Developing an Ontology of New Interfaces for Realtime Electronic Music Performance

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Abstract

This paper presents the current state of research undertaken as part of *Performance Practice in New Interfaces for Realtime Electronic Music Performance*[i] under the working title, TIEM (Taxonomy of realtime Interfaces for Electronic Music performance). This research is being carried out at the Virtual, Interactive, Performance Research Environment and the MARCS Auditory Laboratories at the University of Western Sydney in partnership with Electronic Music Foundation (EMF), Infusion Systems and The Input Devices and Music Interaction Laboratory (IDMIL) at McGill University.

The project seeks to develop a taxonomy for new interfaces for real-time electronic music performance. Key developments of the TIEM research to date are the creation of an online questionnaire[ii], which has resulted in a publicly accessible online database[iii] of the interfaces and instruments submitted to the survey (if they elected to be listed publicly).

The questionnaire consisted of a mix of textural and numeric, qualitative and quantitative questions arranged into six sections –

1) General Description,
2) Design Objectives,
3) Physical Design,
4) Parameter Space,
5) Performance Practice,
6) Classification.

Since launching the online database eight months ago, it has had over 500 unique visitors per month and 1800 page views per month. The TIEM database has also been referenced in (amongst others) WIRED[iv], CNN[v] and Electroacoustic Resources[vi].

1. Discussion

There is little clarity or consensus in current approaches to developing an ontology of digital musical interfaces or instruments (DMI). The prevailing accepted taxonomy of acoustic instruments (Mahillon [1] and later expanded by Hornbostel and Sachs [6]) focuses on the initial vibrating element in an instrument that produces its sound, and consists of four top-level classifications

1) Aerophones, 2) Chordophones, 3) Idiophones and 4) Membranophones.

Each of these top-level classifications is broken into numerous sub-categories, creating over 300 basic categories in all. In 1940 Sachs expanded the classification system to include a fifth top-level group, Electrophones for instruments involving electricity. In Sachs' classification system the electrophones were separated into three sub-categories

a. instruments with an electronic action;
b. electro-mechanical, acoustic sounds transformed into electric through amplification;
c. radioelectric, instruments that are based on oscillating circuits.

This classification system is inadequate as a classification system when seeking to capture the richness, diversity and trends of current digital musical instrument design. By placing the focus on the initial sound making device, the differences, similarities and relationships between new digital musical instruments such as, for instance, Bob Glucks *eShofar* [5], Sid Fels' *Tooka* [4] and Joseph Malloch's T-stick [10] become unclear. Mahillon's and Hornbostel and Sachs approach would loose many of the subtleties of these and the other instruments in the TIEM database.

More recent approaches to developing taxonomies of digital musical instrument (DMI) have focused on:

1. The sensor types used,
2. the nature of the interface,
3. the way gestures are captured and
4. the mappings between interface and sound generating functions [11].

Pringer [13] compared DMI with respect to expressivity, immersion and feedback. While Pressing [14] and Birnbaum et al. [1] have proposed multi-dimensional spaces to represent DMI, which seek to incorporate the various interactive potentials these instruments often offer.

Birnbaums [1] proposed a multi-dimensional space to represent DMI, seeking to incorporate the various interactive potentials these instruments often offer. This model includes seven dimensions —

1) Role of Sound,
2) Required Expertise,
3) Music Control,
4) Degrees of Freedom,
5) Feedback Modalities,
6) Inter-actors,
7) Distribution in Space.

2. REVISING DEFINITIONS

The TIEM project database represents a wide range of innovative approaches to electronic music performance. Whether seen as an instrument or interface, it is clear that their principle focus is live music making. Underlying all of the instruments currently listed on the TIEM web site (http://vipre.uws.edu.au/tiem) and much of the discussion in the literature and the NIME community, is a foundation concept of '*Instrument*'. It is useful to unpack that concept to illuminate the influence it has on design and development.

Daniel J. Levitin [8] discuses musical schemas in his book *This is Your Brain on Music*. The relevance to this discussion is his discussion of perceptual expectations and how these inform musical expectations and establish constraints and limitations in musical practices. They also form the basis for idiomatic writing for any instrument. Levitin points out how trained and untrained people can sing 'happy birthday' regardless of the starting pitch. We hold a schema that is: isomorphic, it can be applied to any starting point, is widely shared and, always retains its integrity, and furthermore, is context sensitive.

A musical instrument schema clearly exists. It is generally understood what is being communicated when one uses the term Musical Instrument, however an examination of organologies [11] [7] fails to illuminate such a schema. An examination of the application or organologies through the lens of musical performance is very helpful, as it essentially forms a design brief.

Stanley Godlovitch's [17] philosophical deconstruction of the notion of musical performance carefully unpicks the construct of the musical performance. Endeavouring to address new instruments Godlovitch puts forward the concept of 'remote control', saying that *"Computer assisted music, musical quasi-readymades, and experimental music challenge the centrality of immediate agency. … Primary causation involves direct control. Not all causation is primary. Causation is indirect when what the maker does skilfully is at a significant procedural remove from the final effect. Indirect causation is standard in computer art and music. I will call the process remote control."*

It is true that new interfaces/instruments are primarily used/presented within an understood performance convention, but immediate agency is often challenged by a lack of observable primary causation.

Godlovitch's frame of reference for "computer assisted music, musical quasi-readymades" is where a sequence of musical material is predetermined and a performance entails the replay of that material without intervention. Much has changed in the last ten years with computing power facilitating realtime software synthesis languages such as Supercollider[vii], Max/MSP[viii], Pd[ix], Chuck[x], Impromptu[xi], Audiomulch[xii] etc. wherein variables within these software synthesisers can be controlled in realtime. Such a paradigm is not considered by Godlovitch.

There are then, two distinct approaches to computer assisted music;

1. the control of predetermined sequences of sounds (such as the triggering of sound samples in Ableton Live[xiii], or any other sample based software instruments),
2. the creation of sounds in realtime by the manipulation of software synthesis variables.

These approaches may be differentiated as *Control* or *Create*.

The *Control* or *Create* division is not clear-cut, they are often combined in performance setups, where samples may be triggered, however filters, delays, granulation time etc. may be varied in realtime in order to effect the sound outcomes. This co-habitation complicates the classification of such performance systems as musical instruments. An examination of NIME/DMI demonstrates that both 'remote control' and primary causation occur simultaneously. It may be agreed that where the act of performance is limited to the triggering of pre-determined sequences (remote control), that the interface acts as a controller (a process of control is paramount), however, if primary causation is observable, a direct and immediate agency is again central to the performance and as such a vestigial reference is made to a definition as musical instrument (a process of creation is paramount).

A collective agreement on such definitions is important to the development of common schemas. Returning to Levitin's discussion of musical schemas, a shared model of perceptual and musical expectations and a common understanding of constraints and limitations in musical practices provide the framework for a shared understanding of causation and agency in acoustic music performance. The authors suggest that without such a shared schema for computer assisted music, which may start with the delineation of **control** and **creation** processes, the general public will always be uncertain about the authenticity of a computer music performance. In acoustic instrument performance, gesture is central in providing immediate agency and drawing attention to primary causation. Of course computer music performance has developed some conventions (laptop performance without an obvious gestural interface, no-input mixing desks, performances with a Monome[xiv] interface etc.), and repeated exposure provides a constant updating of any schema associated with such performances.

3. METHOD

The TIEM project approaches all of these challenges, seeking to define a framework, a taxonomy or schema that might help to present a unifying base for discussion and comparative studies in this area.

The online TIEM Questionnaire[xv] consisted of 72 questions examining the practice and application of new interfaces for real-time electronic music performance. The questions consisted of a mix of textural and numeric, qualitative and quantitative, arranged into six sections—

1) General Description
2) Design Objectives
3) Physical Design
4) Parameter Space
5) Performance Practice
6) Classification

Participants were not required to answer all questions and were able to revisit the questionnaire to complete their submission as often as necessary. The questionnaire was launched in June 2008 and as of December 2008 there were over 800 unique survey views with 70 completed responses.

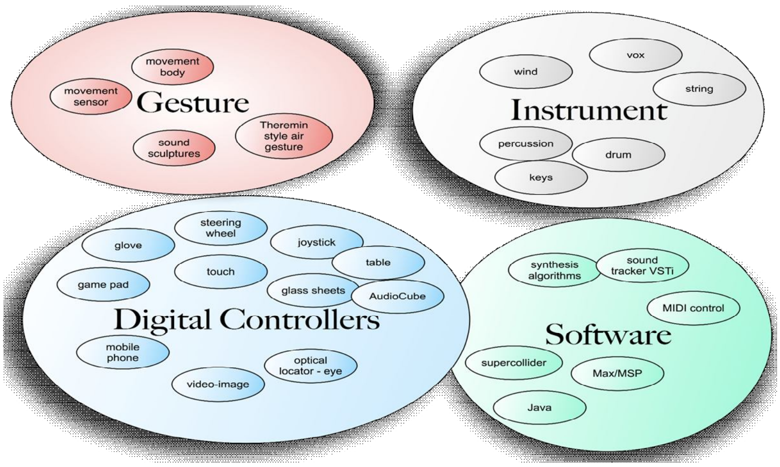

Figure 1 An overview classification derived from textual qualitative analysis of the submissions to the TIEM database provides a broad concept map containing four principle concepts: *Gesture, Instrument, Digital Controllers and Software.*

4. PRELIMINARY OUTCOMES

From averages and trends the instruments/interfaces submitted to the survey have –

- a moderate learning curve (faster rather than slower - 6.05),
- a performer can become an expert with the instrument/interface (8.45)
- increase in practice time does result in (8.7) increase in skill

There is a clear correlation between the trend for becoming an expert and the trend for practice time/skill. The trend suggests that both very slow and (perhaps) very fast learning curves are not desirable.

Would you describe your interface/instrument as:	Count	Percent %
Polyphonic	53	88.33%
Monophonic	7	11.67%
Multitimbral	52	86.67%
Monotimbral	8	13.33%
Do you need to touch it?		
Yes	50	83.33%
No	10	16.67%
Does the interface/instrument provide haptic (tactile/kinaesthetic) feedback to the performer?		
Yes	21	36.84%
No	36	63.16%
Would you describe your interface/instrument as –		
Process Based (Create)	34	60.71%
Event Based (Control)	22	39.29%

Table 1. Summary of responses to some of the quantitative questions in the survey.

Table 1 presents an overview of the responses given to the quantitative questions. From the responses there is a clear preference evident for creating polyphonic (88.33%), multitimbral (86.67%) process based (CREATE rather than CONTROL) (60.71%) interfaces/instruments. There is also a strong preference evident for interfaces that are touched (83.33%) i.e. the performer has a physical connection with the interface/instrument. However, despite this preference for tactile interfaces, only 36.84% reported providing haptic (tactile/kinaesthetic) feedback to the performer.

It is clear from the responses, that performers have a strong need for a physical connection with their instrument. A crucial step in the development of new musical interfaces therefore is the design of the relationship between the performer's physical gestures and the parameters that control the generation of the instrument's sound [15] [1]. This process is known in the computer science and engineering worlds as control mapping [15] [2], however the musician perceives it as a more homogenous engagement, where agency is decisive.

The survey asked how contributors thought of their system (instrument, interface, composition or other.) There was a slight preference for describing the systems as instruments (67.16%) versus interface (55.22%) with some (16.42%) also thinking about their systems in terms of a composition. Responses under the other category included—*All the above; Composition tool; Holistic approach to sound; Installation; Interactive environment; Interface and composition; Performance device; Performance environment; Rhythm generation system; Semi-automatic improviser.*

It should be noted that this notion of interface/instrument being represented 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. This is well represented by Margaret Kartomi's assertion that *musical instruments are fixed, static objects that cannot grow or adapt in themselves.* (2001:305)

The survey participants' distinctions between interface and instrument were further revealed in some of their textual responses. A selection of these is presented in Table 2.

"I have never been able to draw a distinction between these two."

"I think an instrument is anything which is performable, through which a human can control parameters to afford expressive results."

"I consider it an instrument in the sense that I am dedicating my life to improving it, much like a violin builder dedicates his/her life to making the best violin they can."

"The more memory ("state") and autonomy a device has, the more likely I would be to call it an interface as opposed to an instrument."

"In my opinion, it's no clear distinction between an interface and an instrument."

"An interface is a controller that cannot create sound without some extra interface/tone generator/software. My interface becomes an instrument when I integrate it with the software I specifically developed for it to create the actual sound."

"A "musical instrument" includes mapping, synthesis, and sound production in the system. An interface can be part of a "musical instrument."

"I think the distinction is blurred, but by instrument we can talk about the physical object, by

interface we focus on the actions that are needed for making music with the instrument"

"the aesthetics of the actual interface controller makes an audience believe its an instrument."

"The interface is the mediator between the performer and the sound generator"

"all instruments have interfaces. But many interfaces are not instruments. … I consider a musical instrument a tool that allows you to express yourself musically through interaction with it."

Table 2. Selected responses to Q. 46: In your opinion what differentiates between an interface and an instrument? Is there an objectively definable distinction?

A recent study [12] carried out by the first author at the University of Western Sydney examined the fundamental control parameters utilised by expert musicians on traditional instruments. The model developed proposed the musical parameters; *Dynamics, Pitch, Vibrato, Articulation and Attack/release* as the focus of the physical instrument control, and of primary focus in achieving a well-developed instrumental tone, the principle concern for all musicians interviewed in the study. The model further identified four primary physical controls used to achieve musical outcomes—*pressure, speed, angle and position*.

Building on this research the survey asked participants to rank musical control parameters in order of importance

1) Expression,
2) Pitch and Intonation,
3) Dynamics,
4) Tone Colour,
5) Articulation,
6) Volume,
7) Attack, Release, Sustain,
8) Duration,
9) Vibrato

Table 3. Question 9: Rank in order of importance with respect to your interface/instrument.

Expression was clearly rated the most important while Vibrato was rated the least important. Dynamics, Tone Colour, Articulation, and Volume were grouped closely in the middle. The categories of Tone Colour; Articulation; Volume are very close together in their weightings. A log function calculating the arithmetic mean - supported by calculating the geometric mean and harmonic mean assist in teasing out the order of importance (see below).

In line with the above research, participants were also asked to select what types or qualities of movement are needed to play their interface/instrument .

1. Position ranked highest (81.13%) followed by
2. Speed (71.70%),
3. Pressure (58.49%) and
4. Angle (49.06%).

5. FUTURE PLANS

When examining the design and development of new interfaces for electronic music performance (where affordances inherent in the acoustic instrument move into the virtual) the affordances gained by clear primary causality (an observed link between performative gestures and principal control components used to shape the resultant sound properties) have a great deal to do with perceived authenticity. A striking reflection on this issue is the common perception of laptop music performance as a kind of counterfeit.

It is proposed that somatalogical affordances provide sufficiently convincing gestural control affordances to overcome any concern about authenticity in performance, but more importantly, it is proposed that a consideration of these subtle levels of engagement between the musician and their instrument are imperative to the design and development of new instruments/interfaces for electronic music performance.

The interface and its implementation, serve two primary goals:

1. To increase performability, allowing the musician to nuance musical outcomes in a way not possible with existing interfaces or mouse/keyboard;

2. To increase communication with the audience, displaying something of the energy and intent of the performer, providing a conduit for engagement in the realtime qualities of the performance – ie. The ritual of performance.

This paper presents just a brief overview of the data we have collected through the TIEM online survey. The broad scope and diversity of the field of DMI design resists fitting into a simple classification system. Yet a number of trends and groupings are starting to become apparent. The process of analysing the data is continuing and there are many sections of the questionnaire not covered in this paper. We are currently conducting an in depth qualitative analysis of the textural data captured and the TIEM online database will be expanded to include as many of the interfaces/instruments submitted to the project as possible.

REFERENCES

[1] D. Birnbaum, R. Fiebrink, J. Malloch, M. M. Wanderley, "Towards a Dimension Space for Musical Devices." *2005 International Conference on New Interfaces for Musical Expression (NIME'05)*, Vancouver Canada, pp. 192-95, 2005.

[2] J. Chadabe, "The Limitations of Mapping as a Structural Descriptive in Electronic Music." *2002 International Conference on New Interfaces for Musical Expression (NIME'02)*, Dublin, 2002.

[3] P. Cook, "Principles for Designing Computer Music Controllers". *2001 International Conference on New Interfaces for Musical Expression (NIME'01), CHI 2001*, Extended Abstracts, Seatle, 2001.

[4] S. Fels, L. Kaastra, S. Takahashi and G. McCaig. "Evolving Tooka: from Experiment to Instrument." *2004 International Conference on New Interfaces for Musical Expression (NIME04).* pp.1-6, 2004.

[5] R. Gluck, "eShofar as a Culturally Specific Live Electronic Performance System." *SEAMUS*, Vol. 19, Society for Electroacoustic Music in the United States, Fall, 2006.

[6] E. M. Hornbostel and C. Sachs. Systematik der Musikinstrumente : Ein Versuch. *Zeitschrift für Ethnologie* Translated by A. Bains and K. Wachsmann under the title "A Classification of Musical Instruments." *Galpin Society Journal*, [1914] 1961.

[7] M. J. Kartomi, *On Concepts and Classifications of Musical Instruments*. Chicago: University of Chicago Press, 1990.

[8] D. J. Levitin, *This is your brain on music: the science of a human obsession*. New York, N.Y: Dutton, 2006.

[9] V. C. Mahillon. *Catalogue descriptif et analytique de Musée* Instrumental du Conservatoire Royal de Musique de Bruxelles, vol. I, second edition. Paris: Gand, [1880] 1893.

[10] J. Malloch and M. M. Wanderley, "The T-Stick: From Musical Interface to Musical Instrument." *2007 International Conference on New interfaces for Musical Expression (NIME07)*, New York, USA, 2007, pp. 66-69, 2007.

[11] E. R. Miranda and M. M. Wanderley, *New Digital Musical Instruments: Control and Interaction Beyond the Keyboard*. Middleton, Wis: A-R Editions, 2006.

[12] G Paine, I. Stevenson, and A. Pearce, "The Thummer Mapping Project (ThuMP)." *2007 International Conference on New Interfaces for Musical Expression (NIME'07)*, New York City, NY, 2007.

[13] J. Piringer. "Elektronische musik und interaktivität: Prinzipien, Konzepte, Anwendungen." Master's thesis, Technical University of Vienna, 2001.

[14] J. Pressing. "Cybernetic Issues in Interactive Performance Systems." *Computer Music Journal*, 14(2):12-25, 1990.

[15] D. Wessel, and M. Wright, "Problems and Prospects for Intimate Control of Computers." *Computer Music Journal*, 26(3), 11-22, 2002.

[16] T. Winkler, "Making Motion Musical: Gestural Mapping Strategies for Interactive Computer Music." *1995 International Computer Music Conference*, San Francisco, 1995.

[17] Godlovitch, S. (1998). Musical performance: a philosophical study. London ; New York: Routledge.

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ii see http://tiem.emf.org/survey (viewed 29/01/09)

iii see http://vipre.uws.edu.au/tiem (viewed 29/01/09)

iv see http://www.wired.com (viewed 29/01/09)

v see http://edition.cnn.com (viewed 29/01/09)

vi see http://ressources.electro.free.fr (viewed 29/01/09)

vii see http://supercollider.sourceforge.net (viewed 29/01/09)

viii see http://www.cycling74.com (viewed 29/01/09)

ix see http://crca.ucsd.edu/~msp/software.html (viewed 29/01/09)

x see http://chuck.cs.princeton.edu (viewed 29/01/09)

xi see http://impromptu.moso.com.au (viewed 29/01/09)

xii see http://www.audiomulch.com (viewed 29/01/09)

xiii see http://www.ableton.com (viewed 29/01/09)

xiv see http://monome.org (viewed 29/01/09)

xv http://tiem.emf.org/survey (viewed 29/01/09)