Designing the EP trio:
Instrument identities, control and performance practice in an electronic chamber music ensemble

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ABSTRACT

This paper outlines the formation of the Expanded Performance (EP) trio, a chamber ensemble comprised of electric cello with sensor bow, augmented digital percussion, and digital turntable with mixer. Decisions relating to physical set-ups and control capabilities, sonic identities, and mappings of each instrument, as well as their roles within the ensemble, are explored. The contributions of these factors to the design of a coherent, expressive ensemble and its emerging performance practice are considered. The trio proposes solutions to creation, rehearsal and performance issues in ensemble live electronics.

Keywords

Live electronics, digital performance, mapping, chamber music, ensemble, instrument identity

1. INTRODUCTION

Formed in late 2009, the EP trio is a small ensemble dedicated to research, creation, and performance in live electronic music. The trio is comprised of a unique combination of commercially available electronic instruments and equipment: electric cello with sensor-enabled bow controller and volume pedal, digital drum kit augmented with real-time DSP controller and amplified acoustic percussion, and digital turntable-based electronics. The group is focused on artistic applications of existing technologies within an ensemble framework.

In designing individual instrument identities and forging relationships between them, the EP trio draws on both Western classical chamber music (e.g., piano trio) and rock / pop / jazz "band" models. Sonically, the group blends contemporary electroacoustic and electronic music aesthetics. Its initial aim was to establish a streamlined set-up for small ensemble live electronic performance, emphasizing musical flexibility and technical self-sufficiency. By working within a partially fixed medium (i.e., fixed hardware and software), the trio explores this framework in depth, experimenting with various approaches to achieving compatible instrument control capabilities, sonic identities and gesture-sound mappings. This paper presents the challenges met by

the EP trio in the creation of new repertoire and emergence of a performance practice for an electronic chamber music ensemble [2] [3] [8] [9].

2. ESTABLISHING SET-UP AND CONTROL CAPABILITIES

R. Murray Schafer coined the term *schizophonia*, meaning "split sound", to describe the disconnect between original acoustic sounds (i.e., those coupled to their physical production mechanisms) and their reproduction in other times or places [10]. The instruments of the EP trio possess highly contrasting sound (re)production and manipulation capabilities – they are *schizophonic* to varying degrees and in different ways. Thus, a challenge facing the group was to design instrumental set-ups that provide the expressive musical control and interaction possibilities necessary to function as a cohesive ensemble.

2.1 Individual Instrument Set-ups

Miranda and Wanderley define a digital musical instrument (DMI) as having three components: a sound source (synthesis), an interface (sensor input), and a mapping configuration relating these two [6]. The EP trio has carefully selected and combined newer and established commercially available equipment to enable diverse and complementary sound creation and control capabilities for each of the three performers. In the cello and percussion set-ups, the group sought to greatly expand the sonic palettes of acoustic instruments while utilizing many aspects of acoustic performance techniques. This section outlines the hardware and software employed by the EP trio and the reasoning behind these decisions.

2.1.1 Cello Set-up

The cello set-up is built around a Zeta Strados electric cello, chosen for its sound quality. Its active preamp is powered by a StringPort Polyphonic Stringed Instrument to USB2 Converter [4] that sends a polyphonic audio signal to a laptop. The cello is played with a K-Bow, a wireless sensor-bow that measures several bowing parameters and communicates via Bluetooth to the K-Apps software[1] [5]. Measured bowing parameters are: grip force, hair tension, 3D acceleration and tilt, and length and distance from IR and RF emitters, respectively, attached under the cello fingerboard. The K-Bow is a gestural controller and becomes a DMI when its sensor input is mapped to a sound source: it may be used to control processing and playback of live audio and/or samples in K-Apps. The K-Bow/K-Apps thereby adds an extra

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[1] K-Bow and K-Apps Manual: www.keithmcmillen.com

layer of gesture-sound control capability to the cellist's performance. Every bowing gesture may perform two tasks, controlling not only sound production on the cello but also continuous processing parameters. This presents significant mapping and compositional challenges, which are addressed in 3.2.2 and 4.

The limited amplitude range of the electric cello was initially problematic in the ensemble. A Roland EV-5 Expression Pedal[2] was added as a volume controller to expand dynamic range and enable abrupt changes, allowing the cello to better match the ADSR (i.e., envelope) characteristics of the turntable and V-Drums. The volume pedal controls the main output of the K-Apps software, attenuating the audio signal sent from the cello set-up to the mixer.

2.1.2 Percussion Set-up

The percussion set-up is built around a 4-piece Roland V-Drum kit[3] with a TD-9 sound module used as a MIDI interface. This V-Drum kit was selected because it is portable, reliable, and provides tactile feedback similar to acoustic drums. Samples are triggered by velocity-sensitive drum pads and processed by a laptop running Native Instruments' Kontakt sampler[4]. Various DSP parameters are mapped to the sliders and knobs of a Korg NanoKontrol[5]. This set-up allows the percussionist to activate and modify samples in an intuitive and precise manner.

V-Drum cymbal pads are replaced with acoustic cymbals. This set-up is augmented with small, resonant acoustic percussion instruments (e.g. bowed crotales), amplified to suit the performance space and processed by the turntablist at the mixer (see Figure 1). These modifications provide acoustic sound options that expand the percussion sound palette and are often used to enhance blend with the cello sounds.

2.1.3 Turntable Set-up

The turntable set-up consists of a Pioneer CDJ-1000 MK3[6] digital turntable and an Allen and Heath Xone 92 mixer[7]. The CDJ-1000 MK3 was selected for its robustness, portability, and wide feature set. Its control features are modeled on those of standard vinyl turntables, including touch sensitive platters, master pitch/tempo controls and brake. The CDJ also has adjustable brake speeds, reverse, and expanded pitch range and cue options, which enable greater manipulation of audio materials.

Manipulating and mixing multiple sound sources in real time is the core of DJ performance practice. In the EP trio, the cello and percussion set-ups take the place of additional turntables that might be routed to the mixer and adjusted by the turntablist. Musical use of EQ, cross fading, mixing and effects processing, applied to the ensemble as a whole, help to achieve balance and blend, resulting in a cohesive ensemble sound.

2.2 Ensemble Set-up

Figure 1 depicts the hardware set-up and signal flow of the EP trio. The dotted line represents a Bluetooth connection.

2.2.1 Ensemble Sound Scheme

As shown in Figure 1, sound is mixed within the ensemble (by the turntablist) and a single mix output as a stereo

signal to both house and onstage monitors. This decision was motivated by the desire for technical autonomy (i.e., no need for a sound person); the trio retains control of onstage monitor levels. Decisions not to use individual mixes, headphones, or spatialized monitors were prompted by performers' wishes to keep physical set-up simple and to hear the same mix as the audience, thereby developing control of their own sounds as part of the ensemble (much like an acoustic chamber group). These choices present major implications for the design of individual instrument sounds, identities and roles within the group, and their means of control – sounds must be reasonably distinct and performance gestures clear (as noted in Donald's previous ensemble DMI performance experience)[9].
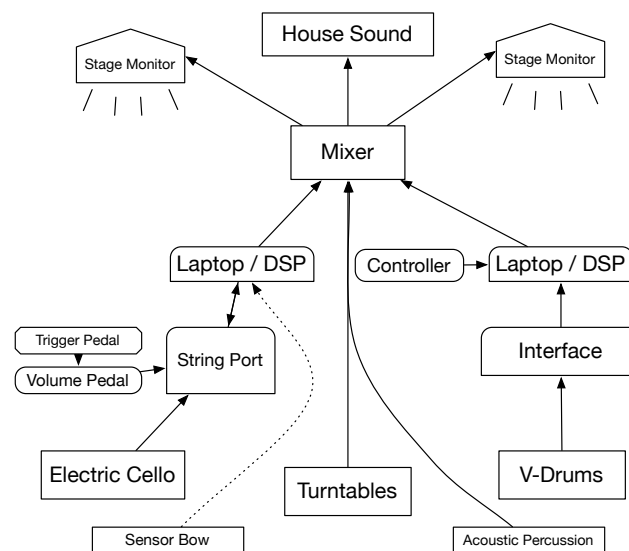

Figure 1: EP trio set-up and signal flow.

3. CREATING INSTRUMENT AND ENSEMBLE IDENTITIES

Individual instrument identities, and roles within the EP trio, are dependent on decisions relating to all three components of DMIs described by Miranda and Wanderley. These are: the physical interfaces and control capabilities they afford; the sounds produced, whether inherent (acoustic) or assigned (sampled, synthesized or processed); and the mappings between the two. The fixed set-up of the EP trio was described in the previous section. In the present section, the contributions of sounds and mappings to the development of instrument identities and roles, and finally the emergence of an ensemble performance practice, will be considered.

3.1 Instrument Identities and Mappings

In a context where each of the instruments can sound like (almost) anything, they begin to be defined by their control capabilities and limitations. Individual instrument identities will become more defined as a larger body of repertoire for the EP trio is created, revealing which sound and mapping elements are particular to specific compositions and which are consistently retained by each instrument.

The decision to hear only one mix from shared monitors results in additional challenges (described in 2.2.1). When instrument sounds are similar and their source shared, performers have difficulty distinguishing their own sounds, resulting in diminished control [9]. It is preferable that each instrument's sounds be distinct, however, the ability to blend

[2]Roland Corporation. www.roland.com/products/en/EV-5
[3]Roland Corporation. TD-9 V-Drums, Japan. (2008)
[4]Native Instruments. Kontakt. Berlin, Germany. (2010)
[5]Korg, Inc. NanoKontrol. Tokyo, Japan. (2008)
[6]www.pioneer.eu/uk/products/archive/CDJ-1000 MK3
[7]www.allen-heath.co.uk/uk/xone92.asp

may be essential to some compositions. In these instances, control/performance gestures must be very clear. Therefore, the EP trio is developing a core of gesture-processing mappings that remain quite consistent, despite changing sonic materials (see Figure 2). These include gestures to control volume, envelope shape and aspects of timbre for each instrument, with particular attention to filtering, amplitude control, velocity scaling and gain staging. This provides a means for performers to play expressively and "together" as an ensemble – dynamic and timbral ranges are controllable and compatible. A stable set of mappings also establishes mutual understanding of the control resulting from performance gestures, providing some degree of multi-modal congruence between gesture and sound. Additional mappings may vary from one composition, or moment, to the next according to the need to control specific sonic materials (see Figure 2).
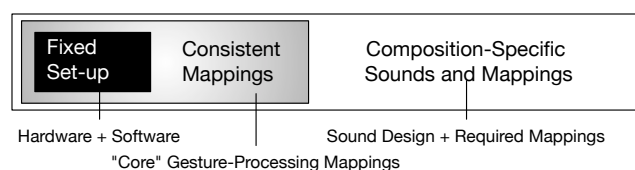

Figure 2: Core and composition-specific mappings.

3.1.1 Cello Identity

The electric cello is the least *schizophonic* in the ensemble – its sonic identity is largely tied to its acoustically generated sound. Like the electric guitar, it produces an amplified audio signal that may be modified by applying various digital signal processing (DSP) effects. In the EP trio, the cello is the only instrument able to accurately perform pitched material, suggesting a role as a melodic instrument. The K-Bow/K-Apps enables playback of samples, and continuous control of sound processing by bowing gestures, potentially allowing the cello to assume other roles.

3.1.2 Cello Mapping

The K-Bow/K-Apps adds a dual layer of gesture-sound control capability to the cellist's performance: bowing gestures may determine both sound production on the cello and continuous processing parameters. Achieving compatibility between the two presents significant mapping and compositional challenges. The cellist and/or composer specify the types of DSP and their control (and scaling) by assigning sensed bowing parameters to effects (e.g. bow length to delay; distance from fingerboard to filter frequency.) in K-Apps. Sound production and control gestures must be congruous, highly repeatable, reasonably intuitive, and ergonomic to the cellist. This necessitates close collaboration between cellist and composer and careful compositional planning. Infinite mappings are possible, but most successful combinations draw on established cello techniques.

3.1.3 Percussion Identity

The identities and roles of the percussion set-up in the EP trio are defined by the sample libraries controlled and the limitations imposed by trigger-based performance. Despite these constraints, it can produce both event-based and textural sonic materials, using sample manipulation parameters and acoustic percussion. To fulfill these roles, appropriate sample library construction is critical. Much of the percussion's sonic identity is re-created with each piece.

3.1.4 Percussion Mapping

Logical sample to drum pad assignment is paramount for the V-Drums. The standard drum kit organizes drum location based on pitch range: lower sounds are located at the player's right (floor toms) and feet (kick drum)[8]. As the kick drum is typically the lowest pitched instrument, the kick drum pad is reserved for lower-pitched or loop-based samples, utilizing that drum's association with keeping steady time. Pitch, envelope, and filters are modified in real time via NanoKontrol, mapped according DSP required.

3.1.5 Turntable Identity and Mapping

The limitations and idiosyncrasies of the turntable define its identity within the EP trio. It has fixed mappings of performer gesture to control/manipulation parameter but the sound materials available may change from moment to moment and piece to piece. The sounds the turntable (re)produces are samples created by the composer or selected by the performer. Textural drones, rhythmic materials, events, transitions, scratch solos and pre-recorded tape passages are musical/structural roles the turntable can readily perform.

3.2 Flexibility of Sounds and Mappings

Despite arriving at a fixed set-up, the wealth of sound and mapping possibilities for each instrument is only partially constrained. Some sounds are inherent to an instrument (i.e. acoustic percussion, electric cello) but may be modified through digital processing. Other sonic materials are entirely at the discretion of the performers and/or composers (i.e. those reproduced by sample-based instruments: turntables, V-Drums, and potentially K-Bow). The instruments of the EP trio also differ greatly in their capacity to alter mappings, thus ranging from minimal to total flexibility in both their sonic and mapping possibilities. Each instrument's sounds and the performance gestures/playing techniques enabled by its mapping(s) contribute to its individual identity and role(s) within the ensemble.

3.2.1 Two Dimensions of Flexibility

As represented in figure 3, the cello set-up has the least flexibility in its sonic identity (when not using the K-Bow as a sample playback controller) while the percussion has the most, as it can readily trigger more simultaneous samples than the turntable. However, the cello set-up affords highly flexible gesture-processing mapping strategies because a multitude of DSP parameters can be mapped to a number of continuous sensor input streams from the K-Bow (and combined with live creation of audio material). In contrast, the mapping of turntable control gestures to sound processing is essentially pre-established and fixed. The EP trio percussion set-up falls somewhere in the middle in its mapping flexibility – though its samples must always be triggered by a striking gesture, both samples and processing effects are flexibly assigned to the drum pads and the NanoKontrol's knobs and sliders, respectively. Because of its high flexibility in terms of both sonic identities and mappings, the percussion set-up often serves as the "glue", or mediator, between the cello and turntable set-ups, providing a middle ground between the two.

4. REHEARSAL AND CREATIVE ISSUES

Numerous, interrelated challenges encountered during the creation and rehearsal of new works continue to influence the development of the EP trio's instruments and the emergence of an ensemble performance practice.

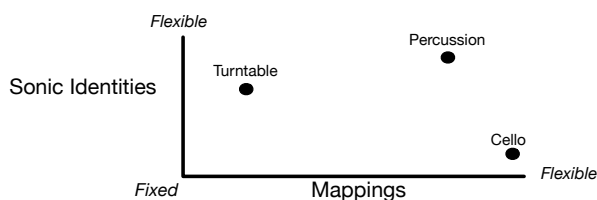[8]Based on normal kit set-up for right-handed drummer

Figure 3: Flexibility of sonic identities and mappings.

4.1 Latency

With practice, all performers can learn to adjust for a certain amount of latency, but too much or variable/random latency can destroy performer and audience perception of sounds resulting from performance gestures (i.e. multisensory congruence). The V-Drums and turntable have imperceptible to minimal latency. However, the cello is affected by variable latency depending on the DSP applied. To reduce the negative effects of this issue [7], cello parts with demanding processing are composed primarily of sustained sounds and textural effects that do not require rhythmic precision. Latency challenges are resolved through collaboration between composer and performers on successful musical materials and careful adjustment of DSP and mappings, and by individual practice.

4.2 Ensemble Performance and Expressivity

Successful negotiation of latency issues allows the EP trio to overcome synchronization difficulties. Oore advocates technical mastery on new instruments [8] – this is of utmost importance in an ensemble setting. Not only must performers be highly proficient and consistent on their own instrument, they must be flexible enough to adapt in real time to nuances in colleagues' performance. It has been extremely helpful for members of the EP trio to understand the limitations and capabilities of each other's set-up so they may anticipate and react to best effect, resulting in "tight" ensemble performance and enhanced musical expressivity.

4.3 Making Changes in Rehearsal

Working with DMIs in an ensemble context presents a special rehearsal challenge: namely, that sample-based materials, DSP effects and mappings cannot be instantly modified. This limitation influences the sonic materials, compositional structures and mapping strategies used by composers and performers. Building flexibility into patches, sampled materials and compositions can allow for some on-the-spot tweaking. Minor adjustments become an important part of the rehearsal process, however major changes require work outside of ensemble rehearsal. For each performer, a thorough knowledge of the sound creation and mapping processes behind their instrument is invaluable as it allows for rapid troubleshooting and clear communication with composers and colleagues.

4.4 Composition Process

Composers writing for the EP trio must either accept previously established sound palettes and gesture-processing mappings and rework these into a new composition (as they would in writing for acoustic instruments), or create new sonic materials and mappings. In the latter case, it is preferable that composers work closely with ensemble members to develop comfortable and effective means of controlling sounds. However, despite collaboration, developing and learning to perform with new mappings require time and practice and will invariably increase the scope and duration of a compositional project.

5. CONCLUSIONS

The EP trio has achieved its goal of establishing a robust and musically expressive ensemble. Through various approaches to developing instrument identities, mappings, and performance practice, the group has integrated three contrasting instrumental set-ups. Careful attention to musical identities and limitations has laid the foundation for a viable and musically satisfying electronic chamber music ensemble

5.1 Future Directions

The EP trio will expand its repertoire and commission outside composers. This collaborative process will provide new perspectives though the practical and artistic challenges encountered in each project. During creation, rehearsal, and performance phases, the ensemble's "performance practice" will continue to evolve. The trio plans to assemble the findings of these processes into a detailed set of compositional and procedural instructions that may prove useful to others working with live electronics in chamber ensemble settings.

6. ACKNOWLEDGMENTS

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