EXPLORING THE INTERSECTION OF MUSIC AND ARCHITECTURE THROUGH SPATIAL IMPROVISATION

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Abstract. Creative practice design research brings forth rich opportunities for the exploration of inter-domain connections between music and architecture. Through inter-disciplinary creative practice explorative project work founded on a methodology of improvisation on the digital drum kit, two stages of design research project work are outlined. In the first stage, a language of polyrhythmic drumming is parametrically spatialized as a reflective lens on an extant creative practice. From here, a new form of ‘Spatial Improvisation’ is explored, where conceptual spatial forms are generated from improvisations on the digital drum kit. This new musico-spatial design practice involves mediating a spatio-temporal-dynamical ‘Y-Condition (Martin, 1994)’ wherein temporal and dynamic design decisions translate from the musical domain into the spatial domain through ‘spatial thinking-in-action’.

Keywords. Music and Architecture; Design Research; Spatial Improvisation; Design Process; Parametric Digital Design.

1. Introduction

Whilst there has been much inter-disciplinary research and practice between the domains of music and architecture, the focus has largely been on conceptualising translations of music into “architecture” through analogue or computational processes. Elizabeth Martin, in the publication ‘Architecture as a Translation of Music’, proposed a theoretical Y-Condition as ‘the middle position of music and architecture when translating one to another finding an organic union between the two (Martin 1994)’. Many researchers and practitioners have addressed music-architectural translations, moving from architecture to music through sonification and computational analysis (Tomara, Liapi et al. 2011) and music to architecture (eg. Holl (1994) and Hansen (2015)) and as digital representations with architectural qualities (e.g. Ferschin, Lehner et al. (2001), Levy (2003), Christensen and Schnabel (2008), Krawczyk (2012) and Tomara, Liapi et al. (2011)). Marcos Novak is notable in his extended philosophical, experimental and computational explorations of archi-music as the ‘art and science that results from the conflation of architecture and music (Novak, 2007)’. Amongst these practitioners and preceding many, one truly inter-disciplinary practitioner clearly stands out. The work of Iannis Xenakis provides the foundation for the exploration...
of music and architecture through his complex design and compositional processes, where synergies evolve from the translation of concepts from one domain to another. In this paper, I examine elements of a theoretical continuum between performance (in the musical domain), notation of performance (in the visual and spatial domains) and 3D spatial representation, then introduce the idea of a Spatial Improvisation as a new form of ‘Musico-Spatial design’ creative practice.

2. The Digital Drum Kit as Interface between Domains

This research is based on the author’s creative practice as musician (drums and percussion) and spatial designer (architect). The home music-design studio provides the location for explorations in the fuzzy conceptual territories that exists between music and spatial design. The research is founded on the principles of design research as ‘research through design’ (Downton 2003) wherein ‘designing is (also) a way of conducting research of the kind that design undertakes and, by this means, of producing knowledge for use in designing’. Two stages of a larger creative practice Ph.D. by project work are discussed in this paper.

Drumming creative practice operates along a ‘Functional-Compositional Continuum’ (FCC) between novice and advanced, experimental drummers who exercise the four ‘levers of control’ of the temporal, the metrical, the dynamical and the timbral in their expressive playing (Bruford 2015). Drumming is under-recognised as a highly complex physical and cognitive activity that involves the live selective triggering, by way of striking with sticks, of certain drum kit ‘notes’ (bass drum, snare, toms, cymbals) at certain velocities at certain times, resulting in digital note outputs of certain durations. We can reduce the complex skill of drumming down to the dynamic placement of polyrhythmic drum notes of certain durations in at certain times, within an overall temporal structure.

For the research, a Roland TD20 digital drum kit acts as musical instrument, translation tool as a spatial generation interface for a variety of outputs (See Ham 2016, Ham 2017). Project workflow involves the export of Musical Instrument Digital Interface (MIDI) data from the Roland TD20 drum kit and processing these data in Reaper on a Mac desktop. Using the Sekaiju app, MIDI files are converted to Excel format, which are then read into Rhino3D Grasshopper (GH) (Figure 1). Digital drum parameters are then translated into spatial parameters as 3D Spatial Drum Notation (3D-SDN) and for spatialization. A key attribute of the Grasshopper definition is the ability for all spatial parameters to be flexibly adjusted easily depending on specific user requirements and purpose using numeric input panels and sliders. The same definition in Grasshopper can be adapted, exported or used in conjunction with other applications ranging from digital fabrication to Virtual Reality. MIDI data have also be used in the creation of Digital DrumScape compositions in the musical domain as a means of furthering dual-modality creativity (See www.jjham.com).
Improvisation has been used as a methodology for the generation of a large data set to provide the basis for translation into the spatial domain. Through a process of divergent thinking (Medonca and Wallace 2005), the improvising ‘compositional’ drummer refers to, adapts and evolves a set of ‘referent (Pressing 1998)’ patterns and phrases as a set of schema ‘which aid improvisation, as they provide variation to music improvisations while reducing the risks involved (Lewis and Lovatt 2013)’. The concept of referents draws parallels with architectural design processes, wherein the architect sub-consciously draws upon a body of knowledge to inform a current design task as ‘reflection-in-action’. The relationship between improvisation and design has been made by Donald Schön, who described ‘reflection-in-action’ as a means to ‘generate new knowing, as when a jazz band improvises within a framework of meter, melody, and harmony (Schön 1995)’. Thus, musical improvisation can be considered as a form of composing in real time that has similarities to designing, however with music this involves split second decision-making and response time.
Thus, using improvisation as a generative methodology, this paper discusses musico-spatioexploration through design research project work in two stages:

- As ‘Spatializing Polyrhythm’ where the drum solos are translated into the spatial domain using parametric digital design software. Here, the focus is on exploring ways and methodologies of spatialization of the parameters of improvised drumming performance using ‘Spatial Prototypes’. The focus here is on music;
- As ‘Spatial Improvisation’ where the spatial parameters of these spatial templates are driven through a process of design exploration using the digital drum kit through a new form of spatial improvisation. Here, the focus is on spatial design.

3. Spatializing Polyrhythm

3.1. FOUR SPATIAL PROTOTYPES

MIDI drum notes (eg snare drum, hi-hats, bass drum, tom toms and cymbals) are played as events in time against a certain metronomic tempo at certain velocities resulting in drum sounds of certain durations. Four ‘Spatial Prototypes’ were developed as Grasshopper definitions for Rhino3D that reads time, note, note duration and velocity data in Comma Separated Values (.csv) format. Using a complex series of parametric operations, data from the .csv spreadsheet are concatenated and sorted into a series of data points along a timeline with velocity and note durations embedded. Metadata tagging of drum solo information in Excel allows hundreds of files to be accessed through sliders. The four spatial prototypes reference architectural elements or conceptual ideas: as 3D Lattice Structures (Refer Figure 3, rows 1 and 2), ‘Fluid’ structures (rows 3 and 4), ‘Wave’ or tunnel structures (rows 5 and 6) and as ‘Column’ structures (rows 7 and 8). Each of these treats the dynamic placement of drum events in time differently in the spatial domain. The Lattice and Fluid form prototypes place drum notes in the “Y” axis and time in the “X” axis, whereas the Wave and Column prototypes are based on the flexible positioning of drum events around arcs, with velocity and note duration.
radiating outward from a central set point.

Figure 3. Rhino3D Grasshopper Spatialization of polyrhythmic drum solos in Lattice, Fluid, Wave and Column prototypes.

3.2. SPATIALIZATION OF 100 DIGITAL DRUM SOLOS

This project involves the transformation of drum improvisations from the musical domain into the spatial domain. Musical drum improvisation is thus explored through the lens of spatial design, wherein musical parameters are embodied within spatial parameters and parametric functions enable form-making explorations. Here, there is an inversion in the freedom vs complexity workflow between improvised drumming, mixing and mastering to final output and the mapping of musical: spatial parameters and the production of multiple potential outcomes: ‘One moves from simplicity of operation to complexity in processing, the other from complexity of parameterisation to simplicity of generation of multiple spatial alternatives (Ham et. al 2016)’. Once the parametric ‘system’ is established, multiple variations can be explored with ease. This parametric play is, in itself, is a form of improvisation.

This project explores the author’s ‘polyrhythmic idiolect (Gander 2017)’ as brought about through a methodology involving the generation of a large number of drumming improvisations. From the corpus of hundreds of 60-second drum beats and drum solos, 100 short (1-4 bar) patterns and phrases were curated that
represent the ‘go to’ schema or ‘referents’ that are called upon in improvisational situations. These may range from a standard 4:4 beat pattern, to breakout drum rolls, flams and other commonly used elements of drumming. Previous research has used 3D-Spatial Drum Notation (3D-SDN) to enable the analysis of these patterns and phrases in plan, elevation and 3D to unpack elements of micro-timing, rubato, ritardando, ghosting and other individual elements of drumming style (Ham, 2017).

By evolving the 3D-SDN Grasshopper definition, this research moves from notational to representational means of understanding drumming improvisation. As a secondary outcome of this process, novel and unique spatial forms are created that serve artistic or creative purposes as ‘proto-architectures (Fowler, 2012). Figure 4 illustrates a sample of ten 10m x 10m 3D Delaunay ‘Event-Time-Dynamics’ lattice structures. Drums are arranged on the “Y” axis (Bass drum at bottom, tom toms, snare in middle, cymbals and hi-hat at top) and time is arranged on the ”X” axis from left to right. Drum notes at variable velocities and note durations are represented by data points in the “Z” axis. A 3D Delaunay triangulation GH function finds the closest data point from one drum to another. From this superimposition of a geometric relational overlay on the drum data points, insights into what Frank Zappa termed the ‘statistical density (Redrup 2012)’ of the author’s ‘polyrhythmic idiolect’ can be spatialized in three dimensions. Fast double kick drumming and closed roll fills are spatially identified by the tight spacing between points in the triangles, whereas sparse, minimalistic playing results in more ‘open’ triangulation of the lattices (Figure 4, below). A square outline of the lattice indicates use of the bass drum and hi hats at the start and finish.

![Figure 4. 3D Delaunay ‘Event-Time’ lattices of ten referent patterns and phrases.](image)

This small example is one of many methods of spatial representations of drum improvisations that have been developed as part of the greater research project. These representations can be used to provide an ‘affordance’ for analytical purposes in terms of how the attributes of designed objects provides visual cues as to how they are to be used (Gibson 1979, Norman 2002). In this case, the 3D spatial representations provide insights into musical attributes of drumming patterns and phrases that are otherwise unavailable in musical notation or through listening. At the same time, the spatial representations reveal properties of drumming improvisation that architects may find opportunities to exploit in real
or imagined scenarios.

4. Spatial Improvisation

Following from the ‘Spatializing Polyrhythm’ project, the ‘Spatial Improvisation’ project adapts the practice of drum based musical improvisation into a new practice of spatial exploration. This requires the transformation of a musical practice into a ‘musico-spatial design’ creative practice. In this context, the project addresses the following question:

- How can the knowledge and skills inherent in a musical improvisation practice translate into the spatial domain as Spatial Improvisation?

A series of five spatial design propositions were established that set up spatial intentions for spatial improvisation. These propositions required the spatial drummer to ‘design in time and space’ by exercising the ‘levers of control (Bruford, 2015)’ to generate forms in the spatial domain. Designing in space and time requires the translation of spatial thinking into physical interaction with the drum kit through drum-based improvisation. Spatial intentions were ‘designed’ through a process of mass improvisation, with twenty drum improvisations performed for each design intention. The spatial design intention discussed in this paper imagines a 30-metre-long fluid wave form that twists and deviates from one end to another, with an enlarged section in the middle (refer Figure 5). Based on the layout of certain drums along the length of the twisted form, the drummer designer must perform certain notes at certain times in order to produce the required form in the spatial domain. The GH definition utilises two forms of lofting to create a 3D spatialization with thickness and double-sided NURBS surfaces. On the top side, note duration data points are lofted, whereas on the underside, note velocities are lofted. This lofting provides an element of indeterminancy brought about by the sweeping of surfaces along curves derived from velocity and note duration data points. This indeterminancy, in turn, brings an element of complexity into the design process.

Figure 5. Ten ‘Twisted Deviations’ Spatializations derived from the playing of the bass drum (bottom right), snare drum (middle section) and hi hat (top left) as well as other drums.

The term ‘spatial improvisation’ has been used in the areas of dance and the arts and in architectural research to refer to layered sketching as design process (Philemon, 2015) and as a means of understanding the creative process
amongst multiple actors (Waddell, 2017). The temporal displacement between
improvisation as design and static representation inherent in the project workflow
(see Figure 1, above) brings a degree of intuitive to this form of spatial
improvisation. With musical improvisation, the drummer is able to respond
to micro-second timing variations instantly, whereas with spatial improvisation,
spatial intentions are designed with only intuitive insights into the outcome of
each iteration. This makes spatial improvisation a very difficult creative practice
to master. Spatial improvisation constitutes a new creative practice that requires
the adaptation of the body of referent patterns and phrases used in the musical
domain into the spatial domain. The new creative practice is not entirely musical,
nor spatial- but 'musico-spatial’. I propose that that musical improvisation
constitutes a form of design activity, or at least a 'design-like' activity. Design
thinking within this new practice of spatial improvisation involves the translation
of skills and knowledge from a career of drumming into spatial thinking-in-action.
Spatial thinking-in-action plays with the temporal and the dynamical. Whereas
a drummer performing a solo musical improvisation will initiate a series of
phrases and patterns on the drum kit in succession to serve musical intentions,
the spatial improviser plays the drum kit to serve pre-conceived or improvised
spatial intentions. This occurs in the knowledge of a spatio-temporal-dynamical
‘Y-Condition (to borrow the term from Martin (1994))’ wherein temporal and
dynamic design decisions translate from the musical domain into the spatial
domain.

This spatial thinking-in-action, as a new practice, involves learning the system,
and gaming the system until degrees of ‘tacit knowing-in-action (Schön 1995)’ can
inform novel spatial improvisations. The knowledge and skill base is drawn, in this
case of a dual skilled practitioner in the author (as musician-architect) separately
from the creative practice of drumming, and also the practice of architecture into a
third practice of spatial improvisation. In this new practice, a new knowledge base
evolves that integrates the skills, dexterity and temporal thinking of the drummer
with the spatial compositional skills of the architect. Physical combinations of
drum patterns and phrases as musical ‘referents’ are thus re-purposed as spatial
‘referents’. This requires a certain ‘untraining’ from a long-established musical
practice. The ‘in the moment’ nature of this improvised practice forces spatial
decision-making, providing an environment where risk of failure is real. Within
this risk, novel opportunities arise- just as in musical improvisation where ‘in
the moment mistakes’ form the basis for new improvisational directions. This
spatial improvisation is also founded on the temporality of design decision making.
Unlike traditional spatial design, the designer must make split second design
decisions that cannot be undone, are final and are not made with the benefit
of immediate visual feedback. Spatial improvisation is thus ‘spatial design
in-the-moment’. Mastery of this new spatial improvisation, as an evolving
practice, may take many months or years to master.

5. Conclusions and Further Research

The nexus of music and architecture has been explored through a trajectory of
research starting at 3D Spatial Drum Notation (not discussed here) through to the
spatialization of polyrhythmic digital drumming, and a new spatial improvisation as a ‘musico-spatial design’ creative practice. The mapping and translation of drum data into the spatial domain provides affordances for understanding elements of improvisational drumming practice whilst also allowing creative opportunities in the spatial domain. Spatial improvisation, as a complex and indeterminant form of improvisational practice, relies on the interplay between design thinking and physical dexterity and skills on the digital drum kit. This transforms the design process from the spatial to the spatio-temporal. The concept of ‘spatial thinking in action’ references Schön’s ‘reflection-in-action’ and proposes a process whereby designers engage with the interface of the drum kit to deliver spatial intentions. This requires an adaptation of the skills of a musical practice into a new form of spatial practice. Improvisation as methodology provides opportunities for this practice to be developed through a process of repetitive learning by playing. Thus, ‘Spatial improvisation’ provides a basis for creative exploration and, through learning the system, repetition, and learning from anticipated and unanticipated outcomes, skills as a musico-spatial designer are built.

This Spatial Improvisation informs the next stage of the research, wherein the practices of music and spatial design are brought back together as Musico-Spatial Improvisation. Working in a Virtual Reality environment, musico-spatial improvisation relies on the integration of musical and spatial design practice through the real-time dynamic contemporaneous generation of spatial and musical outputs. This design exploration is facilitated by the use of the digital drum kit in association with VR headsets and spatial sound arrays. This extension of the design research trajectory will be explored in future publications.

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