* seems more challenging. Fundamental questions related to the very nature of NIME practice are still unanswered. How are performers’ artistic practices supported by the NIMEs they play? What are the common elements among NIMEs?

Such discussions have been a major theme almost since the beginning of the conference. The call for papers of NIME 2003 invited authors to submit a category of papers (“usability reports”) discussing pros and cons of performing with a certain interface as compared to existing options. However, this category of papers was dropped from successive editions of the conference and such discussions have only continued as conversations among members, at Steering Committee meetings, and at annual *town hall* meetings that conclude the conference [22].

The objective of this paper is to open a window into the practices and values of NIME performers, doing so in the most inclusive way possible with the constraints of authored paper format. Answering Jensenius’s call for action to survey members of our community about their sense of NIME [22], we collected comments about their experience with NIME performance practice directly from 78 musicians with an online survey. The answers were analysed with a thematic analysis to determine how the technical tool suits the artistic aims of the performer. We propose and discuss possible commonalities and differences in NIME practice.

2. RELATED WORK

NIME researchers have been producing a large amount of self-reflective work discussing the characteristics of the community [30], its critical areas of interest [9], its common research approaches [10], and the evaluation strategies used (or not used) [4]. Several papers have focused on the NIMEs themselves, often with a focus on technical aspects such as mapping strategies [20], performance gestures [21], interaction modalities [20], player-instrument relationships [24] and design subtleties [2]. Notably, discussions about the characteristics of new digital musical instruments pre-date the first NIME conference/workshop [43].

If technical aspects of NIMEs have been relatively well defined, the same does not hold true for the artistic side, whose study has received a less systematic approach. A handful of studies have identified characteristics that are typical in DMI practice. Magnusson and Hurtado suggested that DMIs are usually created for specific needs, as opposed to traditional instruments that require players to “mould” oneself to it [28]. Investigating technical issues is the peculiarity that Torre and Andersen attributed to NIMEs [39]. Many NIMEs never quit an initial exploratory phase, which would traditionally be followed by a second phase in which the designer settles on a specific solution and by a third



Licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0). Copyright remains with the author(s).

NIME’18, June 3-6, 2018, Blacksburg, Virginia, USA.

phase that allows for customisation. Ending at the experimental phase is the main reason that the authors attribute to the short lifecycle of NIMEs, an aspect that has been previously recognised [24] and documented [33].

The limited lifecycle of the instrument has an influence on the performance practice, in particular for its learnability and potential for virtuosity. Learning to play a DMI significantly differs from that known from traditional instruments due to the non-standardisation of learning procedures and the common lack of visual or haptic feedback [18]. Also, DMIs do not always have straightforward, predictable responses, which necessitates a different type of engagement. Virtuosity in music performance, it has been argued, comes from the Romantic-era ideals of music performance and might not apply to more recent musical activities like sequencers, live-coding, and algorithmic music [29]. Also, the artistic aims of DMIs performers sometimes differ from those of classical performers: they can be achieved with a wide range of processes that often involve integrating physical objects, electronic circuits and computers [27].

A repository of values of NIME performers can be found in interviews and personal writings by individual well-known artists, a number of which were included in two recent anthologies [6, 23] and include retrospective comments about experiences with instrument design and performance. For instance, Marije Baalman elaborated upon her experience as DMI artist and designer. She commented that her experience with the design and performance of *Gewording* blurred the boundaries between composition, design, and performance. The double role of designer-performer had implications on her artistic practice, in that the instrument evolved and changed for a long time before settling in. A similar comment was offered by Michel Waisvisz. He had to spend a considerable amount of time to make *The Hands* playable. Eventually, he stopped the building and development process and learn to play the instrument as it was [39, 41]. A similar story was narrated by Jeff Snyder about the evolution of *the Birl*, which had undergone several drastic design changes to the extent that the latest versions are completely unrelated to the original design [34].

This brief review reaffirms that the NIME community has been interested in exploring its own individuality since its formation. However, NIME artistic practice has not been systematically analysed outside of the writings of a few influential individuals. The next section presents our contribution towards offering a clearer sense of whether these views are broadly held. Believing that a conversation about NIME *identity* - intended as the set of commonalities among NIME instruments and NIME practice - should be initiated in an inclusive way, we report and compare reflections from NIME performers about their own experiences.

3. METHODOLOGY

We conducted an online survey to offer a comprehensive view that takes into account as many recent NIME performers as possible. This research method has been previously adopted by NIME researchers [28, 33, 37] as a way to directly collect insights from members of the community.

3.1 Performer selection

To be as methodical as possible in the selection process, we started off identifying the musicians that played at the NIME conference. We limited the selection to those that performed at the last five editions of the conference, from 2013 to 2017. We avoided digging further into the past as people’s recollections about specific performances practices may start to become unreliable. In order to identify the individuals that performed at NIME we consulted the concert

programmes that are available online. We aimed to contact only those whose role in the concert was NIME player (as opposed to, for instance, visual artists and composers that were not also performers). However, in most cases, the programmes do not specify the performers’ role in the concert. Thus, we contacted all performers and we dedicated the first question of the survey to filter the respondents (see Section 3.2). The questionnaire was sent to 171 performers (40F); 102 answered (24F, 59.6% response rate).

We also prepared a second questionnaire to be sent to well-known performers of NIMEs that, for a host of reasons, did not play at the editions of the conference under scrutiny but whose opinion take on the topic would be valuable. An initial list of performers was prepared by the authors of this paper, who can count on a solid network of connections among NIME (and pre-NIME) performers. We limited the potential biases derived by the boundaries of our own network by allowing each respondent to nominate other NIME performers they knew. After the pertinence of the suggestions was checked, we sent the survey to the nominees (all 19 nominees, 4F, were accepted). This second questionnaire reached 45 performers (6F); 26 answered (3F, 57.7% response rate). To disambiguate between the two groups of respondents we next refer to those that performed at the NIME conference as *Group A*, the invited and nominated performers as *Group B*.

3.2 Questionnaire

Both questionnaires included the same 24 open and closed questions querying different aspects of practices with the instrument they performed at the conference (Group A), or with a NIME instrument of their choice (Group B). The questionnaire for Group A started with a question about their role in the performance. Following the objectives of this survey, only those who described their role as *NIME player* or *software instrument player* were routed to the successive 24 questions. From this survey we collected 52 complete responses (the remaining 50 respondents had a different role; Table 1). From the invited performers we collected 26 responses, for a total of 78 responses².

Table 1: Role in NIME performances with number of responses and relative percentage (Group A).

NIME player	46	45%
Composer	24	23.5%
Live coder / live sound processor	10	10.2%
Traditional musical instrument player	9	8.8%
Software instrument player	6	5.8%
Visual artist	5	4.9%
Dancer	2	1.9%
Total	102	

3.3 Data analysis

The data discussed in the next section integrates the analysis of the answers to the open questions about respondents’ performance practice with quantitative answers to some survey questions. A thematic analysis was performed on this data using a deductive approach. The most interesting comments related to our research aims were identified and associated with a code. Codes were iteratively analysed and clustered into themes considering findings and discussions from related work. Each theme, which are discussed in the next section, takes into account one possible commonality of artistic practice among NIME performers.

²The questionnaires and the results are available at <http://instrumentslab.org/data/NIME18Survey.xlsx>

4. COMMONALITIES IN NIME PRACTICE

By definition, the *newness* of the instrument should be the most obvious unifying element among NIME performances. Our analysis only partially supported this view. One survey question asked performers to indicate how long they have been playing the instrument under discussion. A total of 28 performers from Group A (37%) reported that they have been playing the instrument for more than 5 years, 13 of which indicated that have played it for more than 10 years. This result suggests that performances at the NIME conference often involve instruments that are not so new, at least by technological standards of the word. Similar results were collected from Group B: 20% of the performers have been playing the instrument for more than 5 years. NIMEs seem to continue to serve performer's artistic practices even when the instrument is no longer new. This result calls for reflecting on how the community defines "new".

4.1 Functions and reasons for existence

Related studies suggest that DMIs are usually created to satisfy specific needs [28]; answers to our survey suggested that some of these *needs* are common among NIME musicians, whereas others are unique.

4.1.1 An exploratory instrument

One question of the survey asked performers their motivations to play that specific instrument. The answers of 9 performers similarly discussed that their NIME is an exploratory tool to extend their performance practice. For example, Paul Stapleton reported that his *Ambiguous Devices*, which was created and performed in collaboration with Tom Davis, allowed him to explore timbral material and different forms of collaborative improvisation. Another example is Luca Turchet, whose urge to design the *Smart Mandolin* [40] was motivated by his artistic needs to explore novel pathways for composition.

Rather than expanding one's own artistic practice, the answers of 10 performers to the same question suggested that their instruments are designed to connect their practice to other practices. Rikard Lindell's *Critical Digitalism* [26] suits his artistic aims as it allows him to "explore the connection between the acoustic, analogy and digital reflection". Similarly, when elaborating on his motivations to play the *Feedback Cello* [16], Chris Kiefer reported that "it is a mix of acoustic, electric and digital: it's fascinating and engaging to explore a mixture of these worlds". Four other instruments were intended to connect *music* with other areas that are not strictly musical, i.e. *theatre* (Marjie Baalman and Dianne Verdonk), *dance* (Alex Nowitz), and *gaming* (Spencer Salazar).

4.1.2 Extending control, augmenting expression

Eleven performers attributed the role of their NIME to augmenting the expressive potential of existing instruments. This is the case, for instance, of Bernt Isak Wærstad, whose *COSMO Collective*'s goal is to "extend the possibilities of the electric guitar, while maintaining the level of musical expression", and of Ian Hattwick's and colleagues' *Unsound Objects* [19], which was created to "use my current percussion practice of extended techniques" (Zachary Hale). Similarly, the *Living Strings* [13] is used in Palle Dahlstedt's practice to "take advantage of piano playing technique, while offering enhanced timbral qualities and control. As such it is very rewarding for a pianist to play". A similar example with a NIME that is no longer quite new, is proposed by Mark Goldstein, who chose to play Don Buchla's *Marimba Lumina* because it enables extended gestural control based upon standard mallet technique.

The comments of 8 respondents resonated with Alperston's take on new musical instruments as tools to blur the boundaries between the body and the instrument [1]. When talking about the aim of his *Strophonion* in his practice, Nowitz explained: "It is a gesture-controlled live electronic instrument that allows me, without any constraints to the body movements, to extend my vocal performance". A similar comment is offered by Myriam Bleau, who considers the *Soft Revolvers* a tool that enables physicality in electronic music performance, and by Atau Tanaka who described *BioMuse* [36] as an instrument that offers an intimate level of corporeal interaction that "helps to create in the performer a unique awareness of his own body".

4.1.3 Redistribution of agencies

Musical agencies are defined as "the capacities of human beings or technologies to generate music" [8]. Recent theories [7, 8] proposed considering musical creativity as a distributed network of musical agencies. This concept was originally proposed in the context of algorithmic music: distributing agencies to non-human performers can spark new forms of creativity [8, 32]. Comments from our survey suggest that the artistic practice of 7 performers can be analysed under the lens of musical agencies redistribution.

Stapleton built *Ambiguous Devices* to research distributed agency in improvisation ecosystems. Sharing control with the instrument was also mentioned by Kiefer ("I am interested in exploring shared control with the instrument - the player is a shaper of continuous loop rather than directly controlling the instrument") and Dahlstedt ("Due to its unpredictability, the system works almost as a co-musician, triggering unique interaction patterns").

The augmented version of an instrument can modify the musical agencies of the performers and, as a consequence, the roles in an ensemble of the non-augmented counterpart. This idea is explained by Hans Leeuw when describing his experience with the *Electrumpet* [25]: "its best aspect is to have the trumpet to have different role in music than purely being the melodic player; now I can more easily take on roles that are typical of other instruments like piano, bass or drums".

Musical agencies can also be distributed to the audience (see [38] for an overview). In our survey we collected one comment discussing this point: "Notesaaz shares a part of the musician's thought process with the audience. As a musician it may put me in a somewhat vulnerable position, but can as well engage the audience in an active perception" (Erfan Abdi Dezfouli discussing his *Notesaaz* [15]).

4.1.4 "Uncommon" reasons for existence

Several performers identified *reasons for existence* of their instrument that were not shared with anyone else's. This result is particularly important for our investigation: NIME also includes diverse performance practices that do not share much with other NIME performers. For instance, Stephan Moore and Scott Smallwood designed *Losperus* to reflect on their fascinations with Marcel Duchamp's ready mades and the sonic potentials of everyday objects. Other unique functions of NIMEs are that of Ryan Jordan, whose *Possession Trance* is an "attempt to create an altered state of consciousness - to create multi-sensory hallucinations" and Tijs Ham's *States*, which "investigates balance and tipping points in chaotic systems".

4.2 Designer = composer = performer

A total of 78% (N=61) of the performers designed the NIME that they play. The percentage of performers that answered that they have been involved in the process of instrument

making is even more striking: 97% answered that they have been; only 2 performers (out of 78) have not. On a related note, the answers of 8 performers to open questions of the survey indicated that composition can also be strictly connected to performing and designing an instrument.

The analysis of the survey distinguished between two different ways to consider the equivalence *designer* = *performer* = *composer*.

In one case, performers/composers had to develop their own instrument because no existing instruments met the needs of their artistic practice. This is the case of Mercedes Blasco, who designed her instruments following a “frustration derived from commercially available hardware” and Nicole Carroll, whose instrument “addresses a need that no other mass-produced instrument/controller does”. Similarly, Jordan Rudess co-designed *GeoShred* because he needed “to seamlessly shift in and out of fretless or chromatic play”.

In the other case, the roles are inherently fused together such that it wouldn’t be possible for them to be separated. Bleau’s *Soft Revolvers*, for instance, is “conceptually linked to the whole performance and the music that is played, the instrument is part of the work of art”. When describing his *Auditorium*, Rui Penha said: “It was an instrument / composition. I will not use it for any other composition nor could I do the composition with a different instrument”. Similarly, Miguel Ortiz explained that his instrument was designed specifically for the piece *I’ll Be On The Water*.

These comments reflect the ongoing debate within the NIME community of whether the instrument follows the artistic goals, or vice versa. In 2001 Cook suggested designing musical pieces and then considering the controller that might make them possible [12]. A counterargument was offered by Wanderley in his expert commentary on Cook’s updated paper on the NIME Reader [42]: there exist instruments like the T-Stick and Gyrotyre that were produced without a musical piece in mind but subsequently were extensively used musically [17].

The answers to our survey suggest that the overlap between the roles results in a tension, expressed by Abdi Dezfouli as an unceasing “dilemma between changing the design of the instrument or learning its current features”. In Leeuw’s words, bringing balance in practising and designing is the most challenging aspect of learning to play his *Electrumpet*. Blasco further reflected on this topic, stating: “I could keep on working with it forever, since I am also the designer so it is a constant process of re-tweaking and advancing”. Covering the two roles is the most challenging aspect: “It is hard to *just* be the performer”.

4.3 Background and repertoire

It is not uncommon for performers of traditional musical instruments to play a variety of instruments that are *organologically similar*. For instance, violin players can often play violas, and vice-versa. We searched for the existence of common trajectories in the background and musical expertise of NIME performers.

One question asked whether performers play or have played more than one NIME; 63% (N=49) have. We then asked about their background with traditional musical instruments. The great majority (91%, N=71) do play traditional instruments, with guitar (45%, N=35) and piano (42%, N=33) being the most popular; one out of four players play typical orchestral instruments (24%, N=19). Seven respondents mentioned instruments that can arguably be considered NIMEs (e.g. laptop, synthesizer, electronics, *Continuum*) as traditional instruments that they play. The *Roli Seaboard* was mentioned by 3 performers when asked to list the NIMEs they play but it also appeared in the list of the

traditional instruments that one respondent plays, indicating lack of agreement among performers when labelling a musical instrument as a ‘NIME’.

The repertoire played with the instruments provides another indicator of practices that are common among NIME performers. Performers were asked to indicate the genres they typically perform with their NIME (multiple choices available). The answers to this question are shown in Figure 1. *Experimental* pieces were selected by 4 out of 5 performers and *electronic* and *noise* were also selected by a large number of respondents. Notably, 8 performers (10%) answered *other*, specifying genres that are not typically associated with NIME like *hip-hop*, and *Indian music*.

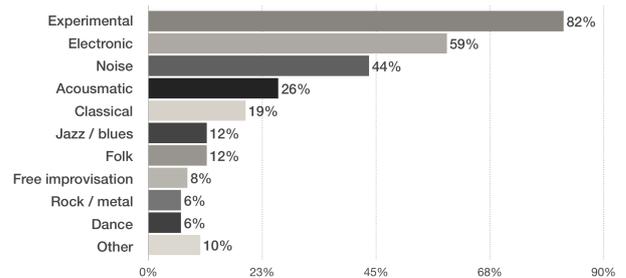


Figure 1: Distribution of the genres played with NIMEs (multiple answers allowed).

4.4 Learnability and virtuosity

A section of the questionnaire enquired about the development of virtuosity with NIMEs. We asked to indicate on a 5-point likert scale their level of virtuosity with their instrument. The result, shown in Figure 2, indicates that most performers are confident considering themselves virtuosos with the instrument. Surprisingly, 22 performers (28%) self-reported their level of virtuosity with an instrument that play or have played in public as 3 or 4 (1: *virtuoso*; 5: *beginner*). Answers to another question partially contradict this result: when asked to indicate the number of musicians that can be considered virtuoso with the instrument, 76% (N=60) answered that no virtuosos exist (so far).



Figure 2: Answers to the question: *How would you consider your level of proficiency with the instrument?* 1: Virtuoso - 5: Beginner

4.4.1 Virtuosity is not always an aim

One question asked whether respondents considered it possible to develop virtuosity with the instrument, and, if so, how long it might take. Most of the performers that answered this question believed it is possible, taking from a few months to a few years. By contrast, 8 performers believed that virtuosity does not apply to their practice: “It is not clear to me what virtuosity would look like with this instrument” (Tom Mudd). Four respondents simply do not value the development of virtuoso performance in their practice: “It is not the goal of practice with this instrument. To think about virtuosity would be to miss the point of what the instrument has to offer” (Moore).

For other performers the longevity of their instrument is purposely limited and tied to certain musical styles, thus limiting the possibility to develop virtuosity, which can arise only from extensive training: “That particular instrument was designed specifically for the piece performed. It does not have much space to develop a virtuoso performance practice. The software can be changed to provide a larger performance palette using the same physical interface, but I would consider it a different instrument.” (Ortiz).

As opposed to traditional musical instruments, which have often been subject to centuries-long process of redesign and refinement, the infancy of NIMEs results in a limited possibility to develop virtuosity. This is the case of Mark Ijzerman, who believes that it is probably not possible to develop virtuosity with his *Augcordion*, which was “a technical prototype mainly meant to see what certain sensors could do. As such, it was not developed thoroughly and the controls and sensors are too weird to be able to develop virtuosity”.

The tension in the combined performer-designer role has implications for NIME virtuosity. When the performer is also the designer, virtuosity is not only a matter of extended practice but also of instrument redesign: “I am busy with developing advanced performance practice” (Leeuw).

4.4.2 Unpredictability

In traditional music performance, a necessary condition for being a virtuoso is the capability to have predictable control over the instrument. A virtuoso can quickly recall internalised mechanisms acquired through extensive training that allows her to anticipate the actions and detect errors before the sensorial feedback arrives [44]. A predictable response from the instrument does not seem to be a condition that NIME musicians necessarily look for in their practice. *Unpredictabilities* are sometimes purposely programmed in NIMEs because they keep the instrument interesting [11] and help improvisations, which “tend to become predictable if nothing surprising happened” [35].

Thirteen respondents of our survey supported this view: “One can develop advanced performance skills with the instrument, but not in the virtuoso sense of highly specified and predictable control” (Stapleton). Alberto De Campo explained that the impossibility to precisely predict the behaviour of his *Trio Brachiale* is necessary in his artistic practice: “I enjoy being surprised by the difference between my imagined expectation and what really happens”.

Exploiting unpredictability for creative inspiration is not limited to NIME. Jonathan de Souza [14, p. 88] describes how jazz guitarist Kurt Rosenwinkel retunes his guitars in unfamiliar patterns, a practice he describes as “voluntary self-sabotage”.

4.4.3 Unique learning trajectories

The peculiar overlapping roles of a NIME performer impacts the learning experience, as discussed by 6 performers. Donna Hewitt expressed her scepticism for developing proficiency with her *Doppelganger*: “it is possible to become proficient, but the performance and composition are entwined”. Other performers have similar opinions: “the performance requires some skill but is more dependent on appropriate composition and sound design” (Salazar); “Proficiency depends on the type of synthesis and mapping, which can be freely modified on my instrument” (Ivan Franco).

Insook Choi backed this view: “Learning is mainly about executing the compositional plans”. But she specifies: “composition provides a learning architecture with respect to a performance system”. Tobias Grosshauser also explained that the challenging part was learning how technology reacted. These comments suggest that musical agencies re-

distribution not only impacts artistic practice but also the learning process, particularly in case of unpredictable systems: “As a feedback instrument it is extremely non-linear and sensitive to external conditions, so sometimes it’s difficult to exactly repeat something” (Kiefer).

The lack of playing community is another barrier in the learning process, as elaborated by 9 performers: “Nobody is virtuoso with this because the instrument is new and unique” (Kiefer). Martin Marier has a similar take on the issue: “The training of virtuosos could only come after the creation of a repertoire and of a culture around the instrument”.

5. FINAL REMARKS

We talked to NIME performers to identify their values and the way their instruments embody those values. Some of them had been previously identified by other authors when reporting their experiences with NIME development and performance [3, 13, 34, 41]. This article proposes that these values, rather than being peculiar of individual musicians’ practices, are often common among several other artists, contributing determining some of the greatest identifying factors of NIME performances. However, the extent to which these values are idiosyncratic traits of NIME performances, as opposed to more general DMIs, is left for future work (a comparisons between instruments presented at NIME versus instruments presented at other HCI conferences and on crowdfunding platforms is discussed at [31]).

We provided evidence to the relative diversity among performers, confirming the feeling that a NIME performer is also somebody that strives to elude definitions and categorisations. A wide range of repertoires exists within NIME, and NIMEs have a variety of roles in the performers’ practice and a variety of learning trajectories. Commonalities among NIME practices can be highlighted, but they remain highly personal. Trying to associate them with categories risks missing the point of their essence.

It can be identified a difference between the scientific and artistic side: technology researchers might seek to find common directions, while artists might seek individuality. The body of NIME performance practice reflects this productive tension, where instruments are designed with shared tools and methodologies and they cross-evolve by practitioners sharing ideas via papers and technical reports, while artistic practice seeks an individual identity as well as collectively belonging to the NIME community.

This paper did not aim to offer indisputable arguments about the identity of NIME performance practice. Rather, it initiated a conversation, which we encourage to be continued in a participatory way. We believe that bringing back structured conversations in the form of paper presentations, panels, and workshops could help define NIME artistic practice. Members of the community could join this conversation by continuing making art with NIMEs and reporting the stories of their creations and their performance experiences. Reviving the call for papers of NIME 2003, these reports could include comparisons about the different possibilities that the instrument enables in one’s artists practice compared to existing solutions.

6. ACKNOWLEDGEMENTS

We are grateful to all the performers that participated to this study and to the reviewers for their excellent job at suggesting ways to improve our work. This research was supported by EPSRC under grant EP/N005112/1.

7. REFERENCES

- [1] P. Alperson. The instrumentality of music. *The Journal of Aesthetics and Art Criticism*, 66(1):37–51, 2008.
- [2] J. Armitage, F. Morreale, A. McPherson, et al. “The finer the musician, the smaller the details”: NIMEcraft under the microscope. In *NIME*, 2017.
- [3] M. Baalman. Interplay between composition, instrument design and performance. In *Musical Instruments in the 21st Century*, pages 225–241. Springer, 2017.
- [4] J. Barbosa, J. Malloch, M. M. Wanderley, and S. Huot. What does “evaluation” mean for the nime community? In *NIME*, 2015.
- [5] D. Birnbaum, R. Fiebrink, J. Malloch, and M. M. Wanderley. Towards a dimension space for musical devices. In *NIME*, 2005.
- [6] T. Bovermann, A. de Campo, S.-I. Hardjowirogo, and S. Weinzierl. Musical instruments in the 21st century. 2017.
- [7] O. Bown. Attributing creative agency: Are we doing it right? In *ICCC*, 2015.
- [8] A. R. Brown. Understanding musical practices as agency networks. In *ICCC*, 2016.
- [9] J. Cantrell. Designing intent: Defining critical meaning for NIME practitioners. In *NIME*, 2017.
- [10] B. Carey and A. Johnston. Reflection on action in NIME research: Two complementary perspectives. In *NIME*, 2016.
- [11] J. Chadabe. The limitations of mapping as a structural descriptive in electronic instruments. In *NIME*, 2002.
- [12] P. Cook. Principles for designing computer music controllers. In *NIME*, 2001.
- [13] P. Dahlstedt. Physical interactions with digital strings—a hybrid approach to a digital keyboard instrument. In *NIME*, 2017.
- [14] J. de Souza. *Music at Hand: Instruments, Bodies, and Cognition*. Oxford University Press, 2017.
- [15] E. A. Dezfouli and E. van der Heide. Notesaaz: a new controller and performance idiom. In *NIME*, 2013.
- [16] A. Eldridge and C. Kiefer. The self-resonating feedback cello: interfacing gestural and generative processes in improvised performance. In *NIME*, 2017.
- [17] S. Ferguson and M. M. Wanderley. The McGill digital orchestra: An interdisciplinary project on digital musical instruments. *Journal of Interdisciplinary Music Studies*, 4(2), 2010.
- [18] S.-I. Hardjowirogo. Instrumentality. on the construction of instrumental identity. In *Musical Instruments in the 21st Century*, pages 9–24. Springer, 2017.
- [19] I. Hattwick, P. Beebe, Z. Hale, M. M. Wanderley, P. Leroux, and F. Marandola. Unsonding objects: Audio feature extraction for the control of sound synthesis. In *NIME*, 2014.
- [20] A. Hunt and R. Kirk. Mapping strategies for musical performance. *Trends in gestural control of music*, 21:231–258, 2000.
- [21] A. R. Jensenius. To gesture or not? an analysis of terminology in NIME proceedings 2001–2013. In *NIME*, 2014.
- [22] A. R. Jensenius and M. J. Lyons. Trends at NIME—reflections on editing “A NIME Reader”. In *NIME*, 2016.
- [23] A. R. Jensenius and M. J. Lyons. *A NIME Reader: Fifteen Years of New Interfaces for Musical Expression*. Springer, 2017.
- [24] S. Jordà. Digital instruments and players: Part II—diversity, freedom and control. In *ICMC*, 2004.
- [25] H. Leeuw. The Electrumpet, a hybrid electro-acoustic instrument. In *NIME*, 2009.
- [26] R. Lindell and T. Kumlin. Augmented embodied performance. In *NIME*, 2017.
- [27] D. H. M. Lopes, H. Hoelzl, and A. de Campo. Three flavors of post-instrumentalities: The musical practices of, and a many-festo by Trio Brachiale. In *Musical Instruments in the 21st Century*, pages 335–360. Springer, 2017.
- [28] T. Magnusson and E. H. Mendieta. The acoustic, the digital and the body: A survey on musical instruments. In *NIME*, 2007.
- [29] J. Malloch and M. M. Wanderley. Embodied cognition and digital musical instruments: Design and performance. In *The Routledge Companion to Embodied Music Interaction*, pages 440–449. Routledge, 2017.
- [30] A. Marquez-Borbon and P. Stapleton. Fourteen years of NIME: the value and meaning of ‘community’ in interactive music research. In *NIME*, 2015.
- [31] A. P. McPherson, F. Morreale, and J. Harrison. Musical instruments for novices: Comparing NIME, HCI and crowdfunding approaches. In *S. Holland et al., eds. New Directions in Music and HCI*. Forthcoming, Springer, 2018.
- [32] F. Morreale and R. Masu. Renegotiating responsibilities in human-computer ensembles. In *Colloquio di Informatica Musicale*, 2016.
- [33] F. Morreale and A. P. McPherson. Design for longevity: Ongoing use of instruments from NIME 2010–14. In *NIME*, 2017.
- [34] J. Snyder. The Birl: Adventures in the development of an electronic wind instrument. In *Musical Instruments in the 21st Century*, pages 181–205. Springer, 2017.
- [35] H. Tammen. Case study: The endangered guitar. In *Musical Instruments in the 21st Century*, pages 207–221. Springer, 2017.
- [36] A. Tanaka. Biomuse to bondage: Corporeal interaction in performance and exhibition. In *Intimacy Across Visceral and Digital Performance*, pages 159–169. Springer, 2012.
- [37] A. Tanaka, A. Parkinson, Z. Settel, and K. Tahiroglu. A survey and thematic analysis approach as input to the design of mobile music guis. In *NIME*, 2012.
- [38] B. Taylor. A history of the audience as a speaker array. In *NIME*, 2017.
- [39] G. Torre and K. Andersen. Instrumentality, time and perseverance. In *Musical Instruments in the 21st Century*, pages 127–136. Springer, 2017.
- [40] L. Turchet. The hyper-mandolin. In *Proceedings of AudioMostly Conference*, pages 1:1–1:8, 2017.
- [41] M. Waisvisz. Gestural round table. *STEIM Writings*, 1999.
- [42] M. M. Wanderley. Expert commentary: Perry Cook’s principles still going strong. In *A NIME Reader*. Springer, 2017.
- [43] M. M. Wanderley and M. Battier. *Trends in Gestural Control of Music*. IRCAM, 2000.
- [44] R. J. Zatorre, J. L. Chen, and V. B. Penhune. When the brain plays music: auditory–motor interactions in music perception and production. *Nature reviews neuroscience*, 8(7):547–558, 2007.