

Surveying Digital Musical Instrument Use Across Diverse Communities of Practice

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Abstract. An increasing number of studies have examined the active practice of performers who use digital musical instruments (DMIs) and applied findings towards recommendations for the design of new technologies. However, the communities of practice typically considered in these works tend to be closely aligned with the design communities themselves, predominantly found in academic research and experimental and technology-based music practices. Here we report on an online survey of musicians designed to look beyond these distinct communities to identify trends in DMI use across a wide variety of practices. Compared with current literature in the field, our diversified group of respondents revealed a different set of important qualities and desirable features in the design of new instruments. Importantly, for active and professional performers, practical considerations of durability, portability and ease of use were prioritized. We discuss the role of musical style and performance practice in the uptake and longitudinal use of new instruments, and revisit existing design guidelines to allow for the new findings presented here.

Keywords: digital musical instruments, NIME, survey, communities of practice, design

1 Introduction

The field of digital musical instrument (DMI) design, and much of the music technology domain wherein it resides, can be seen as a dichotomy between multidisciplinary technological research and creative musical practice. This relationship is mutually beneficial, as each side informs the other: innovative technology and design introduce new instruments that augment the capabilities of music production and performance, while expanded musical practice inspires and informs research in new directions. Evaluation of new musical instruments and interfaces is a critical area of research in the field [1], and a focus on embodied, phenomenological perspectives [4, 5] has led to in-depth examinations of communities of practice [7] and the interconnection between performance and design.

The technical definition of a DMI is relatively straightforward, described as an instrument that uses computer-generated sound and consists of a gestural controller to drive musical parameters of a sound synthesizer in real time [8].

In practice, the term DMI, along with the related term “NIME” (when referring to an instrument or interface, ie., *a performer playing a NIME*)¹, is most commonly associated with non-commercial, atypical musical instruments and interfaces that are not generally used, or available, in mainstream music performance.

This constrained scope tends to be transferred to the prevailing research on DMI user groups as well, with most scholarship on DMI performance situated within academic and experimental music contexts. However, beyond these focused communities there is a diverse ecosystem of performers who use instruments that may fit the technical definition of a DMI but not the typical social and cultural context associated with the term.

While studies of DMI-centric musical practice are valuable, they may fail to capture unique and diverse perspectives coming from other communities. For example, electronic dance music (EDM), hip hop, DJs, experimental rock bands and modular synthesizer communities are just a few areas of practice that rely heavily on existing and emerging digital technologies for performance, but are not typically included in the discourse. Input from these groups can broaden the understanding of where and how DMIs are being used in different contexts, and ultimately inform the design and evaluation of new DMIs for successful and long-term use in active musical practice.

To investigate this further we created a new online survey to poll musicians on their use of digital, electric and computer-based instruments in performance. The survey contained a wide range of questions about respondents’ backgrounds, performance practices, musical styles, and instruments.

Our work differs from related previous studies by our open invitation for any and all musicians to take part. In the survey we chose to use the term *electronic musical instrument (EMI)* as a generic and inclusive name for various overlapping terminologies used in the field such as DMI, NIME, computer-based instrument, interface, controller, etc. By avoiding domain-specific jargon we hoped to make the survey accessible and applicable to a diverse cross-section of performers.

Here we report on our initial findings from the survey. First, we review related surveys and questionnaires about use of DMIs in performance, which informed the design of our own survey (Sec. 2). Next, we describe the formulation of our questionnaire and how the survey was carried out (Sec. 3). We then share the results of our analysis which was carried out in two rounds (Sec. 4). Finally, we reflect on our findings, comparing them to previous work and reflecting on implications for the design of EMIs intended for long-term use in performance (Sec. 5).

¹ New Interfaces for Musical Expression, coming out of the conference of the same name. (nime.org)

2 Related Work

In the interest of providing designers with better tools and more information to aid the creation of new instruments, researchers have utilized questionnaires to survey performers about the use of DMIs in their musical practice. In our own work, we are interested in identifying underlying factors that contribute to the adoption and long-term use – or rejection – of new digital musical instruments. Here we review previous questionnaire-based surveys of DMI performance communities which provided the background for our work. While each had its own specific focus and goals, they all placed a primary focus on the embodied connection between performer and instrument.

2.1 Dual Performer-Designer Roles

In 2006, Magnusson and Hurtado conducted a survey of musicians who play electronic music, with a focus on the differences between acoustic and digital instruments [6]. Respondents describe the tools they used and the nature of their relationships with them. Participants were recruited through several audio programming mailing lists including the investigators’ own audio software mailing list. Accordingly, most respondents were highly computer-literate and skilled computer programmers.

Two particular findings of the survey highlight the specialized nature of the DMI user community that was investigated. First, respondents liked the ability to easily create and modify digital instruments according to specific needs of a performance or composition. The technical knowledge necessary for these “easy” designs and modifications indicate advanced skillsets in various non-musical areas (such as computer science and software development) that are not typical of most musicians. Furthermore, it shows that many of the respondents identify as instrument designers as well as as performers.

Second, the respondents tended to be more critical of digital instruments than their acoustic counterparts. Entropic (non-deterministic) characteristics of digital instruments were generally considered to be flaws or errors in the system, whereas entropy in acoustic instruments was regarded favorably as giving the instrument character leading to discovery of new sounds or playing techniques. This outlook indicates a design-centric evaluation of an instrument, understandable given that most respondents were instrument builders themselves, well-versed in the craft and background research of the field.

In [11] Paine carried out another questionnaire-based study that gathered data about DMIs for the development of a taxonomy for DMIs. As with [6], respondents identified as both performers and designers. Furthermore, they varied in how they thought of or referred to the systems they were discussing: instruments, interfaces, compositions, or something else. The authors observed that the “...*notion of interface/instrument considered also in terms of a composition, while familiar to those working in the area, is of course radically different from the concept of a traditional acoustic instrument.*” Again this illustrates how select and idiosyncratic the “typical” DMI performance community is.

2.2 Surveying the NIME Community

A pair of recent surveys elucidate some of the limitations around performance and the continued use of DMIs over time. The first surveyed instrument makers whose instruments had been presented at the NIME conference over several years [9]. This was followed by a survey of NIME performers to explore and understand the roles of DMIs in their practice and understand common values among performers [10]. They confirmed that a majority of new DMIs fail to be developed or used beyond their initial design and infrequent use in actual performance, and identified a few primary factors contributing to this trend: DMIs are often designed as research probes or works-in progress not intended for real-world use; instruments are most frequently used by only one or two performers (and most often the primary/only performer is the designer); instruments frequently suffer from maintenance and reliability issues; perspective performers lack the opportunity to use them in performance.

Common themes that were identified around the use of DMIs included the desire for bespoke instruments that could meet personalized and idiosyncratic needs most commonly associated with performing experimental and exploratory styles of music. Consistent with the other surveys discussed in this section, they also found that most (78%) of the performers who responded had designed their own instrument.

2.3 Beyond NIME

The studies discussed above illustrate an active, engaged, and highly skilled community of performers, researchers and designers. The area has grown and matured, and is a vital contributor to continued innovation in both instrument design and evolving musical practice. However, a vast community of electronic and digital instruments – and the performers that use them – exists outside of these surveyed communities. Whether by virtue of mass appeal and commercial availability, or their use in more conventional and mainstream music communities, perspectives from these populous and highly active communities of digital instrument users are seldom included in DMI user research.

Our investigation in this direction began with a preliminary survey to examine DMI use across widespread communities of practice [13]. A key finding of that work identified the largely pragmatic factors influencing the abandonment new instruments and technologies. This led to our literature-based analysis of essential qualities for DMIs to be viable for use in professional performance situations, most importantly instrument stability, reliability, and compatibility with other instruments, performers and industry standards [14].

3 The Electronic Musical Instrument Survey

Following our previous work, we were interested to conduct a more comprehensive online survey that again targeted performers across a wide variety of

performance practices and focused on factors that contribute to the uptake and continued use of new instruments in performance. Additionally we wanted to compare behaviors and preferences of user groups like those researched in previous works to those operating in more mainstream and popular music circles.

3.1 Participant Criteria and Recruitment

The survey was open to all performers, with no specific requirement that they use electronic musical instruments (EMIs) in performance. The survey was administered online and formatted conditionally so that only those who reported using EMIs saw those relevant sections. Participants were required to be 18 years of age. Beyond that, the only requirement was that respondents identified themselves as “active musicians”.

Calls for participation were sent via academic mailing lists and across social media and online music forums to musicians and performance communities. As an incentive for participating, respondents were invited to enter a drawing for a gift certificate to an online music retailer.

3.2 Questionnaire

Our previous survey had used mostly closed and short answer questions to both minimize the length of time to complete the survey (and in doing so, maximize the number of respondents) and to optimize and automate analysis of the data. For this survey we chose to ask more open-ended questions, and conducted qualitative analysis of the free-format responses.²

The questionnaire was organized in two parts with a total of four sections. The first section collected demographic (age, gender, location) and background information about the respondents and their musical training, including how long they had been playing music, details on formal training, areas of focus, and experience with computer programming and electronics. Section two asked about their performance practice: primary genres and sub-genres of music that they perform, frequency and types of performance, what kinds and sizes of venues, if they play solo or with groups/ensembles, and what kinds of instruments and setups are used.

Part two of the questionnaire was dedicated to the use of electronic musical instruments and controllers. Because the survey was open to all performers, it started with the question, “Do you use electronic musical instruments in performance?” If a respondent answered no, the survey concluded at that point. If they answered yes, they moved to section three, which asked about the types of instruments and controllers they use. They were asked to give information about the instrument or controller they use the most, and could repeat the section up to three times to give information on multiple instruments. Section four of the survey contained several open-ended questions about the respondent’s opinions on acquisition and continued use of EMIs.

² The questionnaire can be viewed at: <https://emisurvey.johnnyvenom.com/questionnaire.pdf>

3.3 Data Collection and Analysis

A website was built to host the survey and put online at the domain `emisurvey.online`³. Responses were saved on a server database, then compiled to a spreadsheet that was downloaded for analysis.

We began our analysis by classifying the participants by background, experience, musical styles, and how active they were as performers. Then we analyzed the respondents' answers qualitatively using techniques taken from Grounded theory [12]. Our methodology used multiple rounds of coding, first open, then using the constant comparison method, where codes between answers and participants were associated into related concepts and themes. This process yielded several high level insights and provided the the motivation and rationale to perform a deeper analysis that focused on the more active performers, those who performed more frequently.

4 Results

A total of 85 people responded (M=60; F=22; other/not specified=3). Respondents were primarily North American and European, and most were between 26 and 65 years old (26 - 45: 65%; over 45: 27%; under 25: 8%). Collectively, the survey population is highly experienced, with 89% reporting more than 10 years of experience in music performance, and 64% more than 20 years. 85% have received formal training with more than a third at or above graduate level.

4.1 Performance Practice

As shown in Table 1, there was a wide range of diversity in the frequency and type of performances across respondents. Over half perform 10 times or less per year. Average audience size varies from less than 100 to over 1000. Most play both solo and in groups.

Performances/year		Avg. audience size		Solo/group performance	
10 or fewer	53%	less than 100	56%	Both solo and group	60%
11 - 20	22%	100 - 500	47%	group only	25%
20 - 50	13%	500 - 1000	16%	solo only	15%
50 or more	12%	more than 1000	8%		

Table 1. Performance frequency, average audience size and configuration of respondents. Multiple answers could be chosen for audience size.

To classify musical styles, we used the list of genres was taken from AllMusic, an online music database⁴, with some changes made to reflect some of the tastes

³ Now archived at <https://emisurvey.johnnyvenom.com/survey-archive/>.

⁴ <https://www.allmusic.com/genres>

and nuances of expected respondents. For instance, *electronic* music may mean vastly different things to popular or experimental musicians, so it was divided into *EDM* and *electro-acoustic*. Respondents could choose multiple genres and could specify additional sub-genres or styles. Totals for each category were adjusted to include any sub-genres that we felt belonged in the given categories. The most common styles of music reported were: avant-garde/experimental and electro-acoustic, followed by classical, EDM, rock/pop, jazz, and folk. The full results are shown in Table 2.

Musical Style	Percent	Total	Musical Style	Percent	Total
Avant-garde/Experimental	68%	58	Stage/Theater	8%	7
Electro-Acoustic	34%	29	International	5%	4
Classical	26%	22	Blues	2%	2
EDM	22%	19	Latin	2%	2
Pop/Rock	14%	12	R&B	1%	1
Jazz	12%	10	Rap	1%	1
Folk	11%	9	Country	0%	0

Table 2. Self reported musical performance styles.

The results show significant blending and mixing of genres, especially across and between traditional classifications of “art” music (ie., avant-garde, electro-acoustic) and “popular” music (EDM, rock/pop, etc.) styles [2]. It should also be mentioned that self-categorization of genre and style is extremely subjective, and similar musics may be reported across different categories by different respondents.

75% of respondents use traditional instruments in their performances (played by either themselves or others they perform with). This includes orchestral instruments and typical rock instruments (ie., guitars, drums, etc.), and both acoustic and electric instruments. The full instrument classification is shown in Table 3. Nearly half use computers in performance, and a quarter use DMIs or DIY or self-made instruments. Interestingly, 92% of respondents reported that they have experience with computer programming or electronics.

Our intent was to reach a number of different performance communities, but we still found that many respondents fit into typical DMI-centric performance practices. 68% (58 total) came from formal training and academic settings, were involved in experimental music practices, and were technologically adept. As this study was carried out in an academic research environment, many of the respondents can be recognized as operating in or adjacent to academic practices. Therefore we recognize the implicit bias of our networks through which the survey was distributed, and acknowledge the limits of our attempt to capture a sufficiently broad diversity of performance communities. However, 33% (28) of respondents work across both art and popular music genres, and another 12%

Instrument classification	Percent	Total
Traditional instruments (acoustic and electric)	75%	64
Computers and software	48%	41
Synths/sequencers/samplers and other hardware	35%	30
DIMs and DIY instruments	25%	21
Controllers	21%	18
unspecified electronics	13%	11

Table 3. Types of instruments used in performance.

(10) strictly in popular music genres. Ultimately we found our population significantly diverse, representing a variety of different approaches and perspectives to performance.

4.2 Electronic Musical Instruments

In the second half of the survey, participants were asked if they use electronic musical instruments in performance. Of the 85 total respondents, 23 (27%) answered that they do not, bringing them to the end of the survey. The remaining 62 participants continued to the second half of the survey, where they identified and gave information about their their primary electronic instrument(s) (up to 3), and responded to general questions about instrument uptake and longitudinal use. The instruments were categorized and are shown in Table 4.

Electronic instrument category	Percent	Total
software	71%	44
MIDI controllers	69%	43
keyboard synths	47%	29
FX processors	40%	25
FX pedals	39%	24
samplers	37%	23
drum machines	35%	22
modular synths	31%	19
other	19%	12

Table 4. Primary electronic musical instruments used.

Initial coding of the responses to the remaining survey sections revealed a number of consistent trends across users. Most noticeable was the prevalent use of computer software and MIDI controllers. Asked whether they prefer computers or dedicated hardware for performance, 26% chose hardware and 19% chose

computers, while nearly half said it depends and didn't indicate a preference for one over the other. Positive attributes for hardware included stability and reliability, as well as a preference for tactile controls, imperfections (consistent with [5]), "live-ness and risk-taking", and simplicity of devices used for dedicated tasks. Computers were favored for size, convenience, versatility, affordability compared to the cost of hardware, and ability to handle more complexity than dedicated hardware.

Instrument Satisfaction (and Dissatisfaction) The most common factors that contributed to instrument satisfaction were largely pragmatic: size and portability was the most frequently mentioned, followed by flexibility and versatility, ease of setup and use, responsiveness, and compatibility with other gear and software. Factors that lead to dissatisfaction included a lack of desired features, not enough controls, desire for more flexibility, and desire for better sound quality.

There were differing opinions about flexibility, occasionally from the same participant. On one hand flexibility is desirable for discovery and exploration, as well as plain economics: one versatile piece of gear can do the job of several dedicated devices. On the other, performers appreciate the simplicity and reliability of dedicated devices for specific tasks. Furthermore, dedicated devices may provide useful constraints which can enhance exploration and creativity (as investigated by Zappi and McPherson in [15] and Gurevich, et al. in [3].) One participant pointed out different priorities for composition/production and live performance: flexible instruments are beneficial in the studio but are a liability in live performance, for which they prefer the direct control and reliability of dedicated devices. Interestingly, while many found flexibility to be a desirable quality, most respondents only use basic configuration options that their instruments provide, such as tweaking factory presets and basic parameter mapping.

Uptake, Longevity and Retiring Instruments The most popular reason given for taking up a new instrument was to explore new musical possibilities and expand creative expression. Other frequent reasons were to meet an established compositional or performance goal, to acquire new functionality (new features, workflows or remove restrictions), and to upgrade older gear.

Most respondents reported that there is no time limit on retiring an instrument. If it works and fits within their setup, they will use it until it is no longer functional. Participants cited obsolescence, lack of continued manufacturer support and loss of compatibility as factors that lead to instrument retirement. Another important factor mentioned was evolving musical styles and practices, along with diminishing interest and enthusiasm for an individual's existing instrument, with one participant saying that "new instruments inspire new music."

Two respondents who reported designing their own instruments (or instruments for others) also stated that their instruments are frequently redesigned or in a continual state of development. This behavior is consistent with previous

research within DMI communities (as discussed in Sec. 2) but was uncommon in our results.

4.3 Demands of Performance

Throughout the initial analysis, we noticed distinct differences between the answers of respondents who performed frequently and those who didn't. We then conducted a second round of analysis with only the more active performers. From the 62 respondents who use EMIs, 32 who reported playing 10 or fewer shows per year were removed, leaving 30 "active" performers for analysis. Of the 30, 20 play art music genres, 5 play popular music genres, and 5 play both.

Consistent with the first analysis, these active performers primarily use popular and commercially available hardware and software. None build their own instruments, though two use instruments built for them. Of the non-commercial instruments mentioned, there were three augmented instruments (traditional instruments equipped with sensors to control computer-based audio processing), and one custom built synthesizer. Also consistent with the larger group, the active performers primarily use computers and software in performance. The most common software and languages mentioned were Ableton Live, Max and Pure Data.

There were some important differences as well. When the less active performers were filtered out, much more attention was given to pragmatic issues of functionality for performance like reliability, portability and ease of setup, and less to creative or musical concerns like expressiveness, achieving virtuosity and novel interaction methods. The most common factors influencing instrument choice for active performers were:

- needing flexibility and versatility
- importance of (small) size and portability
- simplicity and ease of setup and use
- potential for exploration and discovery with new instruments
- evolving musical styles and performance practice dictate choices in equipment
- concerns about instrument failure, build quality and reliability
- coping with compatibility issues, connectivity, support, obsolescence

Preference for Computers Active performers indicated a decisive preference for computers and controllers over dedicated hardware, citing simplicity and portability as their biggest advantages. This highlighted the greater technical proficiency in the active performance group versus the rest. Whereas, in the first analysis, some respondents found computer-based performance setups to be unreliable and preferred hardware, the active group indicated the opposite, citing concerns about hardware failure, build quality and reliability, and relying heavily on computer based setups. Technical competence was also indicated with the active performance group reporting much deeper configuration and customization of their instruments and performance setups than the less active performers.

5 Towards Design for Performance

One of the key differences we have found between our results and those of previous studies is that our participants are much less involved in the design and development of the instruments that they use. Most work with popular, commercially available instruments, controllers and software available off the shelf.

Morreale and McPherson’s survey on instruments includes design considerations for instruments intended for long-term use [10]. Our results were consistent many of their key concepts: simplicity of interaction, quick and easy set-up, portability, quality and craftsmanship, use of commonly used, stable technologies, and extending musical possibilities. They also identified the appeal of “signature features” and unique aesthetic qualities. Results from our survey showed that these considerations, while mentioned, were secondary to more practical issues related to performing with reliable, functional instruments such as compatibility and flexibility.

6 Final Remarks

Our survey aimed to associate instrument preference and desirable attributes with differences across various types of practice and musical styles that may be less represented in previous research. In doing so, we hope to uncover latent factors across diverse performance practices that could inform the design process of new instruments intended for use in active performance practices.

Our intent was to target a wide diversity of musical practices and styles to compare and contrast with previous user research that has tended to focus on academic and research-based DMI design communities and is aligned with avant-garde and experimental music styles. Our success in this endeavor was mixed, and many of our respondents fit within these conventional DMI research frameworks. However, several others reported active DMI use in other dedicated performance contexts, most notably in popular music performance, and illustrated significant diversity.

Some of our findings were consistent with previous studies, while we found other aspects of DMI performance that should be added to the conversation. Most importantly, we found that there are differing design priorities between individuals who maintain an active performance schedule as opposed to those who perform less frequently.

Continued analysis will aim to more closely associate these results to distinct communities of practice, within and beyond typical NIME and DMI-centric paradigms such as those examined in [7]. For example, previous studies found DMI users are frequently closely associated with, or active in, the design and research of new instruments, however this trend was not reflected in our own results which prioritized active performers. In these cases it becomes important to disentangle the roles of design and creative practice in order to examine DMI use from a purely performer-oriented perspective.

Our current work is focused on the design and longitudinal evaluation of new instruments for performance. Informed by the results shown here, we are running

co-design workshops with performers to develop new instrument prototypes. Multiple iterations will produce a stable, performance-ready instrument to be evaluated by several participants in real-world conditions over several months.

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