Digital Musical Instrument Composition: Limits and Constraints

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Abstract

This discussion investigates the importance of understanding and establishing limits on the following three areas during the compositional process of creating music for a digital musical instrument (DMI): group paradigms; performance practises; sound-gesture combinations. I will propose a compositional model in which composing for and performing on a DMI requires rigourous technique attained only by proper training; thus, the proposed model advocates physically active on-stage music-making in the field of computer music – rather than typical and current static representations. Examples are drawn from performances featuring different DMIs, as well as a small selection of ensemble music combing digital with acoustic instrumentalists. These examples serve to assess the implementation of limits and constraints in the compositional approach of different composers.

Keywords: computer music composition and performance, interactive software systems design and implementation, gestural controlled audio systems, digital instrument/controller design

1. Introduction

In this discussion, I endeavour to expand on the current literature about creating music with gestural controllers from the perspective of a composer. I present a number of important limitations that I feel should be implemented before composing for a digital musical instrument. I hope the reader will also sense my desire to recognise DMI composition within a compositional heritage not entirely routed in the lineage of electroacoustic music, but more generally in the tradition of music transmission and reception.

2. Digital Musical Instrument Composition

In this paper, my references to composing entail writing music for live on-stage digital musical instruments with and without traditional acoustic instruments. All the instrumentalists follow a musical score either printed on paper or on a computer monitor. I am evoking the compositional processes found in the Classical chamber music tradition while bringing to mind performance aspects of the experimental art music of nineteen-sixties and seventies.

3. A Group Paradigm

In the following sections, I focus on an interdisciplinary group paradigm consisting of (1) music technologists, (2) acoustic instrument performers and (3) classically trained composers, especially informed by my own experiences as a member of the McGill Digital Orchestra. [1] I will outline how interdisciplinary teamwork is crucial to determining the appropriate limits and constraints that both produce a malleable and intractable DMI and lead to idiomatic musical gestures that can be used in a composition. Malleable and intractable are used to mean the ease or trouble with which a performer can produce a desired sound. For instance, the recorder and oboe are representative of this opposition (i.e., malleable versus intractable). The malleable recorder offers little resistance due to its extreme sensitivity to changes in air pressure, while a musician may often find the oboe recalcitrant because of the fatiguing nature of maintaining an appropriate embouchure and air pressure while playing at all times. The next three sections deal with the contributions that each member brings to the paradigm.

3.1 Technologists

Engineering and mapping concepts are usually best explained by technologists, although performers and composers also need to grasp the general meanings and implications of these concepts. Technologists can play a major role in bridging any sort of jargon gap, especially if they are able to translate technical terms into musical analogies. For example, latency may be described as a slow speaking instrument or an accompanist who is always behind the beat. What is true of the jargon gap is also true of a performer's grasp of interfacing with a DMI. In an effort to make the interaction between performer and digital instrument tangible, technologists can help performers by designing a DMI whose individual channels of sensor data remain imperceptible and whose playing technique focuses on sound and the relation of sound to the entire instrument.

3.2 Performers

In my own experiences of working with performers, musicians have quickly expressed a desire to have an instrument on which the control over a sound is repeatable with some uniformity in playing technique. Repeatability is integral to what I call a malleable DMI. More precisely, a malleable DMI is one that offers a consistent regulation over (1) sound excitation, (2) articulation and (3) volume. Controlling volume is particularly significant for musicians, who are used to having their control surface attached to their sound. The sonic feedback a musician expects while, say, executing a crescendo on a DMI may seem disembodied and disassociated from the physical playing gesture unless the movement is easy to carry out. A thoughtful placement of loudspeakers is also an obvious requisite. After mastering the malleable aspects, performers usually express a need for control over timbral detail and subtlety – an intractable attribute. Similarly to mastering sound colour control on acoustic instruments, DMI performers must commit themselves to lengthy timbral control training. Their primary goal is to learn how to maintain a sense of morphing or transitioning among different timbral states and not necessarily to learn how to reproduce repeatedly any timbre at the drop of a hat. In this way timbral shading is an intractable attribute that relies on performer proficiency, as well as subjectivity, dictated by musical intelligence, intuition and pure training. Mastering the intractable aspects of a DMI also goes a long way toward helping performers reach high levels of expressiveness.

3.3 Composers

Composers bring their expertise in sound colouring and organisation, in addition to creating meaningful compositional structure and form. They also come with a knowledge of musical instruments that are normally imbued with certain idiomatic characteristics. Through a grasp of the malleable and intractable attributes of a DMI, in combination with an understanding of the importance of idiomatic gesture – musical and physical playing gestures – a composer can fashion the musical material for a piece. This naturally leads to the organisation of the material, culminating in compositional structure.

4. Idiomatic T-stick Gestures

Malleable and intractable techniques are easily illustrated with the t-stick DMI. [2] Throughout the development of the t-stick, idiomatic sound and physical gestures were established and refined. Thrusting and fingering, which are responsible for sound excitation on the digital instrument, are examples of malleable attributes (Figures 1 and 2). Timbral morphing, an intractable attribute, is predominantly a factor of tilting and rotating (Figures 3).

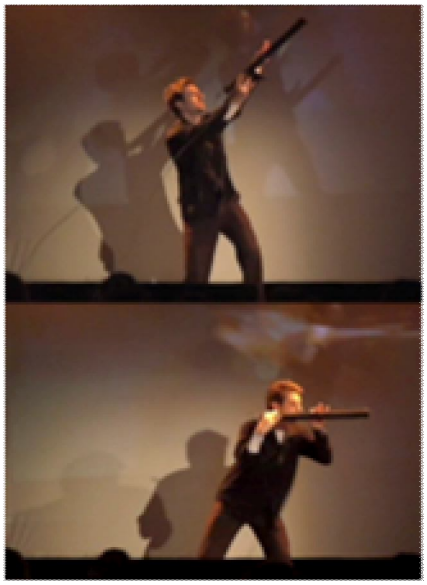

Figure 1. Thrust excitation (malleable). D. Andrew Stewart performing *Everybody to the power of one* (2008).

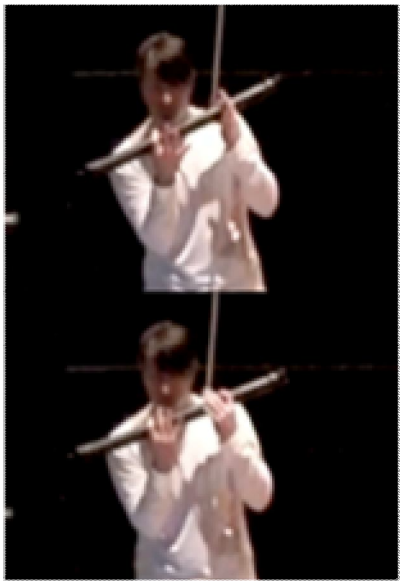

Figure 2. Finger excitation (malleable). D. Andrew Stewart performing *Everybody to the power of one* (2008).

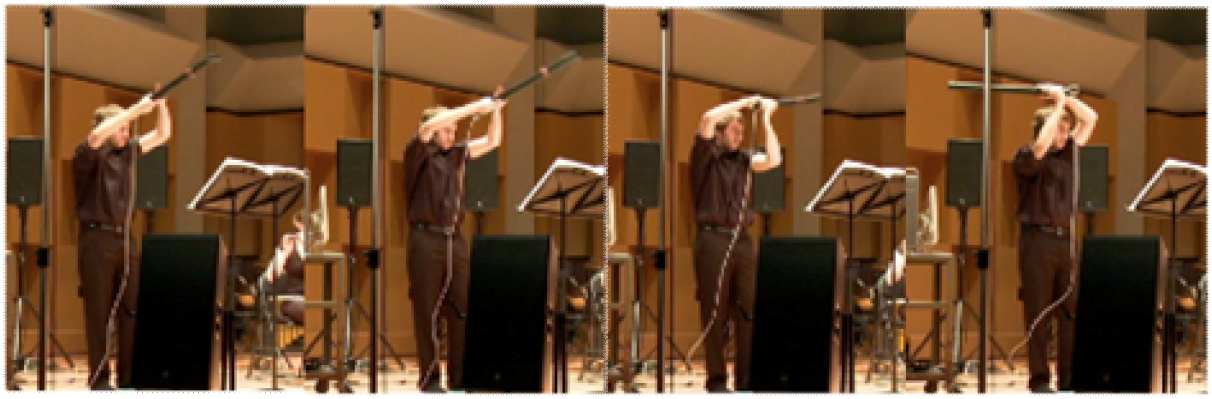

Figure 3. Lassoing (intractable). Eric Derr performing *Catching Air and the Superman* (2009).

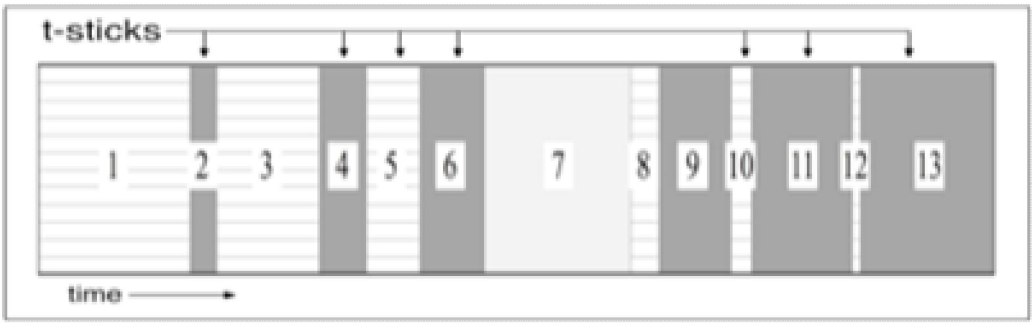

Figure 4. Proportional view of the sections of *Catching Air and the Superman*.

4.1 Compositional Idea

The idiomatic treatment of two t-sticks occurs in my composition, entitled *Catching Air and the Superman*, and subsequently helped me to organise the structure of the work. On a very basic level, this piece is about the confrontation between strongly articulated chords, which metaphorically represent the Superman, versus sustained textures that represent Air. As the work progresses, the chords and chordal sections are dominated by sustained tones that comprise complex motion and growth patterns (i.e., the Air gradually overcomes or smothers the Superman). A quick glance at a proportional representation of the structure of the work illustrates how the t-sticks are less present at the beginning and gradually become more involved as the piece progresses (Figure 4). This is because I primarily wanted to associate the DMIs to complex, sustained motion and growth, thus, the t-sticks are the vehicles through which Air takes over.

5. Performance Practise

A composer can more effectively imbue his/her music with a sense of structure by defining and enforcing performance practises on a DMI. The next three sections suggest approaches to three types of performance practises in relation to a DMI.

5.1 How We Move

In this section, I give a simplified overview of a three-step process for defining how one might move with a DMI. Firstly, one begins by experimenting with actions that come naturally, intuitively and ergonomically. Data acquisition may be implemented at this stage, allowing one to chart, list and rate activity levels of specific sensors, as well as compare global movements to individual sensor activity. Secondly, one should consider DMI movements in relation to the real-world. A DMI may be perceived as having some innate connection to an object or culturally embedded technology of the outside world. As a result, we must consider the extent to which limits and constraints are imposed or presupposed by the appearance – geometry and dimension – of the instrument. Moreover, one must ask whether the manipulation of the instrument evokes any common praxis: agrarian, fashion, military, musical? Lastly, one defines DMI movement by enforcing an instrument-specific playing technique. A well-defined playing technique not only makes for an identifiable DMI, but also goes a long way in helping an audience to understand any attempt at expressiveness by the musician.

5.2 How We Sound

The timbal consistency of acoustic instruments is the inspiration for defining how we sound with a DMI. In the case of acoustic instruments, their physical properties are essentially responsible for how they sound. Taking into account timbral consistency, I propose a threefold procedure for creating DMI sound. Firstly, a source sound is created. A source sound has easily perceivable and clear onset and termination attributes. Furthermore, the sound's sustain or continuant segment is relatively consistent without a complex textured interior. Secondly, numerous variants of the

source sound are synthesised by incrementally modulating the parameters of the synthesis algorithm. Similarities among the variants and their respective source sound are maintained along two directions. One set of variants maintains the structural attributes of the source sound while the other group of variants has altered structural properties but retains a transformational resemblance to the source sound. Generally speaking, variants are perceived as more complex than their source sound. Thirdly, morphing or modulation paths among variants and source sound are implemented using the synthesis software. Performers are able to access any point along a morph path while playing. This presupposes that the software allows for such an implementation.

5.3 What Spaces We Inhabit by Moving and Sounding (Sound-Gesture Combinations)

The spaces we inhabit by moving and sounding can be understood as the places, rooms and concert halls in which DMIs are played. In this section, however, I discuss the spaces we evoke and simulate – the metaphorical spaces created on-stage by the performer through a co-ordination of physical gesture and sound. This is standard fare in *acousmatique musique* composition, during which a multi-dimensional space is simulated through the compositional organisation of sounding objects and landscapes. In addition, evoked, simulated and metaphorical space is a product of acoustic instrument compositional thought. Gilbert Rouget, in his work on music and trance, suggests that the sounds of, say, nature, bring us information on the movement of nature, just as human sounds inform us of our own presence and tell us something about our activities within a space. [3] Consider these aspects of sound-gesture in relation to the following implementations of digital instrument technology.

Figure 5. Performance of *Ex asperis* (2008) by Sean Ferguson, McGill Contemporary Music Ensemble, Denys Bouliane (conductor), Chloé Dominguez (violoncello), Fernanda Rocha (data-gloves)

6. Data-gloves and Polhemus Motion Liberty Tracker: *Ex asperis* (2008)

Movement, sound and space are intrinsically combined in Sean Ferguson's *Ex asperis*, from 2008. The title is a truncation of *Dulcius ex asperis*, meaning through difficulty, comes sweetness. It is composed for solo violoncello, data-gloves, polhemus motion liberty tracker, chamber ensemble and a two-stratum twenty-four-channel sound spatialisation system. *Ex asperis* is important to my discussion because of the gesture-controlled spatialisation of sound, primarily regulated by a data-glove-playing spatial conductor, who is positioned up stage on a podium (Figure 5). The composer does not actually consider the combination of data-gloves and polhemus as a DMI in this context. However, in my view, the thoughtful gesture-to-sound mappings and the placement of the performer – floating above the ensemble – points to the gloves idiomatic digital instrument role. The spatial conductor directly controls the positioning of single sounds or sound groupings in real-time through pinching or grabbing gestures. [4]

6.1 Compositional Idea

Ex asperis is in three movements. The composer has suggested that the outer movements have a great degree of gravity, while the second movement represents a state of weightlessness. Furthermore, the perception of gravity has the effect of drawing the audience's attention to the performance on stage, as if the actual concert hall were metaphorically slanting downward toward the stage. This gravity analogy is conveyed through the materials and structure of the piece. For instance, the outer movements consistently contain ensemble gestures whose linear contours, accompanied by sudden crescendos, depict a sense of both agglomeration and simultaneous convergence, as if all instruments were being pulled to a single source of gravity. The second movement, on the other hand, is weightless. It is the only movement with the data-glove-playing spatial conductor. Consequently, the action-response relationship between the physical gestures of the spatial conductor and sounding result has the effect of shifting the centre of concert hall gravity away from the stage back into the audience, as if the concert hall space were slanted toward the rear of the hall. In this way, the idiomatic presence of the gloves as a DMI strengthens the composer's concepts of gravity within the composition.

7. Silent Drum: *Flotante* (2007-08)

Inhabiting space through movement and sound is central to Jaime Oliver's *Flotante* (2007-08) for solo percussionist. The composition successfully integrates percussion instrument timbres and sound synthesis controlled by the silent drum. [5] According to the composer, electronic and acoustic sounds in *Flotante* behave organically as they weave into a single line of performance. The composition is also a good example of how we might inhabit space. First, the timbres are predominantly metallic and resonant, covering a large frequency or spectral space. Generally speaking, this tends to evoke a perception of large open areas for the audience. Second, the stage set-up of the work entails placing the vibraphone and silent drum next to each other along the floor, while gongs are hung perpendicularly to the floor (Figure 6). The composer views this configuration as interacting along horizontal and vertical axes. That is to say, he is concerned with the sounds of the instruments in relation to the movement trajectories necessary to perform these sounds.

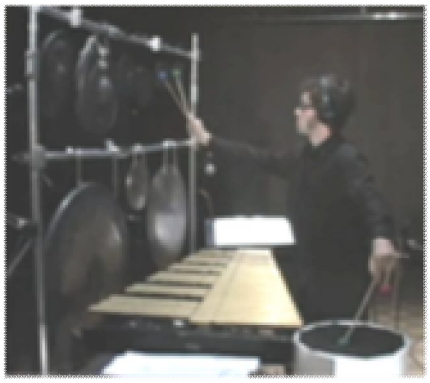

Figure 6. Performance of *Flotante* (2007-08) by Jaime Oliver, Mathew Jenkins (percussion and silent drum)

7.1 Compositional Idea

Flotante can be broadly described as having three sections following an ABA form. In the outer sections, the percussionist plays the silent drum and adjoining percussion instruments. Resonant and metallic tones predominate while the silent drum adds sound colouring. The middle section, on the other hand, is for solo silent drum and roughly recalls the metallic timbres of the first section, but without the long reverberation time. The ABA form, thus, could be characterised as beginning in a large room or hall, moving to a smaller space, and then back to large.

8. Compositional Model

A composer's job is to put limits and constraints into play by way of his/her understanding of idiomatic instrumental gestures and the possibilities of originating material through these gestures, subsequently moulding compositional structure. This is something Pierre Boulez hinted at in 1977: "Musical invention must bring about the creation of the musical material it needs; by its efforts, it will provide the necessary impulse for technology to respond functionally to its desires and imagination". [6] In the following sections, I briefly detail four constituents of a compositional model that encourages composers to think about the stages of implementing limits and constraints while working with digital technology.

8.1 Studying and Training

The composer trains with the DMI, preferably within the context of an interdisciplinary group described above. The composer's engagement with the DMI results in an active and rigourous approach to music-making. Moreover, he/she quickly grasps the idiomatic nature of a digital instrument.

8.2 Realising Compositional Idea/Thought

The composer realises his/her compositional ideas while accounting for active on-stage music-making with the DMI, meaningful visual gestures – possibly suggesting a musico-theatrical work – and the sound-gesture co-ordination versus any compositional goals of delimiting space.

8.3 Structuring Material Leading to Compositional Form

Structuring a musical work for a DMI is similar to organising the material for any creation (e.g., *acousmatique musique* or Classical chamber music). Some possibilities for structuring material have been discussed above in relation to the compositions *Catching Air and the Superman, Ex asperis* and *Flotante*.

8.4 Transmission and Reception

The composer determines the most effective way of implementing limits and constraints in regards to how his/her musical gestures will be transmitted to, and received by, both the performing musicians and an audience. At this stage, for example, the composer strictly defines a system of notation for the DMI.

9. Conclusion

Placing compositional idea/thought as the primary directive is fundamental to my process on integrating technology and the compositional project. The technological aspects of a composition should not play a lesser role than the project. Nor is the electronic technology subordinated to the project. Instead, I maintain the compositional project as a primary concern while weaving technological elements into it. In particular, I look for ways in which the limitations of project and technology come into direct conflict. In fact, it is the confrontation of limits and constraints imposed by technology, on the one hand, and the compositional project, on the other, that serves as the material for this musical composition and, at the same time, unites them both.

10. Acknowledgements

I wish to extend my gratitude to those musicians – those performing and scientifically-minded musicians – without whom the outcome of my work would have been much less enriching, and surely meagre in comparison to the advancements we made as an interdisciplinary team while working at the Centre for Interdisciplinary Research in Music Media and Technology (McGill University), as well as the centre's satellite studios and laboratories.

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