Parallax: Dancing the Digital Space

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Abstract

Parallax is a contemporary dance work that integrates live performance and stereoscopic illusions. This performance work was designed to demonstrate the transformative potential of stereoscopic technology for contemporary dance.

Parallax explores how the technology can change the traditional theatrical idea of space. We propose that the theatrical space is overlaid by a stereoscopic space that is best defined as a square pyramid. The stereoscopic image within the theatre environment creates a new area for the, choreographer, dancer and audience to experience dance and opens new creative possibilities. First, the choreographer needs to negotiate a different form of perceived space, and to work with both live and animated bodies. Second, the dancer may become less central and more part of a technical system, and s/he is required to negotiate digital environments and objects that are invisible to them.

Finally, the audience experience of the stereoscopic dance performance is significantly different from, and potentially more immersive than, other forms of dance that use technology. This paper proposes that the inclusion of three-dimensional (3D) scenography requires a reorganizing of the conception of space in the creation and performance of contemporary dance and theatre.

Keywords

3D, stereoscopic, dance technology, choreography, multi-media dance, trans-media dance.

Introduction

This paper focuses on the use of stereoscopic imagery in live contemporary dance performance. In particular, we examine how the stereoscopic illusion changes the perception of space in the theatrical stage setting. We will argue that through the use of the stereoscopic illusion the perception of space is altered and the experience of space is transformed for the participants of dance, the choreographer, dancer and the audience. We will do this by focusing on a contemporary dance stereoscopic contemporary dance work, *Parallax*, created by the first author. [1] Through *Parallax* we will highlight how 3D changes the traditional role of participants of dance performance, the choreographer, the dancer and the audience. The choreographer needs to negotiate how the stereoscopic imagery exists within the live performance and stereoscopic space and how the 3D imagery can be placed with the live performer in space.

Through the use of stereoscopic imagery the performer is required to dance with images that are mostly invisible to them but which provide powerful contextualizations through virtual stage settings and performance partners. The dancer also needs to perform 'with' these images, which have a different form of gravity and space. Audience perception of a 3D enhanced performance space is very different from that of a traditional theatrical space since the audience becomes part of the technical process, in the sense that the audience must 'complete' the technical process of 3D projection by fusing the images in their minds. The 3D imagery opens up the theatrical stage space with panoramic views and environments that can rapidly change and which are inhabited by stereoscopic objects that appear to move into the audience space. We aim to show how conceiving of the theatrical theatre space as having a pyramid shaped overlay that embeds the stereoscopic content is a helpful concept in understanding how this is altered environment functions artistically and aesthetically.

Approach

Parallax was developed using a multi-modal practice-based research approach, intertwining artistic and theoretical perspectives. The practice-based method is described by Australian and English writer and academic, Linda Candy as; 'original investigation undertaken in order to gain knowledge partly by means of practice and the outcomes of that practice' Candy's explanation of a practice-based methodology encapsulates the processes undertaken within this work. [2] The performance *Parallax* was created to explore the issues involved in using 3D in live performance as part of a dual process where the creative domain of art creation and the investigative domain of 3D informed each other. Australian choreographer and academic Cheryl Stock describes the dual process:

'These artist/researchers play dual roles reflecting on, contextualizing and theorizing their own practice whilst drawing on dance and cultural studies and a range of methodologies to inform their practice.' [3]

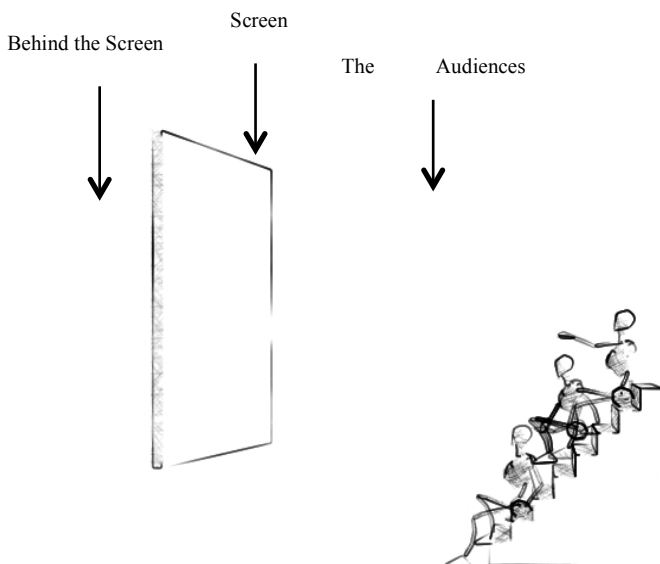In this process, the first author/choreographer particularly drew on technical work by Robert Neuman a stereoscop-

Figure 1. Film Depth Budget. ©Megan Beck-

Figure 2. Live Dance Performance Depth Budget. ©Megan Beckwith

ic supervisor at Walt Disney Animation Studios. His work provided a rich source of technical artistic provocation in relation to space, during the development of the performance *Parallax*. She also drew on her triple roles as choreographer, performer and animator in the development of *Parallax*, using a hybrid process to create the different elements of the performance. These multiple roles gave the choreographer/animator a unique insight to the development and creation of performance work that utilizes stereoscopic illusions for performance and the construction of the performance and stereoscopic space as one entity. The stereoscopic dance practice was developed in an intertwined and reciprocal process where the animation and choreography informed each other.

Parallax was created as a 40-minute contemporary dance and stereoscopic work. The dramaturgy serves to help drive the journey of the live character, explain and contextualize the constantly changing environments and give the audience a hook in which to situate the performance. The work explores the human body in an induced illusionary and virtual environment. Through the use of 3D stereoscopic animations *Parallax* explores how a person might physically and emotionally interact with illusionary or hallucinated worlds. This work explores two key questions; how does the body react within a distorted reality and how does hallucination affect emotions? This performance takes the dancer and the audience through a seemingly infinite set of virtual spaces, which are animated abstract environments, hyper-real landscapes and rooms. These spaces are inhabited by stereoscopic props that function as agents of change that seemingly 'interact' with both the dancer and audience.

The work explores the boundaries between the real, virtual and illusionary states. The performance opens as a woman drinks a green drink and appears to enter an indu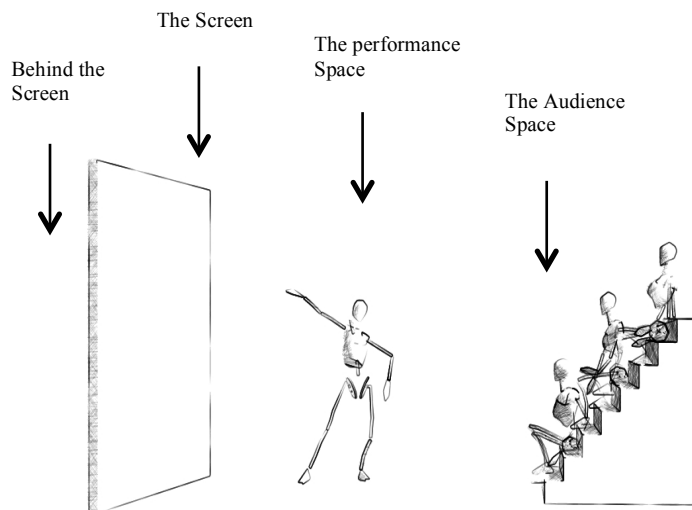ced illusionary world in which she is transported through a series of iconic spaces and times. The hallway she is standing in becomes a portal to new digital worlds. Each world she enters is different, sometimes dangerous, though sometimes not. The environments she enters contain fragments of the past that are 3D objects such as, Leonardo da Vinci's spheres from his *Treatise on Painting* and Charles Wheatstone's stereoscopic cubes from his paper *Contributions to the Physiology of Vision. Part the First. On Some Remarkable, and Hitherto Unobserved, Phenomena of Binocular Vision*. Each object she encounters creates different physical and emotional problems the woman needs to negotiate. In each world she sees herself from different perspectives, creating an effect of parallax.

Background to Stereoscopic Imagery in Performance

The stereoscopic image changes the perception of space. The stereoscopic image is a visual illusion that manipulates binocular vision, transforming the appearance of space and the animated objects within it. Imagine the letters on this page floating towards you and the page falling through your hands and away from you into infinity. It is this type of illusion of visual depth and relief that the stereoscopic image can achieve. Objects appear to hang impossibly in space directly in front of the audience's eyes and scenographic views fall away from the audience infinitely. Two-dimensional (2D) projected surfaces appear three-dimensional and panoramic scenes and animated objects seemingly become part of the viewer's world. It is these apparently magical possibilities that have an impact on the live theatrical performance space and require new conceptual ideas around space and relationship with the choreographer, dancer and audience.

The use of the stereoscopic image in live theatre and in particularly with dance is not a new phenomenon. The stereoscopic image has been in the domain of film since its
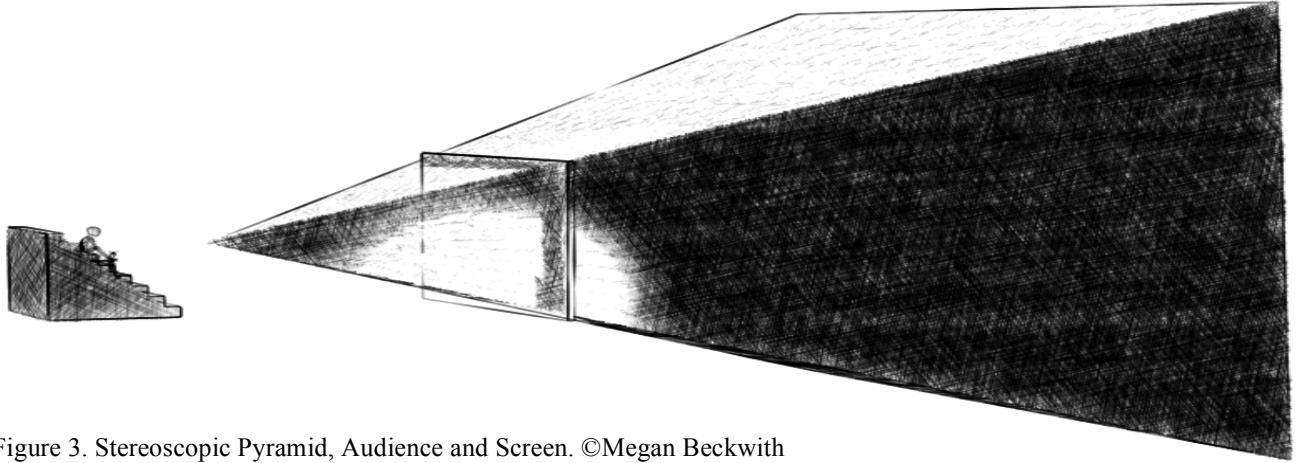
Figure 3. Stereoscopic Pyramid, Audience and Screen. ©Megan Beckwith

inception in the peepshow boxes of the 1900s. There was one early attempt by Laurens Hammond, the inventor of the Hammond organ, to popularize the stereoscopic illusion for live performance. [4] Hammond's patented *Shadow Graph* an anaglyph lighting technique was used within the 1927 Florenz Ziegfeld's review called *Padlocks*. [5] From Ziegfeld's seminal 3D dance performance it was not until the 1990s that the stereoscopic image was more successfully used in dance performances in dance works by artists such as; Billy Cowie; Klaus Obermaier; Robert Lepage; Heather Raikes; John McCormack; Wayne McGregor and Garry Stewart. The dance and animated shows that these artists create represent an emerging style of performance that includes stereoscopic 3D within the theatrical staging conventions and is a small but growing phenomenon.

Stereoscopic Space and the Live Theatrical Space

The use of the stereoscopic element in performance creates a digital aesthetic that is different, both from other dance forms and from dance that has historically used technology. One of the changes that the stereoscopic illusion affords dance is how the space is perceived and potential use of this space within live theatrical performance setting. This research is born from a desire to explore the potential of the 3D environment for contemporary dance performance and live theatre to create a greater understanding of the stereoscopic illusion in my own practice. The key point is to examine specifically the impact of stereoscopic image on live dance, which introduces a different kind of perceptual experience to performance. Part of this experience is how the live theatrical performance space is changed with the use of stereoscopic imagery and how can it be potentially be utilized.

The stereoscopic image offers an alternative layer of artistic possibilities for the creator of dance or live theatri-

cal performance. The stereoscopic animated image appears other than just background or an interesting lighting device. This image is constructed by a technical system that presents two different but very similar images to the right and left eye. The images themselves are slightly off center, one for each perspective of the right and left eye. The two images are fused together in the brain where the illusion of relief and depth is created. The brain processes the stereoscopic illusion as a three-dimensional landscape or object. The visual (and neurological) impact can be seen when the audience reacts to the 3D imagery by jumping, flinching or reaching out to grab the projected image. [6] Even though the audience knows it is an illusion, it is almost impossible to fight the urge to react. Some audience members enjoy and indulge this instinctive effect.

In tandem with the physical reaction the audience may also experience an emotional reaction to stereoscopic illusion. Robert Neuman describes this emotional response:

'the emotional distance we feel from what we see transpiring on the screen is proportional to our separation from it in 3D space. Of particular significance the emotional distances is the relationship of the subject to the point of zero parallax, the screen'. [7]

Neuman is describing how when the 3D images move past the screen and closer to the audience there is potential to elicit a more emotional response from the animated content. This artistic technique is potentially a powerful tool for the choreographer or theatre creator as audience reactions can be increased or decreased by the placement of the animation in space in relation to the audience.

In film, the detailed placement of 3D imagery is described as a depth budget. The depth budget is 'analogous to a musical score in how it is orchestrated to reflect the emotional content over time'. [8] This technique is also relevant to live theatrical performance that uses 3D imagery. However, the depth budget for live performance is different from a depth budget for film. In film, the stereoscopic image moves through the screen and, as Neuman
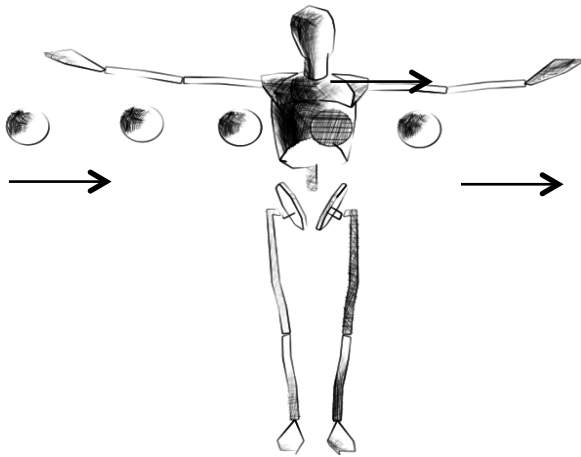
Figure 4. Front Projected Choreographic Violation, as the 3D image moves across the un-polarized body the 3D affect is lost ©Megan Beckwith
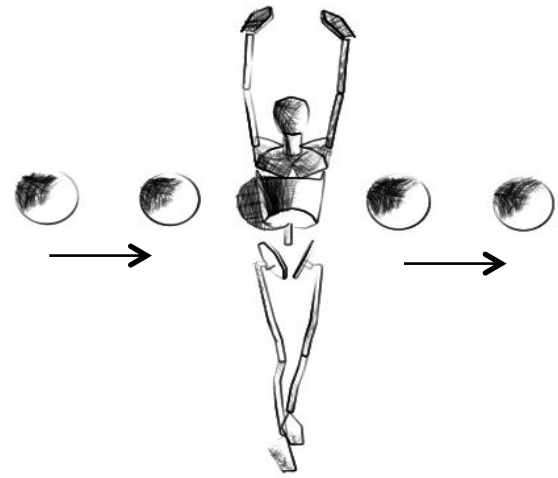
Figure 5. Back Projected Choreographic Violation, as the 3D projected image moves behind the body the 3D image it is hidden from view or occluded by the performer's body and the illusion is lost ©Megan Beckwith.

describes, into the 'audiences space' (See Fig.1). [9] Yet, stereoscopic live performance has another layer, the performance space (See Fig.2).

We propose that using stereoscopic projection in live performance creates a space that we refer to as the performance stereoscopic space. This space is created by the elongation of the animation due to the larger animation throw created by the need for the dance performance space. This space stretches from the screen to the audience space. We also think of this space as a pyramid as this is more accurate and precise term as it indicates the height, depth and width of the shape rather than indicating the floor space or a general area. The pyramid of animation space is situated lying on its side, with the tapered end facing the audience (See Fig. 3).

If the animation moves out side of this pyramid space a window violation will occur and a visual conflict will be created for the audience, also known as a 'paradoxical stereo window effec. [10] Neuman describes the window violation as 'the conflict of depth cues that occurs when an element that in terms of stereopsis lies in front of the screen, nevertheless is being occluded by the vertical surrounds of the frame line, which lies behind it as screen depth.'[11] In short, when a stereoscopic image appears that in front of the screen moves off the screen without appearing to move behind the screen, a visual conflict happens.

There are two common ways to project the stereoscopic imagery in the theatrical stage setting. The first method involves the projectors placed in front of the performance space, usually hung from the lighting rig, with the stereoscopic image being projected onto a polarized screen. Alternatively, the projectors are situated behind the performance space and the projection is shone through a shear polarized scrim. Even though the stereoscopic image is being projected from different directions, the pyramid scape is the same as the illusion is created through the sep-

aration of the imagery and not the direction of the projection.

The dancer appears in the stereoscopic space as they are bathed in the projection light and placed within the same visual scape as the animation. Due to the live performer appearing in the stereoscopic pyramid 'choreographic violation' can occur. Not unlike window violations, 'choreographic violations' become apparent with front projection when the stereoscopic image appears over or occludes the performer. The stereoscopic image appears to squash flat on the performers body (See Fig. 4). This flattening of the animation happens due to the stereoscopic image needing a polarized surface to be projected from. Unlike the stereoscopic screen surface the performer is not a polarized surface and therefore the illusion is unable to be maintained, since two identically shaped but horizontally separated images are no longer presented to each eye.

With the back projection, the image does not appear on the body as the image is occluded by the live body. The audience perceives this as the 3D imagery disappearing behind the performer. The visual conflict can occur if the illusion is perceived further forward than the live performer in space. As the image disappears behind the live body it appears to impossibly disappear only to re appear on the other side of the performer. (See Fig. 5) This visual conflict created is very similar to a window violation. This visual conflict appears to be more forgiving than front projection and is a way of reducing the appearance of occlusion of the imagery of the body. However, in the theatrical stage setting the use of back projection can be problematic as the space required at the backstage of the scrim is often only available in very large theatres even with the use of short throw projection lenses.

The construction of the stereoscopic space in the theatre environment is very different from the traditional use of theatre space where the wings, cyclorama, backdrop, floor

and proscenium arch mark out the viewing and performance space. While the space itself is not structurally changed by the use of the stereoscopic image the audiences' perception of space is altered. For the audience the back wall is opened up with panoramic views that have texture, depth and ambiance and the screen appears, as Neuman describes in the case of 3D movies, as 'proscenium arch to this stereoscopic content'. [12] The space above and around the stage can be potentially filled with 3D objects. The theatrical imagined fourth wall can be breached by animated imagery and the space directly in front of the audience can be apparently filled with 3D objects.

In *Parallax* the construction of this performance design can be understood from the layering of the different components within the performance scene. There are three elements that make each of the individual components work in conjunction with each other and builds the work in three ways, through: 1) an animated background that can include 2D and 3D animations and video content; 2) a dance work that is situated within the traditional performance space and; 3) stereoscopic imagery that exists behind the screen, in the performance and audience space (See Fig. 6). The use of this volume and indeed the perception of space changes for each participant of dance; the choreographer, dancer and audience members.

The Choreographer's Space

The negotiation of space is different for the choreographer in a performance work that uses 3D imagery due to the different layers of real and illusionary content. The stereoscopic image creates alternative choreographic opportunities within a carefully constructed virtual world that appears spatially infinite containing endless possibilities, but also has specific limitations. The opportunities are found in the animation process where the director or choreographer could create any image and is only limited by imagination, time and financial budget. Limitations can be found in the pyramidal nature of the stereoscopic animation space and the need to confine imagery to within the cone defined by this space and particularly, to the available space in front of the screen. The pyramid space narrows as objects move closer to the audience and in the use of the live body within that space is limited by the need to avoid choreographic violations by avoiding obscuring key stereoscopic imagery.

In *Parallax* the ability to place animated objects within the choreographic and stereoscopic space was an interesting element. The animated objects could be choreographed, not unlike live performers, and could appear as a soloist, duo partner or virtual corps de ballet.

In *Parallax* this dance between the 3D objects and performer was a careful negotiation between choreographic and animation processes. The choreographer/animator started with the animation process creating the stereoscopic landscapes, environment and props for the performer to work with and contextualize themself. The linking to the animation and the movement was conducted throughout the choreographic development. She often re-worked ani-

The Virtual Space - Stereoscopic Content

To infinity and byond !

2D Animation Space

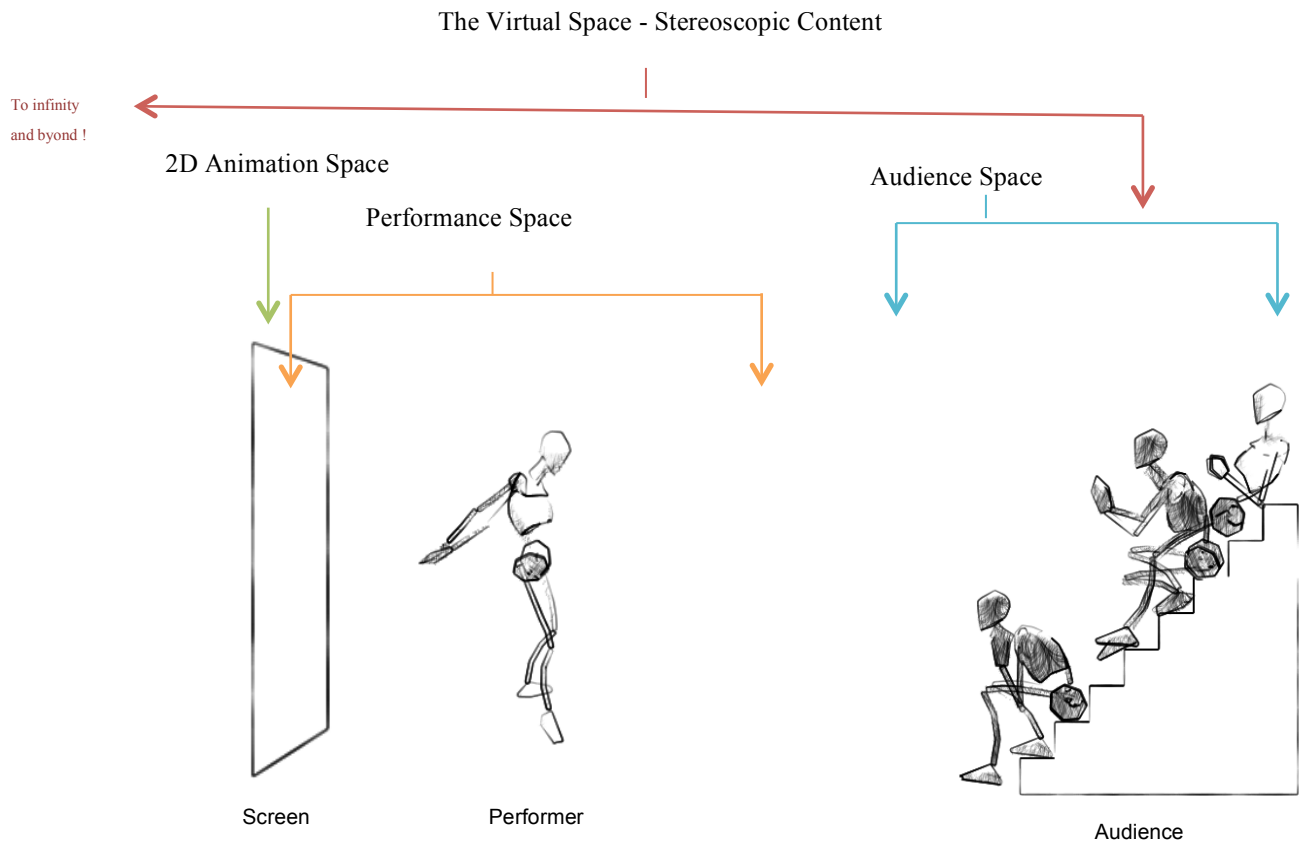Performance Space

Audience Space

Screen Performer

Audience

Figure 6. The Layered Design of the Space. ©Megan Beckwith

mation during the choreographic process drawing the two different elements into one performance. In this way the different elements work in conjunction with each other and appear as one performance.

One reoccurring problem within the space of *Parallax* was the creation of choreographic and window violations. One technique that proved useful was the use of animated small particles as this seems to confuse the eye and appeared to be a more forgiving affect. Yet, simply dropping the performer to the floor or moving the dancer out of the way of the animation was also very useful. Furthermore, using the choreographic violation proved a powerful effect when employed to deliberately disturb the audience. When animation moved forward in the space towards the audience, due to the visual perspective the animation appears larger, however the stereoscopic pyramid space tapers in, creating possibilities for window and choreographic violations. This visual conflict is usually avoided by keeping the images within the stereoscopic pyramid. However, in *Parallax* where relativity of size was not paramount, reducing the size of the animated objects as they moved forward in space was a successful way of avoiding violations. In the future, the use of back projection would possibly also help minimize the affect of choreographic violations in my work.

The Dancers Space

In stereoscopic performance the dancer must negotiate both physical and virtual 3D space. The stereoscopic image appears to co-exist with the dancer and becomes part of the dance performance, appearing as both content and performance partner. The stereoscopic animation transforms the environment and situates the dancer differently within the performance space.

The dancer experiences the stereoscopic space much differently from the choreographer and audience members. The dancer does not wear glasses and is facing away from the screen and therefore cannot see the 3D illusion. The performer can only see the video content on the screen as a blurred 2D image. In *Parallax* this issue was addressed in several ways. The choreography and movement was carefully blocked with an eye on where the animation would appear, and marking of the floor with tape was also helpful for dancer orientation. The performance was rehearsed with the animation footage from the early development phase and the animation in turn was animated directly over the rehearsal video footage. The use of a video fold back during performance was also extremely helpful in enabling the dancer situate herself within the space and in relation to the animation.

While the animation is palpable for the audience but invisible to the dancer, in *Parallax* the performer needed to appear to interact with the animation. This interaction was difficult, and for the performer, the stereoscopic space had to become like an imagined space. In a way that seems, on

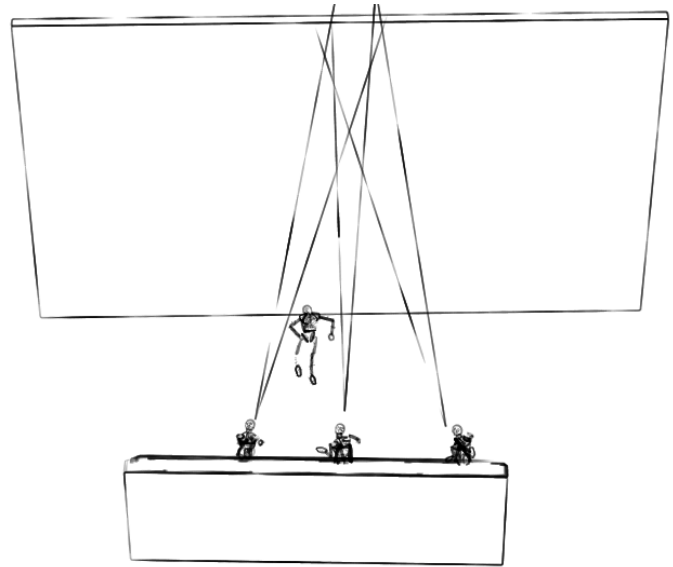reflection, not dissimilar to visualization and ideokinesis

Figure 7. Example of the different view points of the stereoscopic image fro the audiences point of view. In relation to the performer the image changes perspective. ©Megan Beckwith.

techniques used in contemporary dance development, the dancer needed to create a 'virtual map' of the space rather than simply respond to the visible, physical, limits of the performance volume.

In *Parallax* the performer is sometimes not the most important thing in the space. Often, the audience was presented with imagery that are not visible or apparent to the performer. This can be unusual for a dance performer as the focus of most contemporary dance performance tends to centre on the performer, and specifically the performer's embodied presence. Furthermore, the audience wearing glasses can be a distancing effect for the performer, who cannot see the audience's eyes or gaze, and this presents a different environment in which the dancer relates or responds to the audience. Finally, in *Parallax* the video element does not change as the video projection is pre-rendered. Performing with an animated partner that does not alter or react to the dancer is unforgiving and the dancer needs to employ a spatial accuracy throughout the choreography and movement that is defined by the image, not the performer or the physical space.

The Audience Space

The audience perceives the theatre space differently when stereoscopic imagery is used. In a stereoscopic performance the audience completes the performance and the stereoscopic animation. This could be said of all live performance, yet within stereoscopic theatrical performance the animation is fused within the audience's perception. If

the audience is not present, no one can see the animated objects as three dimensional. In this way the audience is, in a sense, part of the technical set up as they must perceptually fuse the animation. By wearing 3D glasses, the audience completes the animation and the stereoscopic element and stereoscopic performance space emerges.

It is the fusing of the imagery that tricks the brain's perception of the stereoscopic imagery as if it was a real object, prop, scene or room. In *Parallax,* by using animated imagery as a choreographic element the choreographer was able to create emotional audience reaction. This was achieved by bringing the 3D imagery forward (downstage) and backward (upstage) in the space. This positioning of the 3D imagery in relation to the audience became an interesting choreographic tool.

In *Parallax* it also became apparent that established and traditional theatrical placement cues and choreographic blocking of the space had changed through the use of the stereoscopic image. The dancer is bound by the normal conventions of time, space and motion in the stage space. However, powerful and compelling 3D imagery and theatrical information can be included in space not available to the live performer, such as behind the screen, above the performer and directly in front of the audience within the stereoscopic pyramid. It also appears that the ability to fill the space directly in front of the audience can draw the audience into the performance making them feel like they are almost part the show.

Each audience member has a different viewpoint of the performance, which happens in live theatre and film, however the issue is amplified by 3D projection. The perspective or angle of the stereoscopic animation in space can change dramatically in relation to the placement of the live performer, and objects appear to move horizontally depending on how far from centre the viewer is located. This can create visual conflicts depending on where the audience member is sitting (See Fig. 7). This shifting of perspective for audience members has the potential to create a new premium-seating plan for stereoscopic performance audiences, where the middle centre of the performance seating becomes the prime space rather than the traditional stall seating plan.

The potential placement and perception of stereoscopic imagery in live performance is outlined in Beckwith and Vincs (2013) [14].

Conclusion

Parallax, the performance, demonstrates some of the ways in which stereoscopic imagery in live contemporary dance performance changes the perception space in the theatrical stage setting. The perception of the theatrical space in contemporary dance is altered and the experience of space is transformed for the participants of dance, the choreographer, dancer and audience. In particular, *Parallax* reveals how the traditional roles of the choreographer, dancer and audience can be changed. The choreographer's role has shifted as s/he is required to negotiate stereoscopic imagery and live performance within a performance space that is embedded within a pyramid shaped stereoscopic space. The performer is required to dance with images are mostly invisible to them but are a powerful contextualization, stage setting and performance partner. The audience perception of the performance space is also altered as they become a part of the technical process by fusing the imagery and space in their own minds and experiencing animation that appears from infinity to directly within their space. New possibilities became apparent that include alternative choreographic strategies, such as the use of animated imagery and depth control to heighten the audience's perceptual experience through the use of the stereoscopic space in tandem with the live space.

The use of stereoscopic imagery in live dance performance may not be for everyone. Just as not all movie audiences seek out 3D experiences, stereoscopic work in dance has sometimes been described as 'more of a distraction than enhancement', and may be interpreted as confusing, disconcerting and an annoyance for some theatrical theatre audiences' [13]. Our contention is that the spatial ambivalence between physical and 3D projected space can be constructed as either troubling and confusing, or as choreographically generative and productive, by virtue of the potential for disruption of traditional stage space and choreographic process described here.

Future explorations would see a development of the *Parallax* performance or other new performances with specialized theatrical lighting for the optimizing of the 3D effect. Powerful stage lighting can enhance or reduce the stereoscopic illusion and animation texture. The use of active projection techniques for live performance would also be an interesting possibility.

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Authors' Biographies

Megan Beckwith is a Melbourne based choreographer who works across the fields of dance and animation. Megan is currently studying for her PhD at the Motion.lab at Deakin University and is researching the application of the 3D stereoscopic illusion within the live theatre environment. Megan creates live animated dance works by combining contemporary dance and animation in a choreographic process that layers one over the other. Megan is a research assistant within the Building Innovative Capacity in Australian Dance through New Visualization Technology Building Creative development project for Kim Vincs, she also teaches at Deakin University and is a founding member of the hybrid live arts organisation Punctum Inc.

Professor Kim Vincs is the Director of the Deakin Motion.Lab, Deakin University's motion capture studeio and performance technology research centre, which she established in 2006. She has been a choreographer for over twenty years, and has focused on interactive dance technology for the last ten. Kim has five Australian Research Council projects in dance, technology and science, and has established numerous industry collaborations in motion capture, movement analysis and digital art.