FROM INPUT TO OUTPUT: HARNESSING HARDWARE IN MIXED PERFORMANCE

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Abstract: **At the core of this paper is the notion of hardware as compositional material and sound engineer as performer, specifically in the practice of electro-instrumental (mixed) performance. The key issues that I aim to examine are the practical matters surrounding the performance of mixed music, which information is best communicated prior to performance and how this can be done. I explore the impact of hardware and venue architecture on performance and remark on some existing communication issues regarding musical intention. I then present various case study documents, addressing some of the points that I have examined and exploring feedback from practitioners in the field.**

1. INTRODUCTION

> "Today's loudspeaker is a great anonymous pulveriser of sound that does not measure up to the means which have been developed to create a new sonic world."[1]

Thirty years on and Boulez' words still resonate for a large number of mixed performances. Perhaps though, the loudspeaker is now a scapegoat for more ingrained communication issues in the mixed music community. As composers and performers we spend a considerable amount of time perfecting the inner nuances of software interaction and practising our instruments attentive to minute details, yet mixed performances still so often appear "pulverised", lacking in precise projection. Reflecting this is a comparative lack of literature surrounding the performance of mixed music, particularly regarding musical elements are relayed for clear sound projection.

The presentation of mixed music is a tough discipline. First, we are dealing with live sound, held at the whims of microphones, loudspeakers and other diverse forms of soft and hardware in between. Second, sound is emanating from *two different media*, acoustic instrument(s) on the one hand and some form of loudspeaker setup on the other. We are presumably attempting to form a unified piece of music with them, yet the varieties of setup are far from fixed and therefore difficult to anticipate. Third, and most importantly, all these factors are bound to the physical spaces in which they take place. Each venue carries with it its own hallmarks, its own layout, social conventions, possibly sound engineer and other architectural idiosyncrasies that can be impossible to predict until hours before the performance. In this paper I try to examine how these musical situations can be successfully managed through clear and informed communication on one side, and a flexible approach to performance on the other.

Whilst there isn't a huge amount of literature surrounding this type of performance, it is not to say that there has been no attempt at discussion. Recently there seems to be more interrogation of the actual performance of computer music, with some more specialised discourse about mixed music in particular. The notion of musical performance as an ecosystem highlights an area previously overlooked regarding physical space and hardware as *embedded musical parameters*. DiScipio [2], Waters [3], and Green [4] survey this landscape particularly well, with Di Scipio's *Background Noise Studies* using feedback loops between microphone, space and loudspeakers as sonic flag posts of their own presence. No longer is there the tacit assumption of neutral devices and a simple transplantation of music from one space to the next. Each space, stage and venue carries with it its own characteristics which are ultimately embedded in each performance.

With all this in mind, two questions I would like to address in this paper are: how can you first provide enough third party information for mixed music to be realised to the best of your intentions? And how can the variances of particular venues be best allowed for in mixed music? One answer to each lies in the flow of succinct and clear communication between *all parties* involved in the music. In other words musical collaboration through technological documentation.

2. MIXED MUSIC: WHAT ARE WE COMMUNICATING?

Before we dicuss *how* communication can be achieved, understanding *what* is being communicated is crucial. It should be noted that the setup documents I present, particularly the textual description of the interaction, are related to composed music, and therefore has the privilege (or curse) of quite specific temporal information. Improvisation systems need further examination, and are not in the scope of this paper.

In previous presentations I explored with some depth ways that instrumental material can be treated in attempt at the elucidation of musical form, with a key focus being realtime software that behaves in a perceptually coherent way with this material. I began with solo instrument and computer, examining individual note qualities and their extrapolation into a larger musical timescale, how meter, spatial location and harmony can all affect our perception of the whole (or its parts). I then moved on to the consideration of the ensemble as *acousmatic landscape*, surveying the notes by ear through the lens of acousmatic analysis, drawing heavily from the work of Denis Smalley [5] and Albert Bregman [6]. Smalley's work draws acousmatic syntax away from the solely abstract organisation of material through the study of different spaces as musical parameters, with musical analysis extending to the physical characteristics of performances.

As reflection on mixed music has increased, the role of the computer in performance has also emerged as another type of musical parameter with Croft [7] and Frengel [8] proposing fairly defined categories of behaviour. Croft [7] proposes five paradigms that describe the relationship between instrument and computer, whereas Frengel introduces a *multidimensional framework of relations*, consisting of nine separate compositional axes. These extend to practical considerations on a *pragmatic axis*, with the inclusion of hardware and software choices as key musical decisions.

Axis	Type	Action
Segregational	Mono morphological	Light Processing
Proportional	Live Weighted	Reactive patch
Temporal	Synchronous	Metrical
Timbral	Similar	From Instruments
Behavioural	Singular	Score following
Functional	Instrumental extension	Musical emphasis
Spatial	Fig. 3	Quad speaker setup
Discursive	Analogous	Gesture/gesture
Pragmatic	Sound as interface	Reinforcement

Table 1: Frengel's Multidimensional axes template for *Labyrinths, Movement I*

Using these frameworks incorporates relationships between musi-

cians, technology and performance environment into the compositional process. This is relevant to performance because it equips the composer with knowledge that can be usefully dispersed further on in the making of the music.

So to return to *what* we are communicating. In my experience, early compositional choices regarding interaction in mixed music have also become the most useful thing to communicate. In other words, the process by which these musical parameters have been reached are the best descriptors for behaviours to expect in a performance situation.

3. How can we communicate?

Scores and additional performance materials

Whilst developing my practice I have been examining extra score material to provide to performers, sound engineers and gig organisers in order that we have as much mutual understanding as possible about the musical situation. Providing information to performers in the score via simple symbols and extra audio files, references to tempo, meter and so on can be considered as separate from what a sound engineer may require. Though it is most helpful for everyone to have all the different forms of direction, each stakeholder necessarily seeks detail in different places. *Stakeholders in this paper refer specifically to composer, musicians, sound engineers, stage technicians and venue management.*

As discussed earlier, a high degree of compositional precision regarding interactions between instrument and computer means the composer already knows how they have programmed the software to behave in performance, the aforementioned *what*. *How* this information can be exchanged changes from performance to performance. As I am focussing on music with scored notation, there is an assumption that there has already been a single translation stage at which performers are provided notes and the necessary information on the forms of interaction that occur, types of sound that might arise and when this happens. However, this type of score embedded with details on interaction often doesn't serve as a particularly useful document for *all* stakeholders - not least because information spread over 20 pages in a score can most likely be distilled into a much briefer record that is more relevant to the projection of sound.

A score for a musician, with notation related to each separate technique, is a document that can hold specific indications of the desired sound world. To this musician, information in the notation often relates to nuanced expression *involving their instrument*. However, it is debatable that a document for a sound engineer need contain this level of prescription. There are alternative ways to communicate the quality of the sound world and how it changes through time.

Consequently, I have assembled a shorter collection of setup documents that contain relevant information about what I deem to be the most important and recognisable qualities and interactions within the music. This goes beyond physical signal flow and speaker layout to more descriptive vocabulary about what they can expect as the music is performed, as well as my musical intention with the qualities of the sound. I find this is particularly important with multi-movement works that shift greatly in character from movement to movement, as it allows a sound engineer to treat the sound as they wish from this more informed perspective. Further media can also extend to audio demonstrations and pointers to previous performances.

4. Hardware as compositional parameter?

In the previous section I began to explore my first question, related to the provision of information to each stakeholder. The second relates to the characteristics of each performance venue, and their influence on the behaviour of the sound - all part of the oft referred to *performance ecosystem*. Again, there is a growing body of writing related to the loudspeaker as an "active" musical participant ([9], [10]). There's also some particularly interesting research into its incorporation as a compositional parameter with Tremblay et al [11] importing acoustic properties of concert hall (via impulse responses) into the studio for a more informed compositional process.

Detail from the outset regarding desired PA and setup is most important, not necessarily because you will be guaranteed what you request, but rather because you will give a full idea of the way you want to project your sound. That way the sound engineer can on the one hand work with what they have, but on the other hand have the best chance of projecting a a sound world as close to concept as possible. Likewise detail regarding input of instruments, as well as signal flow in and out of the mixing desk is a highly evolved practice, with some established and accessible syntax.

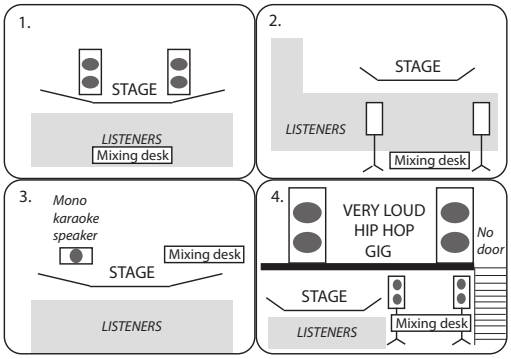

Figure 1: 4 Performance Situations

Green [12] suggests that technological stipulations should be considered useful but perhaps not requisite. Whilst wanting your favoured setup to be as clear as possible, should this not be realised unnecessary performance stresses can still be kept at bay by arriving at the venue equipped with some practical coping strategies. This is certainly an approach that I have adopted considering the different venues that I have performed at. Site visits are often not viable, and Fig. 1 reflects a few of the varied performance settings that I've been presented with on the day of the gig. In other words it seems that the idealism of a perfect layout combined with a healthy pragmatism regarding setups in a variety of venues is a robust starting point.

4.1. Textual Description

Textual descriptions are also a valuable tool to help communicate how you want the loudspeaker to sound. For example, in much of the discourse surrounding mixed music, there seems to be some collective pursuit towards an understanding of balance between amplified instruments and electronics. Arguably a prominent feature in textual information can be found in one of Frengel's axes, *live weighting* [8], which approaches the the amplification of sound as a compositional parameter, similar to Mulder's *Levels of Amplication* as musical function [9]. This can be found on a continuous rather than discrete scale, and description of how this changes over time places can be an extremely efficient communication tool, effected in a single line of text (see Fig. 5).

5. The venue and its social architecture

The architecture of the venue isn't only physical, and awareness of where responsibility for different elements of the music lies can lead to the most efficient communication documents. Splitting information into sections including technical rider, separate layout and signal flow documents and finally an aesthetic description means that venue management, sound engineer and musicians can quickly understand the particular demands of the music *on them*.

Two way communication is necessary for a mutual understanding of the exact performance context, prior knowledge of what is to take place will give the venue manager the opportunity to flag up any potential issues. However, this level of investment into the music isn't always guaranteed and what is clear is that when communication within the venue is clouded, the performance often suffers for it.

5.1. Space and amplification

In his paper *Functions of Amplified Music* [13], Mulder draws attention to Theo van Leeuwen's [14] ideas on how social spaces can be sonically encoded, in order to reflect on out how microphones can transcend physical distance in performance. Related to this, physical responses to a space can also overcome problems with amplification. This was exemplified in our experience with a noisy neighbour (see Fig. 1, box 4), where we were unable to compete with another gig. This prompted the movement of the audience closer to us, shifting the listening space to enhance their experience of the music. Being unable to properly amplify the sound changed the social distances at play; the architecture of the venue forced a modification in the structure of the social space, allowing for some leeway in the strength of sound that the audience were able to hear. The listener's response in restructuring the environment at the time felt appropriate, in another performance space they may have felt too close.

This experience first emphasised the necessity for a more dynamic software response to the architectural demands of the performance. More importantly however, it demonstrates the limitations of any document: though information to a sound engineer before the event could flag up warnings to potential conflicts, often these situations don't arise until the performance of the music has begun. No set of performance documents is infallible.

6. SETUP DOCUMENT

CASE STUDY, *Labyrinths*

Having previously established the requirements of various setup documents, I will now go through a set of these in detail. *Labyrinths* is a four movement piece for string quartet and computer, featuring live electronics through a set of bespoke Max/MSP patches. Each movement has its own flavour and forms of interaction, the role of the computer and sound qualities are quite distinct. I formed the computer part based largely on Albert Bregman's perceptual theories on the Auditory Organisation in music [6], specifically how we group sounds, and have documented the proposed interaction loosely based on Michael Frengel's *multidimensional axes* for mixed music [8].

6.1. A general description

Target stakeholders: Venue management, sound engineer, musicians

Labyrinths, for string quartet and computer is a four movement work exploring different musical spaces inspired by short stories of Jorge Luis Borges. The preferred listener's vantage point is from within a quadraphonic speaker layout, either surrounding the ensemble or with a more usual stage and listener setup (see Fig. 3 for layout). The intention of this is to engulf the listener in each environment, with light amplification of each instrument and light processing creating tricks of perception as to which voice each sound belongs. Instructions regarding the mood of each movement can be found later on in this document, as variable amounts of reverberation, delay and compression are intended for each differing movement.

This paragraph - though technically vague - gives each stakeholder a feel for some general intentions for the piece, whilst also explaining why certain requirements (e.g. A quadrophonic speaker setup) are important to the fabric of the piece. This makes sure that emphasis is placed on the most important aspects of the music.

6.2. Technical requirements, Fig. 2

Target stakeholders: Venue management

Tech riders, perhaps the most general requirement for technical communication when it comes to gigs, can often appear patchy and incomplete. As discussed above, heavy detail - even if not realisable - can at least provide a good idea regarding overall intentions for the sound projection. Even going into the level of detail such as types of connections will preempt any problems with missing equipment on the day.

Tech Rider:
Labyrinths for String quartet and computer

Supplied by musicians:
4 x DPA 2060 microphones
All firewire and MIDI cables
1 X RME Fireface
All MIDI interfaces (if needed)

Venue must supply:
1 x table (12ft x 4 ft) for computer
5 x chairs
4 x music stands (with lights)
12 x XLR cables
2 x 4 way power supply
PA (EAW system favoured)

Speaker position:
Please see attached layout

Loudspeakers		4
Subs		1
Stage Monitors		2
Ensemble microphones		4 (supplied by us)
I/O	Mixer ins	1 - 4: 4 x DPAs from Quartet 4 - 8: 4 x TRS from Computer
	Mixer outs	1 - 4: To PA 4 - 8: Quartet DPAs To Computer 9 - 10: Monitors 11 : To sub

Figure 2: Tech rider for *Labyrinths*

6.3. Setup document: Stage setup, Fig. 3

Target stakeholders: Venue management, sound engineer

A lot of detail can be placed into a graphic representation of the arena space, including direction of speakers, position of listeners, musicians, mixing desk, position of onstage power and DIs and types of microphone. There are also some standardised graphics to represent different forms of hardware, such as graphics related to microphones, loudspeakers and mixing desks.

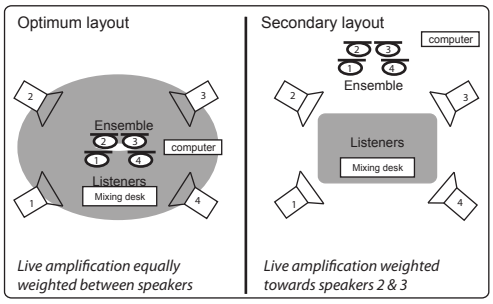

Figure 3: Stage setup document

6.4. Setup document: Signal flow, Fig. 4

Target stakeholders: Venue management, sound engineer

A separate document related to the signal flow of the piece clarifies any doubt over what you intend to project and where it should be sent. References to instrument reinforcement and monitoring can also be located here.

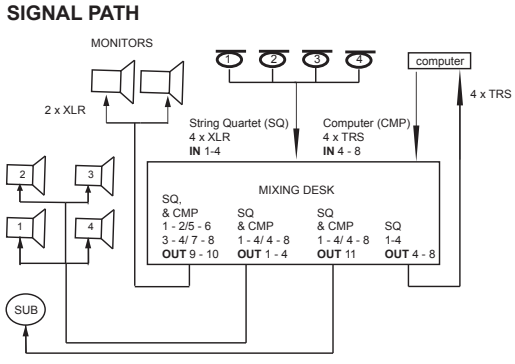

Figure 4: Signal flow for all movements

Signal flow from *within* the mixing desk also ensures further precision.

6.5. Textual information, Fig. 5

Target stakeholders: Sound engineer

This is where the more detailed information documenting modes of interaction and aesthetic preferences can be found. The information in this document can be drawn directly from decisions made at the beginning of the composition process, in my case based around Frengel's multidimensional axes, see Tab. 1.

Information can be extrapolated from this and communicated in clearer textual form. In Fig. 5 I have chosen to highlight certain types of information. First, I state what type of material will be heard in the computer part, in order to stop disparate musical elements being confused for "mistakes", for example a synthesiser sounding like feedback. I document where the balance lies between instrument and electronics from movement to movement, which isn't always static, whether the patch is tempo synchronous or not, what role the computer is inhabiting and finally a general indication of intended dynamics and quality of the sound.

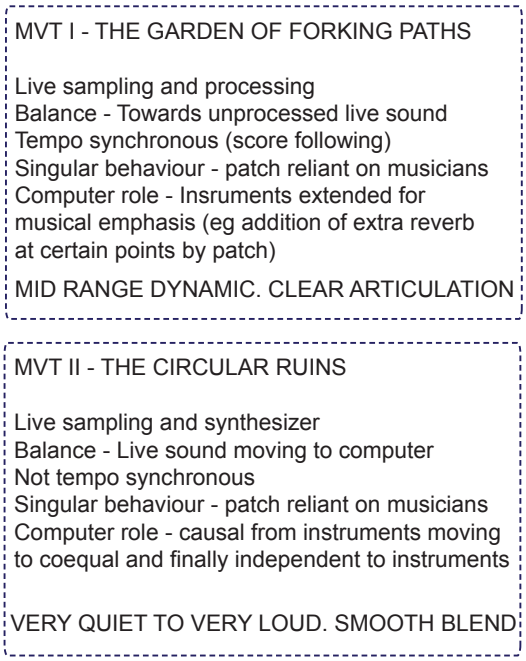

Figure 5: *Labyrinths* Movement I and II, textual information

This sort of information is important because if there are points in the music where it isn't clear that the musicians and computer are meant to be interacting in a certain way, for instance with the computer part becoming louder than the amplification of the instruments in *The Circular Ruins*, then the sound engineer may take unnecessary steps to counteract this specific intention. Explaining what you are expecting to hear gives the sound engineer the freedom to focus their skills on bringing out the best in the music, rather than spending their time guessing whether something is meant to be there at all.

7. Conclusions

Methods for the communication and staging of mixed music will always be in a state of development. Each performance will throw up a variable that was different to the last. However I have attempted here to cover eventualities that I am able to foresee through research into other composers' work and collaboration with sound engineers regarding the best ways of presenting information. I have done this through a set of documents containing general textual description, tech riders, stage and hardware layouts, signal diagrams and brief description of aesthetic intention.

Understanding that music is a finely balanced network of many different activities, including factors completely beyond compositional control helps to manage if not specific problems, then at least identify certain types. The documents presented in the paper demonstrate my response and rationale to these issues, including varying levels of detail for different parties involved in the performance. It should be stressed that this often boils down to individual preference, indeed some people I consulted suggested more detail and some less in the documents. For me the crucial points are clarity and flexibility - the documents are detailed with different levels of focus directed to different individuals, coupled with some pragmatic software and hardware responses to a variety of situations.

What underscores all of this work is that the presentation of mixed music is built on a number of dialogues between different parties, and that without a shared understanding of what is to take place, the loudspeaker often unnecessarily remains a *great anonymous pulveriser*.

8. Acknowledgements

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References

[1] P. Boulez: *Timbre and composition - timbre and language*. In *Contemporary Music Review*, volume 2(1):161–171, 1987.

[2] A. DiScipio: *Sound is the interface: From interactive to ecosystemic signal processing*. In *Organised Sound*, volume 3(8):269 – 277, 2003.

[3] S. Waters: *Performance Ecosystems: Ecological Approaches to Musical Interaction*. Electroacoustic Music Studies Network Conference, 2007.

[4] O. Green: *Pondering Value in the Performance Ecosystem*. In *eContact!*, volume 10(4), 2008.

[5] D. Smalley: *Space-form and the acousmatic image*. In *Organised Sound*, volume 12(1):35 – 58, 2007.

[6] A. Bregman: *Auditory Scene analysis: The perceptual organisation of sound*. MIT Press, 1994.

[7] J. Croft: *Theses on Liveness*. In *Organised Sound*, volume 12(1):59 – 66, 2007.

[8] M. Frengel: *A Multidimensional Approach to Relationships between Live and Non-live Sound Sources in Mixed Works*. In *Organised Sound*, volume 15(2):96 – 106, 2010.

[9] J. Mulder: *The Loudspeaker as Musical Instrument*. New Interfaces for Musical Expression, Sydney, Australia, 2010.

[10] S. Emmerson: *Living Electronic Music*. Ashgate, 2007.

[11] N. B. Pierre Alexandre Tremblay and S. Pohu: *Thinking Inside the Box: A New Integrated Approach to Mixed Music Composition and Performance.* International Computer Music Conference, Montreal, 2009.

[12] O. Green: *User Serviceable Parts: Practice, Technology, Sociality and Method in Live Electronic Musicking*. Ph.D. thesis, City University London, 2013.

[13] J. Mulder: *Functions of amplified music: a theoretical approach*. International Congress of Acoustics, Sydney, Australia, 2010.

[14] T. V. Leeuwen: *Speech, music, sound*. Macmillan, Hampshire, UK, 1999.