Bridging Abstract Sound and Dance Ideas with Technology

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Interactive Dance Composition as Practice-Based Research

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Abstract

In this paper, I review recent interactive music and dance collaborations and discuss my composition interest in mapping sound to bodily movement

in the field of computer music. I argue that the engineering perspective of this field of research should be broadened to include, in particular, creative composition processes in collaboration with professionally trained contemporary dancers. I then introduce my investigation into using the Gametrak controller to create choregraphic stimuli via the choreographic methods of the contemporary dance choreographers William Forsythe and Wayne McGregor, and set up a compositional model based on that proposed by the composer Simon Emmerson. Finally, I demonstrate how my research is articulated through a presentation of my original works.

Keywords

Interactive dance
Composition
Practice-based research
Methodology
Gametrak
Restriction

Introduction

As a sound artist and a researcher who creates interactive sound and dance collaborations, I have sought a methodology for my practice-based research. This paper presents my thoughts on this topic and an inquiry into a possible way to make this research valuable. I should emphasise that what drives me to create interactive systems is the facilitation of a dialogue between the sound system and the dancer so as to devise choreography and sound compositions together. I find that in the field of computer music this type of work focuses on technological development in terms of new interfaces or mapping strategies for generating music, but lacks a choreographic concern based on dance practice. Since interface technology seeks a use in corporeal dance performance and is of an interdisciplinary collaborative nature, I propose another perspective from which to conduct this field of research, giving as an example my own original works with contemporary dancers.

1.Background research to raise questions

The term *interactive dance* typically refers to dance works created with an interactive system that perceives movement data from the dancer in real-time to produce other events in other media such as sound or visuals. In turn, the sonic or visual results affect the creation of the choreography. The term has been in frequent use since the genre of *dance and technology* or *dance tech* emerged at the end of the 1990s as seeking the usage of newly developed tools "to reinvent the perceptual and ontological role of dance in the context of a digital zeitgeist" (Salter 2010, 261). Although the origin of interactive dance can be traced back to John Cage and Merce Cunningham's collaboration *Variations V* in 1965, the active research on developing wearable or camera-based motion-tracking sensors has been conducted since the 1990s by composers. For instance, Todd Winkler created interactive dance works in Max[1] using analysis of gestural movement and musicality (Winkler 1995a), and published a pedagogical book in interactive composition (Winkler 1998). Wayne Siegel developed wearable motion-tracking interface using flex sensors in collaboration with contemporary dancers (Siegel and Jacobsen 1998). Because of its use of technology, interactive dance has also attracted scientific, engineering and computing research centres looking for artistic and real-world applications (Salter 2010, 262–263). One example is the EyesWeb system, using gestural analysis of emotional and expressive values and developed by Antonio Camurri and his research team from Info-Mus, University of Genoa, within the European Union-sponsored MEGA project (Camurri 1997). The fever for the genre became obvious as the entire *Dialogue* section of the 1998's spring volume of D*ance Research Journal* was dedicated to discussion about dance and technology, with both Richard Povall and Robert Wechsler writing about the subject.

As a consequence, debates and criticisms followed regarding the usage of technology. How it could "enlarge dance as a historical and cultural practice" and what kind of aesthetics could be aroused with gesture-driven computer music in dance (Salter 2010, 263)? Scott deLahunta (2001) expresses the irony of considering the new musical instrument learning process as dance training in the field of computer music. Julie Wilson-Bokowiec and Mark Alexander Bokowiec (2006, 48) point out that mapping sound to bodily movement has been described in utilitarian terms: "what the technology is doing and not what the body is experiencing". According to Johannes Birringer (2008), developing interactive systems with this utilitarian perspective creates "disjuncture" between movement data and the outcome media whether that is image or sound. This is because the system requires performers to learn "specific physical techniques to play the instruments of the medium", which dancers find hard to think of as an "intuitive vocabulary" that they have gained through their physical and kinaesthetic practice (Birringer 2008, 119).

1 https://cycling74.com/

Discussions about creating musical instruments are still valuable to the development of interactive systems. However, I find that this narrow focus on the gestural or postural articulation of technology misses the aesthetic concerns in creating choreography with dancers.

Wilson-Bokowiec and Bokowiec (2006) provide honest insights about their Bodycoder System, a musical interface with sixteen bend sensors that can be placed on any flexing area of the body and a pair of gloves designed as switches. Similar glove-based interface designs have been used previously in Mattel's Nintendo PowerGlove (1989) and the *Lady's Glove* (1994) by the composer Laetitia Sonami to capture sophisticated finger movement. Winkler (1995a) also began his research in movement by observing hand and finger gestures to help design musical instruments. Wilson-Bokowiec and Bokowiec (2006, 50) write that their initial idea to adopt physical techniques from contemporary dance seemed logical, but they stopped soon after realising that the system was associated with "specific economic movements" like playing an instrument. In interactive dance and music collaboration the dominant compositional approach has been to translate gestures into sonic results. This process of translation is usually initiated by composers and computer scientists with their interpretations of movement qualities, and then realised by dancers. Unfortunately, due to the limits of time and budgets, it is not easy to collaborate with dancers throughout the entire composition process to find out which sounds feel most suitable for controlling the synthesis with their diverse range of movements. Thus composers have mostly sought ways to capture the most natural and precise movements by preserving dancers' free motion for movement analysis. However, I believe this effort ironically caused a disjuncture in the sonification of movement for some dancers because the assumed mapping scenarios and interpretations were not directly related to their dance vocabularies, but rather to an engineering perspective.

Here, two research questions arise: 1) How can my interactive sound system aid collaboration by encouraging dancers to use their intuitive vocabulary, not just demand that they learn the technological and musical functions of the interface? 2) Once I have considered the sounds to be used in a piece, how should I direct dancers to create choreography as well as sound composition with my interactive system? I decided to adopt a more rigorous approach to integrating interactive system into the creative processes in sound and dance, and their resulting performances investigate ways to carefully structure the relationship between music and dance when involving interactive systems in the creative and performance processes. To situate my work within a research perspective, I undertook a survey of papers focusing on dance or choreography from *The International Conference on New Interfaces for Musical Expression (NIME), The International Computer Music Conferences (ICMC), and Sound and Music Computing (SMC)* from 2001 to 2016 to find what other approaches have evolved since the 1990s interactive dance scene. The reason that I chose this period was because the survey was done in 2016, and I decided to search the papers published from the 21st century strictly. When I found interesting approaches from these conference proceedings, I looked up other related publications.

Based on his research on the choreographer Doris Humphrey's classification of rhythms in dance, Carlos Guedes (2007) created Max objects that can extract rhythmic information from dance movement captured with a video camera. Capturing data and analysing patterns to create art became a method when art research combined with Human Computer Interaction (HCI) (Polotti 2011). With this rather scientific approach to human movement, I noticed that some researchers tried to capture even more sophisticated data from dancers using physiological data capturing facilities. For example, Jeong-seob Lee and Woon Seung Yeo (2012) captured dancers' respiration patterns to improve the correspondence between music and dance, and Javier Jaimovich (2016) used

electrocardiography and electromyography to reflect the biology of emotion in music. Nevertheless, these analytical approaches to evaluating the relationships between music and dance still caused me to ask where choreographers might put their aesthetical decisions during the compositional process.

The research I found interesting was the empirical research done by Anna Källblad et al. (2008) for their interactive dance installation for children. They developed their installation in several steps: First, they observed children's movement in a free space with different types of music. Second, the dancers looked at the video recordings of the first step and created a choreography. Third, the composer created an interactive sound composition for the choreographed movements and installed this interactive system in areas occupied by the children. The interesting part of this research was that the analysis of the children's movement became the choreographic challenge; the researchers found that there was "no expression of anticipation, planning or judging" in the children's movement, whereas the adult dancers found it very hard to have the same intent (Källblad et al., 2008). Another interesting work is the prosthetic instruments designed by Ian Hattwick and Joseph Malloch (2014). Although the dominant perspective of Malloch's (2013) thesis was an engineering one, as its purpose was to design instruments that were usable by professional dancers, the design process was done in conjunction with frequent workshops with the choreographer Isabelle Van Grimde and her dance troupe Van Grimde Corps Secrets. They were aware of how the dancers predominantly create movement within a visual domain, as opposed to musicians, and took advice from the dancers when deciding on the appearance and material of their instruments (Malloch 2013). I found their *Spine* instrument for the performance *Les Gestes* (2011–2013) remarkable because it provoked the dancers to create choreography in terms of the relational movement between their head and lower back, which in turn played the instrument. This way of triggering an interactive system with wearable motion-tracking sensors is not common as usually the sensors are placed on limbs or the joints of limbs to receive more natural movement of dancers.

Amongst works outside of *NIME, ICMC,* and *SMC* communities, I find the collaboration Eidos: *Telos* (1995) by the choreographer William Forsythe and the Studio for Electro-Instrumental Music (STEIM) composer Joel Ryan the most interesting, even though it was developed at the very beginning of the period of experimentation in interactive musical synthesis with computer in the 1990s. Across the stage, a net of massive steel cables are set to be amplified by contact microphones and in turn become a large-scale sonic instrument when plucked by the dancers. The instrument was "audio scenography: the replacement of visual scenography with a continually transforming audio landscape" and showed "the shifting of dance music composition in Forsythe's work towards the design of total acoustic environments" (Salter 2011, 57–58). Unfortunately, Ryan's initial idea of using wearable acceleration sensors to control the signal processing techniques applied to a violin and the lights in the Frankfurt Opera House auditorium did not happen because of unstable communication between the STEIM-built sensor device and the house lighting console (Salter 2011, 71). However, the instrument created simple and modern-looking scenography without superfluous technological aesthetic, which Forsythe usually seeks in his other works too, and acted as work's core compositional as well as dramaturgical strategy.

2.Integrating choreographic method with technology

To answer my first research question, I decided to study first how choreographers and dancers create choreography and seek ways to integrate motion-sensing devices as primarily a choreographic tool. Some criticisms have arisen in the dance technology community towards artists who were "eager to work with newly arising

digital tools", but who had "little understanding of the inner workings of electronics or computer code", which in turn created trivial works that were mere demonstrations of the technology (Salter 2010, 263–264). Although this is a critical point of view, I found it not entirely fair towards the artists. The graphical interface of Max (Winkler 1995b), as well as flexible and user-friendly tools like Isadora developed by Mark Coniglio (Dixon 2007, 198), were made to help composers and artists who were not necessarily software developers. I thought the problem was not lack of knowledge of how to adapt the technology effectively, but a lack of investigation and observation required to comprehend artistic media that the artists did not primarily practise. For instance, Winkler's research into gestural composition (1995a) neglected dance practice or techniques, but assumed that their interactive syntheses could be used effectively for dance composition. Marcelo M. Wanderley (2001) thoroughly analyses the gestural qualities of expert instrumentalists during performance, but does not explain how this movement analysis is valuable for dance creation.

What, then, is choreography? Can the instrumentalist's movement be assumed to be dancing? "The term choreography has gone viral", says Susan Leigh Foster (2010). She writes that since the mid-2000s the word has been used as "general referent for any structuring of movement, not necessarily the movement of human beings" (Foster 2010, 32). I saw a good example for Foster's statement when I recently attended the conference *Moving Matter(s): On Code, Choreography and Dance Data* in 2017. The artist Ruairi Glynn presented his choreographic idea in his work *Fearful Symmetry* (2012), but the work did not include a human figure. It was a kinetic sculpture that encouraged the audience to react and move along with it. Perhaps the reason this kind of movement from non-dancers and also non-human movement has come to be recognised as "choreographic" is because dance has changed dramatically since the mid-twentieth century to eliminate virtuosic postures. For example, choreographers such as Paul Taylor and the Judson Dance Theater deliberately incorporated everyday movements such as walking, running, and sitting into their work (Au 2002, 161, 168). Also, as shown at the 2011 exhibition *Move: Choreographing You: Art and Dance since the 1960s* at the Hayward Gallery, the term has been used to describe the process of paintings, sculptures, and installations by artists such as Allan Kaprow's movement score *18 Happenings in 6 parts* (1959), Bruce Nauman's *Green Light Corridor* (1970), and Pablo Bronstein's *Magnificent Triumphal Arch* (2010). These works were focused on certain movements of the artists or the viewers, and were, therefore, choreographed. In his essay *Notes on Music and Dance*, Steve Reich (1974, 41) writes that the Judson group choreographers have embraced "any movement as dance", equivalent to Cage's statement that "any sound is music". It seems that dance has become a more approachable place for laypeople to propose ideas.

Yet, what I have learnt from my previous collaborations with dancers is that I should be aware that dancers and musicians have acquired different physical practices[2]. I therefore felt the need to understand what choreography means in dance first. I investigated the dance movement theory by Rodulf Laban as well as some studies in which this analysis was used. These included the sonification of dance movement research from InfoMus based on the emotional quality of movement and music from choreutic theory, the dance movement archive project by Royce Neagle et al. (2002), and the movement library *Topos* for dance and music gesture control by Luiz Naveda and Ivani Santana (2014). However, what I found the most interesting from Laban's analysis was that he sees choreography as a "continuous flux" of movement that should be understood alongside both "the preceding and the following phases" (Ullmann 2011, 4). Laban's dance notation shows movement "trace-forms" through directional symbols inside the kinesphere rather than specific postures, and it inspired me to

2 In case more scientific proof is needed about how musicians and dancers perceive movement differently, ongoing research is being conducted by Hanna Poikonen at the University of Helsinki into how musicians and dancers use their brains. Poikonen explains that musicians have a tendency to seek precision in certain acts whereas dancers see the entire flow of a movement that uses the whole body. See her article at https://www.helsinki.fi/en/news/health/a-dancers-brain-develops-in-a-unique-way

Figure 1. Motion-sensing device as interface to preserve the dancer's freedom of movement.

think about what principally stimulates which movement, beyond fragments of gestures. The common way of using motion-sensing devices in interactive music and dance collaborations is to use the technology as a mere interface for preserving the freedom of the dancer's movement, and to connect the presupposed musicality of movement data to the output result (Figure 1). Instead, to actively stimulate and engage dancers to create choreography with the interactive system, I decided to provide a physical and tactile motion-sensing device – the Gametrak controller – that primarily challenged performers to 'dance', and to let these movements create the sounding results.

Gametrak was developed as a pre-wireless motion-tracking technology and disappeared quickly after the introduction of Nintendo Wii Remote controllers or Kinect cameras. In comparison with wireless motion sensors, Gametrak's motion tracking system is simple and limited. Each unit has a pair of potentiometers tethered by red cables that users can extend to direct the controller through 360˚; the controller tracks the movement direction and length of the cable. Originally the controller comes with a pair of gloves that let users play a golf game. However, I removed the gloves so as to prevent the dancers from using the controllers only with their hands. Instead, I connected carabiner clips to the end of the controllers so that they could be hooked onto belts and bracelets. The kinetic characteristics of the Gametrak invite dancers to move in certain intuitive ways by playing with the cables – pulling and twisting them, for example. However, the dancers soon understand that they can only reach a limited distance with the tethered controllers. As a consequence, the difference from wearable sensors is that I am 'restricting' the dancers' bodies instead of letting them dance freely.

Gametraks were used by the musician Yann Seznec for the live performance of the composer Matthew Herbert's album *One Pig*, and the artist Di Mainstone developed Gametrak-inspired controllers with her research team from Queen Mary University of London for large-scale installations (Meckin et al., 2012) such as *Whimsichord* (2012) at the Barbican and *Human Harp* (2013) on Brooklyn Bridge. Seznec created The *StyHarp*, using the cables of Gametrak controllers to mimic a pigsty as well as a new musical instrument. Although Mainstone's works were performed by dancers, her primary focus was on the use of the controllers as a visual element with the surrounding architecture while triggering sound simultaneously in an interactive installation. It is apparent that the appearance of the Gametrak has attracted artists to its visual characteristics, but I have not yet found any work primarily integrated with choreographic composition technique.

I found Forsythe's choreographic approach was interesting because he extended Laban's notion of the kinesphere, as shown in his lecture video *Improvisation Technologies* published with ZKM in 2011 (cited in Clark and Ando, 2014: 182). In the video, Forsythe demonstrates possible movement variations depending on a newly given axis without stepping away from the first

position. Furthermore, Forsythe asks his dancers to imagine objects or geometric lines to create movement with or around. Re-orientating physical perception with these imaginary space and objects is Forsythe's core movement creation technique. Similar to Forsythe, choreographer Wayne McGregor proposes his dancers to imagine an object as well as some other sensations to compose choreography. Another technique he uses is to provide dancers with a physical problem, which they have to solve through movement. For example, dancers are asked to "picture a rod connected to their shoulder, which is then pushed or pulled by a partner some distance away" (Clark and Ando 2014, 187). McGregor describes these ways of creating movement phrases with specific physical conditions as a "physical thinking process" (McGregor 2012).

Both Forsythe and McGregor use mental imagery as a choreographic stimulus. Instead of freely improvising, they restrict their physical condition with the imagined objects and space. Inspired by this method, I decided to replace the mental imagery with actual physical restriction using the cables of the Gametrak controllers. In this way, the Gametrak provides a technological restriction that governs my sound composition and movement creation as both an interface and a physical limitation that has to be accounted for by the dancers. This intrinsic physicality of the Gametrak made it possible to provide concrete movement tasks to the dancers, who could then play sound naturally as a result of executing these tasks. This process is explained in Figure 2, which shows the transition between different media from body (dance) to sound via visible and tactile technology.

3.Proposing a methodology: physical thinking and action process

My background research indicates that the primary concern in research so far into new interface design for dance has focused on the kinds of motion that can be captured to control musical parameters, either in one-to-one or more complex interactions. However, this prevalent concern in mapping body movement to sound is limited to musicians and computer scientists (Wilson-Bokowiec and Bokowiec 2006, 48), and rarely takes account of a purely choreographic perspective. My purpose in this research is not necessarily to hand over control of the music to the dancers. Rather, my main interest is in what kind of dialogue can be created between music and dance as a stimulus to collaborative composition, not necessarily that one medium has to determine the other.

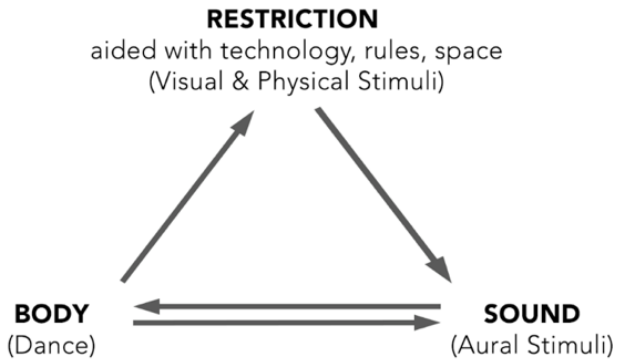

Figure 2. A diagram between dance and sound through Gametrak controllers.

To answer my second research question, and also in order to create a dialogue between music and dance it was essential to look at how they have served as impetuses for each other both historically and more recently. Traditionally choreographers made choreography for already written music, and dance had to be organised to synchronise with music that had been composed for it (Percival 1971, 17). However, since the twentieth century, there have been huge changes in this traditional relationship. Vaslav Nijinsky premiered the ballet *Afternoon of a Faun* in 1912, using Claude Debussy's music "purely as an accompaniment", to demonstrate that the music and the stage design were "equally important in setting a mood" and "equally irrelevant to the movements being performed by the dancers, except that the total length of the action was determined by that of the music" (Percival 1971, 16).

Around the same time, Laban choreographed to a very minimalistic use of percussive musical instruments or sometimes even in silence so as to preserve dance as an independent art form, as seen in his works *The Deluded* (1921) and *The Swinging Temple* (1922) (Laban 1975, 89, 96). Laban did not agree with the dance theatre tradition of that time, according to which dance had to be organised as a literal translation of music (Laban 1975, 175–179). Later, from the late 1940s, Cunningham and Cage started collaborating using methods of indeterminacy and chance, treating music and dance as independent entities (Au 2002, 155–156). From my research the most frequently referenced example as the origin of interactive music and dance collaboration is Cage and Cunningham's *Variations V* (1965), yet notoriously they did not seek to connect expressive musicality and movement. In contrast to these movements, music and dance had a close relationship in Philip Glass's opera *Einstein on the Beach* (1976), with Lucinda Childs juxtaposing slow and almost static movements to Glass's fast and repetitive music (Obenhaus 1985). Similarly, Anne Teresa De Keersmaeker was deeply influenced by Steve Reich's music structure, and choreographed repeated and contrapuntal movement variations for her work Fase, *Four Movements to The Music of Steve Reich* (1982). However, De Keersmaeker explains that although Reich's music "supplied a number of principles of construction", her work "did not copy the musical structure" (De Keersmaeker and Cvejić 2012, 25–27). As a more recent example, at the 2012 Dance Biennale, Forsythe explained that his dance company uses music like "film music"; music can "colour the perception of the event", but it is not necessary to organise a dance according to the structure of the music (Forsythe 2012).

It seems natural to have these constant changes in dance from the twentieth century in particular, since music has also actively changed into various unconventional and uncountable forms through the use of new materials and sound (Cunningham 1968; Percival 1971: 15). However, in gesture-driven music and dance research I feel these kinds of dialogues between music and dance have been neglected because 'interactivity' is considered a crucial element that has to be demonstrated to the audience. This view can easily restrict interactive dance to the folly of mere demonstrations of technology, and fail to make use of it as choreographic tool. Furthermore, what I could see from the dance notations from the seventeenth century (see Weaver 1706) and De Keersmaeker's score for Reich's music was how these two media have changed from rather absolute and common code to abstract ideas. The dance notation from the seventeenth century indicates positions of feet and limbs related precisely to the musical notes, whereas De Keersmaeker's score is drawn with more abstract shapes, directional marks, and numbers. In my previous collaboration with contemporary dancers, I mostly sought ways to orientate the dancers towards the interactive system to help them perform better 'sound'. However, I was aware of the irony in teaching the abstract ideas of music composition to dancers. Instead, I thought these abstract ideas could be bridged through a concrete medium – for me, it was what the restrictive motion-tracking technology could serve – to successfully conduct this interdisciplinary collaborative composition.

I proposed using the Gametrak controllers as a visual stimulus and physical restriction to my main collaborating dancer Katerina Foti. As she was aware of Forsythe's approach she was interested in the method. Yet, this was my first time composing an interactive music with physical restriction, and I thought the best way to find out the most suitable compositional method was simply to try them out. *Locus* was my first composition, using four different sections of sound variations throughout time. I planned several steps to guide Foti and another dancer Natasha Pandermali to gradually construct a choreographic composition with my interactive sound synthesis. Video 1 demonstrates the composition process: First, I asked the two dancers to tether four cables each to

their bodies and to improvise to find out how to move within the restrictive conditions without sound. Second, once they got used to moving within the conditions, I then provided more specific choreographic tasks section by section depending on the structure of the sound composition. During this process, the dancers proposed how they would create choreography with my movement tasks and I selected good materials. Finally, we repeated the proposing, selecting, and modifying process several times until we completed the composition.

Video 1. The demonstration of composition process of Locus (2015). See: vimeo.com/252392147/29e5af8932.

My dancers quickly adapted my composition process as they were trained with similar choreographic techniques. This way of proposing and selecting choreographic materials is the common approach in contemporary dance nowadays, as exemplified by the choreographers Forsythe and McGregor. While I was searching for the origin of this choreographic method, I found that some contemporary dance choreographers in the 1960s used the so-called "problem-solving" concept as research in information theory and artificial intelligence awakened around that time (Rosenberg 2017, 185–186). This technique adopted improvisation as a choreographic compositional method. For example, the Judson Church group choreographer Trisha Brown first provides movement tasks to her dancers and the dancers create movement in response to them. Second, Brown "intervenes as a composer to select, edit, and reorganize this raw material as choreography" (Rosenberg 2017, 185). The consulting historical scholar at Trisha Brown Dance Company, Susan Rosenberg, writes that "Brown cast her dancers into what problem-solving theorists call a 'problem space' defined by an 'initial state, a goal state, and a set of operators that can be applied that will move the solver from one state to another'" (Rosenberg 2017, 186). This algorithmic process is also apparent in Forsythe's choreographic procedure *Alphabet* (Forsythe and Kaiser 1999) and McGregor's "if, then, if, then" process (McGregor 2012).

I also find similar algorithmic thinking in the composer Simon Emmerson's model of compositional process. In seeking a methodology by which to conduct my practice-based research it was helpful to look at it. Since electroacoustic music does not use traditional musical notation systems and materials, Emmerson (1989) writes about composing strategies and pedagogy, and proposes a compositional model for contemporary music. The model consists of a cycle of actions: the composer does an action drawn from an action repertoire, which then has to be tested. After testing, accepted materials reinforce the action repertoire and rejected ones can be modified for the action or not. Emmerson explains that research begins when one "tests" the action, and new actions need to be fed into the action repertoire to evolve the research further (Emmerson 1989, 136). Similar to Brown's technique, John Young (2015, 159) describes the process after testing in Emmerson's model, in which the composer decides whether to accept or reject materials, as a "problem-defining and problem-solving process".

The unique compositional feature of Emmerson's model is that there is the test procedure. Emmerson explains this in "the composer/listener chain": the test has to be done with a group of listeners – not any listeners, but a "community of interest whose views we trust

and value" – since there is no common code for building the same expectation as there used to be in traditional (Western) music (Emmerson 1989, 142). In my composition process my collaborating dancers are not only the performers, but also the primary listeners as they devise choreography that interacts with my sound system. We try a certain condition, explore our experience, and reflect on the next phase. My compositional cycle of actions as an adaptation of Emmerson's model of composition process is: I provide choreographic tasks (*new action*) and the dancers devise choreography with restriction and rules (*action*) drawn from their movement *repertoire.* And then I examine (*test*) the materials created through this process to *accept* or *reject*. Therefore, one composition is completed with multiple iterations of these actions; furthermore, my entire research is structured within this action cycle.

4.My original works

Here, I offer some examples to demonstrate how I mapped movement and my sound synthesis. To prevent the dancers from being too busy dealing with just the musical functions of the technology, I first reduced the number of sound parameters to be performed by the dancers. Mostly only the z (length) values of the Gametrak controllers were used to control the sound parameters; sometimes the x and y values were used to in support to detect more specific locations of the dancers in the performance space. Although I simplified the number of sound parameters each controller could control, I provided different choreographic tasks strictly in order of the allocated time frames. I also wanted to have both direct and indirect interactions between movement and sound so that the dancers could have various conditions within which to devise choreography with differing amounts of freedom.

In *Pen-Y-Pass* (2016)[3] I provided various choreographic tasks throughout time: For the first section of the composition the dancers were asked to tether cables onto their limbs, moving only one arm at first and then gradually use all their limbs. Movement and sound had a direct one-to-one relationship here, and the dancers had to be careful not to move their other limbs from the beginning. As a result, the silent space gradually filled with more and more sounds. For the second part, the dancers were asked to attach one part of their body as though their limbs were extended diagonal lines tethered like the cables as well as the projected visual work behind them. Then the dancers tried to extend their limbs towards the gaps between their bodies. In this section, the dancers' limbs only affected the volume of the sound files, allowing the dancers to focus more on devising choreography. For the third part, they were asked to detach the cables, leaving only one cable each. In this section, there were only two different sounds, one for each dancer, with one-to-one interaction. The dancers were asked to create a circle with their movements and then pause for a while, and repeat this movement. As a result, some silence was created in between. For the fourth section, the dancers were asked to attach one more cable to their limbs, making two for each dancer. One dancer was asked to perform solo, and then the other, and then duet until the end. For this section I programmed different sounds depending on the length of the cables. In return, the more the dancers moved towards the other side and crossed with each other, the louder and more dynamic became the sound.

For other works, I created more game-like tasks between movement and dance. For example, I attached the cables of Gametraks to two chairs in *Temporal* (2016).[4] For the second section of the piece I mapped sounds to be randomly triggered at various locations in the performance space. The dancers were asked to move in response to what they heard. As a result, they moved around the room holding chairs and sometimes even dragging them to make a scratching noise. Depending on the triggered sound, the dancers created dynamic movements from fast to slow. Another example is *The Music Room* (2017), and here sound worked also as a restriction

3 See the video demonstration here: vimeo.com/254723449/2f56001b94

4 See the video demonstration here: vimeo.com/247499380/46af82a55d

Video 2. The composition process of The Music Room with my collaborating dancer Katerina Foti.
See: vimeo.com/247731900/494d98e0ea

to control the dancer's movement (Video 2). I programmed some piano notes to be triggered when the cables were pulled to a certain length. The dancers were asked to stop moving once the piano notes were triggered, and to wait until the note had finished playing. As a consequence, the dancer moved very carefully and created cautious and slow movement variations.

Conclusion

I have introduced my compositional approach in interactive dance focusing on integrating interactive system into the creative processes in both sound and dance. Throughout this paper what I would like to draw out is not only the technological development or mapping interactive sound synthesis as a compositional act, but also the holistic compositional cycle in collaboration as a composition to support interdisciplinary art research.

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