Report on AHRC Project (Small grants) with interactive sound artist Stan Wijnans: 2006/7

Title: ***A preliminary exploration of the choreographic potential of new motion tracking technologies in conjunction with interactive ambisonic surround sound.***

Researchers: Dr Sarah Rubidge and Stan Wijnans (University of Chichester) in collaboration with Lila Dance Company

Introduction

Aims of project were to:

- explore choreographically the use of performers not merely to trigger and modulate sound, but also to *spatialise sound in 3D in realtime* using interactive ambisonic surround sound technologies.
- conduct preliminary choreographic investigations into the possibilities for interactive performance offered by an *innovative non-camera-based motion tracking system.*

The research project undertaken into the use for choreographic purposes of a new motion tracking technology, used a 3D wireless motion tracking system, developed at V2 in Rotterdam, and a new ambisonic (8:1) surround sound system (the framework for which was programmed in Max//MSP by Dave Hunt, but custom programmed for the purposes of this research project by Wijnans).

This preliminary research into the choreographic potential of the programmed sound systems designed by Wijnans was successfully completed on January 12th 2007. Between May 2006 and January 2007 we undertook two intensive research weeks, with interim non-technological choreographic/improvisatory workshops between the two research intensives. Discussions between the research team involved in the project, including the dancers, were integral to the development of the detail of the research during all of the research periods.

The first research week took place in May 2006, the second in January 2007, with intermittent choreographic research taking place between them. In both of the research weeks we installed and tested the Cricket tracking system and the ambisonic sound system in a studio context in order a) to gain the most realistic tracking environment for choreographic research using the tracking system, and b) to explore any issues that might pertain with the ambisonic sound system. After the first research week the tracking system was refined for our particular research needs, in collaboration with engineers at V2, Rotterdam, for use in the second research week. During the latter part of the period between research weeks WIjnans developed further the realtime interactive music composition system in the ambisonic (3D surround sound) system, such that it could be used as the basis for the development of a realtime interactive music-dance choreographic system using the Cricket Motion Tracking system in the second research week. The choreographic potential of the system was tested in the second intensive research week.

The research methodology was thus reiterative, and combined technological research into the tracking systems, choreographic research without the tracking systems and choreographic/technical research with the tracking systems. This methodology was made possible due to the two main researchers' previous experience with simpler tracking systems used in choreographic contexts, which revealed certain choreographic issues that they felt would benefit from further focused research which was not designed to produce a work, but simply to explore the choreographic potential of the systems. The research benefited from their knowledge that the outcomes of the research were not dependent on creating a fully developed performance event during the research period.

Wijnans was responsible for the technological and sonic aspects of the research, Rubidge for the choreographic research. The close dialogue between a choreographer and someone closely involved in the development of the two systems being tested was of considerable benefit in refining the systems for use in a performance context.

(1) First intensive research week (May 2006)

The primary purpose of first research week was the technical testing of the Cricket system, and to a lesser extent the ambisonic sound system. However, our aim was also to create potential conditions for a coherent choreo-sonic relationship by combining the ambisonics cubiform spatial structure of the speakers with the more complex spatial geometry of the sensitive Cricket area (which was determined by the placement and overlay of the range of the combination of the five Cricket receivers in combination). We moved a small way towards this in our first research week.

The Cricket system

The Cricket system was originally developed at MIT in Massachusetts, and then further developed by engineers at V2 in Rotterdam[1]. A complex system of transmitters (fig. 1) and receivers, the latter hung from the ceiling of the studio (fig.2).

Fig. 1 The prototype hand held transmitter

Fig 2. The 5 Cricket receivers on their extendable grid in the ceiling

In the first week of research the physical get-in (set-up) for the Cricket and ambisonic systems (which in physical terms the latter comprised 8 speakers mounted on 4 poles [fig. 3]) took a full day and a half, as the height of the Cricket system had to be adjusted in tandem with the distance and breadth of the speakers so that an optimum height of the Cricket receiving system could be found, along with its actual range in three dimensions, and the optimum placement of the speakers for the ambisonic system within this virtual space. A day and a half was then spent testing the basic functioning of the systems.

Fig. 3 The speaker system and Cricket receiver grid.

[1] *V2 is a private institution that researches interactive systems for use in artistic contexts*

During this time with a research assistant we experimented with both physical and technological factors of the two systems, exploring their range and as far as possible ironing out any basic technological problems before the dancers became involved.

For maximum sensitive floorspace V2 had advised Wijnans to hang the grid holding the Cricket receivers at a height of 4m-6m. This studio space had a very low ceiling – around 3m – so we were compelled to work below the lower limit. She also discovered that for an efficient three-dimensional measurement the transmitter held by the dancer (the handheld) needed to be seen by at least three Cricket receivers. The low level at which the grid was placed made the range (sensitive space) achieved by the system very narrow. In this first research period the inner range of the sensitive space was about 3m x 3m and the outer range 4m x 2.5m. Due to the height constraints the range on the Z axis was *very* limited, approximately 1.5m.

Engaging in this very fundamental technical research is essential when testing tracking systems in a choreographic context, and should preferably take place before the dancers enter the fray, as some of the basic systemic difficulties can be resolved before the dancers arrive, allowing time for the choreographic research to take place without wasting that precious time trying to resolve, or on some occasions identify, basic technological problems.

During this first research week several problems and issues with the Cricket system that might affect choreographic behaviours within the two systems were identified, for example:

a. the extent of the 'throw' of the handheld radio signal transmitter (hereinafter referred to as 'handheld') was constrained by the height at which the Cricket receiving system was mounted, which in turn affected perceptions of the available choreographic space;
b. the optimum area of the three dimensions of the physical space within which live motion data could be transmitted to the computer was dependent on the dimensions of the studio space in which it was mounted, particularly height, and by the number of Cricket receivers available;
c. the lack of sensitivity of the Cricket system with respect to the recognition of movement at higher stages of velocity.
d. problems with different degrees of latency in the recognition by the handhelds the Cricket system caused by direction of movement into and out of the sensitive space. This created an 'sensitive' space that had outer and inner limits, giving rise to an ambiguous 'border'.

Ambisonic sound system

The research with the Cricket system was undertaken in conjunction with a prototype sonic programme developed in the ambisonic sound software. The geometry of the ambisonics surround sound is Cubiform. Wijnans set up 8 small PC speakers in a cubiform, with eight speakers placed in a square lay at floor levels with 4 placed above the at slightly higher than head height (fig 3.)

fig. 3. The speaker system and Cricket receiver grid.

This setup enabled her to create a sonic environment in which the sound could not only move horizontally but also vertically (and thus diagonally), creating a real surround-sound space. In terms of the spatialisation of the sound the interactive environment exploited the fact that movement makes use of a complex combination of movement flows in the three primary directions, horizontal, vertical and sagittal, which gives rise to additional diagonal flows of motion. The sound can echo the spatial flow of movement through the space and/or operate in spatial opposition to it) when the handheld transmitter is moved in and around the sensitive space. Ideally the spatialisation of the sound would extend beyond the visual boundary lines created by the speaker setup. However, as Wessel (1999) notes, this 'depend[s] on the loudness, timbre, frequency, spectral properties of the signal'. As Wijnans was using computer speakers (for financial reasons and transportability), clarity of the motion of the sound, and its extensions beyond the boundaries of the speakers was not achieved in this research week.

The sound environment during this week explored the use of sound samples which could be subject to sonic modulation (of pitch, volume, granulation, etc.) through the motion of the handheld receiver/s. Originally derived from the human voice, the sound samples generated a sonic texture which moved through space three-dimensionally in conjunction with the motion of the dancers. The ambisonic system operated using the spatial parameters of location, direction and velocity of movement, and rotation of the handheld. For example, sound samples would be triggered when a handheld entered a particular area in the sensitive space. Once located they became subject to modulation by the behaviours of the dancers. Additionally there were 'home' places in the space, which would give rise to a loud abstract sound whenever a particular handheld transmitter was present in that area. (These 'home spaces' sometimes moved to keep the dancers searching for the sound.).

Choreographic research

The dancers were invited in on the last two days of this research week to explore and test the system, some of the limitations of which we were now aware,

During this period I had identified certain choreographic possibilities derived from the constraints presented by the features, and limitations, of the Cricket system in its current state of development.

Amongst the ***technical constraints*** were:

i. the physical dimensions of the handheld;
ii. the fact that the sensitive sensors on the handheld (hereafter referred to as sensors) did not 'read' at a certain height – which was below waist level in the space with a low ceiling that we were using;
iii. the fact that the sensor did not recognize the same border when moving away from the centre of the sensitive space and towards that centre (direction parameter); there was considerable latency in the move from sound on to sound off when crossing these borders in both directions;

During the choreographic research in the final two days further limitations were identified. These included the fact that:

iv. the use of rotation as a modulating factor was not a possibility as the crucial sensor was occluded when the dancers rotated their wrists, which meant that the wireless connection between computer and sensors was lost;
v. the dancers' bodies occluded the sensor from time to time if they performed dance movement without attention to the handheld;
vi. it was difficult for the dancers to recognise with any precision where the sound was coming from in the three-dimensional space, in part due to the fact that they were often in close proximity to a sound source (speaker) which increased the volume of the sound emerging from that speaker, and concomitantly diminished the volume of the sonic trajectories of sounds which were working across speakers more distant to them;
vii. if the dancers traveled though space too quickly the sensors found it difficult to 'catch' the motion.

The choreographic possibilities that these limitations presented with the dancers (in case they were not resolvable technologically) were explored, although much of the time was spent in simply testing the sensitivity of the system using dance movement. We followed loose improvisatory exercises devised in the light of the above, using my conceptual knowledge of the two systems, and the practical experience gained from the first three days of the research week. The dancers also began to create their own improvisational strategies as they became more familiar with the system (or simply wanted to dance!).

Experience has shown that it is important to allow the latter to happen when working with these systems, as it can give rise to a choreographer having new ideas as to how one can work with the system.

As each improvisatory explorations took place (see below) a focused dialogue took place between Wijnans, the dancers and myself. This research strategy was essential for the two main researchers develop an understanding not merely of the technological efficacy of the system, and how it sounded to an 'audience', but also of the ways in which the dancers understood their engagement with the systems. Without the latter interactive systems would be built for those who view from the outside, not those who experience it fully from the inside. An understanding of the latter is essential if the potential of systems such as this are to be exploited to the full in a performative context, whether by their creators, by choreographers or by performers.

Improvisational/Choreographic thinking for interactive environments explored during this period
With guidance the dancers moved very quickly from 'mickey-mousing' the sound (in particular its quality) to exploring a simple *dialogue between movement and the sound* it was producing (for example, exploring the use of faster movement with sustained sounds, or slow movement with granulated (more 'jagged') sounds. This is a particularly important skill for dancers to gain in such a system order to allow for the use of both one-on-one sound movement relationships and those which play across movement and sound qualities.

We also experimented with the aspects of the ambisonic sound system in which the *sound moved in the opposite direction to the dancers*. This was less successful at this stage as the dancers found it difficult to locate the sounds, in part due to the small speakers we were using, in part due to the instabilities in the systems as they stood at that time, in part due to the fact that proximity to a sound source made that sound dominant, and thus more recognisable. However, the use of spatial opposition is an important part of the thinking of the choreo-sonic system under development, and thus, we resolved, would be returned to in the second research week. These problems concerning the precision of the three-dimensional sonic space are in part due to what Topper et al (2002) call a "Persistence of Audition", that is, the listener is aware that auditory objects are moving in the space, but is not always totally aware of where or how. This meant that when the dancers, who were both initiators of and listeners to the sonic environment, explored the system choreographically they were not always aware of the shaping of the three dimensional sound space that they were generating. Nor indeed were outside 'viewers' of the improvisations. This requires a greater understanding of the effect proximity to the sound source has on the perception of the spatialisation of sounds of different volumes

Additionally, having seen that the limits of the sensitive space were quite small[2] we began to consider the *use of the non-sensitive space as an integral part of the choreographic domain*. It is only to easy in interactive dance work to consider the electronically sensitive space as the limits of the choreographic space. However, visually, the whole performance space is to all intents and purposes a sensitive choreographic space. Consequently, if there is more than one dancer, even if there is only one sensitive cricket transmitter, a dancer who is moving in the insensitive space outside the border of the sensitive environment could be dancing and responding to the motion of the dancer in the sensitive space and/or the sound generated by that dancer, even though the dancer on the outside is not sensitively generating the sound environment. This would become a part of the choreographic, and indeed choreo-sonic framework, and could be extended with several dancers. Karpinska (2001) argues that 'the immersion of composed space within listening space gives rise to superimposed space'. We designated the sensitive area of the Cricket system as the 'zone of the responsive surround sound system' and the area outside the sensitive area of the Cricket system as the 'superimposed space' in which no new sound manipulations were triggered.

Employing the tactic described above might further destabilise the 'one-on-one' thinking that sometimes dominates interactive sound-movement work, and also the tendency to make everything a dancer does result in a modification to the sonic environment they are creating. We felt that it could be much more interesting if there were *moments when all of the dancers did not modulate their environment, but*

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[2] This is a feature of tracking systems including optical tracking systems mounted in the ceiling that I had hoped would be resolved in this context. The Cricket system could have a far greater spatial range if more receivers were to be mounted in the ceiling grid (we had 5). This would add to the expense of the system.

responded to the modulations generated by their colleagues. In view of the fact that we only had one sensitive handheld develop a strategy was developed whereby one dancer would work with the handheld in the sensitive space and the other (without a handheld) would dance in the non-sensitive space, remaining part of the choreographic image but not affecting the sound. This was later extended to allowing both dancers to dance in the sensitive zone, even if one did not have a sensitive handheld sensor,. The handheld sensor was also left outside of the sensitive zone to allow the dancers to perform unencumbered. This again is a means of *avoiding constant sonic responses to movement*, which over time can lean towards artistic overkill. In this way we were able to control the sonic textures thought choreographic means. The dancers explored these possibilities, and extending them to exchanging the handheld, both within and outside of the space, and experimenting with placing them on different parts of the body.

Two further choreographic limitations were generated by the design of the handheld sensors. One was that the *sensors were larger than we had anticipated*. The original intention was to place them on the bodies of the dancer, on the shoulder, for example (attached with Velcro or some other material), which would mean that the dancers were unencumbered by the Cricket transmitters. The size of the transmitters, some 15cm x 8cm, was such that the dancers had to hold them in their hands. This became a factor in the choreographic explorations in the first two days of choreographic research. The dancers began to focus on the handheld, almost treating it as another partner in the choreographic world they were creating. Whilst this had a place, it was felt that it drew attention too closely to the technology, which was something that we wanted to avoid. Were this not to be resolvable technologically, this limitation would need to be addressed choreographically in the second research week. However, in this period the dancers began to explore placing the handheld on different body parts, the sternum, the foot, the back, the shoulder in order to deflect their attention from using their hands and arms as the primary means of modulating sound

Another unanticipated factor was that the signal from the transmitter could be occluded by the *rotation of the sensor* (it was hoped that rotation of the sensor could be used as a means of modulating sound) as one of the sensors (which were placed on the 'top' and 'bottom' of the handheld) was no longer in the range of the receiver, and or was occluded by parts of the dancer's body. We began to consider *making the occlusion of the signal not a problem, but part of the choreographic//improvisatory thinking*. We explored the use of different scales of movement, and found that very large circular movement would 'read', but not small detailed rotations of the transmitter.

Another limitation identified was that the *velocity of the motion* of the dancer affected the accuracy of the motion tracking by the Cricket system, leading to latency of response. This was a difficult problem to solve choreographically, and one that we felt might need to be addressed technologically. For this research period we *kept within the limits of velocity established by the system*, but it was determined that the Cricket engineers would be asked if this aspect of the sensitivity of the system could be refined to give greater choreographic flexibility.

The focused discussions between the three sets of participants that took place as the choreographic explorations progressed proved to be invaluable and were used for multiple purposes. The insights offered by the dancers helped Wijnans to develop interactive structures for the sonic environment for the second research week. They also revealed choreographic possibilities that might not have been apparent if I had relied solely on my 'outside' perspective of what was going in the sensitive space. Finally they helped the dancers to reflect upon their experiences to better understand the experiential aspects of being in the system, and the choreographic/improvisational possibilities it offered us. Through these discussions we were able to negotiate between the experiential knowledge that the dancers gleaned in the space, and the more distanced knowledge gleaned from the way the improvisation looked from the outside.

Outcomes of the first research period

In terms of process, during the last two days of the research period the dancers and I gradually familiarized ourselves with the kind of improvisatory thinking that we would need to develop when working in a system such as this, and WIjnans familiarized herself with the technical constraints that dance movement made evident, and the sonic possibilities to which the choreographic possibilities we had identified might give rise. It also became even clearer that the ways in which the dancers understand their engagement with both the tracking and the sonic systems is an important factor to consider in the

development of those systems. Without the latter interactive systems would be built for those who view from the outside, not those who experience it fully from the inside. An understanding of the latter is essential if the potential of systems such as this are to be exploited to the full in a performative context by the creators of the systems, the choreographers or the performers.

We had identified several choreographic possibilities inherent in the technical limitations presented by the systems. It was decided that even if the technical limitations were resolved in the period between the intensive research weeks, that the choreographic ideas to which they had been given rise would be used as choreographic strategies in forthcoming choreographic research as they were in testing in their own right.

(2) Interim research period (May 2006 – September 2006)

Technological

In response to the findings of this first week of research the modifications to the Cricket system that were found to be needed after our dialogue explorations were undertaken by the engineers at V2, in discussion with Wijnans. A second handheld was also built by Wijnans in order to allow us to experiment with two 'technologically sensitive' dancers in the system in the second research week. Finally, Wijnans began to develop a more sophisticated sonic environment in the ambisonic sound system for use in the second period of research.

Choreographic

In order to develop more interesting choreographic responses to the limitations the discoveries we had made in the first research week were subjected to more detailed choreographic exploration and development in a 'non-sensitive'[3] studio situation. These were scheduled to take place in the period between research weeks, to prepare us for the second intensive research period. This strategy allowed for the development of choreographic responses when working with the technological systems that, in the context of limited research time with such complex technology, go beyond the first movement responses to the that technology.

By the end of this week there were number of choreographic ideas to explore. The aim during this interim period was to develop improvisatory choreographic systems which utilized the features, and limitations, of the Cricket interface but did not allow the latter to dominate spontaneous improvisatory/choreographic decisions[4]. The purpose of this was to ensure that an interesting movement improvisation, and thus choreographic event, took place, as well as an interesting sound improvisation.

On the basis of this I devised improvisatory exercises, in collaboration with the dancers, that could be built on when the system was mounted in the second intensive research period. Many of these were grounded in large scale spatial concepts (using notions of an extended choreutic space) in order to make sure that the dancers used the fullest extent of the three-dimensional dance space (the vertical as well as the horizontal dimensions). They also entailed practicing improvisation with objects in the hands to diminish the concentration on the direction of the hand movement as the initiator of movement that became evident in the first research period. In this kind of one-on-one interactive interface it is important for dancers to become less consciously aware of the precise nature of the movement that generates the interactive responses in the technological system. The tendency in the early periods of working with such systems is to be overaware of this and to direct movement towards generating sound, rather than developing movement materials and improvisatory strategies that are interesting in a choreographic sense. I work on the principle that, whatever movement the dancers do, a handheld sensor will necessarily be moving through space, and thus tracked by the system.

Inasmuch as we had very little time to rehearse in the interactive space I also used this period to devise strategies to circumvent the basic learning processes needed to work in an interactive sound space. We held several rehearsals in which we explored and modified improvisatory ideas in preparation for the

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[3] 'Non-sensitive studio space' here refers to a normal dance studio space that is not sensitized by the interactive Cricket system or the ambisonic sound system.

[4] The dancers are from a company which grounds its work in improvisationary strategies. As such they were skilled improvisers, and able to repeat and modify strategies in realtime in response to the effects their movement was having on the sonic environment.

second research week. Many of these were concerned with creating improvisatory strategies that were contained within a loose spatial framework in the general space, constructed such that it guaranteed changes in location in the sensitive space, in level, direction, velocity and proximity between the dancers (this last being one of the parameters in the ambisonic system that we wished to explore as a means of modulating the sound). For these purposes I used 'star maps' as the starting point for improvisatory explorations. These were derived from astronomical maps of the night sky. Additionally we worked on generating movement that guaranteed changes in level, which would accommodate the 3D characteristics of the ambisonic sound system. This was done by adding a vertical dimension to the spatial structures, still working within the concept of star maps, but overlaying the vertical dimension maps with the horizontal. These strategies prepared the dancers for their improvisatory explorations of the 'sensitive' space, allowing them to concentrate both on where they were going (in relation to both the space and each other), and on the effects the *where* they were going had on the environment when they entered the space in the second intensive research week.

We also emulated the presence of the handhelds using mobile phones, in order to diminish over-concentration on the motion of the handhelds, rather than on other aspects of movement, when they were in the sensitive space. Such over-concentration diminishes the openness of any improvised movement, and makes the interactive strategies very obvious.

Whilst it is important for it to be apparent to an audience that the motion of the dancers is modifying the sound, it is equally important for us that the effects become part of the structural matrix of the *choreo-sonic* work, rather than its *raison d'etre*. As the compositional structures I prefer are complex, for me this needed to be reflected in the choreography devised for interactive environments, without making the sonic environment too complex. We thus explored a number of exercises that would familiarise the performers with the object, and thus help them to forget its presence except when a more subtle manipulation was needed, e.g. to avoid/deliberately generate occlusion of the signal. Practice in imagining that the object in their hand was the Cricket receiver helped to establish a subconscious 'memory' which could be drawn on during the movement work in the sensitive space.

(3) Second Intensive research week (January 2007)

During this second research week we tested the modified Cricket system, which had accommodated (or not) the initial problems which had been identified in the first week; explored a more developed ambisonic sound system; tested and consolidated the choreographic thinking developed during the first research week and interim research period; and developed choreographic improvisational strategies that could lead to a performatively and sonically interesting improvised event. Being aware of those limitations of the Cricket system that we had identified in the first week that the engineers had been unable to resolve at this time, we worked choreographically and sonically within them. We presented a sharing of our findings on the final day of this second intensive research week.

Technical systems

A day was spent setting up the Cricket and ambisonic sound systems, this time with the help of the dancers, who expressed an interest in seeing how the system was set up as well as working within it. They were also instrumental in calibrating the sensitive space (second day). Going though this process helped them to understand some of the intricacies of the physical and virtual structures of the systems before working within the virtual environment.

Cricket system

In order to address some of the issues with the Cricket system that could be resolved on site, we had booked a theatre space that was larger and higher. The height of the ceiling in this studio space offered a greater range of technologically sensitive height in the upper areas, allowing the dancers to activate the sound at full stretch of their arms. However, it also revealed that simply hanging the system higher does not necessarily improve the range of the system as the radio signal gets weaker at the lower levels the higher the receiver system is mounted. The range on the XY axes that we achieved for the sensitive space on this occasion was 4m x 2.5m (inner boundary) and 5m x 3.5m x (outer boundary) and approximately 4m for the Z axis. We also discovered that above a certain height there was a 'dead' space at floor level. Having experimented with hanging the system lower in order to fill this space, and discovering that the upper height range of the transmitters was diminished, we decided that the lower 'dead' space itself could become an interesting feature of the choreo-sonic space, and of the choreographic explorations. We thus set the Cricket grid such that there was a space of about 5cm

between floor level and the sensitive space in which the Cricket transmitters were not recognised by the system (‘dead’ space).

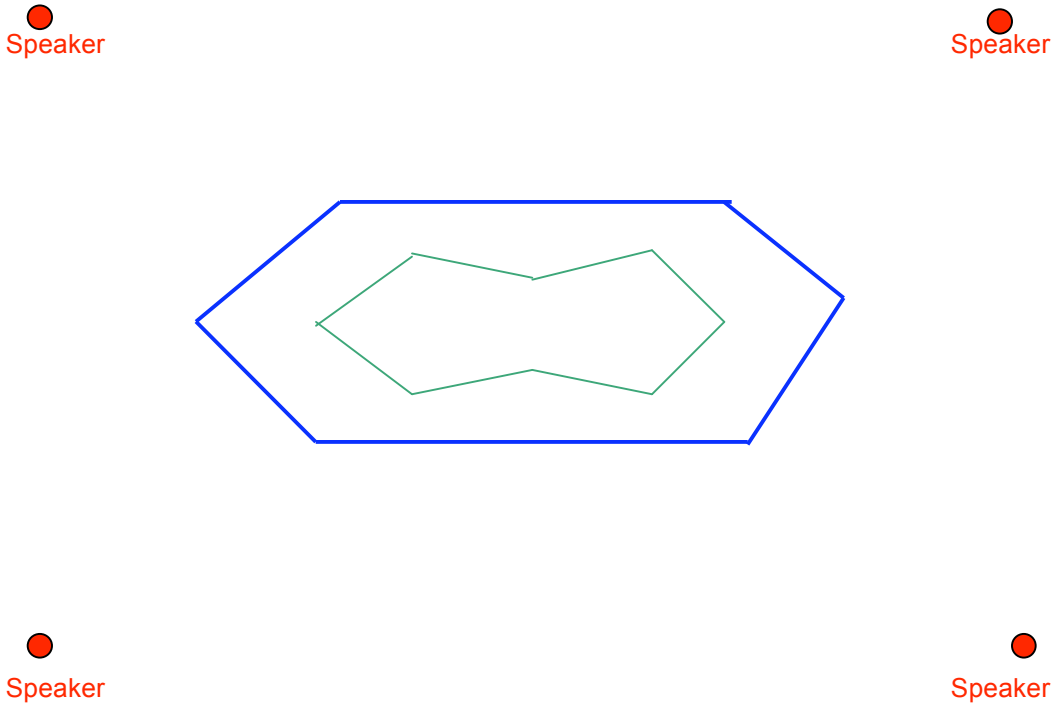

Fig. 5. Shape of Sensitive Space (approx)

We also found that the sensitive space was still very small as we still had only 5 Cricket receivers in the grid. (fig. 5) Only an increase in the number of receivers would resolve this, which we did not have. As a consequence we worked within the space available to us, with the latency of response noted in the first research week unresolved. In fig 4 the inner border is marked in white, the outer border can just be seen approximately 0.50m beyond the shape. (As it would be easier for dancers to be visually aware of where the outer and inner borders of the sensitive space are, we consider that in a live production using the Cricket system as it stood for this research period that the shape created by the borders could be built in to a painted floor cloth as part of the performance design.)

In contrast to the first research week, wherein the speakers almost delineated the extent of the sensitive space, the speakers were set up well outside the outer limits of the sensitive space to increase the sonic space available to the audience. (One speaker pole can be seen on the right hand side of the image in Fig. 4.) As the week progressed we also became interested in testing out whether the dancers could perform in a space in which the audience were present.

Fig. 4. Spatial set up for second research week.

Sonic environment
Wijnans had designed a Choreo-Sonic mapping matrix that combined and categorized the time-space-rhythm parameters that modulated sound. This she used as an index and concept for the realtime sound composition generated by the dancers.

She added an interactive synthesizer to the an interactive sound texture (using voice samples) created for the first research week. This allowed the dancers the freedom to design different timbres and tonalities from individually allocated digital sound partials in the software developed. These partials consisted of basic digital sinusoidal oscillator sound sources manipulated with frequency filters and reverb effects to interactively design the sounds and maximize the perception of a changing sound space. Velocity and acceleration triggers were added in the software, with a threshold set to trigger random explosions of abstract sound samples to emphasize fast dance movements. Proximity of handhelds as a modulating parameter was also added to the system.

The potential sonic environment was thus conceptualized in the interactive software, and consisted of several independent layers. A basic sound layer composed from voice samples, a second layer interactively designed from different sound timbres with distinct single sonic events happening on top influenced by sound effects and three dimensional sound spatialisation depending on position of the dancers in space.

Choreographic Research
The choreographic research on this occasion took place over three days, drawing on the choreographic strategies developed in the interim choreographic research period as a starting point for improvisation. We followed the research methodologies developed in the previous intensive research week, namely improvisatory explorations within the systems followed by focused discussions with the dancers, which were then used to devise modifications to the ambisonic system and further improvisatory explorations.

In order to familiarise the dancers with the interlocking sonic layers, and the parameters that modulated them, the sonic environment was broken into its individual layers (see above), the dancers exploring each layer, and each parameter within the layers, in turn, developing improvisational strategies appropriate to each. At this stage they initially explored the parameters through free improvisation, which were then guided according to the observations I and they had made of potentially interesting choreographic outcomes. This strategy allowed Wijnans to solve certain problems with the two softwares that became evident as the dancers explored each layer, and each parameter, and to note those limitations that were

not possible without an engineer. In this way any limitations that still existed within the tracking system and handhelds were revealed early in the choreographic research, allowing us to accommodate the latter to the former for this research period. It also allowed the dancers and I to identify new improvisational strategies upon which we could build.

One of these limitations was that, although Wijnans had extensively tested the ambisonic sound system in her sound studio, the perception of the three dimensional moving sound, particularly for those outside of the sensitive space but also for those inside, proved even more difficult because it transpired that the diffusion of sound is extended in a bigger space. *Although the detail of the dancers' perception of the space became more refined as the week progressed, although probably at an intuitive level, they were still not completely in control of the level of spatial sound perception* that Wijnans had hoped to achieved. It became obvious that, even in this set-up, in order for the surround sound to be clearly articulated full-range speakers were needed. For example, the dancers found it more difficult to identify the spatial behaviour of low frequency sounds. This is part of the nature of such sounds but was radically exacerbated by the quality of the speakers. At this stage it was unfortunately was still beyond the financial possibilities of this research project to replace the speakers, but will be rectified in future research in the system. Nevertheless, as our aim was to the test the basic choreographic *potential* of the two systems, we were able to continue the research we were committed to undertaking, knowing that the sound issues would be overcome when they became the central focus of the artistic research. We thus continued, in spite of this limitation, to explore the choreographic experimentations we had developed in the (non-technological) interim research period within the sensitive space. This allowed the dancers to become both consciously and intuitively aware of the motional factors that modulated the sonic environment, using improvisational strategies designed for the system with which they were familiar.

During the course of this research week, in the light of the results experienced in the new interactive space we began to modify and refine the improvisatory systems (both spatial and gesture-based) developed in the interim research period. The dancers were allowed to improvise freely for a period of time, and then to refine and modify the improvisatory structures they were developing during that time with my guidance, and in the light of suggestions concerning sonic output from Wijnans. For example, with respect to gesture we explored both peripheral (curved) and linear gesture with each parameter in order to vary the movement vocabulary used in the improvisation. The dancers were asked to look in the opposite direction to the direction in which the handheld was pointing from time to time in order to deflect their, and their audience's attention from the interactive hardware. Rubidge also suggested that the dancers used a 'spacehold'[5] in order to provide a limitation to their free improvisation (one means of disrupting the habitual patterns that tend to emerge even in free improvisation). We returned to the placement of the handheld on different body parts, as well as dancers exchanging the handhelds, and thus generating the other dancer's sound.

I also asked the dancers to shift the centre of each of their 'star maps' (a choreogprahci device we used to facilitate a more complex use of general space, in order to decentralize the sonic and choreographic space. I then asked them to place their 'front' in different orientations on each repetition of the improvisations derived from the map in order to give the choreographic space a sense of being 'in the round'. In this way the two improvisation structures that each of the dancers were beginning to develop took on a different relationship to each other, and generated different sonic detail and textures. We also began to explore the 'dead' space at floor level, and one dancer vacating the sensitive space, or placing the handheld on the floor, or outside of the sensitive space, from time to time (generally not both together). These strategies resulted in occasional 'silences' or sustained unmodulated sounds from one dancer/handheld, which decreased any density of sonic texture that might have emerged. This allowed the dancers to begin to compose the overarching structure of the emerging sonic composition as well as its detail. The placing of the handhelds on the floor also allowed the dancer's moments of free improvisation during which they did not need to pay any attention to the effects they were having on the sonic environment.

As the days progressed we began to explore the use of the layer in which the dancers composed timbres from different partials. This required great attention from the dancers and they went some way towards

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[5] *A term used in Labanotation to denote a hand (for example) maintaining its position on general space, whilst the dancer's body moves around, under or over it according in any manner they wish.*

achieving Wijnans's desire for the dancers to compose, not merely modulate, the sonic detail of the sound environment. Although we only touched on this in this research period, the dancers began to feel their way into this new mode of interacting with sound in this sonic space.

At the same time we were beginning to combine parameters and sonic layers in order develop an improvisatory system that would generate an interesting choreo-sonic event, in terms of structure, dynamic form, and movement and sonic content. Our aim was to presented an improvised choreo-sonic event as a 'work-in-progress' in a sharing. To this end Wijnans began to introduce new factors to the sonic system. For example, proximity was introduced as a modulating factor (close>louder: distant>quieter). This led to the dancers beginning to dance *with* each other, and eventually to make physical contact with each other (a factor that had been missing in the previous improvisational experimentation). She introduced a vigorous sonic gesture when one of the dancer's gestures were very fast, which added dynamic range not only to the sonic environment, but also to the choreographic event. She introduced a contextual sound (from the vocal sound samples) from time to time (when one dancer entered a particular space), which imbued the sounds that the dancers were generating with different tones and textures, and thus (for the dancers) meaning.

These factors, and others, suggested new improvisational structures and thus choreographic forms. For example, when the proximity parameter was in play, the bodies did not always need to be very close together to modulate the sound. Rather the sensors could be held close to each other using an extended arm, leaving the bodies at some distance from each other. This gives a quite different emotional nuance to the choreographic forms, and a sense of ambiguity to the interrelationship between sound and movement,

Gradually the dancers began to identify what they called an 'emotional' content to the sonic spaces that they were developing. This led them to deepen their improvisational responses to the sound, and to enjoy dancing in, as well as generating, the sonic environment. In order to disrupt the tendency to use medium or large scale movements in spatially constructed interactive environments, during this phase I introduced moments and/or places where the small movements predominated, and requested that in each improvisatory cycle the dancers introduce noticeable pauses in their movement, in order to create stillnesses within the flux of movement. These were gradually worked into the improvisational structures until they became second nature. By this time we were beginning to generate a choreo-sonic form.

A loose structure was devised for the improvisation for the *sharing*. These included incorporating the calibration of the sonic system into the performance event itself. This not only allowed the dancers to refamiliarise themselves with the interactive environment, but also the audience to gain an initial insight into some of the interrelationships between sound and motion. (This is, if you like, an example of an auto-pedagogic approach to interactive performance.) We set the structure of entrances, and developed signals for the beginning and ending of 'sections'. For each section the dancers were using different spatial structures at different points in the improvisation in order a) to vary the progression of the choreographic event, and b) the textures of the sonic environment they were generating. Additionally each 'section' had a subtly different sonic focus. For choreographic purposes I also required that the dancers allowed their colleague a short solo moment within the flux of the duet. This was also introduced to ensure that the density of the sonic texture changed from time to time. Many other purely choreographic devices were introduced at this stage, and rehearsed on the morning of the third day. We also decided to ask the audience to enter the 'performance' space, in order to experiment with an idea I have had for some time, which is to create an installation in which a performance takes place in amongst the visitors to the installation. In a non-optical setup such as the Cricket system, such a strategy is possible.

On the afternoon we presented a sharing of the outcomes of our research. First the dancers engaged in a ten-minute improvisation, using the micro- and macro- improvisational structures that we had developed during the research period. Wijnans and I then gave a brief explanation of both the technological and artistic principles underlying the outcomes of the research, using the dancers to demonstrate certain aspects of the system. The dancers then performed a second ten-minute improvisation to allow the audience to view the systems in operation in the light of their new knowledge. We actively encouraged the audience to stand in the active space from time to time to ascertain what such a dialogue between audience and performers would look like, from both inside and outside. There was then a lively question and answer session which lasted 20-25 minutes. More detailed discussions

followed with certain members of the audience who wanted more detail of either the technological or artistic strategies used during the research.

Conclusions

In the light of the aims and objectives of this project we achieved a great deal for very little cost. This innovative research was made possible by the contributions of engineering time provided by V2, Rotterdam, the loan of the Cricket system by V2 and PGacoustics, London, and the work undertaken by Stan Wijnans with both those organisations, and on developing a custom ambisonic environment for the research project.

The research was a genuine collaboration between myself (choreographer), Wijnans (interactive sound artist) and the performers, who brought the system alive. The project was devised in all its detail by both Wijnans and I, who were both interested in focused experimentation with a spatial dialogue between choreography and spatialised sound in a performance context. Whilst many of the parameters devised for the ambisonic system were sound specific, others were choreographic at source (e.g. proximity[6]). However, the framework devised as a starting point for the project underwent considerable alteration in its detail during the course of the research, both at a choreographic and at a sonic level. The structures we developed over the three research periods were inextricably influenced one by the other. Choreographic desires led to modifications to the sonic system; sonic desires led to modification of the choreographic/improvisational systems; the dancers' desires as performers were instrumental in the development of the choreographic/improvisational systems, and led to many modifications in the sonic system.

As such this research period into the technical implications[7] of the development of a choreo-sonic environment proffered a large number of choreographic insights that ultimately will be of value to those working within the field of interactive performance. It also allowed us to devise, over time, a collaborative process that gave the performers as much ownership of the choreographic/improvisational systems as the lead choreographic researcher.

I consider that we achieved some of the (somewhat ambitious) technical and (more modest) choreographic aims of this research project. With respect to the latter, I feel that we went beyond those goals, for not only did the dancers generate and modulate sound with considerable skill, utilising the framework provided by Wijnans, they also spatialised 3D sound in realtime using focused, improvised choreographic forms. For these reasons they were able to create a coherent sonic form and play knowingly with sonic detail and textures whilst sustaining a choreographically coherent semi-structured improvisation in a performance context. It has to be noted that their skills as improvisers gave this project an added dimension that less skilled improvisers would not necessarily have met. Additionally the sophistications of the already sophisticated custom sonic system that Wijnans developed for this project was greatly enhanced by the contributions the dancers made through their responses to the sonic environment and the means of generating and modulating it, and through their reflections of the implications of those responses to the emergent choreographic form.

With respect to the technical goals, our preliminary choreographic investigations into the possibilities for interactive performance offered by a non-camera-based, wireless motion tracking system proved that there is considerable chorographic potential for such systems, although the system we were using proved inadequate for our needs due to certain instabilities. Nevertheless, we found that an interactive performance event which is not dependent on stable lighting states is more than possible with a non-optical tracking system. The lighting conditions for the Cricket system can be variable, indeed even relatively dark, allowing for the use of nuanced lighting states, which are an important factor in giving a performance its atmosphere. This research period has shown that the system could be used in the relatively dark environments favoured by installation artists. Additionally, our choreographic explorations served to highlight some of the limitations of the Cricket system and thus assist in the development process of that system. As such the choreographic research extended beyond merely artistic research.

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[6] *Alistair MacDonald and I used proximity as a parameter for an interactive sound system in* Sensuous Geographies (2003).

[7] *Here I use the term 'technical' to include the development of choreographic/improvisational strategies, as these are, in a very real sense, part of the technical armory of the dance maker.*

The artistic research commenced during this project, which entailed the development of a choreo-sonic form was only just touched upon. Further explorations and refinements of the interrelated sonic and improvisational/choreographic systems will be undertaken in the future with a view to creating a choreo-sonic interactive event that is both legible, nuanced and complex, a balance that we feel is possible to achieve after our experiences during the short preliminary research period.

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