An investigation of performer embodiment and performative interaction on an augmented stage

Richard Brown, BSc, MFA.

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ii. Abstract

This thesis concerns itself with an investigation of live performance on an augmented stage in front of an audience, where performers witness themselves as projection mapped[1] virtual characters able to interact with projected virtual scenography. An interactive virtual character is projected onto the body of a performer, its movements congruent with the performer. Through visual feedback via a Head Mounted Display (HMD), the performer is virtually embodied in that they witness their virtualised body interacting with the virtual scenery and props of the augmented stage.

The research is informed by a theoretical framework derived from theory on intermediality and performance, virtual embodiment and performative interaction. A literature review of theatrical productions and performances utilising projection identifies a research gap of providing the performer with a visual perspective of themselves in relationship to the projected scenography. The visual perspective delivered via the HMD enables the performer to perform towards the audience and away from the interactive projected backdrop. The resultant 'turn away' from facing an interactive screen and instead performing towards an audience is encapsulated in the concept of the 'Embodied Performative Turn'.

The practice-based research found that changing the visual perspective presented to the performer impacted differently on performative interaction and virtual embodiment. A second-person or audience perspective, 'performer-as-observed' prioritises the perception of the virtual body and enhances performative behaviour but challenges effective performative interaction with the virtual scenography. Conversely, a first-person perspective, 'performer-as-observer' prioritises a worldview and enhances performative interaction, but negatively impacts on performative behaviour with the loss of performer-as-observed.

[1] Projection mapping is where the content of a projected image aligns with the structure of the projected object. Here, the projection of a virtual character aligns with the body of the performer.

The research findings suggest that the presentation of differing perspectives to the performer can be used to selectively enhance performative interaction and performative behaviour on an augmented stage.

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Chapter 1 Introduction

Interactive digital technologies permeate everyday life: smartphones, computer game systems and intelligent media devices respond to voice commands and gestures, servicing our social, entertainment and shopping activities. New forms of entertainment, artistic and theatrical productions are continuing to emerge as a result of the rapid development and accessibility of contemporary digital technologies. Artists and experimental theatre groups are finding new ways in which to create mixed realities where 'the virtual' - projected and augmented computer-generated imagery, combine with 'the real' - live performers, buildings and stage sets.
The research is timely in that the technologies of Virtual Reality (VR) and Augmented Reality (AR) are being used in contemporary performance and mainstream theatre.

This research examines the application of projected AR technologies in live theatrical performance, noting that existing examples have not considered using a Head Mounted Display (HMD) to present the performer a perspective of themselves in relationship to the AR projections and the audience. It is this gap that the research addresses.

The thesis describes a practice-based investigation of live performance on an augmented stage in front of an audience, where performers are virtually embodied in that they witness themselves as projection mapped[2] virtual characters able to interact with projected virtual scenography.

[2] Projection mapping is where the content of a projected image aligns with the structure of the projected object. Here, the projection of a virtual character aligns with the body of the performer.

A previous practice producing interactive installations provided the impetus for this performance-orientated investigation, where participants took on the role of performers, interacting with the artwork and other participants before an audience.

The research is informed and shaped by a theoretical framework derived from theory on intermediality and performance, performative interaction and virtual embodiment. The framework informs the literature review and acts as a guiding conduit between theory and practice in the account of the practice-based research and the resultant findings. The concept of the 'Embodied Performative Turn' expresses the new knowledge emerging from the practice-based research and is located at the intersection of the three theoretical areas informing the framework – intermediality and performance, performative interaction and virtual embodiment.

Using the lens of the theoretical framework, a literature review of historical precedents and contemporary practitioners contextualises the research inquiry and qualifies the research gap.

1.1. The Prototype Augmented Stage

The development of a prototype augmented stage provides a platform for the practice-based research, depicted below in Figure 1. The platform enabled the iterative posing and evaluating of research questions through ‘enactments’, a research methodology described in section 3.4.

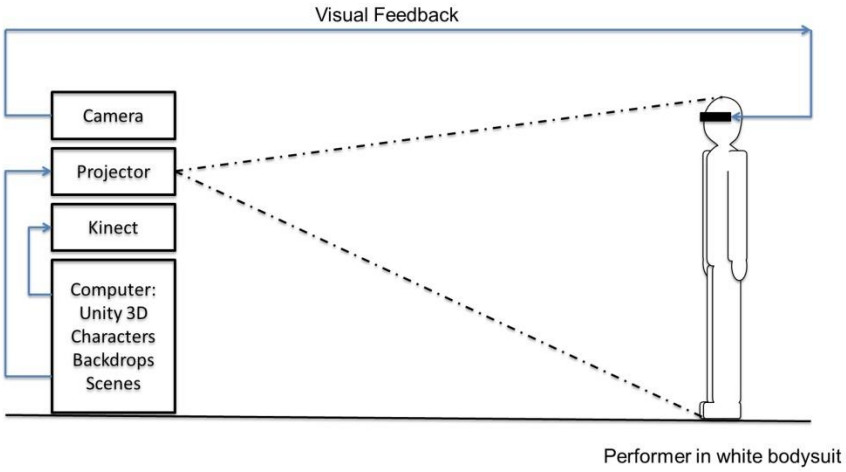

Figure 1: System Schematic

In this section, I present an overview of how the augmented stage operates and introduce the concepts of ‘performative interaction’ and ‘virtual embodiment’, describing how they are made manifest on the augmented stage. The Theoretical Framework expands and contextualises these concepts with reference to the literature, whilst Section 5.2, Research Platform, provides a detailed technical description of the system.

Firstly, I describe how the system supports virtual embodiment.
The system projects a virtual character onto a performer wearing a white body costume. Body tracking using a Microsoft Kinect results in the projected character closely matching the performer’s body location, stance and body movements. The performer wearing a Head Mounted Display (HMD) sees the projected character on their body from the perspective of a video camera located in the audience.

To an audience witnessing the projected virtual character on the performer, the virtual character appears embodied in that it is perceived as a humanoid body with life-like sentient movements and behaviour. Through the HMD, the performer is presented with a second-person perspective from the camera of a virtual body superimposed on their own; they witness their virtual embodiment from the perspective of the audience – as an outside observer. The HMD enables this perspective to be changed between a second-person perspective, body-as-observed, and a first-person perspective, body-as-observer.

Secondly, I describe how the system supports performative interaction. Conventionally, human computer interaction is directed towards a screen; here, by virtue of the HMD, performative interaction can be directed away from the screen and towards the audience. The screen acts as an interactive backdrop which may display a projected three-dimensional scene that can be navigated by the performer, or contain virtual props the performer can interact with. The performer's virtual embodiment enables the performer to interact with the virtual props and to navigate in the virtual scenery, thereby giving the performer 'agency', which in turn enhances the performer's sense of embodiment. The turn away from the screen coupled with the production of virtual embodiment is conceptualised in the phrase the 'Embodied Performative Turn' (see section 5.10).

Having introduced the key concepts of virtual embodiment and performative interaction made manifest by the system, Chapter 2, The Theoretical Framework serves to unpack these concepts and their interrelationships in depth.

1.2. Research Questions

In line with Nelson's observation, rather than starting with a set of well-defined research questions, the research commenced with the specification of a 'research inquiry' (Nelson 2013: 30). I commenced the research in 2011with the idea of creating live interactive theatre that would enable actors to perform and improvise as virtual personas on a virtual stage.

The inquiry was initially somewhat broad, but through an iterative process of practice-based research in conjunction with referencing the literature, the inquiry became more focused and addresses the following set of research questions.

1. How might an augmented stage be realised enabling performer embodiment and performative interaction with virtual scenography?
2. What is the nature of performer embodiment on the augmented stage and how does this relate to embodiment in Virtual Reality and gaming?
3. How can embodiment be made manifest for the performer and the audience and how are they different?
4. What is the impact of differing visual perspectives on performer embodiment and performative interaction?

1.3 Contributions

The investigation of performer embodiment and performative interaction on an augmented stage produced innovative concepts and new knowledge with potential application in theatrical productions, live performance and in health and well-being.

The creation of a prototype augmented stage combining game engine technology, unencumbered interaction and visual feedback to the performer represents a technical and conceptual framework that can potentially inform the development of future augmented performance systems.

The presentation of a visual perspective to the performer on an augmented stage is a novel concept and enables a performer to perform towards an audience whilst embodied as a virtual character interacting with virtual scenography.

The concept has potential application in live music, theatrical performances, mediated lectures and presentations and other situations where performers interact with a virtual backdrop before an audience.

The research found that the viewpoint presented to the performer impacts on their sense of embodiment and their ability to effectively interact with the virtual scenography. A first-person perspective prioritises a world view and enables effective performative interaction whilst a second-person perspective priorities the body and enhances performative behaviour. The presentation of differing perspectives to the performer can be used to enhance performance on an augmented stage. Knowledge concerning the relationship of the second-person perspective to performative behaviour has potential application in drama and movement training and in health and well-being (section 6.2.2.4).

Through workshops and live presentations the research has had an impact in the public domain and the arts, gaming and performance communities. The publicly accessible website, kinectic.net, has also contributed to extending the reach of the work beyond academia[3].

It is hoped that, as a result of this thesis, academic contributions will also be made to the methodology of practice-based research, especially in multidisciplinary enquiries involving performance and interactive media technologies.

[3] Via /kinectic.net/index.html in the accompanying ZIP file archive, kinectic.net.zip

1.4 Thesis Structure

Chapter 2 presents the theoretical framework and, with reference to the literature, describes the theoretical concerns of intermediality, virtual embodiment and performative interaction. The framework informs the literature and practice review (Chapter 4), the account of the practice-based research (Chapter 5) and the analysis of the research findings and conclusions (Chapter 6).

Chapter 3 describes the practice-based research methodology used in the research and provides a brief overview of the related approaches of practice-as research, practice-led research, performative research and performance-led research-in-the-wild. The chapter concludes with a description of the specific methodologies applied in the research, the iterative enactment research process and its documentation and archiving as a research blog.

Through presenting an overview of intermedial theatre and performance and examples of contemporary practitioners, Chapter 4 contextualises the research in relationship to the theoretical concerns of intermediality, virtual embodiment and performative interaction. An account of a previous practice creating interactive installations provides a background to the research and further informs the theoretical concern of performative interaction. The chapter concludes by identifying the research gap through a review of the literature survey and the presented examples.

Chapter 5 presents a narrative account of the practice-based research, the findings analysed with reference to the theoretical concerns of intermediality, virtual embodiment and performative interaction presented in the theoretical framework. Images and references to documentary videos from the research blog are used in the account of the practice-based research to provide visual evidence in support of the research findings.

Chapter 6 presents a summary of the research, restating the research questions and, with reference to the theoretical framework, discusses how they have been answered; the contributions of the research, areas for further research and a reflection on the practice-based research process.

Chapter 2 The Theoretical Framework

The previous chapter introduced the two key concepts of performative interaction and virtual embodiment in relationship to their manifestation on the augmented stage.

This chapter describes the theoretical framework, contextualising the two concepts of performative interaction and virtual embodiment within pre-existing theory. The theoretical framework informs the review of historical and contemporary practice (Chapter 4) and is referenced throughout the account of the practice-based research (Chapter 5) and in the analysis of the research findings and conclusions (Chapter 6).

The evaluation of the practice-based research outcomes, the "data analysis phase" (Grant & Osanloo 2004: 16), served to identify virtual embodiment and performative interaction as being key concepts, which are at the heart of the theoretical framework. Theory from the literature on digital media, computer gaming and VR then further informed and nuanced these central concepts within the overarching context of intermediality and performance.

Figure 2 below diagrammatically depicts the relationships between the two central theoretical concepts, performative interaction and virtual embodiment, their context within theory on digital media, gaming and VR and the wider context within intermediality and performance.

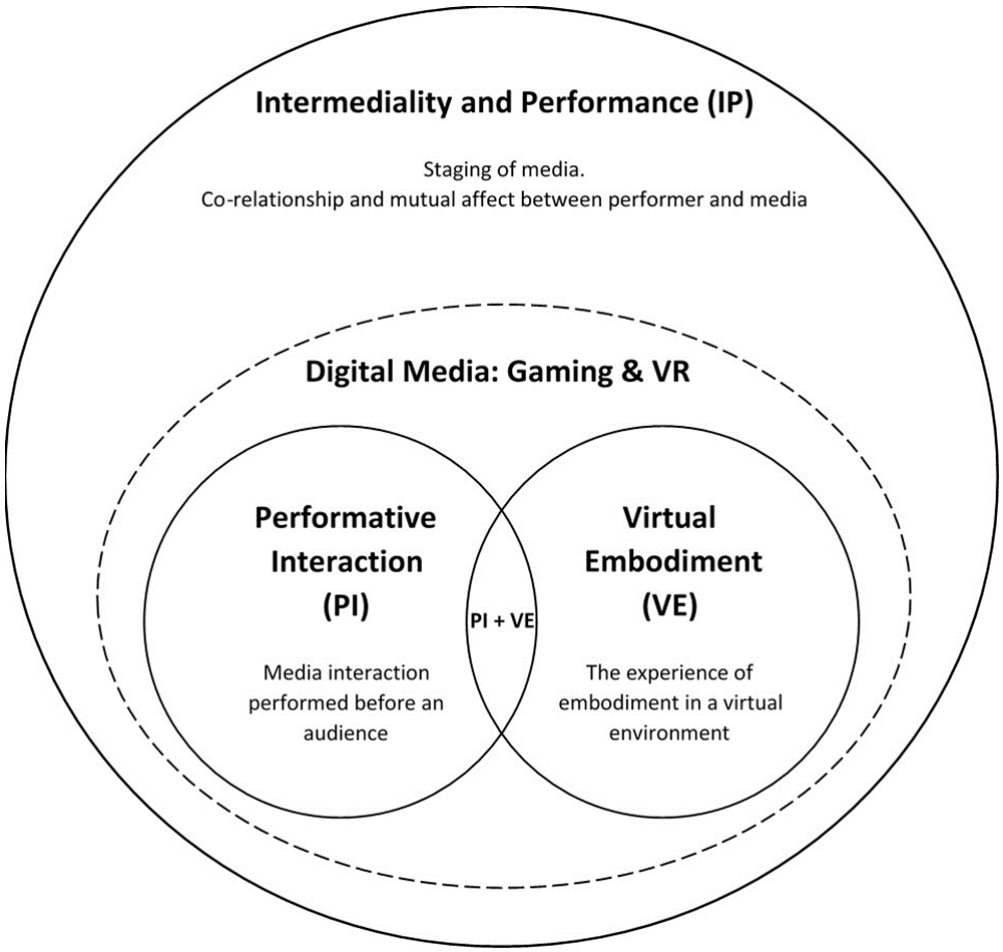

Figure 2: Diagram of Theoretical Framework

The following sections outline existing theory to inform the overarching concept of intermediality and performance, unpack the two central concepts of performative interaction (PI) and virtual embodiment (VE), and provide a means of describing the intersection (PI+VE) and its relationship to new knowledge conceptualised by the 'Embodied Performative Turn'.

2.1 Intermediality and Performance (IP)

The term ‘intermediality’ is derived from intermedia, between- or inter- media (Higgins 1965). Within media theory, intermediality tends to be concerned with representation, fusion and connections between (inter) media, “medial transposition, media combination, or intermedial references” (Rajewsky 2005: 53).

Rajewsky notes that intermediality is an “umbrella term” open to “vagueness and misunderstandings”, suggesting the necessity of presenting one’s own understanding and definition of the term (Rajewsky 2005: 45).

My understanding and use of the term intermediality is the staging of media in the context of live performance (Bay-Cheng et al. 2010: 29) where there is an essential co-relation and mutual affect between performance and media (Kattenbelt 2008: 25).

Contemporary theory on intermediality addresses the impact of digital technology within performance and informs this research in its investigation of the staging of projected Augmented Reality. In *Mapping Intermediality in Performance* (Bay-Cheng et al. 2010), the time-based and interactive affordances of digital media, its mutability, multimodality and connectedness in relationship to intermediality, are presented through a series of ‘nodes’, ‘portals’ and ‘instances’ by the authors. The concepts of embodiment[4], immersion[5] and interactivity[6] connect intermediality to the two central theoretical concerns of virtual embodiment and performative interaction.

[4] (Bay-Cheng et al. 2010: 45)
[5] (Bay-Cheng et al. 2010: 47)
[6] (Bay-Cheng et al. 2010: 186)

Intermediality in the context of performance is concerned with the intersecting relationships between media, performer and audience, described in the literature as a "tripartite phenomenon" (Chapple and Kattenbelt 2006: 12), illustrated diagrammatically below in Figure 3: Intermedial Relations.

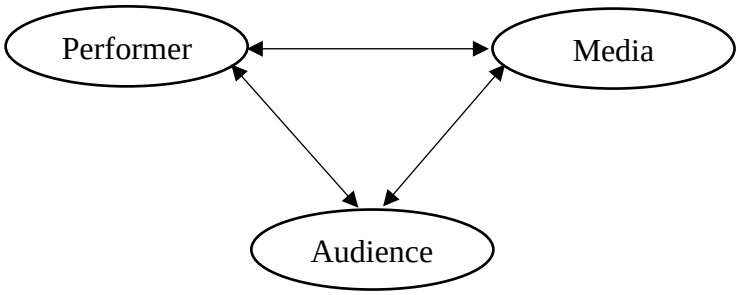

Figure 3: Intermedial Relations

Examining the relationships between media, performer and audience in this way nuances the manifestation and perception of virtual embodiment and performative interaction, highlighting their differing qualities and affordances according to whether the perspective is from the performer or the audience.

In the analysis of staging of media and relationships between performer, media and audience, theory on intermediality and performance provide an overarching theory in the investigation of virtual embodiment and performative interaction on an augmented stage.

Theory on embodiment, immersion and interactivity within the literature of VR and gaming provides a complementary, analytical and technical perspective in relationship to the two core concerns of virtual embodiment and performative interaction within the theoretical framework. In the following sections, I combine these perspectives from the literature and describe how they inform the two central concerns of virtual embodiment and performative interaction.

2.2 Performative Interaction (PI)

In the context of this research, performative interaction occurs when a performer interacts with media before an audience and their interaction forms an integral part of the performance. The resultant interplay is intermedial in that there is "extensive interaction" between media and performer (Gieskam 2007: 8). In the literature on Human Computer Interaction (HCI), performative interaction is used to describe a methodology for evaluating interface design in public spaces, where interaction is viewed by the public and the participant is conceived as a performer (Rico et al. 2010).

This definition of performative interaction resonates with the original motivation for the research, where in a previous practice creating interactive installations it was recognised that participants became akin to performers in group situations with other participants or spectators (section 4.3). In this research, the participant *is* the performer and rather than interacting with a physical interface, the performer interacts through their embodied virtual body with the virtual scenography whilst performing towards an audience.

This approach differs from conventional HCI or computer gaming interaction where the participant interacts with the computing technology through an interface in front of them, be it a screen, keyboard, joystick, game pad or another peripheral. Similarly, with the body-centric interaction of the Xbox games console and Microsoft Kinect, interaction is directed towards the screen, the player(s) face the screen, the site of interaction.

On the augmented stage, the audience faces the performer(s) who perform towards the audience whilst the screen, the site of interaction, is behind them. In order to interact with the virtual backdrop whilst facing an audience, the performer is presented with a visual perspective of their virtual embodiment on the augmented stage. The performer has agency in being able to control the projection mapped character, their virtual embodiment, which in turn has agency in that it can interact with the virtual backdrop.

2.2.1 Agency and Psi

Agency is an important feature of computer gaming, enabling the player to control and move the avatar in the virtual world; it is "the satisfying power to take meaningful action and see the results of our decisions and choices" (Murray 1997: 126).

On the augmented stage, agency is twofold: the performer has agency in that they control and inhabit their virtual embodiment, which in turn has agency in that it can interact with the virtual scenography. The performer interacts with the virtual scenography through the agency of their virtual embodiment.

Through the HMD, the performer witnesses their agency controlling the virtual body and the subsequent agency of the virtual embodiment interacting with the virtual scenography. The witnessing of agency through the HMD conveys a 'sense of agency' and enhances the performer's sense of embodiment (SoE) (section 2.3).

The audience witnesses the virtual embodiment of the projection-mapped performer and its interaction with the virtual scenography, vicariously sharing in the performer's ability to take meaningful action. Witnessing agency enhances the Plausibility Illusion (Psi), a term used in describing one of the conditions necessary in creating a sense of presence in virtual environments:

> .. the illusion that what is apparently happening is really happening, in spite of the sure knowledge that it is not. (Slater 2009: 8)

Creating a sense of presence in virtual environments is conceptually similar to creating audience engagement when witnessing performative interaction with virtual scenography. Appropriate media response to performative interaction suggests to the spectator "what is apparently happening is really happening" whilst at the same time they are cognisant "that it is not".

Within gaming, the computational simulation of physical properties can be used to enhance Psi – a virtual ball imbued with simulated gravity, friction and material properties appears to bounce when dropped onto a virtual surface with the appropriate simulated material qualities. The behaviour of the virtual ball corresponds to the behaviour of what is expected of a real ball – it is a plausible illusion. The use of computational physics simulations to enhance Psi is described in the discussion of the *Mimetic Starfish* in section 4.3, in the *MikuMorphia* enactment in section 5.4 and in the enactment investigating the performative interaction mode of Participation, section 5.9.2.

Performer agency may be theatrically staged in that the media is passive and does not actually respond to the performer's actions, or the media may have interactive affordances and can respond to actions of the performer. Media responsiveness to performative interaction, whether apparent or actual, conveys performer agency to the spectator:

> The efficacy of intermedial performance often relies on interactivity, the perceived (if not actual) engagement of the viewer and a virtual, or simulated, environment. (Bay-Cheng et al. 2010: 186)

The practice-based research concerns itself with interactive media able to respond to performative interaction rather than illusory and make-believe interaction with pre-recorded media. In either case, the witnessed act of performative interaction, real or apparent, emphasises the intermedial relationships of co-relation and mutual affect between performer and media (Kattenbelt 2008: 25).

Through examining the differing affordances offered by interactive media the following section discusses differing types of interaction categories between media and performer. The interactive categories are then used to inform the evaluation of performative interaction on the augmented stage (section 5.9).

2.2.2 Categories of Interaction

In “Digital Performance”, Dixon devised four categories as means of distinguishing different types of interactions found in digital artworks and performances (Dixon 2007: 563). The categories are navigation, participation, conversation and collaboration and are ranked according to their complexity and richness, navigation being regarded as the simplest and least rich, whilst collaboration the more complex and richest form of interaction. The first two categories represent forms of agency; participation being able to interact with objects in a virtual world, and navigation being able to control movement and direction in a virtual world.

The paper ‘Interaction Models for Audience-Artwork Interaction: Current State and Future Directions’ (Schraffenberger et al. 2011) analyses a range of taxonomies used to identify relationships between participants and interactive artworks. The most thorough and nuanced taxonomy presented in the paper emerged from a study carried out by the Ludwig Boltz-mann Institute on the Ars Electronica database of interactive art:

> Keywords for the participant's/performer's actions include: observe, explore, activate, control, select, participate, navigate, leave traces, co-author, collaborate, exchange information and create.
> (Schraffenberger et al. 2011: 4)

The ordering of the terms suggests an increase of interaction complexity and can be seen to be subsets of the broader classifications proposed by Dixon. The interaction categories of navigation and participation are used in the research as a means of evaluating the effectiveness of the prototype augmented stage in supporting performative interaction.

Dixon cites “trust, cooperation, and openness” as prerequisites for conversation (Dixon 2007: 585), traits associated with human relationships; whilst the examples of collaboration Dixon cites are mediated by human participants. Artificial intelligence can be used to enable conversation to take place between humans and machines and Dixon cites David Rokeby’s ‘Very Nervous System’ as an example supporting the interactive mode of conversation (Dixon 2007: 591).

Implementing the higher modes of conversation and collaboration at a system level would require mediation by intelligent agents. In the research however, the interaction categories of navigation and participation were sufficient in enabling the evaluation of performative interaction on the augmented stage.

The performer enacts Dixon's modes of interactivity through their virtual embodiment, the performer's body controlling the virtual body directly through their body movements, resulting in 'congruent interaction'. Unlike the modes of participation and navigation, this layer of interaction is invisible and not perceived by the audience as a mode of performative interaction.

In the paper, 'Designing the Spectator Experience' (Reeves et al. 2005), the spectator's perception of differing types of manipulations with technology is analysed in order to suggest a taxonomy of modalities:

> Our taxonomy uncovers four broad design strategies: 'secretive,' where manipulations and effects are largely hidden; 'expressive,' where they tend to be revealed enabling the spectator to fully appreciate the performer's interaction; 'magical,' where effects are revealed but the manipulations that caused them are hidden; and finally 'suspenseful,' where manipulations are apparent but effects are only revealed as the spectator takes their turn. (Reeves et al. 2005: 1)

From the perspective of the audience, the performative interaction modes of participation and navigation can be termed 'expressive', whilst the hidden layer of congruent interaction being might be termed 'magical'. The expressive qualities associated with realising the modes of navigation and participation are presented in the practice-based account of performative interaction in section 5.9.

Through referencing theory drawn from intermediality, HCI, VR and gaming, the intermedial concept of mutual affect between media and performer has been contextualised in relationship to agency, whilst the theories proposed by Dixon and Reeves provide a means of categorising differing forms of performative interaction.

In a similar manner, the next section draws on the literature from gaming and VR to in order to describe the necessary conditions associated with the production and experience of virtual embodiment in a virtual environment.

2.3 Virtual Embodiment (VE)

Virtual embodiment, the experience of embodiment in a virtual environment, is associated with a "Sense of Embodiment" (SoE), defined as having three subcomponents: the sense of self-location, the sense of agency, and the sense of body ownership (Kilteni et al. 2012: 373). These are conveyed to the performer through the Head Mounted Display (HMD), enabling them to experience their virtual embodiment and interact within the virtual scene whilst performing towards the audience. The subcomponents are now described in detail and will be used to help answer the research questions.

2.3.1 Sense of Body Ownership

Kilteni refers to a sense of body ownership as being brought about through the "synchronous sensory correlation" of movement between the body of a participant and the animation of an avatar as "visuo-proprioceptive" Kilteni (2012: 383).
In a similar manner, dynamic projection mapping of a virtual body onto the performer such that the movements of the performer and the virtual body are congruent conveys a sense of body ownership to the performer.

The literature suggests that visual appearance of the virtual body can also impact on the sense of body ownership. Kilteni suggests that a similarity of appearance between the real and the virtual body maximises the sense of body ownership:

> By maximizing the morphological similarity between one's biological body and the virtual one, top-down influences favour the perception of ownership of the virtual body. (Kilteni et al. 2012: 383)

Section 5.8.2 of the practice-based research explores how the appearance of the virtual body impacts on performative behaviour and its relationship to the sense of body ownership.

2.3.2 Sense of Agency

Agency, "the ability to take and witness the effects of meaningful action" (Murray 1997: 126) is twofold. Firstly, the performer has agency in that there is a congruency between the movements of the virtual body and that of the performer; the limbs of the virtual body move correspondingly in response to the actions of the performer:

> .. the presence of synchronous visuomotor correlations under active movement, one feels oneself to be the agent of those actions.
> (Kilteni et al. 2012: 376)

Secondly, the virtual body has agency in that it can interact with the virtual scenography. This mediated agency enables the performer to interact via the virtual body with the virtual scenography.

Performer agency and the mediated agency of the virtual body are illustrated diagrammatically below in Figure 4.

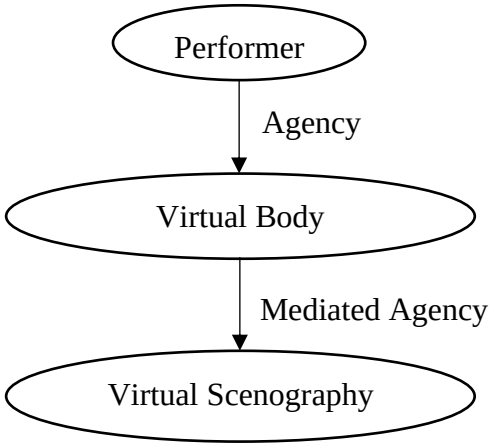

Figure 4: Performer and Mediated Agency

The two forms of agency are simultaneously conveyed to the performer through the HMD, who witnesses their agency controlling the virtual body and the mediated agency of the virtual body interacting with the virtual scenography.

2.3.3 Sense of Self-Location

The changing of the performer's perspective in the HMD between a first-person (performer as observer) and a second-person perspective (performer as observed) impacts on the sense of self-location experienced by the performer and their ability to interact with the virtual scene (borne out, as will be seen, in the evidence from the practice-based research and in the literature in VR and gaming on the effects of differing perspectives on immersion, embodiment and agency).

Computer game theorists concur that the first-person perspective employed in computer gaming is used to produce corporeal, sensory immersion and embodiment:

> In this way, Martthi Lahti, Bob Rehak, Alison McMahan as well as Cathy Cleland privilege 'first-person' visual perspective as being the most 'immersive' (McMahan 2003: 67), 'embodied' (Cleland 2010: 85), 'subjective and unifying' (Lahti 2003: 161) and as causing 'corporeal immersion' and 'sensory immersion' (Rehak 2003: 118).
> (Norgard 2011: 7)

Experimental evidence indicates that experiencing alternative viewpoints to the first-person perspective impacts on self-location and can be used to artificially induce out-of-body experiences (Ehrsson 2007) and to create an experience of swapping bodies (Bertrand et al. 2014).

In her paper 'Prosthetic Bodies and Virtual Cyborgs', Cleland (2010) discusses how differing perspectives can produce the sensation of an out-of-body experience and suggests that a third-person visual perspective of an embodied avatar initiates "a profound split in subjectivity and experience of the self" (Cleland 2010: 85).

2.3.4 Effectiveness of the SoE

The effectiveness of the sense of embodiment (SoE) is dependent on the realisation and conveying of its three subcomponents described above: the sense of self-location, the sense of agency, and the sense of body ownership.

Given that the SoE is conceived as a synthesis of these subcomponents, when any of the subcomponents are compromised or not fully realised the effectiveness of the SoE is reduced.

Using a continuous scale ranging from minimum to maximum, studies have been used in the analysis and measurement of the SoE according to the strength of its three components (Kilteni et al. 2012: 378). In the biological body the three subcomponents are experienced to the maximum degree and "one feels fully embodied" (Kilteni et al. 2012: 378). However, little is known about the relationships between the subcomponents or whether one dominates another in the enhancing of the SoE (Kilteni et al. 2012: 380).

According to the literature (Maselli & Slater 2013; Serino et al. 2013) there is evidence of contributing factors impacting on the effective realisation of each subcomponent. In the conveying of a sense of agency, discrepancies between the visual feedback of the action and the actual movement negatively affect the feeling of agency (Kilteni et al. 2012: 377). The literature suggests that the similarity of appearance of the virtual body and the biological body enhances the sense of body ownership (Lugrin et al. 2015: 3; Kilteni et al. 2012: 383). With regard to the sense of self-location, as discussed in the previous section, the prevalent view is that the sense of self location is enhanced through a first-person perspective:

> Clearly a fundamental requirement is for there to be first-person perspective with respect to the position of the eyes of the artificial body.
> (Kilteni et al. 2012: 383)

The research presented in this thesis does not attempt a qualitative study of the effectiveness in conveying a sense of embodiment; instead the three subcomponents are used to inform the analysis of the performative enactments of virtual embodiment and the findings used to suggest further lines of inquiry in relationship to performative interaction and virtual embodiment on an augmented stage.

Before examining the intersection of performative interaction and virtual embodiment, the following section serves to locate the theoretical references within the framework by means of a 'literature map'.

2.4 Literature Map

Figure 5 below locates the literature references in the previous sections within the conceptual map of the theoretical framework, providing a visual aid to the location of the references with the associated theoretical concerns.

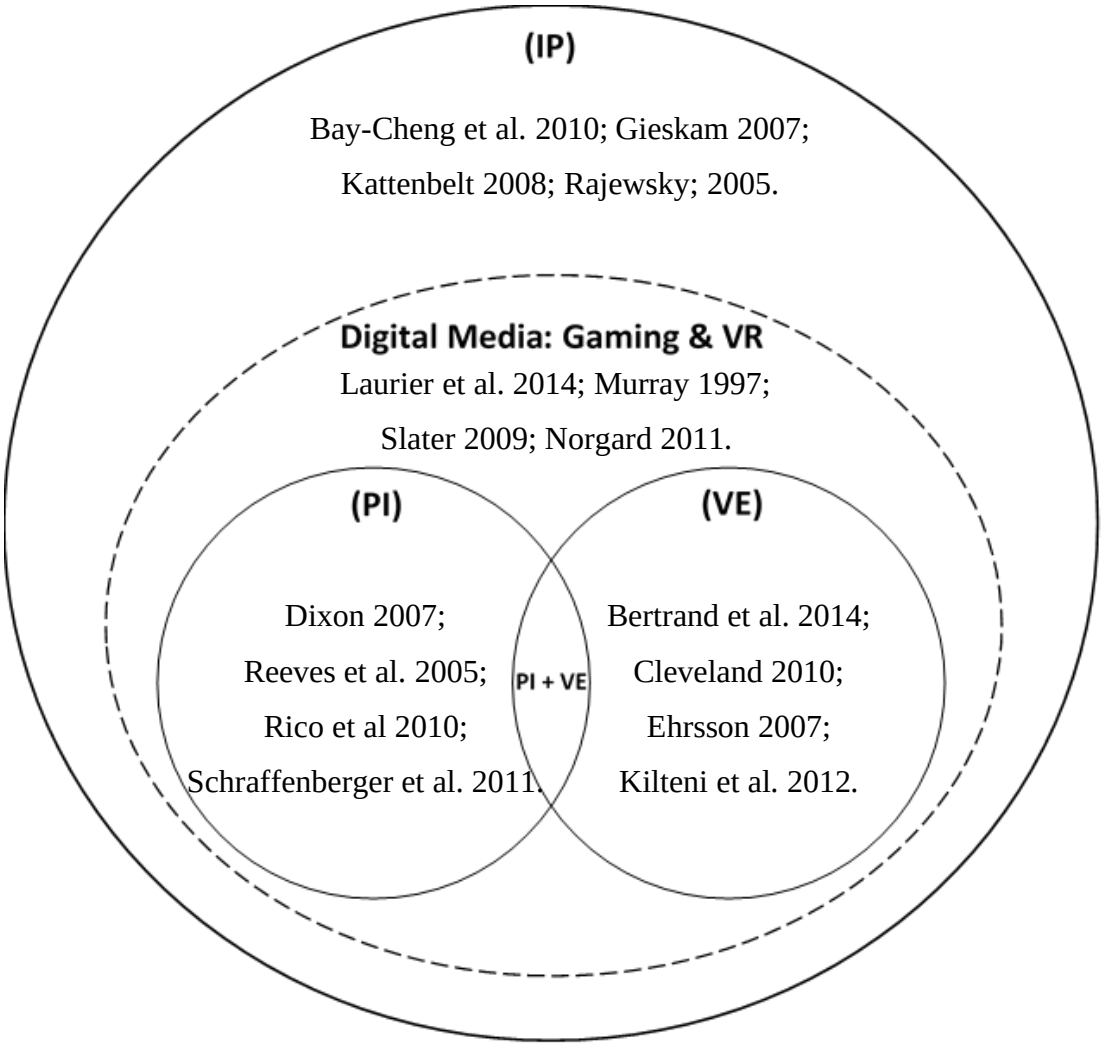

Figure 5: Literature Mapping

The next section unpacks the intersection of PI + VE, describing how the meeting of the differing theoretical concerns mutually inform each other, whilst also locating the concept of the 'Embodied Performative Turn'.

2.5 Performative Interaction and Virtual Embodiment (PI + VE)

The PI modes of participation and navigation require the virtual body and the virtual scene to respond to actions of the performer's body, thereby supporting the SoE components of agency and body ownership.
On the augmented stage, three-dimensional sensing gives the performer agency to participate with the virtual body such that there is congruence between the performer's body and the projected virtual body. Through the agency of the virtual body, the performer is able to interactively participate with props in the virtual scene.

Expressive performative gestures enable the performer to navigate the virtual body within the virtual scene, controlling the viewpoint of the virtual body and the direction of movement within the virtual scene. Together these two aspects of PI, participation and navigation, enhance virtual embodiment through the conveying of agency to the performer and to the audience.

The performer is able to control the virtual body which can interact with the virtual scenography in which the virtual body is located, thereby creating an intermedial dynamic of co-relation and mutual affect between the performer's virtual body and the virtual scenography (media). The audience witnesses the virtually embodied performer interacting with the virtual scenography, thereby witnessing performer agency, and the performer's ownership of the virtual body – the virtual embodiment.

This intersection represents the core of the research: performative interaction and virtual embodiment witnessed by an audience and performed live on a stage. Informed by the literature on HCI, gaming and VR, notions of interaction and embodiment are re-contextualised in this research through a focus on live performance and intermediality, resulting in new knowledge encapsulated by the concept of 'The Embodied Performative Turn'.

2.6 The Embodied Performative Turn

Projecting the virtual world around a performer on stage, and overlaying their virtual body on their physical body, links their performance, interaction and embodiment. Using a Head Mounted Display (HMD) to present the performer with a first-person or second-person perspective of a virtual scene enables the performer to interact with the virtual scene whilst simultaneously performing towards an audience.

'The Embodied Performative Turn' (EPT) encapsulates the notion of a variable performative perspective and represents a turn away from traditional human computer interaction directed from fixed first-person perspective towards a screen, the site of interaction. On the augmented stage the projected scenography, the site of interaction, is behind the performer and the performer though interacting with the scenography, directs performative interaction towards the audience. The traditional site of HCI interaction is thus shifted through the performative turn away from the screen. In order to interact with the virtual scenography the performer is virtually embodied and presented with a variable 'performative perspective'.

2.7 Framing the research questions

Now that the theoretical framework has been established, I return to the research questions posed at the outset and consider how to address them in the context of this wider theoretical lens.

1. How might an augmented stage be realised enabling performer embodiment and performative interaction with virtual scenography?

The answering of this question is informed through the unpacking and application of the theoretical concepts of virtual embodiment and performative interaction to the analysis of the findings from the research.

2. What is the nature of embodiment on the augmented stage and how does this relate to embodiment in Virtual Reality and gaming?

Section Virtual Embodiment (VE)2.3 examines virtual embodiment with reference to theory from VR and gaming. The evaluation workshops in section 5.8 then refer to the theoretical understandings of virtual embodiment and the roles agency, Psi and perspectives play in creating a sense of embodiment for the performer and the conveying of embodiment to the audience.

3. How can embodiment be made manifest for the performer and the audience and how are they different?

The manifestation of embodiment is realised by satisfying the theoretical considerations associated with virtual embodiment addressed above and the conveying of embodiment to the performer via the HMD and its witnessing by the audience via projection. The practice-based research then contrasts the performer experience and the audience witnessing of embodiment through analysis of feedback from performers and spectators.

4. What is the impact of differing visual perspectives on performer embodiment and performative interaction?

The results from the practice-based evaluations of performative behaviour (5.8.2) and performative interaction (5.9) in conjunction with theory from the framework on perspectives (2.3.3) will be used to address this question.

This chapter presented an analysis and unpacking of the concepts that define the theoretical framework, a map of the associated theories within the literature, a contextualisation of the concept of the Embodied Performative Turn and a framing of the research questions.

The next chapter presents the practice-based research methodology, including a discussion of associated research methodologies, the particular form of practice-based research adopted in this research, and the methods used to implement and document the research.

Chapter 3 Research Methodology

Whilst a Research Fellow in the department of Computer Related Design at the Royal College of Art (1995-2000) I created a number of artworks under the umbrella of 'Art as a Mode of Inquiry' where art practice acted as a driver for researching and developing a range of interactive artworks (see section 4.3).

The Mixed Reality Lab at Nottingham University recognises that art practice can be used to inform Human Computer Interaction (HCI) research and has collaborated with groups such as Blast Theory, Active Ingredient and artist Brendan Walker, referring to this particular form of research as 'performance-led research in-the-wild' (Benford et al. 2013).

The key attributes to this methodology are that the research is led by artists creating mixed reality performance-orientated art works that they are located and evaluated in public spaces. Outcomes of the research in the form of published papers are targeted at the computer science community as a means of illustrating how an art-based methodology creates alternative approaches to the traditional HCI models of user studies and user testing as a means of gaining new knowledge (Benford et al. 2015; Crabtree et al. 2004).

Before commencing the research, I set out to find an appropriate research methodology similar in principle to Art as a Mode of Inquiry, such that practice would be an integral aspect of the PhD research. Within academia, the methodologies of practice-based, practice-as, practice-led research are specific to the domain of doctoral research and recognised as methodologies where art or creative practice plays a significant part in the research.

There is some dispute over the definitions of the methodologies; the Arts and Humanities Research Board (AHRB) defining practice-led research as having a significant focus on creative practice:[7]

> Practice-led research is a distinctive feature of the research activity conducted by arts and humanities researchers, it involves the identification of research questions and problems, but the research methods, contexts and outputs then involve a significant focus on creative practice.
> (Smith & Dean 2009: 47)

Candy defines practice-led research as a substantially different activity from practice-based research:

> If a creative artefact is the basis of the contribution to knowledge, the research is practice-based.
>
> If the research leads primarily to new understandings about practice, it is practice-led.
> (Candy 2006: 1)

The PARIP (Practice As Research In Performance) research group acknowledges the definitions are contested.

> Practice as research (PAR) and practice-based research (PBR) — and 'research through practice', 'research by practice', 'performance as research' — are contested terms that resist close definition. Practice as research and practice-based research are frequently used interchangeably to suggest a relationship of research between theory and practice.[8]

[7] The AHRB became the AHRC, the Arts and Humanities Research Council, in 2005. http://www.history.ac.uk/makinghistory/resources/articles/AHRC.html
[8] http://www.bristol.ac.uk/parip/faq.htm

At a conference discussing the future of research involving practice, Hann (2015) recognising the issues concerning definitions, suggests that any form of research involving practice should simply be described as ‘practice research’.

> Secondly, the move away from the micro-politics of practice as/through/based/led was particularly welcome. ‘practice research’ works for me. It focuses on the wider issues related to how researchers share, apply and critique knowledge borne of practice.[9]

I use the term ‘practice-based research’ in this thesis to refer to the methodology I have adopted, though at the same time the research methodology has been informed by the literature on practice-led and performative research (Haseman 2006) and in particular, *Practice as Research in the Arts* (Nelson 2013).

In the next section I describe how the practice-based research amalgamates a number of guiding principles derived from the literature.

3.1 Practice-based Research

The research began in December 2011 with a proposal to research the concept of scalable interactive theatre, which would combine audio visual game engine technologies with natural interfacing using voice and gesture. The initial proposal did not commence with a set of research questions; instead, as Nelson suggests, it described a line of inquiry.

> I prefer to ask for the specification of a ‘research inquiry’, partly because questions typically imply answers and, in turn, evoke perhaps ‘the scientific method’ in which data lead to the resolution of a hypothesis.
> (Nelson 2013: 30)

[9] https://futurepracticeresearch.org/2015/07/28/practice-matters-arguments-for-a-second-wave-of-practice-research/

The broad remit of the inquiry resulted in the practice-based research exploring a number of theoretical areas including improvisation, intermediality, gender and identity, and the nature of the uncanny. As described in Chapter 2, theory on intermediality and performance provided a grounding framework for the research, whilst the evaluation of the practice-based research led to the inquiry becoming focussed and informed by theory on virtual embodiment and performative interaction.

Edmonds describes the trajectories of a practice-based inquiry, involving journeys through the processes of theory, practice and evaluation, citing examples where theory drives the practice and vice versa (Edmonds & Candy 2010). In the case of this research, there were times when theory informed the research, whilst at other times, theory emerged from the practice. The interweaving between theory and practice took the form of an iterative and interdependent cyclical process; to use Nelson's terminology, theory and practice became "imbricated with each other" (Nelson 2013: 61).

The concept of the 'Embodied Performative Turn', for example, emerged from the practice, whilst the practice it emerged from was informed by theoretical ideas derived from the literature on performative interaction and virtual embodiment.

A website 'kinectic.net' was created to document the research and features a 'research blog', which acted as an online diary, recording the research journey as it evolved over time. A summary of the research journey is presented at the end of the thesis in section 6.4 and an offline archive of the website is included in the form of a ZIP archive with the ethesis.[10]

The next section describes the research website and its relationship to practice-based methodologies.

[10] Via /kinectic.net/index.html in the accompanying ZIP file archive, kinectic.net.zip

3.2 Research Website

From the onset of the research, a website, 'kinectic.net' was created to act as repository for the research findings, using the Content Management System, WordPress. The structure of the website evolved over time embracing two key ideas from the literature on practice-based research, an artistic audit and a research blog documenting the time based research practice incorporating videos, images and text.

Haseman (2016) contrasts the familiar quantitative and qualitative approaches to evidence collection inherent in traditional PhD research methodologies with his proposal of a 'performative research' methodology, see Figure 6: (Haseman 2016: 6), below.

Quantitative Research	Qualitative Research	Performative Research
"the activity or operation of expressing something as a quantity or amount – for example, in numbers, graphs, or formulas" (Schwandt, 2001: 215).	refers to "all forms of social inquiry that rely primarily on qualitative data…i.e., nonnumeric data in the form of words" (Schwandt, 2001: 213).	expressed in nonnumeric data, but in forms of symbolic data other than words in discursive text. These include material forms of practice, of still and moving images, of music and sound, of live action and digital code.
the scientific method	multi-method	Multi-method led by practice

Figure 6: (Haseman 2016: 6)

The description of the data types inherent in performative research inspired the creation of the research website to record the progress of the research as a multimedia research blog and act as a repository for the research findings with video examples and textual analysis of other practitioners and related research.

Haseman stresses the importance of an "artistic audit" in order to contextualise the research practice alongside other works and practitioners.

> As researchers 'practice' - it is essential they reach beyond their own labours to connect with both earlier and contemporaneous productions which contribute to the overall research context for their work.
> (Haseman 2006: 8)

On the research website, the audit takes the form of pages displaying an historical and contemporary context to the research, video examples of related performative works and reviews of performances and works I had witnessed.[11]
With reference to the theoretical framework, Research Context Chapter 4, Research Context presents the artistic audit through examples of intermedial theatre and performance and contemporary practitioners.

The research blog archives twenty-two date-stamped posts describing the evolving research practice, from the first prototype in November 2013, through to an experimental public performance in April 2017.[12]

The research website proved to be a useful research tool and informed the research methodology. Recording the progress of the research, the blog acted as a sounding board, whereby I could revisit previous posts and appraise how the research had developed and how it might develop in the future. Maintaining a blog gave a voice and presence to the research, the process of writing posts providing a means of reflection and helping to clarify the research process.

Nelson regards critical reflection as essential in the process of rigour in practice (Nelson 2013: 27), taking time out to assess the outcomes of the practice-based research rather than continually making. The ongoing process of continual

[11] http://kinectic.net/research-overview/
or offline via /kinectic.net/index.html in the accompanying ZIP file archive, kinectic.net.zip
[12] http://kinectic.net/category/research-blog/
or offline via /kinectic.net/index.html in the accompanying ZIP file archive, kinectic.net.zip

documentation and the ability to access the research at any time supported the process of critical reflection.

The addition of a tag cloud to the website enables a non-linear, heterarchical method of accessing posts according to content. The size of each tag indicates the presence of major and minor research topics and provides a rich overview of the research content, illustrated in the screen shot below, Figure 7: Research tag cloud.

Figure 7: Research tag cloud

The website[13] includes a technical section describing Kinect software and applications,[14] a reference section on practice-based research,[15] and a section describing the doctoral training centre,[16] detailing an internship, conference papers and research writings.

3.3 The Research Platform

In order that actual practice could begin, it was necessary to create a technical platform on which to carry out the practice-based research. The early vision of a scalable interactive theatre platform was refined through technical research into what was feasible given the PhD constraints of available time, skills and budgets. Off-the-shelf, ready-made solutions were sought to ensure time could be spent on practice-based research rather than becoming overburdened by technical and programming demands. The natural interfacing of gesture and voice control made possible by the readily available and affordable gaming interface, the Microsoft Kinect, appeared ideal for the project. Open Source software[17] and an online Kinect hacking community[18] provided resources for creative software applications, technical solutions and developmental support.

Section 1.1, The Prototype Augmented Stage, presented an overview of the research platform, whilst its development process and technical details are described in the account of the practice-based research in section 5.2, Research Platform.

[13] Accessible offline via /kinectic.net/index.html in the accompanying ZIP file archive, kinectic.net.zip
[14] http://kinectic.net/the-kinect/
[15] http://kinectic.net/practice-research/
[16] http://kinectic.net/centre-for-doctoral-training/
[17] http://www.openni.org/
[18] http://kinecthacks.com/

3.4 Enactments

The research platform enabled research hypotheses to be evaluated in the form of documented ‘enactments’, a term used to describe short performative acts recorded on video either involving myself, one or two other participants and possibly a small audience.

Enactments represent an open qualitative methodology where the performative acts are documented on video and audio recordings made of open-ended discussions by the participants. The recordings were then analysed through repeated listening, watching and taking notes to draw out key experiences and observations made by the participants.

The practice-based research provided a mechanism for generating evidence in the form of documented enactments. The iterative process of developing and implementing the enactments drove the research inquiry forward, revealing new potential research directions whilst also raising research problems.

Haseman (2007) suggests that research problems can be solved through practice:

> Practitioner researchers do not merely “think” their way through or out of a problem, but rather they “practice” to a resolution.
> (Haseman 2007: 147)

Section 5.9 describes a research problem encountered during the process of evaluating performative interaction. A solution to the problem was found through practice. The design and evaluation of further enactments demonstrated that a first-person perspective is more effective in enabling performative interaction than the previously used second-person perspective (section 5.11).

Video recordings of the enactments were posted onto YouTube and archived alongside textual analysis and documented observations as a series of time stamped entries on the research blog.

The documentation methodology resonates with the notion of performative research proposed by Haseman (2006) where he asserts that not only should the outcomes of practice-based research be presented in the appropriate symbolic media, but that presented media *is* the research.

> The symbolic data works performatively. It not only expresses the research, but in that expression becomes the research itself.
> (Haseman 2006: 6)

And further:

> People who wish to evaluate the research outcomes also need to experience them in direct (co-presence) or indirect (asynchronous, recorded) form.
> (Haseman 2006: 4)

The blog with its video recordings of enactments performs the functions of expressing the research and providing a means for others to evaluate the research indirectly.

Chapter 5 presents an account of the practice-based research and makes use of the blog posts and associated videos as evidence of specific findings in the form of {n}, where n is the number of the blog entry. The research blog is hosted on the kinectic.net research website and accessible offline[19].

[19] Via /kinectic.net/index.html in the accompanying ZIP file archive, kinectic.net.zip

Chapter 4 Research Context

This chapter contextualises the research within the literature by presenting an overview of intermedial theatre and performance and examples of contemporary practitioners thereby providing an "artistic audit" (Haseman 2006: 8).

Section 4.1 links the concern of intermediality presented in the theoretical framework with examples of intermedial practitioners, whilst the examples of contemporary practitioners presented in section 4.2 relate to the two core theoretical concerns of virtual embodiment and performative interaction.

Section 4.3 contextualises the theoretical concern of performative interaction through referencing a previous practice producing interactive artworks.

Section 4.4 identifies the research gap through a review of the literature survey and the presented examples.

4.1 Overview: Intermedial Theatre and Performance

The literature offers a comprehensive analysis of historical and contemporary examples of intermedial theatre and performance, specifically: *Staging the Screen: The Use of Film and Video in Theatre* (Giesekam 2007) and *Liveness on stage: Intermedial challenges in contemporary British theatre and performance* (Georgi 2014). The authors present and analyse a range of intermedial practitioners, including The Builders Association, Forced Entertainment, Forkbeard Fantasy, Robert Lepage, Station House Opera, Josef Svoboda, Laterna Magika and The Wooster Group.

Georgi presents her survey through a theoretical framework on intermediality framing her examples from a perspective of liveness and mediation, whilst Giesekam presents each practitioner as a case study within the context of film and video in theatre.

Georgi acknowledges intermediality is a contested concept and its definition ranges from very restricted notions to “an almost all-embracing sense of universal intermediality” (Georgi 2014: 24).

The outcome of generalised definitions can result in an “umbrella term” (Rajewsky 2005: 45) where any theatre production staging media may then be classified as intermedial.

> In the case of theatre for example we would have to ask if any and all use of film, video or even slide projections is a defining factor of an intermedial approach.
> (Balme 2004: 8)

> Numerous, if not most contributors to the discussion adhere to a standard formula: `theatre + (other) media = intermedial theatre'.
> (Boenisch 2003: 35)

I suggest that the above classifications define multimediality, “where there are many media in one and the same object” (Kattenbelt 2008: 20), rather than intermediality.

As noted in the theoretical framework, Giesekam and Kattenbelt distinguish intermediality from multimediality by the presence of “extensive interaction” between performer and media Giesekam (2007: 8) and “mutual influences between media” (Kattenbelt 2008: 20).

An early example of an intermedial practitioner is Josef Svoboda (1920 - 2002) who combined film and performance in such a way that they became interdependent on each other. In 1958, Svoboda showcased a production with director Alfred Radok at Expo 58 in Brussels combining the live action of presenters, musicians and dancers with filmed sequences.

> The play of the actors cannot exist without the film, and vice-versa-they become one thing, a synthesis and fusion of actors and projection. Moreover, the same actors appear on stage and screen, and interact with each other.
> (Jones & Unruh 1992: 105)

A contemporary figure in present day theatre using media technology as a means of theatrical expression is Robert Lepage, who in 1994 founded the theatrical company Ex Machina.

> Ex Machina's creative team believes that the performing arts – dance, opera, music – should be mixed with recorded arts – filmmaking, video art and multimedia. That there must be meetings between scientists and playwrights, between set painters and architects, and between artists from Québec and the rest of the world.[20]

In *Intermediality and Spectatorship in the Theatre Work of Robert Lepage*, the author presents a comprehensive intermedial perspective and analysis of the intermedial strategies used by Lepage in his solo works. In her analysis of intermediality, Albacan emphasises the importance of the spectator - "locating the spectator – or observer at the core of the intermedial phenomena" (Albacan 2016: 87).

Section 2.1 of the theoretical framework refers to the "tripartite phenomenon" of interdependent relationships between performer, media and audience in intermedial productions. Boenisch emphasis intermediality it is not simply the staging of media, but is essentially concerned with performance, media relations and the making of meaning.

> Intermediality.. is an effect performed in-between mediality, supplying multiple perspectives and foregrounding the making of meaning rather than obediently transmitting meaning. (Boenisch, 2006: 103)

The supplying of multiple perspectives and the making of meaning in-between media is exemplified in the work of companies such as the Builders Association, The Wooster Group and Forced Entertainment.

[20] http://lacaserne.net/index2.php/exmachina

The Builders Association, founded in 1994, produces theatrical performances with a social and political edge. The company performatively stage a range of multimedia technologies made visible in a self-referential and de-constructivist manner to make the audience aware of the technologies responsible for any theatrical magic.

Dixon likens this mode of incorporating media into theatre as 'Brechtian theatre'. The German playwright Bertolt Brecht (1898 – 1956) created a form of theatre where through theatrical devices, for example, a performer directly addressing the audience, the audience were made aware that they were watching artifice. Brechtian theatre went against the classical theatrical Aristotelian or Dramatic tradition of seducing the audience into a state of suspended disbelief.

> Brechtian theater and deconstructive postmodern performance styles unite in their self-conscious "stepping outside" of illusionistic narrative forms; in framing all action within quotation marks; and in explicitly "announcing" intentions, like a stage conjuror before a trick.
> (Dixon 2006: 347)

The Wooster Group, founded in 1975, also use technology to complement their postmodern theatre "constructed as assemblages of juxtaposed elements... found materials, films and videos, dance and movement, multi-track scoring".[21] In a style similar to that of The Builders Association, their approach is also Brechtian, their use of technology is not to create a seductive illusion but for the technology to be visibly present with the actors who provide multiple perspectives through a dialectic of dialogue and commentary.

Forced Entertainment founded in 1984, include a range of media in their productions with which the performers enter into dialogue with, their productions exploring complex relationships between media, performers and audience. Heightening the role of the spectator in the intermedial relationship, the audience is often treated as witnesses or voyeurs (Georgi 2014: 184).

[21] https://vimeo.com/thewoostergroup/about [accessed 9/7/2019]

> The work makes a strong link between form and content, reflecting our belief that the form of a project – the kind of experience it presents, the contract it makes with its audience and how – is an inseparable and significant part of its meaning.[22]

The above presented an overview of intermedial practitioners, where their productions align to the definition of intermediality given in the theoretical framework. The next section presents a selection of contemporary practitioners addressing the two core theoretical concerns of virtual embodiment and performative interaction within the theoretical framework.

[22] https://www.forcedentertainment.com/about/ [accessed 9/7/2019]

4.2 Contemporary Practitioners

This section presents examples of contemporary practitioners whose works address the theoretical concerns of intermediality and performance (IP), virtual embodiment (VE) and performative interaction (PI). Abbreviations of the represented theoretical concerns are included in the title of each example.

Many of the examples presented here I have personally witnessed, whilst other examples relevant to the research are through researching contemporary practitioners whose work is available online. The inclusion of performative works that have been witnessed live or online substantiates the artistic audit and is in keeping with "transforming the literature review into a more layered and rich analysis of the contexts of practice within which the performative researcher operates" (Haseman 2006: 8).

4.2.1 Tony Oursler, Sculptural Art: VE

I have witnessed Oursler's work on numerous occasions and he is recognised for his distinctive style of projecting videos of talking faces onto the heads of small dummy like figures.[23] The work represents an example of virtual embodiment, it is clear the figures are inanimate dolls, yet the facial projections accompanied by audio of the characters talking, embodies the dolls, bringing them to life in an uncanny manner. I use the term uncanny here according to the definition put forward by Jentsch "doubt as to whether a lifeless object may not in fact be animate" (Jentsch 1906: 8).

[23] http://tonyoursler.com/

Figure 8: *Troubler* (Oursler 1996)

Video projection of images onto three-dimensional objects, such that there is coherence between the projected image and the object, is termed ‘projection mapping’, a technique used in the practice-based research in the realisation of virtual embodiment. In a similar manner to the effect described here, the projection of a virtual character onto the body of an actor wearing a white body suit produces a sense of the uncanny in those witnessing the virtual embodiment. The evocation of the uncanny is described in section 5.4 in the account of the practice-based research. The following example of performative interaction illustrates the effectiveness of projection mapping when combined with live performance.

4.2.2 DandyPunk, Recorded Performance: IP, PI

DandyPunk, a "multimedia performance artist", utilises a combination of projection mapping, pre-recorded material and tightly choreographed performance.[24] The work represents an example of intermediality in that there is extensive interaction between performer and media. The performer engages and interacts with projections of virtual characters and artefacts, which appear to respond to the performer, thereby conveying apparent agency to the audience. The work is presented as video recordings of live performances, the images below illustrating the participatory and expressive nature of the performative interactions of the Dandypunk character with the projections.

The first image, Figure 9, a screenshot from the work *The Alchemy of Light* (DandyPunk 2012) illustrates a virtual figure that jumps and is caught landing into a real book by the performer.

Figure 9: *Alchemy of Light* (DandyPunk 2012)

[24] http://www.adandypunk.com/

Figure 10 is a screenshot from *Imagineers in Exile* (DandyPunk 2013), a live rendering of a conceptual idea for a graphic storytelling performance set in a gallery space. The image illustrates the performer appearing to paint on a canvas with a glowing paintbrush, the projection of glowing and dripping paint aligning with the movements made by the performer's paintbrush.

Figure 10: *Imagineers in Exile* (DandyPunk 2013)

The work of DandyPunk illustrates performative interaction with projected passive media, requiring rehearsal and choreography in order to create the illusion of apparent agency. The witnessing of apparent agency with the projected media heightens the Plausibility Illusion (Psi), "the illusion that what is apparently happening is really happening, in spite of the sure knowledge that it is not (Slater 2009: 8).

4.2.3 Willow, Performative Music Video: IP, PI

The conveying of agency illustrated by the work of DandyPunk has parallels with the projection mapping pop promo *Sweater* by Willow (Willow 2012). Here an actor performs on a white set onto which videos are projected onto the floor and walls. Image captures from the video are shown in Figure 11 and illustrate the actor getting up from a bed then appearing to walk through the bedroom, down stairs, out of the house and then taking a subway train. The actor walks on a treadmill at a speed synchronised with the moving backdrop, resulting in an illusion of the actor walking through various scenes. Additional gestures enhance the illusion of the actor being immersed in a virtual set: he moves to open a door and walks into the next room, his legs move up and down in time to the video backdrop of the descending stairs.

Figure 11: *Sweater* (Willow 2012)

The work is intermedial in that there is extensive interaction between media and performer. Performative interaction is expressive and through rehearsed choreography, the virtual scenography appears to respond to participatory interaction, thereby conveying agency. Projection mapping onto a three-dimensional backdrop creates the illusion of the actor being physically located and participating in a three-dimensional virtual world, thereby enhancing the Plausibility Illusion (Slater 2009: 8).

4.2.4 Shana Moulton, Performance: IP, PI

The live intermedial performance work of Shana Moulton represents another example of performative interaction with virtual scenography, often for surreal and comic effect.

In 2015, I witnessed two performances by the New York performer Shana Moulton at Primary in Nottingham. Moulton uses projections and live performance to tell stories about her alter ego Cynthia, a hypochondriac woman who undergoes strange and surreal journeys through her real and imaginary illnesses.

Shana Moulton's performative work successfully utilises video projections to create engaging and dark comical performance. The technology is minimal, her work relying on careful scripting, choreography and the preparation of visual material such that she can convincingly interact with the pre-recorded material to convey apparent agency, creating illusions where the real and the virtual intertwine.

Figure 12, below illustrates two images from the commissioned performance, *Multiple points in this crude landscape*. In the first image Cynthia is projected as if she were sitting on the physical recliner chair. In the second image, the recliner lifts and Cynthia is projected rising into the air and leaving through the stained glass skylight.

Figure 12: *Multiple points in this crude landscape* (Moulton 2015)

Moulton uses a technique of performing with the virtual as if it were real, creating a sense of engagement with the work as the live real-world performer appears to co-exist with the virtual scenery. There is a dynamic interplay at work between Moulton's expressive performative interactions with the virtual scenography and her fabricated responses to the virtual scenography as if it were real.

Moulton often interacts with the virtual for comic and surreal effect. In the image below, Figure 13, Moulton attempts to convince the spectators that she is climbing a tree. As the projected imagery moves downwards and in sideways steps, Moulton expressively interacts as if she were using handholds in order to climb the tree.

Figure 13: *Whispering Pines* (Moulton 2010)

In Figure 14, below, illustrates the conveying of agency with Moulton performing with the projection, attempting to dust virtual objects, which appear to fly away in response to her actions.

Figure 14: *Whispering Pines* (Moulton 2010)

The scenarios Moulton conveys are comic, yet disturbing, as if the projected world inhabited by Cynthia is out of control with a life of its own and able to interact with the 'real world' of her live performance.

The work is intermedial in that there is a two-way relationship and interdependency between performer and media. Moulton performatively interacts with the media in order to convey agency, but in turn, her performative responses convey a relationship of mutual affect with the media.

4.2.5 Forkbeard Fantasy, Performance: IP, PI

Forkbeard Fantasy is a British theatre group founded in 1973 by three brothers Simon, Chris and Tim Britten. In 1988 I witnessed the performance *Who Shot The Cameraman*, which utilised a technique of blurring the real and the virtual similar in principle to Moulton's work, described previously. The Britten's coined their technique as 'Crossing the Celluloid Divide' where action would take place between live performers and film such that there appeared a blurring between being able to distinguish the difference between live and pre-recorded performance.[25] Their trick being to act with the recorded film material as if it were real, talking with and

[25] http://www.forkbeardfantasy.co.uk/useoffilm1.php

performing with projected characters as if they were actually live and present in the here and now.

Rehearsal, timing and choreography were essential in creating spectator engagement when performing with the pre-recorded films. The spectator was aware that they were being tricked, that the film was a recording and the projected characters could not actually hear or respond to the live actors even though they apparently did. Forkbeard used the 'Celluloid Divide' for comic effect, their humour being of a very English eccentric style, sharing commonalities with Monty Python and the Goons, as illustrated in Figure 15 below.

Figure 15: *Colour of Nonsense* (Forkbeard Fantasy 2009)

Forkbeard productions emphasise a dynamic interplay between media and live performance. Their work is intermedial, where there is extensive two-way interaction between performance and media. Performative interaction is expressive, often for comic effect, whilst agency is conveyed through rehearsed choreography with pre-recorded media. The 'Plausibility Illusion' is playfully and knowingly manipulated creating surreal scenarios of performative interaction with virtual scenography. The interplay between actual, virtual, real and fabricated, results in an engaging experience for the spectator:

> Spectators enjoy recognition of the edge between the actual and the virtual, the real and the fabricated.
> (Lavender 2006: 65)

4.2.6 1927, Animation and Performance: IP, PI

The relatively new company, 1927, share similarities with Forkbeard Fantasy combining live performance and music with projected animation, creating more of a fairy-tale ambience than the surreal slap dash eccentricity of Forkbeard's productions. 1927 were founded in 2005 by animator and illustrator Paul Barritt and writer and performer Suzanne Andrade.[26] I have not yet witnessed their work, but video material and photographic imagery suggest that they successfully blend live performance and animation in a captivating and engaging manner. Their projected sets combine hand drawn animated backdrops with live performance, as illustrated in Figure 16 below.

Figure 16: *Golem* (1927 Theatre Company 2014)

[26] http://www.19-27.co.uk/

Through expressive performative interaction with the virtual scenography, the actors convey agency to the audience, illustrated in Figure 17 below.

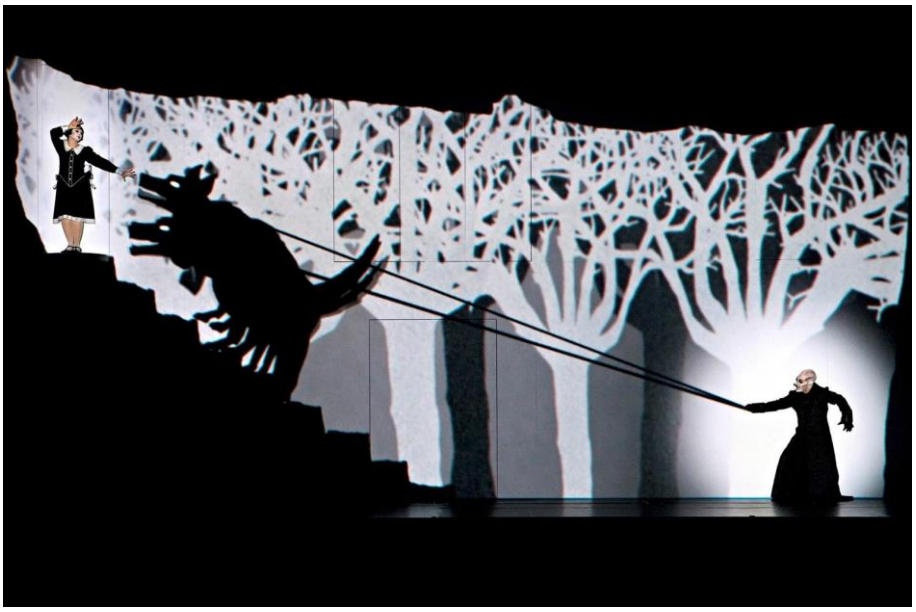

Figure 17: T*he Animals and Children took to the Streets* (1927 Theatre Company 2010)

The theatrical examples presented above illustrate expressive performative interaction with pre-recorded passive virtual scenography. The next example illustrates an experimental production where the virtual scenography interactively responds in real-time to the performers.

4.2.7 *Half Real*, Augmented Theatre: IP, PI

Half Real is a murder mystery and experimental augmented theatrical production shown in Australia in 2011. The production was the result of collaboration between PhD student Michael Marner and The Border Project, a contemporary performance ensemble.

Half Real uses a combination of technologies to produce an augmented stage supporting performative interaction and audience participation. The augmented stage combines projection mapping and computer graphics to produce the illusion of a three-dimensional set. The performers are tracked using the Kinect "allowing the projected content to react to actors' movements" (Marner et al. 2012: 1). Members of the audience use a 'ZigZag', a remote control device, to vote at key moments in the show and control how the murder mystery investigation proceeds.

Interaction between performers and the virtual set is displayed in the form of text and graphics captions which follow the performers as they move about, illustrated below in Figure 18: *Half Real* (Marner 2011).

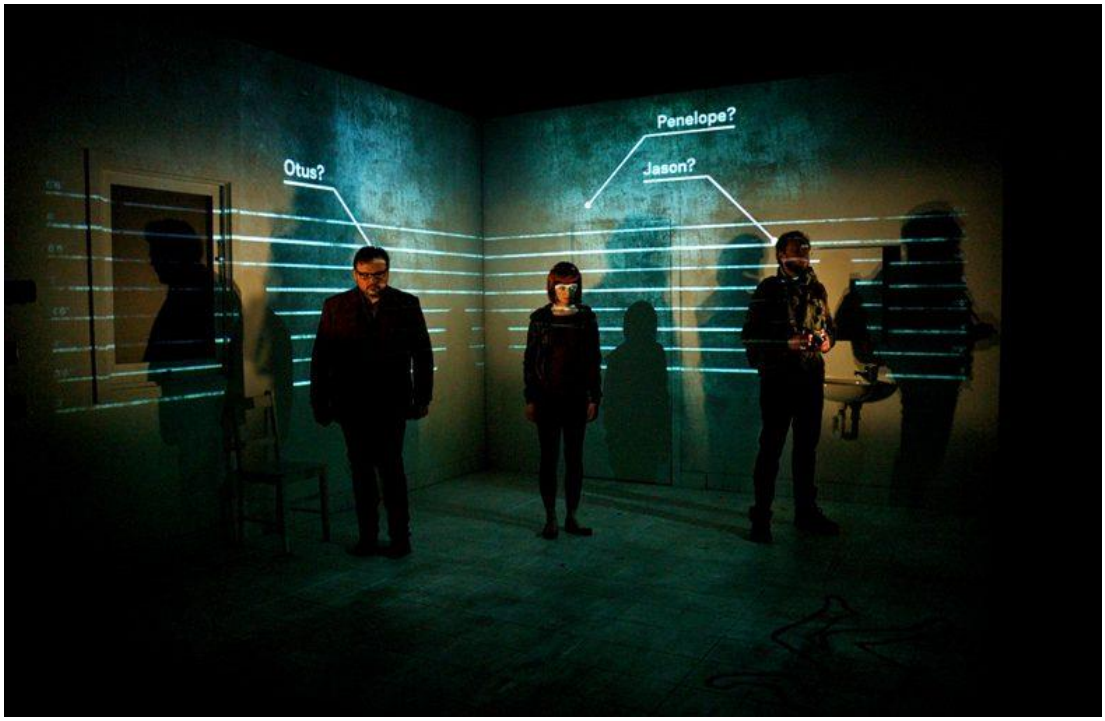

Figure 18: *Half Real* (Marner 2011)

The production demonstrates intermediality, though I would argue it is an example of weak intermediality. Rather than "extensive interaction" between performer and media, interaction is minimal, the projected text simply following the performers as they move around on the augmented stage. Unlike previous examples, the performers do not interact with the media to convey agency, nor do they perform in response to the virtual scenography, instead, the augmented stage serves as a static three-dimensional theatrical set for the performance.

Performative interaction with the projected text is 'magical', the text automatically following the performers without any need of 'expressive' performative interaction.

The next example illustrates virtual embodiment through the projecting of a human form onto a performer and the use of choreography to create congruency between performer and projection.

4.2.8 Klaus Obermaier, Dance Performance: IP, VE, PI

In 1998 I witnessed *D.A.V.E* (Digital Amplified Video Engine) created by Klaus Obermaier, which utilised a linear pre-recorded video projected onto a choreographed dancer, Chris Haring, illustrated below in Figure 19.

Figure 19*: D.A.V.E*. (Obermaier 1988)

The performance was a hypnotic and captivating melding of dynamic imagery and body transformations completely synchronised with the movements of the dancer.

The projection of an animated humanoid figure onto the rehearsed choreography of the performer resulted in a congruence between the performer's body and the projected virtual body. The congruence conveys apparent agency and body ownership to the audience witnessing the virtual embodiment.

In a similar manner to the conveying of agency though performative interaction with passive media, the witnessed virtual embodiment produced is through the congruence of the performer's body and the projected passive media.

In 2004, working in collaboration with Ars Electronica Futurelab, Obermaier produced *Apparition*, another work involving projection mapping and dance, but rather than using passive media, the work used interactive media enabling real-time interaction between the dancers and the virtual projections.[27]

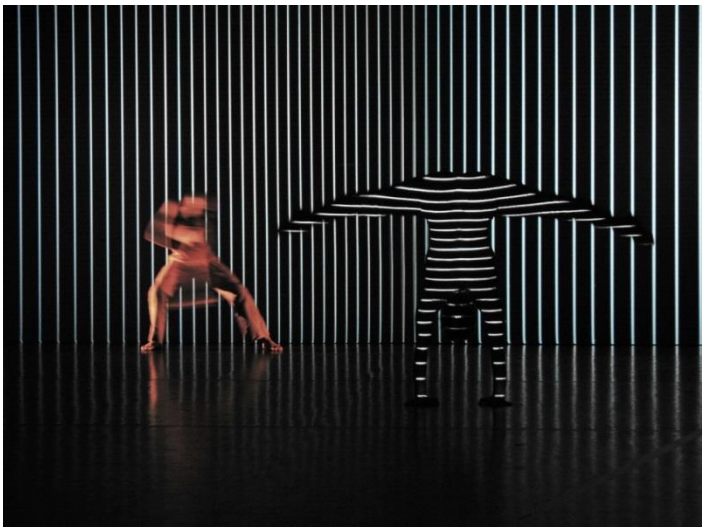

Figure 20: *Apparition* (Obermaier 2004)

I have not witnessed *Apparition*, but the video, images (Figure 20, above) and descriptions indicate that the work no longer uses the projection of human like forms

[27] https://www.aec.at/futurelab/en/project/apparition/

incorporated in *D.A.V.E.*, but instead, the projection of abstract computer graphics generated in real-time in response to the dancers' movements.

Both examples are intermedial with a high level of co-relation and mutual affect between performance and media. In the first example, the media is passive and the expressive performative interaction is perceived whilst in the second example, the media is active and performative interaction is actual.

4.2.9 Anarchy, Interactive Dance: IP, PI

I witnessed *Seventh Sense*, a performative dance work by Anarchy, a Taiwanese dance theatre group, at World Stage Design, Cardiff 2013. The work combines dance with the projection of interactive graphics that respond to the dancers' movements, creating a dialogue between the live action and the virtual scenography.

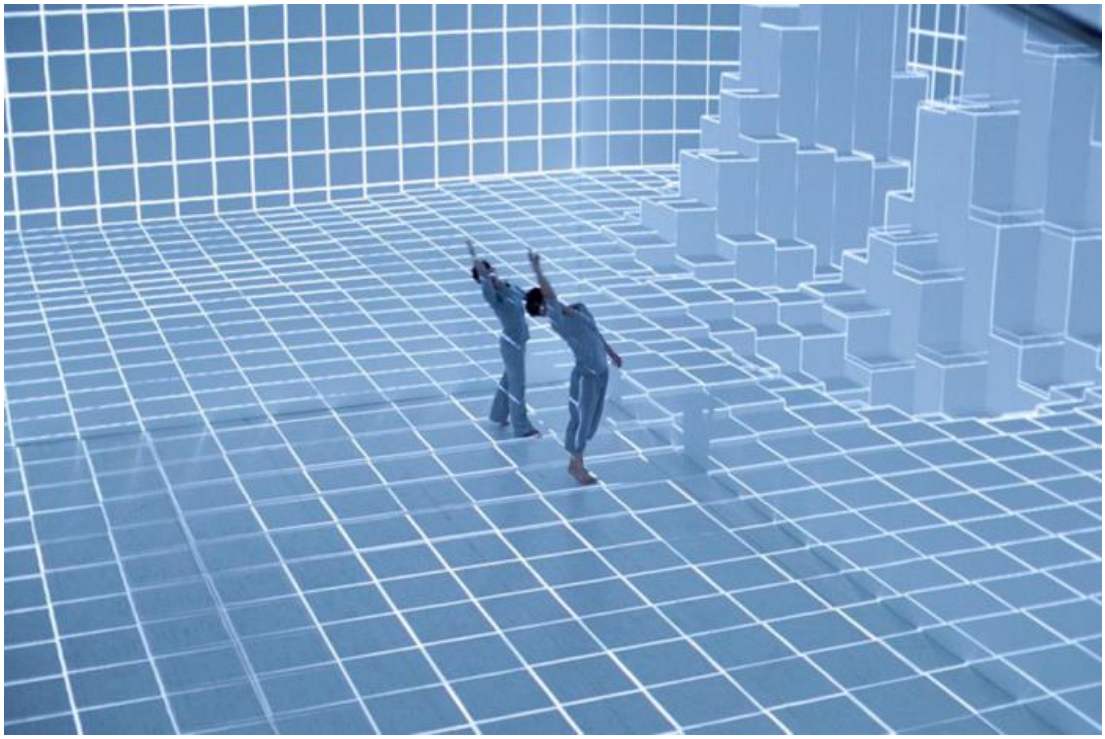

Figure 21: *Seventh Sense* (Anarchy Dance Theatre 2013)

The projections on the stage floor, back and side walls, produce the appearance of the dancers performing in a virtual three-dimensional space, illustrated above in

Figure 21. The illusion is similar in concept to that used in the pop promo *Willow*, shown in section 4.2.3.

Performative interaction between live action and the responsive computer graphics was used to great effect; the virtual scenography shifting in response to the dancers' movements conveying agency, enhanced by the apparent three-dimensionality of the augmented stage. The work is highly intermedial demonstrating extensive interaction between media and performers, whilst performative interaction is expressive and actual.

4.2.10 Myron Krueger, Interactive Art: IP, PI

An even earlier example of engagement with the virtual is Myron Kreuger's *Videoplace*, which I witnessed in 1989 at the Exploratorium, San Francisco.

A feature of *VideoPlace* and shared with this research is the use of the second-person perspective or the presentation of the 'mirrored self' (Morie 2007) to the participant/performer. This perspective enables the participant to view themselves as observed, rather than the first-person perspective commonly used in VR and video gaming, where the participant is situated as observer (section 2.3.3).

Myron Kreuger is often regarded as one of the cutting-edge pioneers of interactive video art and created his own interactive technologies in order to realise his playful vision. Participants would stand in front of a projection screen and could interact with a variety of illusions simply by body gesture. This work using the body as the interface precedes the invention of the Microsoft Kinect by almost thirty years.

One of the works *Critter*, illustrated below in Figure 22, I remember as being particularly effective.

Figure 22: *Critter* (Kreuger 1989)

A virtual creature (the critter) a simple animated line drawing, would walk around the outside of the body, projected as a silhouette on the screen in front of the participant. It would try and walk to an extremity, such as the tips of the fingers; it could even picked it up and moved from one arm to another.

The work is highly intermedial, demonstrating extensive interaction between media and participant. The presentation of the work contextualizes the participant as a performer when witnessed by spectators. The conveying of agency is actual in that the media is active, and performative interaction is expressive.

4.2.11 Analysis of Selected Works

The above examples illustrated a range of the works demonstrating intermedial relationships between media, performer and audience. In the following analysis, I refer to the tripartite diagram presented in the theoretical framework, shown again below, Figure 23: Intermedial Relations.

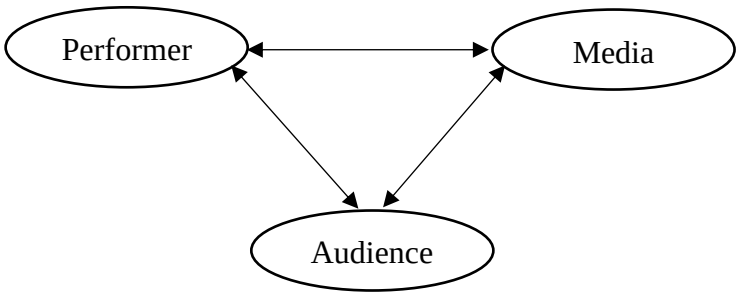

Figure 23: Intermedial Relations

The examples of Dandypunk, Willow, Moulton, Forkbeard Fantasy and 1927 all have a directed intermedial relationship from performer to media conveying perceived agency with passive media. The relationship is bi-directional in that the intermedial relationship between performer and media is of mutual affect, with the performer responding to the media content.

All the intermedial performances are live and witnessed by an audience except for the mediated works of Dandypunk and Willow, recorded on video and witnessed after the event.

In the examples, performative interaction is expressive and the Plausibility Illusion can be seen to be exploited for theatrical, comic or surreal effect.

The works of Oursler and Obermaier illustrate virtual embodiment using projection mapping of virtual humanoid figures onto ‘real’ bodies, be it the body of a performer or the body of a doll. Through the congruence of highly choreographed live performance and the projection of an animated virtual body, Obermaier’s D.A.V.E. production conveys body ownership and apparent agency.

The works of Half Real, Obermaier, Anarchy and Kreuger employ actual interaction with active media rather than perceived interaction with passive media employed by the majority of the examples. In these examples of actual interaction, the media content is of a graphical form, either text or abstract graphics.

The next section describes a previous practice creating interactive installations and further informs the research context examining performative interaction with active media.

4.3 Previous Practice

In this section, I present examples from a previous practice creating interactive art installations designed to engage participants through unencumbered interaction using their body, rather than via a hardware device such as a joystick. The presented artworks exhibit technical and conceptual similarities to those employed in the research:

- Human Computer Interaction (HCI) is realised through unencumbered body sensing, enabling participants to interact with the artworks using body movements and gestures.
- Projection is used to display real-time computer-generated imagery.
- The works are designed to engage the participant and spectators through a combination of mimesis and performative interaction.

In the research, unencumbered body sensing is realised using the Microsoft Kinect, in contrast, the artworks use electric field sensing or image recognition technology to locate and track the body. The artwork imagery is generated in real-time using the computer programming language 'C', whilst the research uses the Unity game engine to generate the imagery.

Both the research and the artworks share a similar conceptual interest in the creation of engaging interactive digital media content with participants witnessed by spectators. A significant difference in the research is the change of role from participant to performer. Through interacting with an artwork witnessed by spectators, a participant unwittingly took on the role of a performer. Section 2.2 notes that in the HCI literature, the public witnessing of participant interaction with digital media is termed 'performative interaction' (Rico et al 2010). Whereas in the research, performative interaction is used to describe the situation where a performer interacts with digital media before an audience.

Interaction and mimetic imagery create engagement with the artworks and in the research. The imagery displayed by the game engine employed in the research offers a higher degree of mimesis through visual realism than the abstract computer graphics generated in the artworks through programming. In contrast to the research, programming enabled the production of behavioural realism, where the interactive dynamics of computer-generated graphics embodied mimetic qualities of life-like movement and of responsiveness.

Mimesis, to mimic or imitate, describes the copying of behaviour from one form to another, or the subjective bestowing of a feature from one form to another. Mimesis invites the viewer of an artificial life work to construe a digital simulation as appearing to be alive or sentient, its behaviour or appearance being mimetically similar to something already known or experienced.

Walter Benjamin describes the phenomena of perceiving similarity as the 'mimetic faculty':

> Nature produces similarities; one need only think of mimicry. The highest capacity for producing similarities, however, is man's. His gift for seeing similarity is nothing but a rudiment of the once powerful compulsion to become similar and to behave mimetically. There is perhaps not a single one of his higher functions in which his mimetic faculty does not play a decisive role.
> (Benjamin 1979: 720).

The visual design and interactive dynamics of the virtual characters used in the prototype augmented stage are subject to the mimetic faculty, by myself as designer and their perceivers, the audience and performers. One of the areas examined during the research concerned evaluating the effect of differing visual representations of the virtual character on performative behaviour (5.8.2). The dynamic behaviour of the character also influences mimesis; the projected character appearing human-like when its movements match those of the performer.

When the visual representations of the human form or its dynamic movements are almost human, but not quite, there is the possibility of creating a sense of unease in the spectator. When mimesis approaches the depiction of human qualities but do not quite get it right, it creates a sense of the uncanny, where the portrayed human like character appears to oscillate between something familiar and alive, or something unnatural and zombie-like. Section 5.4 describes how the uncanny emerged as a potential research strand, referencing the literature on the subject.

Mimesis, projection and unencumbered interaction are qualities featuring in the three artworks: the *Mimetic Starfish* (2000), *Biotica* (1999) and *Alembic* (1997). The artworks were created whilst a research fellow in the department of Computer Related Design at the Royal College of Art (1995-2001). The research methodology utilised 'art as a mode of inquiry', where 'art practice' acted as a driver for the research, similar in principle to the practice-based methodology used in the research.

My interest was in the creation of unencumbered participatory experiences in 'Virtual UnRealties', a quest to pursue an alternative paradigm to the simulation of a Cartesian 'reality' prevalent in VR and gaming.[28] The first manifestation of this approach was the interactive installation *Alembic*, named after an alchemical term for distillation vessel.

[28] Archived Virtual UnRealities website: http://www.mimetics.com/vur/index.html

Figure 24: *Alembic* (Brown 1997)

Alembic, illustrated above in Figure 24, combined unencumbered body sensing, projection and the real-time generation of simulated matter to create a participatory space where viewers moving around the central projection could change the temperature of the simulated alembic to melt and shape virtual matter.

The virtual matter programmed in 'C', represented a physics simulation of particle dynamics incorporating parameters of friction, gravity and energy. Through electric field sensing (Zimmerman et al. 1995), four aerials at the corners of the work enabled the location of participants to be detected. Participants moving around the installation altered the simulated temperature of the virtual matter resulting in the production of mimetic qualities associated with the dynamics of the four alchemical elements, earth, fire, air and water.

Interaction was participatory and agency conveyed through the dynamic responsiveness of the simulated matter.

The second project, *Biotica* (1997-1999) investigated immersion, emergence and Artificial Life (Brown & Aleksander 2001). The *Biotica* installation differed from *Alembic* in being a solo experience, illustrated below in Figure 25.

Figure 25: *Biotica* installation, (Brown 1999)

The installation used two back projected polarised projectors and passive polarising glasses to create a 3D stereoscopic illusion designed to immerse the participant in a three-dimensional world of artificial life. Participants used their arms to navigate around the world, the interaction being realised by the same electric field sensing used in *Alembic*.

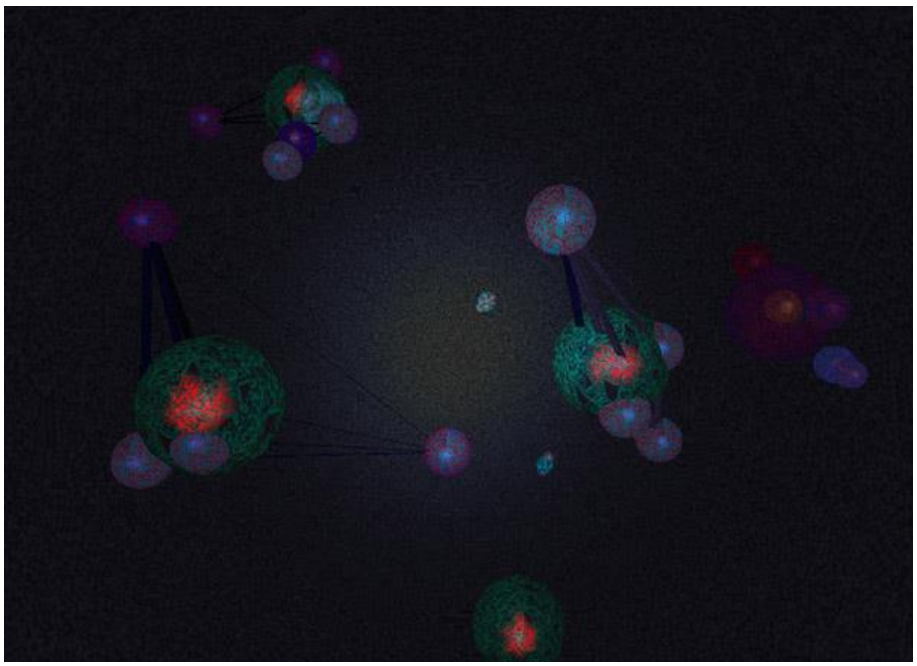

Figure 26: *Biotica* screenshot (Brown 1999)

In a similar manner to *Alembic*, rather than through visual appearance, the dynamics of the abstracted graphics of the artificial life (A-Life) creatures were used to mimetically convey life-like movement and behaviour. Figure 26 above, illustrates the abstract qualities of the A-Life creatures.

Interaction with the work was essentially navigational, creatures responding more to each other than the virtual presence of the participant, resulting in a lack of conveying participant agency with the simulated A-life creatures. The third project, the *Mimetic Starfish* was created with the aim of clearly conveying participatory agency through the dynamic responsiveness and life-like behaviour of an A-Life creature.

The *Mimetic Starfish* premiered in 2000 at the London Millennium Dome and illustrates the use of mimesis and gestural interaction to create engagement with participants and spectators. Figure 27 below, illustrates multiple participants interacting with the *Mimetic Starfish* during an exhibition ‘Emocoa Art.ficial’, in Brazil, 2012.

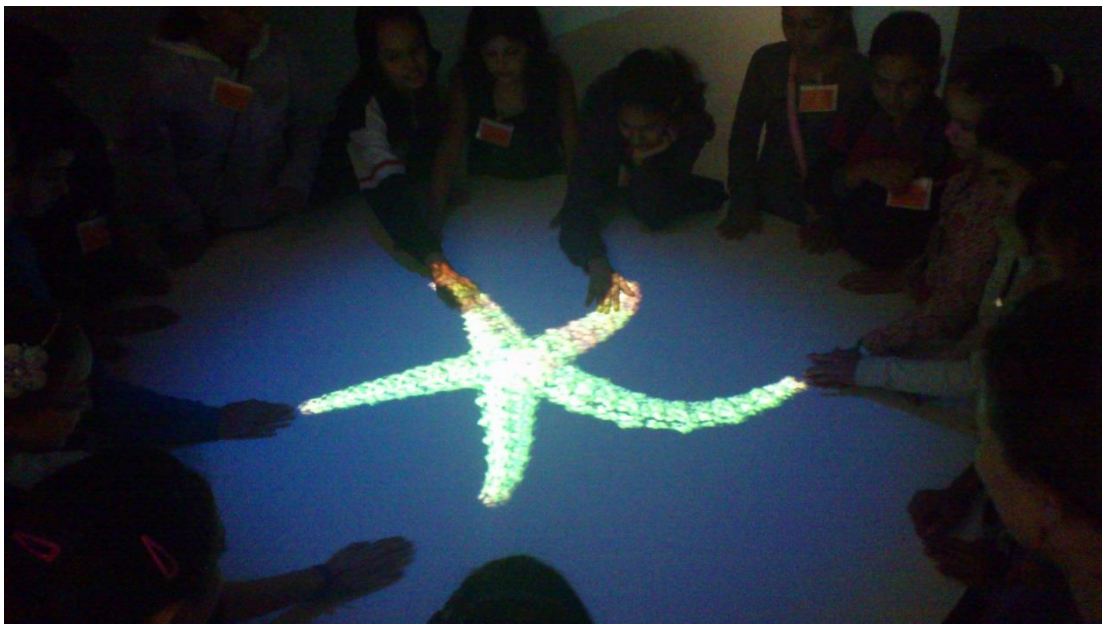

Figure 27: *Mimetic Starfish* (Brown 2012)

The *Mimetic Starfish* represents an example of how participatory engagement with the virtual can be fostered through the engineering of life-like responsiveness to gesture. The work sought to answer the question "how might something virtual and artificial be perceived as if it were alive?" The responsiveness of the creature was deliberately engineered to create the illusion of something that appeared alive – an example of 'Artificial Life' (Brown 2015).

The starfish would reach out a tentacle towards the hands of a participant, if they moved too quickly it would jump back in an organic and life-like manner, as if startled. If a participant gently stroked a tentacle it would curl and pulse with colour, suggesting pleasure. The manifestation of these life-like qualities in response to participatory interaction conveys agency to the participants. The use of simulated physics creates a mimetic life-like organic response to interaction and results in participants engaging with the virtual creature as if it were alive and sentient.

Engagement is associated with the conveying of agency and the enhancement of the plausibility illusion through the use of simulated physics, discussed in section 2.2.1 of the theoretical framework.

The group participation manifested in *Alembic* and the *Mimetic Starfish*, situates participants as performers, in that they not only playfully and performativity interact with the work, they also become performers in relation to other participants and a watching audience. The reframing of participants as performers and the creation of engagement through participatory interaction with the virtual are key concerns in this research and the previous practice. In this research, rather than a participant, the performer is the interactive agent who engages with the virtual whilst witnessed by an audience.

In the interactive art works, I sought to create participatory engagement with the virtual. In a similar manner, theatrical performance with the virtual seeks to engage the audience through the conveying of agency through the performers' participatory interaction with the virtual. The examples presented in section 4.2 illustrate that this interaction may be simulated through choreographed performance with passive media or in the case of this research and with the previous practice, actual interaction with active media.

The next section analyses the presented examples in order to identify the research gap in the investigation of performer embodiment and performative interaction.

4.4 Identifying the Research Gap

Section 4.1 provides an overview of intermedial theatre and performance and section 4.2, examples of contemporary practice. The analysis of selected works highlights their connections with the central themes of virtual embodiment and performative interaction from the theoretical framework. With additional references from the literature, I now review the findings from the previous analysis in order to identify the research gap.

Within performance and theatre, the examples illustrate how practised choreography can be used to create the illusion of a projected virtual set appearing to respond to the actions of the performer (*Sweater,* Willow 2012; *Alchemy of Light,* A Dandypunk, 2012; *the Animals and Children took to the Streets*, 1927 Theatre Company, 2014).

There are examples in dance where projections interactively respond to the movements of dancers; however, in these cases the interactive projections are in the form of abstract graphic effects, animated geometrical lines and particle systems (*Mortal Engine*, Chunky Move, 2010; *Seventh Sense*, Anarchy Dance Theatre, 2011). In a similar manner, performative interaction in the experimental theatrical production *Half Real* is characterised by animated overlays and graphic effects (Marner 2012).

Examples of performances where actors are engaging with apparently interactive projected sets and characters include *The Adding Machine* (ieVR, 1995) and *The Tempest* (RSC, 2017). However, in these cases the virtual projections are controlled by a backstage operator, or 'Virtual Environment Driver' (Dixon 2006: 42)

The projection of a virtual character onto a performer such that the projected character appears to follow the movements of the performer rely on well-rehearsed choreography to achieve the effect of the performer's body appearing congruent with the projected character (*D.A.V.E,* Obermaier 1988). Where there are examples of live performative interaction, the interactive body projections are presented in the form of abstract graphic effects rather than the projection of a human figure onto the performer (*Apparition*, Obermaier 2102).

The review of contemporary practitioners presented examples of works incorporating aspects of virtual embodiment and performative interaction. No examples were found of a fully interactive augmented stage using dynamic projection mapped virtual characters onto performers. Nor did I find examples using HMD's to deliver visual feedback to performers on an augmented stage in order to enhance their performative capabilities.

The research gap is thus identified as the creation of an interactive augmented stage consisting of dynamically projection mapped performer(s) able to interact with virtual scenography, where using HMD technology, they witness themselves performing towards an audience and interacting with the virtual scenography.

Chapter 5 Practice-based Research

At the heart of the practice-based research is the creation and evaluation of *iMorphia*, a prototype augmented stage. The system combines video projection, game engine technology and three-dimensional body tracking to produce a virtually embodied character able to interact within a virtual scene.

iMorphia was created using the Unity game engine, its powerful scripting and rich media support enabling the realisation of a range of virtual characters and interactive virtual scenes. Through the scripting of interactive scenarios, the augmented stage of *iMorphia* enabled the posing of research questions, evaluated via 'enactments' – live performances before small audiences or solo performances in front of a camera. The enactments were recorded on video and documented on the research blog in the form of a series of time stamped posts containing video recordings and textual commentary.

The practice-based research developed in an iterative fashion, reflection on the results of an enactment coupled with audience and performer feedback, providing mechanisms for evaluating and generating further research questions or suggesting new directions for the research.

As mentioned earlier in section 3.1, the research commenced with a broad remit. As a result, the practice-based research explored a number of theoretical areas including improvisation and the nature of the uncanny. The research blog provides evidence of these investigations, whilst the account presented here represents a distillation of the research and references blog postings specifically concerned with virtual embodiment and performative interaction. An account describing how the research developed over time, the Research Journey, is presented in section 6.4 and discusses aspects of the research not included in the thesis.

5.1 Overview

The practice-based research is documented on the research blog as a series of numbered and date stamped posts. References will be made to the research blog in the form {n}, where n is the index number of the research blog entry. The research blog can be accessed online[29] or offline in the accompanying zip file[30].

The practice-based research addresses the theoretical concerns of virtual embodiment and performative interaction presented in the theoretical framework in Chapter 2.

The theoretical concern of virtual embodiment is addressed in the first enactment described in section 5.4 and in the subsequent enactments described in sections 5.5, 5.6 and 5.8. Performative interaction and the two associated categories of navigation and participation are addressed in section 5.9, leading to the conceptualisation of the 'Embodied Performative Turn' presented in section 5.10 and concluding with the evaluation of differing perspectives described in section 5.11.

The concept of triadic intermedial relations, presented diagrammatically in section 2.1 of the theoretical framework, is reintroduced as a means of explicating relationships between media, performers and audience in the enactments evaluating virtual embodiment in section 5.4 and performative interaction in section 5.9.

[29] kinectic.net/category/research-blog/
[30] Via /kinectic.net/index.html in the accompanying ZIP file archive, kinectic.net.zip

The bullet points below summarise key stages of the research and are described in detail in the subsequent referenced sections.

- **Research Platform** **Section 5.2**
  Research and development of a technical platform on which to carry out the practice-based research.

- ***MikuMorphia*** **Section 5.4**
  Documentation and evaluation of virtual embodiment using the first prototype, *MikuMorphia*, November 2013.

- ***iMorphia*** **Section 5.5**
  Development of *iMorphia*, a platform based on the Unity game engine, realised in March 2014.

- **Early Trials** **Section 5.6**
  Documented enactments of early trials evaluating virtual embodiment using the *iMorphia* system and resultant research observations.

- **Performance and Games Workshop** **Section 5.7**
  Creation of a prototype participatory game using *iMorphia* combined with motion capture, Lincoln March 2014.

- **Evaluation Workshops** **Section 5.8**
  Evaluation of virtual embodiment using *iMorphia* with fifteen participants, April 2014. Identification of research outcomes through analysis of video documentation of enactments and audio recordings of workshop discussions.

- **Performative Interaction** **Section 5.9**

  Enactments evaluating the functionality of Dixon's concepts of performative interaction applied to *iMorphia*, August 2015 – March 2016.

- **The Embodied Performative Turn** **Section 5.10**

  The observation that audience orientated performative interaction challenged screen directed human computer interaction, leading to the formulation of 'The Embodied Performative Turn'.

- **Visual Perspectives** **Section 5.11**

  Evaluation of the effectiveness of first- and second-person perspectives in performative interaction, May 2016. Modification of the concept of the Embodied Performative Turn.

- **Summary of Results** **Section 5.12**

  Summary of the research outcomes resulting from the investigations of virtual embodiment, performative interaction and visual perspectives.

- **Practice and Process** **Section 5.13**

  Account of the challenges, problems, benefits and rewards experienced in the practice-based process.

5.2 Research Platform

An early PhD research proposal specified the outline of a multimodal performative platform using projection and virtual scenography. The platform was labelled 'multimodal' in that it would support the output and input of a variety of information modes such as sound, image and gesture. The capabilities and design of the platform are outlined in some detail:

> A system for delivering multimodal performance would comprise of projection mapping (single or multiple projectors), 3D body interfacing (for one or more performers) and real-time 3D content generation.
>
> A minimal system might comprise of a projector, a gaming computer with a Game Engine such as Unity interfaced to a Microsoft Kinect for 3D body, gesture tracking and voice recognition. It is envisaged that a headset would deliver a live feed of the performer on stage, producing a sense of immersion and engagement as the performer sees his or her self in character and located in the virtual set.
>
> A software model of a multimodal performance would represent the 3D content of the sets, objects and characters, an encoding of the dynamic and interactive behaviour of its characters and a model of potential trajectories or paths through scenes.

Due to time and financial constraints the platform I envisaged had to be affordable and readily available. The Microsoft Kinect appeared to be a practical choice of sensing device; it was an affordable consumer product and since it had become accessible to the Open Source community there was a wealth of demonstrations and software applications available via the internet.[31]

[31] https://blog.adafruit.com/2010/11/10/we-have-a-winner-open-kinect-drivers-released-winner-will-use-3k-for-more-hacking-plus-an-additional-2k-goes-to-the-eff/

Research led to the discovery of a video illustrating the Kinect being used to control a virtual character in real-time, the user puppeteering the virtual character using their body.[32] The demonstration was based on the Japanese MikuMiku Dance software and resonated with how I envisaged a performer might control a virtual character.

However, rather than the user acting as a remote puppeteer looking at a screen, my goal was to give the performer the visual sensation that they were embodied as the virtual character. To achieve this I projected the virtual character onto the performer who wore a white bodysuit. A Head Mounted Display (HMD) connected to a camera pointing at the performer enabled them to see themselves transformed into the virtual character, illustrated below in Figure 28: System schematic.

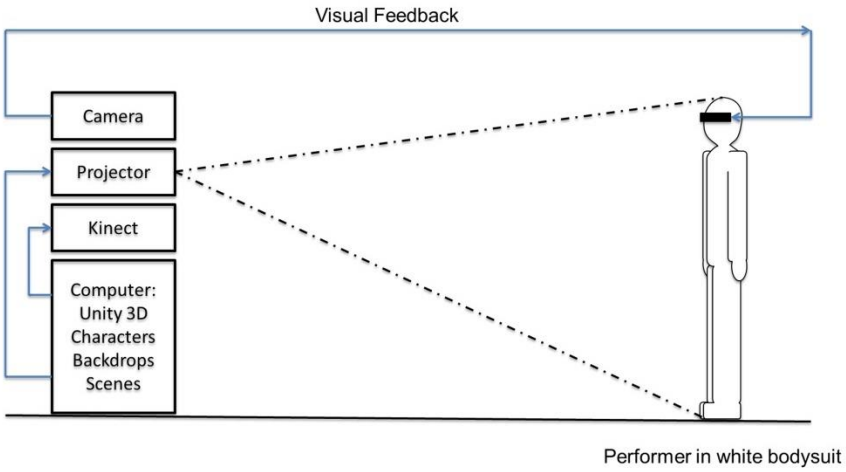

Figure 28: System schematic

Section 2.3 of the theoretical framework describes how congruency of the performer's body with the projection mapped virtual character is associated with creating a sense of embodiment (SoE), specifically the sense of body ownership which is conveyed through visual feedback to the performer via the HMD.

[32] https://www.youtube.com/watch?v=JQvLt7DQhaI

The viewpoint the performer witnesses is from the perspective of the audience, it is a second-person perspective and differs from the conventional first-person perspective used in VR and gaming, discussed previously in section 2.3.3.

The rationale here was pragmatic; whilst performing towards the audience, the live video feed from the camera to the HMD enables the performer to see themselves 'in virtual character' as the audience sees them.

Research revealed that employing this unusual second-person perspective impacted on performative interaction and virtual embodiment, these effects are described in detail in section 5.11.

5.3 Technical Details

The first prototype *MikuMorphia* was based on the MikuMiku Dance software to control and render the virtual scenography, whilst subsequent research used the Unity game engine. The reasoning behind the move from MikuMiku to Unity is explained in the account of the *MikuMorphia* enactment, section 5.4.

As illustrated in Figure 28: System schematic, the system components are: a computer, a video projector, projection onto the body, an HMD, a video camera and the Microsoft Kinect. These elements are described in detail below.

The computer used in the research was a laptop PC with an Intel i5 processor and graphics accelerator running Windows 7. The evaluation of visual perspectives in section 5.11 required a higher specification desktop computer capable of supporting the Oculus Rift Virtual Reality headset.

The research used a bright 2000 lumens projector capable of producing an image large enough to cover the performer's body with an image of the projected character. To produce an appropriately sized image, the throw distance (distance between projector and screen) is calculated based on the throw ratio of the projector. For example, a throw ratio of 2:1 would require a distance of 8 metres to produce an image 4m wide by 3m high (aspect ratio 4:3). When showing the work in different locations it was necessary to ensure that the throw ratio of the projector was appropriate to the dimensions of the allotted space.

The performer acts as the screen by wearing a white body suit. In workshops and public events, a white boiler suit was worn over the participant's clothes and a muslin cloth placed over their head. The boiler suit proved convenient and practical though producing a somewhat wrinkly and oversized projection surface. Wearing a white 'Spandex' bodysuit produces a smoother and better fitting projection surface but is less practical for workshops, requiring the performer to remove their clothes in order to wear the suit.

The HMD presents a second-person perspective to the performer from a video camera placed behind the projector in the location of the audience.[33] The video camera also served to document the enactments, recording the viewpoint presented to the performer. The HMD connected to a composite video output of the video camera by a long video cable. Wireless visual feedback would enable performers to move more freely and would be employed if the system were to be used professionally. Instead of a live video feed delivering a fixed second-person perspective, a stereoscopic rendered display was used in the later stage of the research so as to present a variable first-person or second-person perspective of the augmented stage, this is described in section 5.11, Visual Perspectives.

[33] Vusix iWear AV920

Due to the limited body coverage of a single projector, it was found that the ideal position to see the projected character on the performer was from directly behind the projector. The video camera was located on this 'sweet spot' and the viewing audience situated in the area behind the camera. When viewing the performer from the side, rather than face on, the front projected image became less visible. If the system were to be used in theatrical spaces with larger audiences, multiple projectors could be employed to improve the coverage of the projected image on the performer's body and provide a larger angle of view for an audience. These and other enhancements are described in section 6.2.1, System Development.

The final element of the technology is the Microsoft Kinect. Originally designed as a game controller for the Microsoft Xbox 360 game station, the Kinect enables players to interact with games by using their bodies. Throughout the research I used the Kinect V1 (2010), an updated version, the Kinect 2.0 designed for the Xbox One (2013) was briefly evaluated. The Kinect 2.0 offered faster and more accurate tracking but can only function on specific computer hardware.[34] For the purposes of the research, the Kinect V1 proved perfectly adequate.

Software drivers for the Windows PC enable the Kinect to interface to character rendering software so that a performer can puppeteer a virtual character. The prototype platform used the MikuMiku Dance application to render virtual characters and Open Source drivers from OpenNI (Open Natural Interaction).[35]

The subsequent platform for the research used the Unity game engine and software drivers from the Microsoft Kinect SDK (Software Development Kit). A project downloaded from the Unity Asset Store provided useful script examples demonstrating how to puppeteer virtual characters using the Kinect.[36]

The next section, 5.4 *MikuMorphia*, describes the first enactment using the MikuMiku Dance platform.

[34] https://developer.microsoft.com/en-us/windows/kinect/hardware-setup
[35] http://vocaloidism.com/mmd-gets-real-time-motion-capture-add-on-using-kinect/
[36] Kinect with MS-SDK: Scripting/Avatar Systems by RF Solutions.

5.4 *MikuMorphia*

In November 2013 I documented the first enactment, *MikuMorphia*, using the Japanese MikuMiku Dance application {1}.[37] This first enactment acted as 'proof of concept', demonstrating the feasibility of performing as a virtual character.

The enactment was a solo performance before a video camera, without an audience witnessing the performance the enactment appears to only concern the intermedial relationship between performer and media, the projection mapped character. Examining the enactment from an intermedial perspective, the relationships between performer, media and camera can be unpacked with reference to the triadic relationship presented in section 2.1, shown again below in

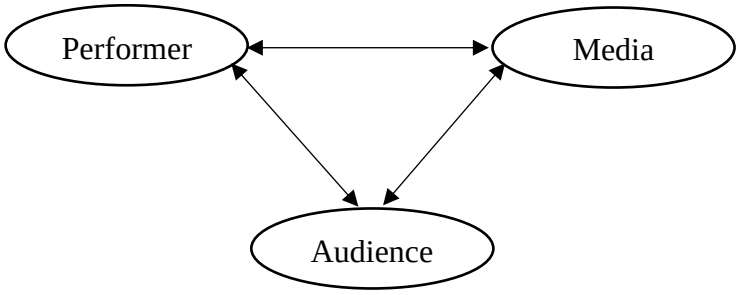

Figure 29: Intermedial Relations.

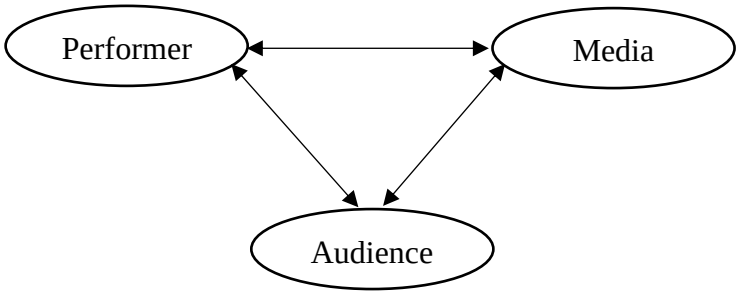

Figure 29: Intermedial Relations

However it can be argued that the video camera located in the audience witnessing the virtually embodied performer, takes on the role of a spectator. This is the case

[37] {1} refers to blog entry number 1 on the kinectic.net research blog.

with live solo performances before a video camera, where the performer is aware of, and performs to the camera as if the camera were the spectator.

When performing using the system, I was unaware of facing a camera, the HMD conveying a viewpoint of the projection mapped character on my body from the location of a spectator in the audience.

The experience can be described as witnessing ones virtual embodiment as if observed at a distance. I performed in response to witnessing my live virtual embodiment, rather than to the camera as spectator; I was the spectator of my performance. Figure 30: System Intermedial Relations below, diagrammatically illustrates the intermedial relationships between the performer, the media and the 'spectator camera'.

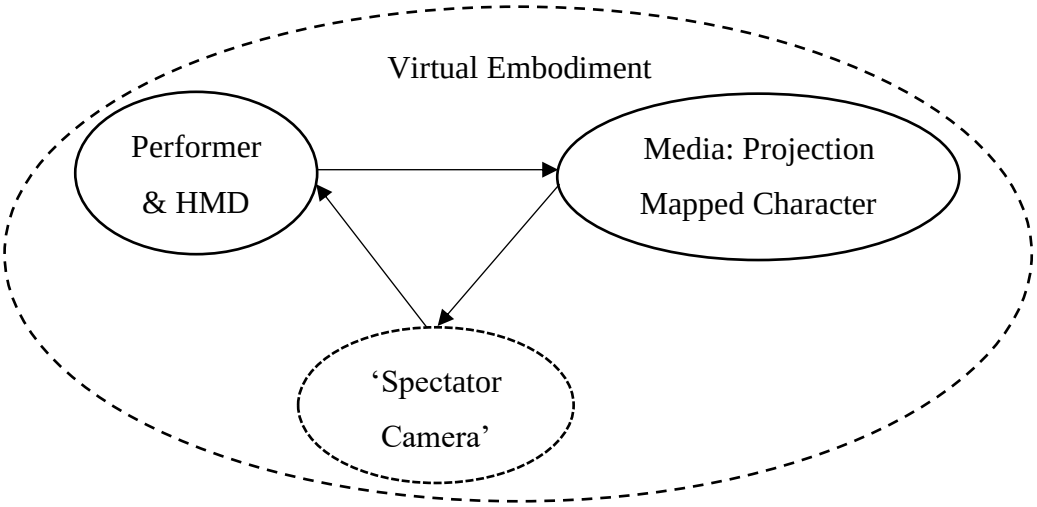

Figure 30: System Intermedial Relations

The dotted ellipse enclosing performer, media and 'spectator camera' signifies the virtual embodiment of the performer through witnessing the projection mapping of the virtual character onto their body via the HMD. The 'spectator' camera is in a dotted ellipse, signifying its invisibility to the performer wearing the HMD. The arrowed lines indicate directions of interaction, the performer interacting in response to the projection mapped character displayed in the HMD from the 'spectator

camera', and the projection mapped character interacting in response to the movements of the performer.

This enactment examines virtual embodiment from my viewpoint as the performer and practitioner. Subsequent enactments include my commentary as a spectator witnessing other performers, and in the Evaluation Workshops, commentary from participants who took on dual roles as both spectator and performer.

An image from the video illustrating the anime aesthetic of the projected character is shown below, Figure 31: MikuMorphia body projection. The portrayed image is the view the performer witnesses through the HMD of the live feed from the video camera.

Figure 31: MikuMorphia body projection

The witnessing of the video projection on my body through video feedback via the HMD, and the responsiveness of the character to my movements created a sense of embodiment (SoE).

As described in section 2.3 of the theoretical framework, the three qualities associated with producing a sense of embodiment are a sense of self-location, a sense of agency and a sense of body ownership (Kilteni et al. 2012: 373).

These qualities were relayed to me through the HMD where I could witness agency in that the virtual character moved as I did, the HMD presented a view of my body giving a sense of self-location, and the sense of body ownership resulted from the witnessing of the congruency between my body movements with those of the virtual character.

In my experience of the enactment, I was aware of the virtual body as 'other' – a female anime character. The 'otherness' was enhanced by the unfamiliar second-person perspective resulting in the witnessing of my virtual embodiment at a distance, as an observer.

This sense of embodiment resulted in my performative behaviour being influenced by the aesthetic and dynamic qualities of the virtual character. For example, the long hair responded to body movements, thereby encouraging performative behaviour that would cause the hair to flow in a dynamic manner. Section 2.2.1 notes that the plausibility illusion can be enhanced through physics simulations, the simulated long hair of the anime character being an example, in response to my body movements it appeared to behave like real hair, it was a plausible illusion.

This is illustrated in the three images shown in Figure 32: *MikuMorphia* body movements. The images are screenshots captured from the video documentation of the enactment, viewable on the research blog {1}.

Figure 32: *MikuMorphia* body movements

On the blog entry I describe the experience of bringing the figure to life and inhabiting the female character as ‘uncanny’, the character appearing life-like whilst at the same having the appearance of an artificial doll-like figure.

The experience was akin to possessing another body, albeit a doll-like one, whilst also being possessed by its appearance and behaviour. The experience was uncanny in that there was a blurring between the awareness of my own living body and the witnessing of the virtual body of the anime character appearing as if alive, being imbued with my liveliness, as if possessed by my living body.

The blurring between the living and inanimate marries with the definition of the uncanny by Jentsch:

> Doubt as to whether an apparently living being really is animate and, conversely, doubt as to whether a lifeless object may not in fact be animate (Jentsch 1906: 8)

The experience of the uncanny may also be connected to the sense of body ownership being challenged; cognitively in terms of body awareness, the presented image of the other body appearing to move in response to my movements resulted in a tension between the familiar mental image of my body and that of the presented female avatar, thereby invoking a sense of the uncanny, "the familiar made strange" (Royle 2003: 1).

In the design of computer graphic renderings of human characters and humanoid robots, the uncanny has negative connotations, the film or robot creating a sense of unease in its audience, appearing as something in-between alive and dead.

This in-between place is known as 'the uncanny valley', a term coined by robotics professor Masahiro Mori (Mori 1970). When designing human-like robots and virtual characters the uncanny valley is to be avoided, otherwise the affinity between the artefact and its audience is compromised (Tinwell & Grimshaw 2009).

The advances of technology enable more realistic and human-like virtual characters to be created and as a result they run the risk of falling into the uncanny valley (Tinwell et al 2011). Rather than viewing the manifestation of the uncanny as problematic and to be avoided, the uncanny was seen as a rich area for creative exploration.

In order to investigate the manifestation of the uncanny further, a requirement of the subsequent research platform was that it should be able to render more realistic human-like figures than the restrictive anime aesthetic inherent in the MikuMiku Dance software.

With its ability to import externally designed characters, including human-like figures of varying degrees of realism, the Unity game engine presented a more flexible and capable alternative.

Unity enables characters, sets and props to be imported into a scene creating a greater flexibility in aesthetic design than the inherent constraints of the anime aesthetic of the MikuMiku Dance software. In addition, Unity also supports the implementation of features associated with gaming whereby objects in a scene can be imbued with scripts that enable them to interact with their environment.

The simulation of physical properties including friction, weight and gravity can be added to game objects so that they might realistically fall to the ground or bounce off surfaces. It was noted in section 2.2.1 of the theoretical framework that computational physics simulations can be used to enhance the Plausibility Illusion (Psi). The enhancing of Psi through the simulation of physics is exploited in the evaluation of the performative interaction mode of participation, described later in section 5.9.2

Additional Kinect scripting assets enable unencumbered interaction, whereby scenes can be created that respond to voice or gesture commands, features utilised later in the investigation of the performative interaction mode of navigation, described in section 5.9.1.

Given the above features and benefits, Unity was selected as the platform on which to carry out subsequent research.

5.5 *iMorphia*

The Unity based research platform commenced development in January 2014. The research blog documents an early evaluation of imported ready-made characters {2}, whilst the blog entry {3} presents an overview of two character design programs, Daz3D Studio and MakeHuman. The two character design programs enable the creation of semi-realistic human-like characters which can then be imported into Unity as game assets.

MakeHuman, an Open Source platform enables a wide range of human life-like figures to be created, with the ability to shape and mould the figure using sliders to control skin tones, gender, musculature and age.[38] The software is very flexible but limited in the provision of clothing. However, items of clothing can be imported into the software, either designed by the MakeHuman community, or with the appropriate design skills, created using Blender, an Open Source 3D design program.[39]

Daz3D Studio is a commercial package, which is free to download and includes a male and female character and a few items of clothing. A wide range of additional characters, body morphing tools and clothing assets can then be purchased and downloaded from the Daz3D Studio store.[40]

I named the Unity based platform *iMorphia* - shorthand for a system which enables the morphing of a performer into a virtual character able to interact with its virtual environment and other virtually embodied performers. The 'i' stood for the performer witnessing the transformed self and able to interact with the virtual scene through their embodiment as a virtual character.

[38] http://www.makehuman.org/
[39] https://www.blender.org/
[40] https://www.daz3d.com

iMorphia was used as the research and development platform throughout the practice-based research and proved capable of supporting the many different research questions and associated enactments the research raised. Examples include: the impact of character visualisations on performance, the evaluation of different forms of interaction with the virtual set and the implementation of alternative performer perspectives using the Oculus Rift Virtual Reality headset.

5.6 Early Trials

After establishing *iMorphia* as a suitable performative platform for the research, in February 2016 I began to trial the system with colleagues and invited performers, documenting the results on the research blog {4, 6}.

The early trials explored the manifestation and effect of virtual embodiment on participants, described in section 2.3 of the theoretical framework. Participants were witnessed by myself as a solitary spectator rather than in front of an audience.

I was particularly interested in how the conveying of the sense of embodiment (SoE) to the participants via the HMD might impact on their performative behaviour.

Observations were made from watching videos of the performers in different characters, conversations with the participants and from listening to remarks made on the audio track of the video. The observations resulted in the identification of three potential directions for the research, summarised below with associated commentary from the performers (in italics).

5.6.1 Visual Appearance

Changing the appearance of the projected character impacted on how a participant performed, particularly when changing gender.

One female participant found becoming the male surfer character uncomfortable, commenting, *this isn't someone I would want to talk to; I have nothing in common with them.* Another female also reacted negatively, finding performing as the male character problematic, commenting, *I don't feel like me and him are one and the same*. One female participant clearly enjoyed being the male character, play acting and commenting, *look - I'm a really cool guy*. From the video recordings, male participants generally appeared uncomfortable in the female character, but were not forthcoming with any explanatory comments. Although the sample size was small, the evidence suggests that the visual appearance of the character impacted on performative behaviour and warranted further study.

The responses given by the participants who felt uncomfortable relating to the presented virtual body indicate that the sense of body ownership is being challenged because of dissimilarity between the participant's biological body and the presented virtual body. Kilteni suggesting a similarity between the real and the virtual body maximises the sense of body ownership.

> By maximizing the morphological similarity between one's biological body and the virtual one, top-down influences favour the perception of ownership of the virtual body. (Kilteni et al. 2012: 383)

The comment *I don't feel like me and him are one and the same* clearly expressing this dissonance between the known biological body and the perceived virtual body.

Though a fascinating area, I recognised that to implement a research study on the effect of differing body representations on the sense of body ownership would require a significant in-depth study involving many participants and the creation of multiple representations of virtual bodies, and the appropriate skillsets for analysing the resultant data. Such a research study was therefore deemed out of remit, though recognised as a potential area for further research, especially in relationship to gender and identity, described in section 6.2.2.4.

5.6.2 The Uncanny

The manifestation of the uncanny appears to relate to the motion of the character.

A female participant described the female bikini character as uncanny because of the seamlessness of its movements. This character differed from the other characters having been generated by the MakeHuman software. The software produces a more realistic rendering of the human form and an armature with more joints than those generated by Daz3D Studio, factors contributing to a higher degree of visual realism and more realistic movement when embodied by a participant.

The dynamics of character motion is regarded as an important factor in connection with uncanniness, and if incorrectly designed, "motion could exacerbate an uncanny situation already existing in form" (Pollick 2009: 73). This suggests that both the immediate visual appearance and the dynamics of how a character moves are contributing factors in the manifestation of the uncanny.

In section 2.3 of the theoretical framework, a sense of body ownership is noted to be conveyed through the perceived correlation between the animation of a virtual body and the movement of the participant, the correlation is "visuo-proprioceptive" (Kilteni et al. 2012: 383).

The literature suggests that we are sensitive to gestural movements and facial expressions through the *Action Perception System* (APS) of the brain and that this can help explain the 'uncanny valley' phenomenon (Saygin et al. 2011). In a similar manner to the manifestation of the uncanny through close, but not quite realistic visual appearance of humanoid figures, movements that appear almost human but not quite, then fall into the uncanny valley (Tinwell et al. 2011).

5.6.3 Glitches

Participants unused to the limitations of the system pushed its capabilities by moving too quickly or in ways the system could not track.

A new observation was made as a result of participants pushing the limits of the system. During my solo enactments I was careful to move in ways that would ensure the system functioned correctly.

These movements resulted in 'glitches' where the tracking would fail and produce distorted characters or the sudden jumping of limbs. On discovering these effects, participants would play with the system and try to encourage further glitching.

The resultant glitching challenges the conveying of a sense of body ownership to the performer, the perceived correlation between the movements of the projected virtual body and the movements of the performer break down. Despite this, participants were amused by the surprising body and movement distortions of the virtual body the glitching produced and would try and further exploit this breakdown of control.

The observations informed a more extensive study of the glitching effect in the evaluation workshops, described in section 5.8.4.

The early trials confirmed my observation made in the solo enactment *MikuMorphia* that the visual appearance of the projected virtual character affects performative behaviour.

The manifestation of the uncanny was also a reported outcome of the *iMorphia* system. My understanding of the uncanny however was enriched by the observation that the manifestation of the uncanny was a result of the dynamics of the virtual character and not just its visual appearance. If a further investigation were to be carried out on the factors that are associated with the manifestation of the uncanny, it would need to examine the underlying influences of dynamics and visual appearance.

The theme of the uncanny occurs again in the later user studies and is described in section 5.8.3. The manifestation and creative exploitation of the uncanny is regarded as a rich area for further research, but with the focus on virtual embodiment and performative interaction it was recognised that further research on the uncanny would be out of remit. It is therefore identified in section 6.2.2.5 as an area for further research.

The exploitation of glitching was as an unexpected discovery. When trialling the system in order that I obtained the results I was aiming for – a strong coherence between the projection mapping of the virtual character and my body, I ensured I did not challenge the tracking ability of the Kinect by moving too quickly or in unusual ways. Having other participants not follow the methodology I had adopted resulted in the new discovery. In terms of my own practice this recognition encouraged the idea of sharing my work with an audience of new participants who had no prior knowledge or expectations of how the *iMorphia* system might work.

The performance and games workshop described in the next section provided such an audience. The workshop investigates the potential of combining motion capture with *iMorphia* in the development of a prototype participatory game, where the glitching effect observed in this study is again used creatively by participants.

5.7 Performance and Games Workshop

In March 2014 I was invited to participate in a Performance and Games Workshop at Lincoln University. The workshop offered a platform to share the research and gain feedback from a community of researchers practising in performance and computer gaming. As noted previously, the workshop enabled the trialling of the system on a new group of participants who had not experienced the *iMorphia* system. In addition, a focus group provided the opportunity to collaboratively develop *iMorphia* into a prototype participatory game.

I joined the Interfaces for Performance group where we had a lively group discussion on notions of interface, HCI and 'Human Human Interfaces' with the idea of creating challenging, embarrassing and awkward interactive acts and interfaces. I worked with artist/performer/dancer Ruth Gibson of Igloo exploring the use of motion capture as a tool for improvised performance.

Playing on the idea of awkwardness, we created a prototype game where two or more people would record a short awkward, challenging or embarrassing performance for other players to try and copy or improvise around. One player would record a short sequence of movement using a motion capture tool. The sequence was then played back through *iMorphia* and the other players would then try and copy that movement. We demonstrated the game to the group where it was warmly received with much laughter as players attempted to copy the pre-recorded motion capture sequence of a previous player. As the game progressed, players would purposely try and create unusual and difficult postures and movements for the other players to try and copy.

In the recording process it was noted that distorted body movements produced by Kinect tracking errors were used creatively by the performer. Rather than attempting to correct the recording, the performer regarded the distorted movements as a creative outcome. The creative exploitation of tracking errors was previously noted in section 5.6.3 and is further explored in a subsequent evaluation workshop, described in section 5.8.4.

In the discussion after the demonstration it was suggested that the prototype resembled a motion capture version of the game 'Exquisite Corpse', leading to discussions of how it could be developed into a game with scoring and also find application in serious games such as dance training, sports exercise and Tai-chi.

In order to develop *iMorphia* for serious gaming applications, a convolution like algorithm would be used to generate a 'coherence value' indicating the closeness of the performer's movements to the virtual character which would be used to give real-time user feedback or generate a score. Generating real-time visual feedback of coherence would enable a performer to learn to copy and move in time with the movements of the virtual character.

The notion of coherence adds another dimension to a performer using *iMorphia* – rather than a performer being influenced purely by the visual appearance of the virtual character; the performer is influenced by the underlying physical and time-based dynamics of the virtual character. Instead of the performer controlling the character where the virtual character directly responds to the movements of the performer, this alternative mode suggests a game-like or training mode, with the virtual character controlling the movements of the performer. In this mode, rewards might be generated according to the coherence between performer and character. For example, if the participant correctly followed the slow movements of an old man, this might then lead to the unfolding of new scenarios. The development of coherence feedback and character dynamics are identified as areas for further research in section 6.2.2.3.

This notion of coherence relates to the conveying of the sense of embodiment, specifically the sense of body ownership resulting from visuo-proprioceptive coherence produced through the synchronous correlation of body movement and the animation of the virtual body (Kilteni et al. 2012: 383).

In the subsequent user studies, feedback from participants is used to describe the effects on the sense of body ownership when visuo-proprioceptive coherence either lags or breaks down through glitching.

The results generated by the workshop suggest that *iMorphia* could operate in two modes:

i) Being ‘possessed’ by a virtual character - where the participant follows its movements.

ii) The participant ‘possesses’ the virtual character - where it follows the movements of the participant.

In terms of my own practice, the workshop generated new application ideas for the development of *iMorphia* as a game or training system, ideas that would not have arisen through solo enactments.

Rather than having participants simply trial *iMorphia*, the focus group acted as a collaborative design process, resulting in ideas for the development of *iMorphia* beyond its original concept as a system for the transformation of performers through the projection of dynamic projection mapped characters.

The observations resulting from the workshop concerning ‘possession’ and the earlier identification of the impact of visual appearance on performative behaviour informed the design of the evaluation workshops, described in the next section.

5.8 Evaluation Workshops

In order to evaluate *iMorphia* in a more rigorous manner, a workshop was designed with each participant undergoing the same *iMorphia* enactment. Rather than attempting to create a range of characters that would focus the research too much on visual appearance and create too many options, the character range was reduced to two stock characters from Daz3D Studio, a female and a male and a more realistic female figure generated using MakeHuman, see Figure 33, below.

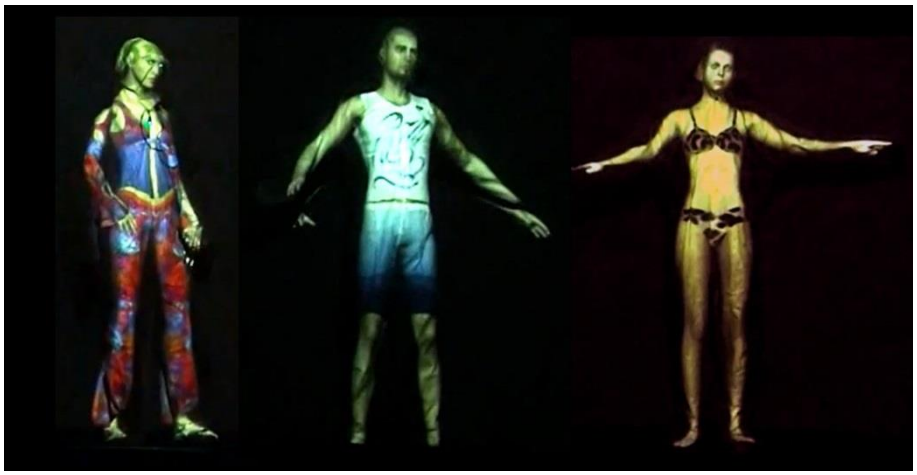

Figure 33: Projected Characters, Daz3D Studio female and male, MakeHuman female.

Using the three virtual characters, two exercises were designed for all the participants to experience. In the first exercise the participant controlled the movements of the virtual character, whilst in the second exercise, 'the following exercise', the participant attempted to follow the repeated movements of a virtual character which had been previously recorded as a motion capture sequence.

The idea of the following exercise emerged from the Performance and Games Workshop, described previously in section 5.7.

An ethics application was approved for the workshop and a webpage created providing details of the event. The workshop was announced through social media, contacts and email lists. The workshop attracted twenty responses of which fifteen

participants attended four sessions. Feedback from a survey of the participants indicated interests in theatre, performance, gaming and digital technology.

The fifteen participants were comprised of eleven males and four females: four research students (3 male, 1 female), five academic staff (4 male, 1 female) and six practising performers (4 male, 2 female).

The enactments carried out by the workshop participants were documented on video and audio recordings taken of the discussions conducted after each session. A short video presenting selected enactments can be viewed on the research blog {8}.

The following sections describe observations made during the workshop alongside relevant commentary (in italics), from the transcripts of the video recordings of enactments and audio recordings of discussions, included in

Appendix 1: Workshop Transcripts.

The observations are contextualised and analysed in relation to the theoretical framework concerning the experience of virtual embodiment from the perspective of a performer and when not performing, the witnessing of another performer's virtual embodiment. The participant being able to perform and witness others performing enables the contrasting of observations between the performer experience and the witnessing of virtual embodiment. The next section, Performing and Watching, presents an analysis of the reported observations alongside my own commentary.

5.8.1 Performing and Watching

In the analysis of this enactment, the tripartite relationships between media, performer and audience come into play. I refer to the diagram of intermedial relations between the performer, the media and the 'spectator camera', introduced earlier in the account of *MikuMorphia*, section 5.4. The diagram of intermedial relations is modified by adding the role of audience alongside the 'spectator' camera', illustrated below in Figure 34.

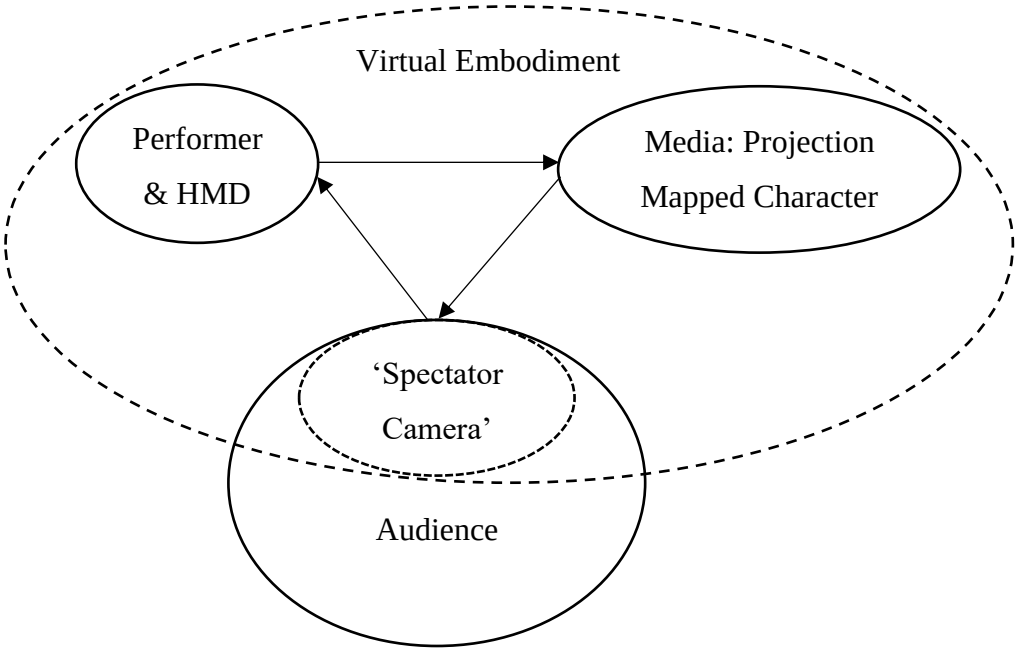

Figure 34: Intermedial Relations – Performer, Audience and Virtual Embodiment

The performer experiences their virtual embodiment through the HMD. With reference to the theoretical framework, the three qualities associated with conveying a sense of embodiment are, the sense of self-location, the sense of agency and the sense of body ownership (Kilteni et al. 2012: 373). These qualities are referenced in the analysis of the accounts of the performer experience. The experience as a performer is contrasted with the witnessing of another performer's embodiment from the perspective of a spectator in the audience.

In the discussions, participants reported they felt a stronger emotional response experiencing their virtual embodiment as a performer than when watching the virtual embodiment of another performer from the perspective of the audience.

a. *Audience perspective is intellectual; stepping into it becomes an emotional response.*
b. *It's different being inside it from watching it.*
c. *Watching other people doing it, as a performer it is different.*
d. *My self-conscious went completely out the window.*
e. *Took you into another space, absolutely, an out of the body experience.*
f. *I did not care about all the things when I was in suit, it was not about trying to do well or match up, it became something else.*

From these comments it can be inferred that when performing, participants experienced a sense of embodiment, specifically the sense of body ownership and the sense of self-location. Comments *d* and *e* suggest that the sense of self-location is being influenced by the presentation of a second-person perspective to the performer. According to the literature presented in section 2.3.3, altering the perspective from a first-person perspective impacts on the sense of self-location, and echoing comment *d*, can induce " an out of the body experience" (Cleland 2010: 85).

In the recorded videos of the performers and in the discussions afterwards, performers expressed differing feelings when in virtual character:

g. *The content effects the way I feel and want to behave.*
h. *I feel quite powerful, I like this.*
i. *You felt naked, aware of being wrongly gendered – self-conscious.*
j. *I feel more sensual, the body shape, what she is wearing.*
k. *I felt more vulnerable as a female character.*
l. *I felt very sensual sexy in my body as a female.*
m. *I felt vulnerable.*
n. *How different it makes you feel.*

The comments all express how the experience of virtual embodiment made the performer feel. The comments (*g* - *n*) suggest that performing as a virtual character has a more emotional effect than watching the projection as an audience member (*a* – *f*), which was regarded as a more objective and intellectual position. The comments expressing how the performer felt (*g* – *n*) appear to be made in response to a sense of body ownership, comment *i* highlighting uncomfortableness as a result of a disparity between the biological body and the appearance of the virtual body. Kilteni suggesting that a similarity of appearance between the real and the virtual body maximises the sense of body ownership (Kilteni et al. 2012: 383).

Despite the potential reduction of a sense of body ownership as a result of the appearance of the virtual body, the majority of performers role played, taking on stances and moving the virtual body in a playful manner. The literature suggests that a sense of body ownership is also conveyed through the synchronous correlation of body movement and the animation of the virtual body (Kilteni et al. 2012: 383). The congruence of the virtual body with the body of the performer and their sense of agency in being able to control the virtual body represent other factors including visual appearance in conveying a sense of body ownership.

When there is a conflict between the visual appearance of the virtual body and the body of the performer, for instance when appearing in opposite gender, it is suggested that the sense of body ownership through congruency of movement and agency is sufficiently strong enough that it overrides the lack of similarity between the visual appearance of the virtual and the real body in the conveying of a sense of body ownership.

From my observations and the comments made by participants, most performers enjoyed role playing in opposite gender, whilst only a few expressed a feeling of discomfort. The difference of appearance between the virtual body and the body of the performer through gender transformation is further examined in section 5.8.2.

Though the audience and the performer share the same second-person perspective, the differing responses between watching and performing is due to the performer experiencing a sense of embodiment. The HMD conveys to the performer a sense of body ownership, the projected virtual body moving congruently with the performer's body, a sense of self location from viewing the virtual body as an observer, and a sense of agency with the virtual body moving in response to the performer's body.

In agreement with the participants, I also felt that viewing the projection as an audience member presented a greater degree of realism and three-dimensionality, whereas the view through the HMD appeared flatter and two-dimensional.

o. I like the fact that the projection takes on some of the 3D form.

p. The projections look more real from the outside than when you are inside.

Regarding comment *o*, *the projection takes on some of the 3D form*, is a result of projection mapping onto three-dimensional objects, which generates the appearance of a three-dimensional image even though the projected image is two-dimensional. This effect is utilised in the projection mapping work of Tony Oursler and Klaus Obermaier, illustrated in sections 4.2.1 and 4.2.8.

In line with my own view, the comments indicate that viewing the body projection from an audience perspective produces a greater degree of realism and three-dimensionality than the view presented in the HMD.

The presented view is from a single camera and not stereoscopic, thereby losing the conveying of three-dimensionality. In addition, the view is less realistic, being mediated through a video camera and the HMD, resulting in a loss of quality, fidelity and resolution when compared to directly witnessing the projection. Improving the mediated view presented to the performer is noted as an area of further research in System Development, section 6.2.1.

The next section further examines the sense of body ownership created as a result of the appearance of the virtual body.

5.8.2 Performative Behaviour

In this study, in line with previous observations (sections 5.4, 5.6.1) it was noted that the visual appearance of the projected virtual character influenced the performative behaviour of participants.

The visual appearance of the virtual body is one of the factors associated with conveying a sense of body ownership, the other being the congruency of movement between the body of the performer and the body of the virtual character. In addition to the sense of body ownership, the other qualities associated with conveying a sense of embodiment are a sense of agency and a sense of self-location.

As mentioned previously in section 5.8.1, the literature suggests that the sense of body ownership is affected by the visual appearance of the virtual body (Kilteni et al. 2012: 383). The literature also notes the impact of differing perspectives on subjectivity and the experience of the self (Cleland 2010: 85).

The research suggests that the sense of self-location and its relationship to the presented perspective to the performer is an important factor when considering how the sense of body ownership is influenced by the visual appearance of the virtual body and it subsequent impact on performative behaviour.

The use of a second-person perspective has a profound impact on the perception of the virtual embodiment in that it presents a different viewpoint from the everyday egocentric, first-person perspective of the world. The performer is no longer the observer but instead is observed, they witness their virtual embodiment at a distance.

In the account of the *MikuMorphia* enactment, I commented, *I was the spectator of my performance*; the statement encapsulates how I felt watching myself perform as a virtual embodied character, at a distance, as an outside observer, a spectator. The distant witnessing of the virtual embodiment is noted in the comments made by participants, where they liken the experience to looking in a mirror.

a. *That is very weird, I'm expecting it be like a mirror and it's not.*
b. *It's not the same as watching a screen – the only comparable experience is a mirror.*
c. *You are not looking in a mirror, it's still fine, feels strange – I feel like I have a very different body – is that a representation of me?*
d. *Second life is looking at the screen; this is different, it's looking at yourself.*

The analogy to a mirror is indicative of the distancing effect the performers felt in describing their response to the unusual and unfamiliar viewpoint of their virtual embodiment. Comment *d* supports the notion that the viewpoint is not like looking at a screen, but at oneself as an observer, *this is different, it's looking at yourself*.

The witnessing of the virtual embodiment from the perspective of an observer enables the performer to apprehend the visual appearance of their virtual body, as if looking in a mirror. At the same time performance is directed at the 'spectator camera' located in the audience, thereby supporting performing towards the audience.

The following comments from participants express how the visual appearance of the virtual body influenced their performative behaviour.

e. *My first thought was I want to dance – content effects the way I feel and want to behave.*
   (Male participant in female character wearing dance costume)
f. *I did not think the image would make a difference to the way you perform, hands on hip straight away.*
   (Male participant in female character wearing dance costume)
g. *Even though you know it's a projection it make you feel different in terms of adopting a posture.*
   (Female in male character)

The responses, *I want to dance, hands on hip, adopting a posture* all indicate the effect of visual appearance on the sense of body ownership and its resultant effect on performative behaviour.

Gender transformation appeared to consistently have an effect on all participants. Virtual embodiment in opposite gender polarised how participants felt, from positive expressions of enjoyment, freedom of expression and playfulness to more negative reactions of uncomfortableness, self-consciousness and embarrassment. Males were split between either feeling uncomfortable in female gender (*h, i, j*) or positively enjoying the transformation (*j, k, l*).

h. I feel a bit more responsible for her, you feel lascivious in female character.
i. I felt challenged when projected with a female character; I did not know how to behave.
j. I was very aware of how I looked, aware of being wrongly gendered – self-conscious.
k. I feel more sensual, the body shape, what she is wearing.
l. Being a female character was really good, it addresses how in the future people will be able to change their bodies from day to day.
m. (Laughs, poses) *I did not think the image would make a difference to the way you perform, hands on hip straight away*

In contrast nearly all the female participants expressed positive reactions appearing in male gender.

n. I wanted the bandy legs of a bloke. I couldn't get it do the bandy legs of a bloke.
o. When it was a man I wanted to jump around, typical male acrobatics.
p. I feel quite powerful, I like this.
q. Poses – it is interesting how it immediately makes you adopt a stance.
r. This chap swaggering down the street, bandy legged – I wanted to do that with that character.
s. (Playfully performs*) Oh oh ohh!*

The bikini figure tended to produce uncomfortableness in both males and females, with participants commenting on feeling naked, self-conscious and vulnerable.

a. *I was very aware of how I looked where I might touch it, you felt naked, aware of being wrongly gendered – self-conscious.*
   (Male participant)
b. *You can't cover up, there is no modesty to be had.*
   (Male participant)
c. *It's difficult not to feel kind of vulnerable because she's naked.*
   (Female participant)
d. *I felt more vulnerable as a female character – confronted by my own femininity, as a male character I was freer to move around.*
   (Female participant)
e. *I felt conscious about where I was putting my hand, it was like it was another person I did not want to touch.*
   (Female participant)

Participants made a significant number of comments on how the visual appearance of the virtual bodies conjured up stereotypes.

a. *You change how you move and how you behave. You react against that, conscious of how you react to stereotypes.*
   (Male participant)
b. *The characters drew on certain stereotypes - probably put me off. The characters belong in a fantasy world, a male fantasy world.*
   (Female participant)
c. *Getting away from traditional stereotypes – an interesting experience – when do you ever get to do that?*
   (Male participant)
d. *Stepping into it becomes an emotional response, a feeling of responsibility, not want to behave in a gender stereotypical way*
   (Male participant)

e. *Stereotype how males and females behave – license to behave like this, getting away from traditional stereotypes.*
(Female participant)

f. *How can I ridicule the stereotype I have in my mind, how can I push against it, how can I have fun with it?*
(Male participant)

g. *How does it feel to be that person – the tiniest insight of what it feels like to have a body like that to stand or behave in a cultural stereotype?*
(Male participant)

Through the conveying of a sense of body ownership, some participants expressed responsibility towards the virtual body (comments *f* and *g*), whilst others took pleasure from or consciously reacted against behaving stereotypically (comments *a*, *c*, *e* and *f*).

> A virtual body with characteristics associated with certain social stereotypes but different from those of the biological body (e.g., with respect to race, gender, or age), could result in the participant engaging in behaviours associated with those stereotypes.
> (Kilteni et al. 2012: 383)

Evidence of participants playfully engaging with behaviour associated with stereotypes can be seen from the comments cited above (*hands on hip, adopting a posture*) and in the video documentation on the research blog {8}.

The results of the study suggest that a sense of body ownership involving the visual appearance and congruency of the virtual body with the body of performer and the sense of self-location conveyed through a second-person perspective via the HMD influences performative behaviour.

Further research on the relationships between identity, gender, stereotypes and visual appearance from an experiential perspective through virtual embodiment is outlined as an area for further research in Gender and Identity, section 6.2.2.4.

The next section addresses the agency of the performer and further explores the sense of body ownership involved in visuo-proprioceptive coherence between the body of the performer and the virtual body.

5.8.3 Control and Possession

In the previous exercise examining performative behaviour, participants controlled the virtual character. Participants commented that at times they were unsure as to whether they were actually controlling the virtual body.

a. *Mixture of feeling I was controlling, it was controlling me, being controlled by the lag – toing and froing - who is following who.*
b. *Even though you possess it, it possesses you.*
c. *I could not tell whether I was making the character move or it was making me move.*
d. *I seem to follow her; I don't know who is following who.*
e. *There is a lag, I want to adjust to it, to follow the avatar rather than control it.*

One possible explanation for the confusion regarding the performer's agency in controlling the virtual character is system lag, resulting in the projected virtual limbs lagging behind the limbs of the performer, so the performer either waits for the projected limb to catch up and be congruent with theirs, or the projected limb continuously lags behind whilst the performer attempts to compensate by moving their limbs faster or slowing down. The literature suggesting that the lag negatively impacts agency and subsequently the sense of embodiment.

> Several studies have shown that discrepancies between the visual feedback of the action and the actual movement negatively affect the feeling of agency. (Kilteni et al. 2012: 377).

Another problem the research revealed in conveying a sense of embodiment is associated with a sense of self-location. In the research, the performer views the projection mapping of the virtual body onto their body via the HMD from the second-person perspective of a video camera located in the audience.

Comments from participants indicate awareness that the sense of self-location is not the same as when looking in a mirror.

a. *The mirroring thing is quite.. you are not looking in a mirror, it's still fine, feels strange.*
b. *I'm expecting it be like a mirror and it's not. I lost track of which hand is mine then.*
c. *It's a mirror image, actually it is very confusing.*
d. *You are not looking in a mirror.*

The second-person image presented to the participant via the HMD is from a camera located in the audience and the confusion experienced by participants is a result of losing the familiar horizontal inversion between left and right experienced when looking in a mirror.

The confusion between left and right is exacerbated in the 'following exercise' where the participant attempts to follow the movements of a virtual character performing a looped sequence of pre-recorded movements, previously captured by motion capture. The following exercise represents a version of the prototype game described earlier in the Performance and Games Workshop, section 5.7.
The object of the following exercise is that the participant has to move their limbs in time with the projected limbs of the virtual character so that from the perspective presented in the HMD, they appear to be congruent.

The comments indicate how difficult this was for the participants to achieve.

e. *In the copying exercise - the mirror issue is more apparent. It's hard to tell which arm is which.*
f. *Left and right it's a nightmare!*
g. *Left right mirroring thing, difficult, making your brain follow.*
h. *You lose track of which hand is which.*
i. *It's hard to tell which arm is which.*

Participant feedback indicates that although the experience of virtual embodiment appears similar to looking at one's body reflected in a mirror, the familiar left-right reversal produced by reflection in a mirror is missing, resulting in confusion between left and right limbs and subsequent problems with visuo-proprioceptive coordination.

Success in achieving the following exercise proved difficult in that participants were not aware of how well or how badly they were doing in following the movements of the virtual body. This is likely to be a result of the inability of being able to determine the difference between the location of the real limbs and the projected ones. Participants commented on using the shadow from the projection in order to help perceive the difference between the projection and the locations of their limbs.

a. *I am using the shadow to work out whether I am following, left and right it's a nightmare!*
b. *I think that I think that I am doing it far better than I am, I am fooled into thinking they are my arms but when I see the shadows…*
c. *Do you think you are copying movements well?*
   I think so, I don't know, hard to tell. I can only see shadows.

Presenting the performer with feedback relaying the coherence between the limbs of the performer and the virtual limbs has been described in the previous section 5.7 in the context of gaming. Coherence feedback would alleviate the problems participants experienced in determining how closely they were following the animated limbs in the following exercise.

This might be achieved by presenting the performer a visual overlay comparing the infrared image from the Kinect of the performer's body with that of the virtual character. The development of coherence feedback would enable *iMorphia* to be used in dance or martial arts training and is identified as a topic for further research in section 6.2.

It was noted earlier that body tracking lag impacts negatively on agency and the conveying of a sense of embodiment. Reducing body tracking latency in order to improve the sense of agency is identified as an area for future system development in section 6.2.1.

The confusion between left and right resulting from the sense of self-location being presented as a second-person perspective from a camera in the audience was found to be problematic when attempting the task of following the movements of the virtual body. Section 5.9.2 describes the results of an experiment altering the sense of self-location so that it is akin to looking in a mirror, where tasks associated with participatory performative interaction become easier to accomplish when the second-person perspective presented via the HMD is horizontally mirrored.

5.8.4 Glitches and Seams

Due to a lack of familiarity with the system participants pushed the limits of the tracking ability of the Kinect, by moving too fast, or turning round, or moving in ways the tracking system could not follow such as by bending or squatting down.

These movements resulted in glitches where the projected figure would contort or distort in a macabre fashion. Rather than viewing the glitches as errors or problems, participants would then play with the glitches, causing them to repeat and creatively perform with the distortions the tracking errors produced.

1. *It is fun doing things you know you are not supposed to do, breaking the character.*
2. *I wanted to test it to see what it can do by moving really quickly.*
3. *Performer rotates arms fast – audience laughter.*
   Audience comment: We all made the assumption we would have to be slow.
4. *He can't bend – oh bless!* (Laughter). *He looks like he has been in an accident.*

As the designer of the system, tracking errors represented a bug, something I wanted to remove from the system. The bug however was used creatively by performers who embraced the twisted figures and would move in ways to increase the tracking errors, resulting in macabre distorted body projections.

In the design of ubiquitous computing systems, system errors can occur from communication 'drop-outs' and are associated with the notion of 'seams'. The design of systems able to cope with errors is known as 'seamful design'.

> Seamful designs go beyond mere accommodation of seams; they let users find ways to take advantage of seams and appropriate them for their own ends.
> (Chalmers et al. 2004: 8)

The tracking errors produced by the Kinect failing to recognise body movements corresponds to the notions of seams, places where communication failures result in system glitches that were creatively exploited by participants. In the Performance and Games Workshop described in section 5.7, players creatively exploited the tracking errors so as to produce distorted motions that would challenge other players in their attempts to copy them. Seamful design was not deliberately engineered, but instead participants discovered and then creatively appropriated the emergent seams. Further examples of participants exploring seams as a result of glitches can be seen in the videos documented on the research blog {21}.

The evaluation workshops provided a rich source of feedback and observations on the differences between performing and watching, underlining the more emotional affect when being a performer rather than watching the projection mapping on another performer as a spectator.

Participants reported problems in controlling the virtual character due to mirroring issues and not knowing where their limbs were in relationship to the projection, whilst again creatively explored tracking errors.

The theoretical framework proved to be a useful and informative lens through which to examine the sense of embodiment in relationship to the findings of the study and in addressing the relationships and impact of its three subcomponents, the sense of self-location, sense of agency and sense of body ownership.

The observations generated in the study confirmed earlier observations on the impact of visual appearance of the virtual character on performative behaviour, whilst also providing additional evidence on the effectiveness of the system in conveying a sense of embodiment to the performer.

The sharing of the work with other practitioners proved to be inspirational and informed my practice. One of the participants described the exercise as foolish:

This is a foolish exercise! Giving people permission – the fool is half in the world half outside the world. Everything gets reversed, it's a big tradition.

The tradition mentioned is the 'Festival of Fools'; the idea of such a festival inspired the creation of a later enactment, a public 'Festival of Fools' event, documented on the research blog {22}. The event was an artistic exercise and due to its informal nature, interviewing of participants was not undertaken. However, I can report the effectiveness of the *iMorphia* system and the fun and pleasure people experienced play-acting and being foolish when transformed in a range of differing virtual bodies. A video documenting the event substantiates my observations and is included on the blog post {22}.

In summary, the evaluation workshops proved to be a useful and informative exercise in the evaluation of virtual embodiment and the theoretical framework a valuable tool in the analysis of the findings. The next section describes the evaluation of performative interaction, referring to the theoretical framework in the analysis of the findings and in the framing of the intermedial relationships between performer, media and audience.

5.9 Performative Interaction

Before presenting the enactments evaluating performative interaction, I refer to the theoretical framework presented earlier in Chapter 2 in order to frame the intermedial relationships between media, audience and performer.

Firstly, I discuss agency in relationship to performative interaction. On the augmented stage the performer has agency in being able to use their body to control the virtual character which in turn has agency in that it can interact with the virtual scenography. The performer interacts with the virtual scenography through the agency of their virtual body, resulting in 'mediated agency', illustrated diagrammatically below in Figure 35.

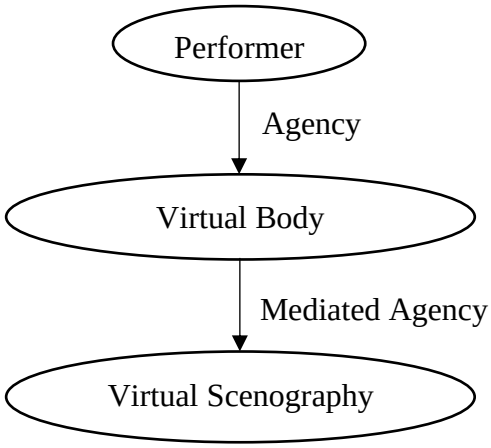

Figure 35: Mediated Agency

However, from the perspective of the audience, the intermedial relations between performer and media are complicated through the perceived merging of the body of the performer with the projected virtual body, resulting in a collapse of distinction between media and performer. In addition, the performer interacts with the virtual scenography (media) through the medium of their virtual body, illustrated diagrammatically in Figure 36 below.

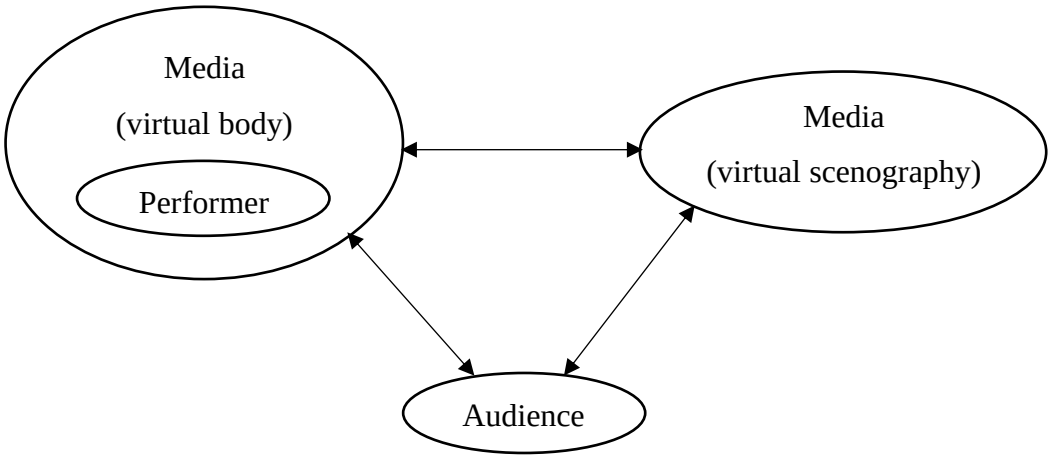

Figure 36: Intermedial Relations - Performative Interaction

From the perspective of the audience, performer interaction with the virtual body is 'magical' in that it is hidden, whilst the interaction of the virtual body with the virtual scenography is visible and 'expressive' (Reeves et al. 2005).

Via a video camera located in the audience, the HMD presents the performer with a sense of self-location from a second-person perspective, as with the audience, the performer witnesses their virtual embodiment from the perspective of an observer.

Performative interaction on the augmented stage is enacted through the virtual embodiment of the performer and evaluated using the categories of navigation and participation proposed by Dixon (2007: 563). Dixon presents his concepts of performative interaction as relationships between media and participants.

Navigation occurs where a participant controls the direction through the media content; this might be spatially as in a three-dimensional video game or as a series of discrete steps via hyperlinks on the internet.

Participation occurs where the participant engages with responsive media content, for instance when playing a video game and controlling the actions of virtual characters.

In the research, the concepts inform the investigation of performative interaction on the augmented stage, where, instead of interaction being an outcome of the agency of a participant, it is an outcome of the mediated agency of the performer's virtual embodiment.

The first form of performative interaction investigated on the augmented stage of *iMorphia* is navigation.

5.9.1 Navigation

In terms of my practice, the idea of navigation on the augmented stage originated from a previous workshop evaluating improvisation[41] in a comparative study between *PopUpPlay*[42] and *iMorphia.* The commentary I made on the research blog {14} describes how the performers expressed a desire to be able to enter the projected virtual scenography.

… to walk down the path of the projected forest and to be able to navigate the space more fully. We felt that the performer should become more like a shamanistic guide, able to break through the invisible walls of the virtual space, to open doors, to choose where they go, to perform the role of an improvisational storyteller, and to act as a guide for the watching audience.

The vision was that of a free open interactive space, the type of spaces present in modern gaming worlds, where players are free to explore where they go in large open environments.

The Unity game engine included a demonstration of 'Tropical Paradise', a large open gaming environment, which the player is able to explore, thereby providing a suitable base from which to develop the scripts necessary to evaluate the performative mode of navigation.

In order to evaluate navigation, I imported 'Tropical Paradise' a pre-existing three-dimensional world into *iMorphia* (see Figure 37 below) and created a number of interactive scripts that would enable navigation to be carried out by the performer in an unencumbered and expressive manner, using the body and the voice rather than a physical interface such as a mouse or joystick. Video documentation of the enactments are available on the research blog {15}.

[41] See Research Journey, section 6.4.
[42] Vear & McConnon 2017.

Figure 37: Tropical Paradise

The initial evaluations were carried out through three solo enactments. In the first enactment navigation was controlled using gesture and spatial location, the second, body orientation combined with gesture and voice, whilst with the third, voice and body orientation controlled the navigation with additional animation to enhance the illusion that the character was walking rather than floating through the environment.

The use of gesture to control the navigation proved problematic, it was actually very difficult to follow a path in the three-dimensional world, and gestures were sometimes incorrectly recognised or performed, resulting in navigational difficulties where a view gesture acted as a movement command or vice versa.

In the second enactment the gesture of ‘both hands out’ activated view control and body orientation controlled the view. This was far more successful than the previous version and the following of a path proved much easier.

Separating the movement control to voice activation (“forward”, “back”, “stop”) overcame the problem of gestural confusion; however, voice recognition delays resulted in overshooting when attempting to stop.

When witnessing the enactment from the second-person perspective presented in the HMD, the rotation of the avatar to face the direction of movement produced a greater sense of believability that the character was moving through a landscape; the subsequent addition of a walking animation enhanced the illusion further.

In the third enactment instead of the previous ‘arms out’ gesture which felt a little contrived, I added the voice command “look” to activate the change of view. Creating a responsive and effective performative interface to control navigation through body movements and voice proved extremely challenging as the video documentation on the blog testifies {15}.

A problem occurs when the virtual character is moving out of the scene towards the audience, the background recedes, but from the second-person perspective the performer cannot see where they are going, only where they have come from, which makes directional navigation impossible.

A solution to the problem is through presenting the performer with a first-person perspective and separating out the viewpoints of the performer and the audience. Section 6.2.2.1 identifies the implementation of multiple viewpoints as an area for further research.

In developing the navigation scripting for the three solo enactments, it was felt that the system was then robust enough to warrant inviting other participants to trial the system.

I invited two performers who had participated in previous enactments to trial the system in order that I might evaluate navigation with participants who were unfamiliar with the gestural and unencumbered interfaces I had developed.

A video of the enactment evaluating navigation is included on the research blog {19}. In the enactment the performer can look around by saying “look” then use their body orientation to rotate the viewpoint. Saying “forward” takes the viewpoint forward into the scene. Saying “backward” or “back” makes the scene retreat as the character appears to walk out of the scene towards the audience.

Control of the character’s direction was through body orientation. Saying “stop” halted the navigation, making the character stationary.

Location became a topic of conversation with both performers commenting on how landmarks became familiar after a short amount of time and how this memory added to their sense of being there.

Two versions of the scene were evaluated, one with the added animation of the character walking when moving, the other without the additional animation. Both performers confirmed that the additional animation made them feel more involved and virtually embodied within the scene.

The images below illustrate a performer navigating the virtual scenography, looking around, moving forward into the scene and moving out from the scene.

Figure 38, below, illustrates the performer using their body to rotate the viewpoint to look around the scene.

Figure 38: Navigation, looking around in a scene

Figure 39, below, illustrates how after saying the voice command “forward”, the performer can navigate moving forwards in the scene whilst at the same time controlling their direction through body orientation.

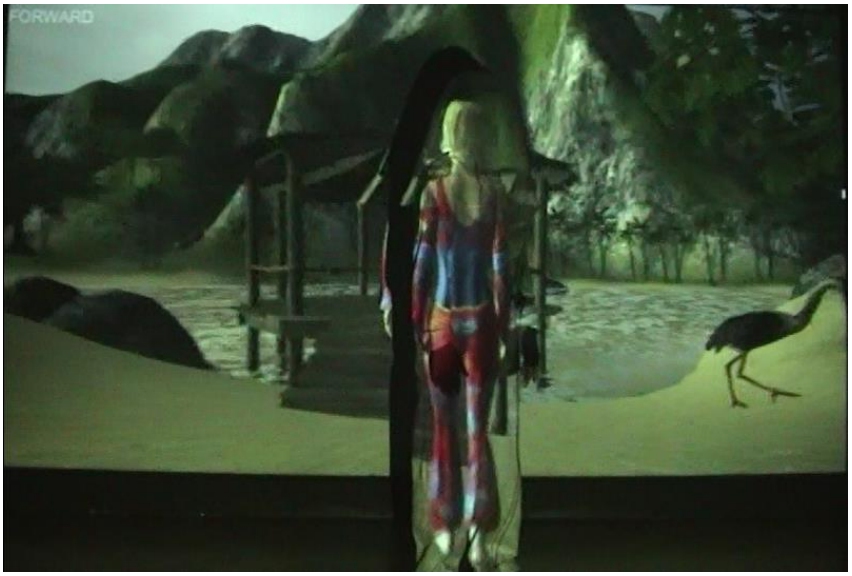

Figure 39: Navigation, moving forwards in the scene

Figure 40, below, illustrates the performer appearing to walk towards the audience with the scenery moving backwards behind them. Though visually effective to an audience, this aspect of navigation was impractical as the performer could only see where they had come from and not where they were going.

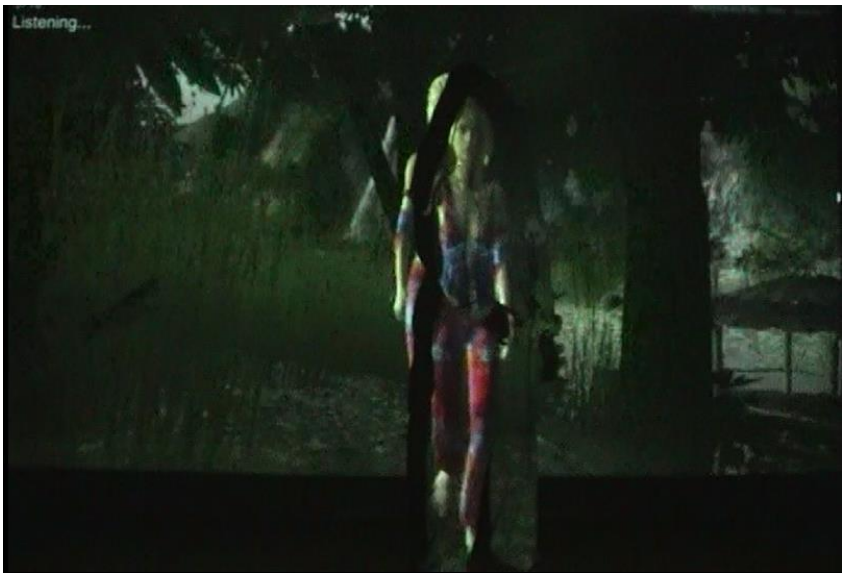

Figure 40: Navigation, moving backwards from the scene

The enactment with two performers revealed a number of issues apart from those I had identified in the solo enactments.

Performers tended to lose a sense of the direction they were physically facing during navigation. This is likely due to a combination of two factors: i) the performer's body has to rotate in order to steer in the virtual scene and ii) a lack of clear visual feedback on the direction the character's body is facing. When the virtual character moves through scenery such as undergrowth, visual feedback is interrupted during moments of occlusion between the virtual scenography and the virtual character in the rendering presented to the virtual camera. Presenting a first-person perspective to the performer would overcome these problems, a solution described at the end of this section.

The enactment also highlighted the challenge of realising navigation on the augmented stage with more than one performer. Group navigation is conceptually challenging, as it would probably make little performative sense; and technically challenging, as it would be difficult to realise requiring direction tracking on all performers and a mechanism for either producing an average from the direction data, or targeting one performer as the navigator.

A more straightforward option would be for one performer to act as the guide, deciding where to go, controlling the movement and direction through the virtual scenery.

The idea of a guide came arose from the suggestion by one of the participants, that *The Domain of Arnheim* by Edgar Allen Poe might be used as a basis for navigation, where a storyteller acts as a 'narrative guide' through an architectural landscape. The navigation of narrative space is identified as an area for further research in section 6.2.2.2.

This section presented some of the challenges in realising effective navigation through the mediated agency of the virtual embodied performer.

The main challenge to effective navigation arises from the use of a second-person perspective to present the sense of self-location to the performer. This is further complicated through attempting to provide the same perspective to the performer and to the audience. The performer always must be able to navigate to where they are heading in a virtual scene, whilst the audience may witness the performer navigating into, or out of a scene. When the sense of self-location is from a second-person perspective, the performer can only navigate into, and not out of a scene.

A major technical challenge in realising navigation on the augmented stage was the amount of time required to implement the Unity scripting and overcoming technical issues, the commentary below taken from the blog indicates the technical complexity involved in implementing the enactments {15}.

Realising the demonstrations took a surprising amount of work, with much time spent scripting and dealing with setbacks and pitfalls due to Unity crashes and compatibility issues between differing versions of assets and Unity. The Unity Kinect SDK and Kinect Extras assets proved invaluable in realising these demonstrations, whilst the Unity forums provided insight, support and help when working with quaternions, transforms, cameras, animations, game objects and the sharing of scripting variables.

It became clear that I could not afford to spend time perfecting the implementation of navigation, which I recognised as a non-trivial task and beyond the scope of what was possible given the time constraints of a PhD study. Instead, as the blog testifies {15}, the exercise of implementing navigation was for it to act as 'proof of concept'. The blog entry serves to evidence how practice based-research as a methodology can not only answer the posing of research questions but also to raise further questions and generate new lines of enquiry. The questions cited above providing stimulus for further research of navigation on an augmented stage (section 6.2.2.2).

The next section evaluates participation with virtual props and the efficacy of performative interaction when the sense of self-location is from a second-person perspective.

5.9.2 Participation

In terms of my practice, the blog {16} describes the creative motivations for implementing participation on the augmented stage.

I envisaged implementing a system that would enable performers to interact with virtual props imbued with real world physical characteristics. This would then give rise to a variety of interactive scenarios – a virtual character might for instance choose and place a hat on the head of the other virtual character, pick up and place a glass onto a shelf or table, drop the glass such that it breaks, or collaboratively create or knock down a construction of virtual boxes.

The following describes the evaluation of the performative interaction mode of participation in a virtual scene consisting of three props: a table, a chair and a book resting on the table, illustrated below in Figure 41: Scene with props.

Figure 41: Scene with props

Using the Unity game engine, the physics properties of ‘rigid objects’ with friction and gravity were applied to the props, and ‘colliders’ applied to the virtual character. The simulated properties of physics enable the virtual props to respond to the mediated agency of the performer through the actions of the virtually embodied character. The addition of physics simulations enhances the plausibility illusion for performer and audience, the virtual props behaving in a similar manner to real physical objects in that they fall over or drop to the floor in reaction to being pushed by the virtually embodied performer.

In order to evaluate participation in the scene, a task was invented of trying to knock the book off the table.

The first evaluation I carried out as a sole enactment, followed by an enactment with two performers who had participated in previous enactments.

I observed several problems in attempting to carry out the task of knocking the book off the table. The main problem I experienced was the difficulty in making my virtual hand come into contact with the book. An illustration of this task being accomplished is shown below in Figure 42 and a video of the enactment can be found on the research blog {18}.

Figure 42: Book being knocked off table

When viewing the enactment through the HMD, the sense of self-location from a second-person perspective resulted in my conventional sense of left and right appearing to be reversed, as unlike a similar second-person perspective presented in a mirror, there is no left-right reversal in the view from the camera. In addition, forward and backward also felt the wrong way round, in real life, from a first-person perspective, when I reach out, my hand recedes, whilst from a second-person perspective, when I reach out, my hand visibly becomes nearer, and vice versa.

This resulted in two perceptual issues, confusion between left and right and an inversion of forward and backwards movements. The left/right confusion is the more difficult to overcome due to our familiarity with looking at ourselves reflected in a mirror.

In order to try and overcome the confusion between left and right, I temporarily added a mirror to the video camera in order to create a mirror image of the second-person perspective presented in the HMD, illustrated in Figure 43: Mirror addition to video camera, below.

Figure 43: Mirror addition to video camera

The mirror-reversed image presented in the HMD enable the determination of left from right without any issues and as a result I was easily able to locate and interact with the virtual props. A more elegant solution to the mirror issue inherent in the second-person camera perspective presented to the performer would be mirror the video stream digitally.

Technically, the forward backward reversal is more problematic to overcome. However, after some practice I did become accommodated to the reversals resulting from the second-person perspective and learnt to move my body appropriately, distinguishing forwards from backwards motions.

Another discrepancy I observed was a mismatch between the location of the physical body and the virtual one. There appeared to a difference in scale, when physically moving in the 'real world' the virtual body did not move quite the same distance.

This problem I labelled as a 'colocation issue' – a mismatch between the physical location of the performer in the 'real world' and the location of the character in the virtual world (Maselli & Slater 2014: 4). Correcting the colocation issue might be addressed by an algorithm that would ensure a one-to-one mapping between the location of the character in the virtual world and the location of the performer in the real world.

The second enactment with two previous performers confirmed my observations: the mirror reversed view helped in determining left from right, both performers learnt to compensate with the inversion of forwards and backwards and experienced the same problem I had encountered in knowing where the virtual character's hand was in relationship to the performer's hand. Video documentation of the enactment with the two performers can be found on the research blog {19}.

One performer commented *it makes me realise how much I depend on touch*, underlining how important tactile feedback is when we reach for and grasp an object. Gloves that provide haptic feedback to the performer present a possible solution to the lack of tactile feedback when interacting with virtual props.[43]

The lack of depth perception inherent in the monoscopic visual feedback to the performer compounds the problems associated with colocation. The presentation of a stereoscopic perspective to the performer would provide depth perception and theoretically reduce the problems of colocation. The effect of depth perception on colocation is evaluated later in section 5.11, Visual Perspectives.

As an alternative to the more challenging task of knocking the book off the table I suggested a second task of simply kicking the furniture over. This was easily accomplished by both performers and prompted gestures and exclamations of satisfaction. Images captured from the video of the enactment {19} illustrating this task are shown below in Figure 44 and Figure 45.

Figure 44: Chair being kicked over

[43] Haptic gloves for use in VR are currently under development, for example the Kickstarter project VRgluv, https://www.vrgluv.com/

Figure 45: Table and chair turned over

The enactment demonstrated the feasibility of performative participation whilst highlighting issues concerning colocation and the challenges of depth reversal and mirroring issues brought about by the second-person perspective.

In terms of my practice, I learnt that working with other performers provided a means of validating my experiences gained through solo enactments. The original creative vision: *enable performers to interact with virtual props imbued with real world physical characteristic* was realised, with the recognition that this proof of concept has the potential to evolve into much richer and more complex forms of interaction with virtual props. For example, adding two or more performers opens up the possibility of realising collaborative interaction noted in the theoretical framework (section 2.2.2).

The enactments revealed several issues that affect the sense of embodiment and its subcomponents. The problems associated with colocation and depth reversal impact on the sense of body ownership due to the subsequent mismatch of visuo-proprioceptive coherence between the virtual body and the body of the performer.

The sense of body ownership is also likely to be challenged when attempting to accomplish tasks that require a strong degree of visuo-proprioceptive coherence between the virtual body and the body of the performer. The sense of agency may also be negatively affected as a result of failing to effectively achieve tasks due to colocation and depth issues.

Given that the sense of body ownership and agency are not experienced to the maximum degree this is then likely to reduce the resulting sense of embodiment. The exact relationship between the sense of embodiment and the interconnected relationships and weightings of its three subcomponents are not fully understood, the literature recommending the necessity of further studies and analysis.

> Whereas SoE may consist of three subcomponents, their relationship is far from understood. Although these may be conceptually independent, it is quite probable that there is an empirical correlation between them. Future studies are needed to detect the existence, if any, of such dependencies.
> (Kilteni et al. 2012: 384).

Such a study is out of remit in this practice-based research where we are concerned with facilitating performative interaction on an augmented stage informed by conceptual theories of virtual embodiment, rather than attempting to produce an empirical study evaluating the sense of embodiment and its three subcomponents.

The enactment demonstrated that the mediated agency of the virtually embodied performer enabled the evaluation of the performative mode of participation, whilst also revealing issues associated with visuo-proprioceptive coherence.

The evaluation of performative interaction revealed a number of issues regarding effective navigation and participation. The discussions suggesting that these issues are a result of the sense of self-location being from a second-person perspective, which negatively affect visuo-proprioceptive coherence.

The evaluation of virtual embodiment suggests that the visual appearance of the virtual body influences performative behaviour and that this is a result of the prioritising of the view of the virtual body because of the second-person perspective.

This presents a tension in that when the sense of self-location is from a second-person perspective it appears there is a positive impact on virtual embodiment and a negative impact on performative interaction. The next section discusses the emergence of the 'Embodied Performative Turn' and suggests how the concept can be used to addresses this tension between performative interaction and virtual embodiment identified in the research.

5.10 The Embodied Performative Turn

Rather than continuing to develop new enactments, a period of reflection and questions followed. I asked myself what was new or novel about the research, what was the essential nugget I could identify that made the research unique? My supervisor pointed out that the perspective I was giving the performer, the second-person perspective, the view from the audience was unusual. The use of the HMD and a video camera presenting a perspective from the audience was a pragmatic solution to the problem of the performer being unable to see themselves when projected with a virtual character. The HMD enabled the performer to witness their virtual embodiment and interact with the projected virtual scenography.

Generally, everyday HCI is directed at a screen, be it a computer screen or the touch screens of tablets and smart phones. On the augmented stage, the screen is behind the performer and interaction is directed outwards, towards the audience and away from the screen. Throughout the research I maintained a journal, where I recorded my thoughts and ideas. On June 21st 2015, I drew a diagram of the research areas as a map and identified what I believed was novel about the research, labelling it as "The Twist", illustrated below in Figure 46: Research map.

Figure 46: Research map

Inspired by the idea of the ‘performative turn’ (Dirksmeier & Helbrecht 2008: 5), I noted that my research was making this idea explicit, embodied or enacted. From this observation, I conceived the phrase ‘The Embodied Performative Turn’ as a means of encapsulating the concept of a performer witnessing themselves from the perspective of the audience whilst virtually embodied and able to interact with the projected virtual scenography.

I believed that this concept represented a novel form of performative interaction directed at an audience and challenged conventional screen orientated interaction. I submitted an extended abstract describing the concept to a conference on Computer Human Interaction (CHI 2016), which was accepted and published (Brown 2016). I later came to question the assertion that the EPT challenges conventional screen oriented interaction, realising that performative interaction was challenged not only because the performer was facing away from the projected screen, but also as a result of the second-person perspective being presented to the performer through the HMD.

The problems I discovered when evaluating performative interactive were a result of the performer witnessing their virtual embodiment from a second-person perspective. The sense of self-location as-observed results in the performer being perceptually distant from their virtual embodiment making accurate interaction with virtual props problematic. Additionally, the unfamiliar perspective presented from the video camera results in confusion between left and right and a perceived reversal of forward and backwards movements.

There were also problems of colocation, the congruency between the virtual space and the ‘real’ space of the performer. On the research blog {18}, I noted that the mapping between the location of the performer in real space and the position of the character in virtual space were out of alignment, resulting in inconsistencies when trying to move the limbs of the virtual body towards a virtual object or prop. Colocation issues were compounded by not having any depth perception, the HMD presenting a monoscopic view from the video camera.

A Virtual Reality HMD (VR HMD) in conjunction with the Unity game engine enables a stereoscopic view of a rendered scene to be presented to the viewer, thereby adding depth perception, which may potentially address the issues associated with colocation.

The concept of the Embodied Performative Turn emerged from evaluations of virtual embodiment and performative interaction where the sense of self-location was from a second-person perspective. The theoretical framework notes that a first-person perspective is prevalent in gaming and VR and with regard to the sense of self-location, "is a fundamental requirement" (Kilteni et al. 2012: 383).

The perspective of the rendered scene in the VR HMD can be altered to present differing viewpoints, for example a first-person or a second-person perspective. The Embodied Performative Turn may thus encompass multiple perspectives and potentially address the tension noted earlier when the sense of self-location was from a second-person perspective.

Using the VR HMD, the next section describes a series of enactments designed to evaluate the effects of depth perception and differing viewpoints on performative interaction.

5.11 Visual Perspectives

In this series of enactments, the Oculus Rift Virtual Reality HMD (VR HMD) was used to evaluate performative interaction through the presentation of differing visual perspectives to the performer. The game engine Unity directly supports the Oculus Rift and delivers a stereoscopic rendering of the virtual set to the VR HMD.

The discussions on performative interaction in relationship to the sense of embodiment in immersion, gaming and VR all advocated the use of a first-person perspective, the aim here was therefore to assess performative interaction from a first-person perspective. Unlike the previous enactments, where the view presented to the performer via the HMD was a live video feed of the augmented stage from a camera, in these enactments the presented view is a rendered viewpoint of the virtual set from the perspective of a virtual camera located in the set.

Initially I trialled the system as a solo enactment and subsequently with a performer who had participated in the previous interaction enactments, repeating the participation exercises previously carried out with a second-person perspective from the video camera, described in section 5.9.2. The idea was to make observations from the solo enactment and then compare these observations with those from the performer repeating the same enactment.

5.11.1 Second-Person Perspective

The first enactment utilised a second-person perspective, presenting the performer with a view of their virtual embodiment as-observed. The Unity rendering was produced by the same virtual camera in the virtual scene as used in the previous participation enactments. The rendered viewpoint from the virtual camera was previously presented to the audience through video projection and to the performer via the HMD. Here, a stereoscopic rendering of the viewpoint from the virtual camera is presented to the performer through the VR headset.

The enactment was a solo exercise with no audience so there was no need for projection mapping of the virtual character onto the body of the performer or projection of the virtual scenography.

On the research blog it was noted that the colocation issue is compounded by not being able to perceive the three-dimensional location of the virtual character due to a lack of depth perception{18}. In the enactment I wished to ascertain whether the added depth perception provided by the stereoscopic rendering would help in resolving problems associated with colocation.

Both myself and the additional performer accomplished the tasks of knocking over the book, the table and the chair with relative ease, both of us agreeing that the added depth perception made locating our virtual limbs and their contacting the virtual objects far easier than in the previous enactment without depth perception.

However, as noted before in section 5.9.2, the act of moving a hand or limb forward and away from the body of the performer was visually perceived in the VR HMD as a movement towards the rendered viewpoint, and vice versa, a movement towards the body of the performer was perceived as a backward motion away from the rendered viewpoint. As a result of the perceptual inversion of depth movement, the carrying out interactive tasks proved to be challenging.

The perceptual inversion of depth movement produced by the second-person perspective impacts on visuo-proprioceptive coherence and according to the literature, the sense of embodiment is then affected due to the sense of body ownership being related to visuo-proprioceptive coherence.

When conveying a sense of embodiment, visuo-proprioceptive coherence is associated with self-location being presented from a first-person perspective.

> Clearly a fundamental requirement is for there to be first-person perspective with respect to the position of the eyes of the artificial body.
> (Kilteni et al. 2012: 383)

In the enactment, through trial and error the problem of visuo-proprioceptive coherence due to inverted depth movement was overcome. It also appeared that we were also becoming familiar with the lack of inversion of left and right, as normally presented in a mirror. This suggests that over time, a performer can overcome the perceptual inversions of left and right and forward and backwards movements resulting from the second-person perspective and successfully accomplish interactive participation. These findings echo those presented earlier in section 5.9.2 when the presentation of a sense of self-location from a second-person perspective was realised using a video camera located in the audience. The difference here being the presented imagery in the VR HMD is stereoscopic, supplying extra depth information unlike with the previous monoscopic camera feed.

The images below, Figure 47and Figure 48 illustrate the accomplishment of the task of knocking the book off the table, viewed from the rendered second-person perspective.

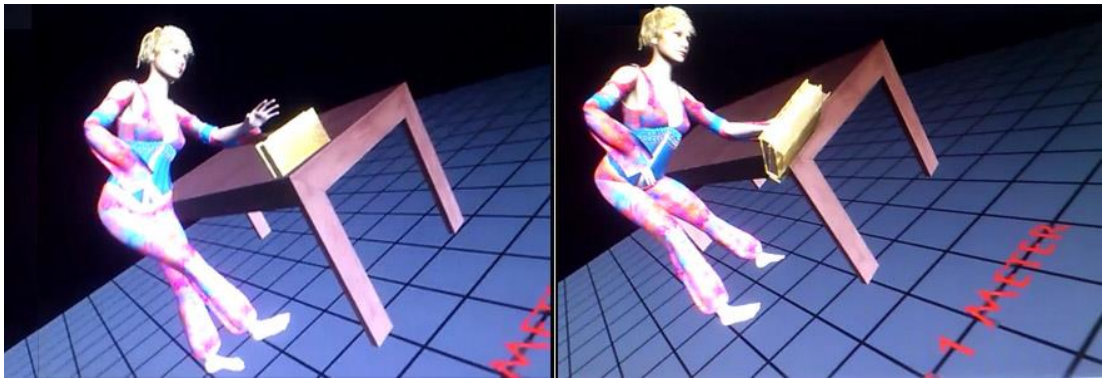

Figure 47: Book Task (1 of 2)

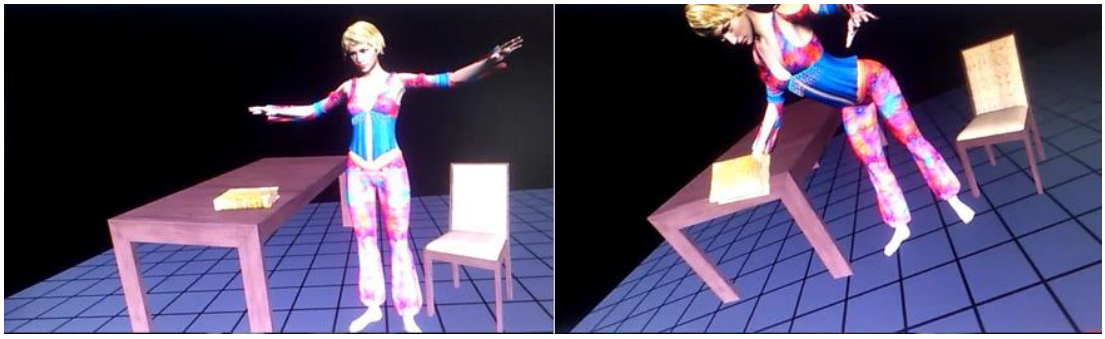

Figure 48: Book Task (2 of 2)

The images below, Figure 49 and Figure 50 illustrate the accomplishment of the tasks of knocking over the chair followed by the table.

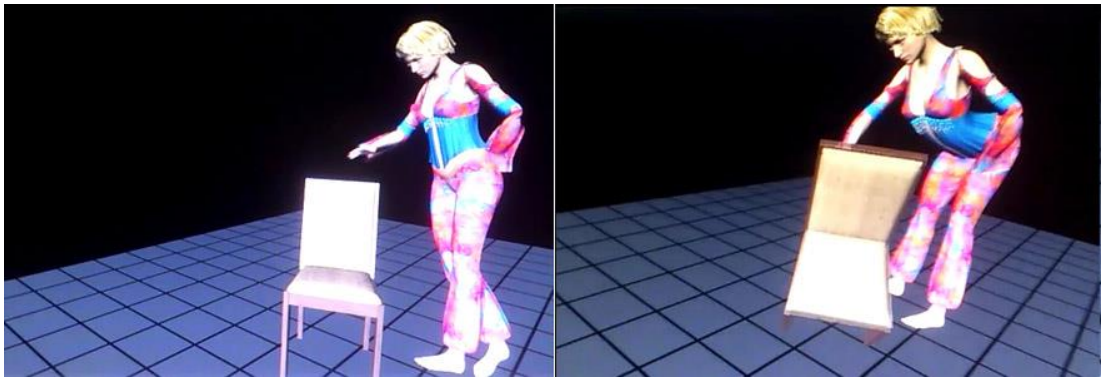

Figure 49: Knocking Over Chair

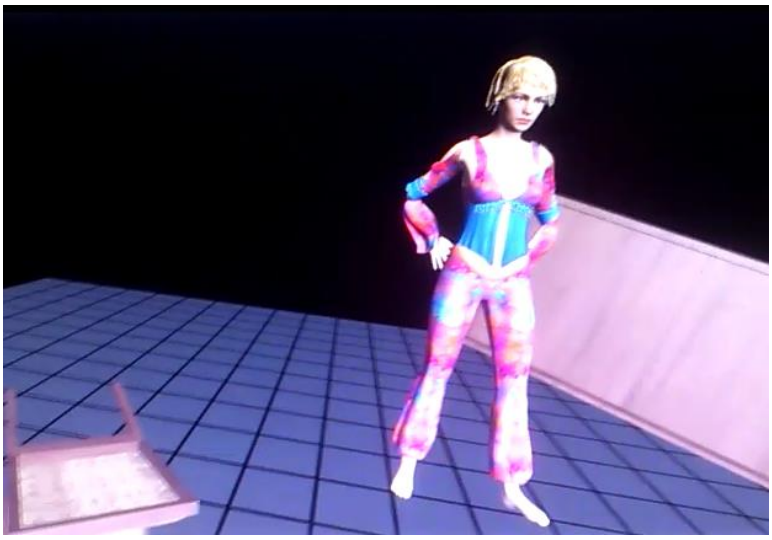

Figure 50: Knocking Over Chair and Table

One of the minor problems encountered in this task was the shifting of the angle of the virtual camera, noticeable in the presented images and in the video on the blog {20}. This is as a result of the VR headset mapping the orientation of the virtual camera in accordance with the angle of the participant's head; the functionality is inbuilt, but potentially could have been overridden through modifying the underlying code.

The enactment using the VR HMD evaluating performative interaction from a rendered second-person perspective shared the same problems of reversal of depth movements and horizontal mirroring as the previous enactment using the live camera feed from the location of a spectator in the audience to provide the second-person perspective. Despite the visuo-proprioceptive issues, colocation was assisted through the added depth perception enabling virtual objects to be located in relationship to the location of the characters virtual hand.

Recounting my experience of the enactment, the VR Headset presented a qualitatively different sense of body ownership in comparison to the view in the HMD from the live video feed of the camera of the projection mapped character on my body. The sense of location from a second-person perspective was theoretically the same, I was viewing the virtual character as an observer, however because the character was not projection mapped onto my body, the virtual character appeared totally synthetic, a computer game image. Despite the movements of the virtual character being congruent with mine, it no longer felt associated with my body, the rendered virtual character felt completely removed, existing in its own virtual reality.

A similar study of a rendered second-person perspective suggests that the sense of body ownership can successfully be conveyed through the rendered illusion of a mirror:

> It is possible to obtain a body ownership illusion of a mirrored virtual body image when there is synchrony between motor actions of the participant and the seen movements of the avatar mirrored image.
> (Gonzalez-Franco et al. 2010)

Further evaluation would be required in order to fully understand the differences and respective impacts on the sense of body ownership as a result of the second-person perspectives of the rendered virtual body versus the live video camera feed of the projection mapped body.

The next enactment describes performing the same set of tasks with the sense of self-location presented from a first-person perspective.

5.11.2 First-Person Perspective

The purpose of this enactment was to evaluate performative interaction where the sense of self-location is from a first-person perspective. This was a solo enactment and in carrying out the enactment I experienced several issues.

My perspective on the virtual world was completely unfamiliar, the character having different body proportions and the viewpoint of the virtual camera was located at a different height from the location of my own eyes. My account of the experience is supported by the literature where it is noted that morphological appearance is an important factor in conveying a sense of embodiment.

> Generally, a virtual body representation with different morphology with respect to one's own biological properties (e.g., morphological appearance, number of limbs, size), would probably have psychological or even motor consequences.
> (Kilteni et al. 2012: 382)

From my experience I would argue that morphological *appearance* impacts on the sense of body ownership whilst morphological *similarity* is an important factor in conveying a familiar sense of self-location where the first-person viewpoint is rendered from the same height as the location of the eyes in the biological body. The different sense of height in the virtual world impacted on my sense of body ownership as I moved around, it was an unfamiliar and disorientating perspective from the one I was accustomed to.

I experienced further and more problematic issues as a result of the design of the system, producing discomfort in the form of 'VR sickness', a feeling of dizziness and dislocation. When I moved, the combination of tracking information from the Kinect and the head mounted display resulted in a sense of vertigo as the systems competed in defining the spatial orientation and location of the first-person viewpoint.

The virtual camera rendering the first-person perspective was located in the head of the virtual character in-between the eyes and facing outward. The head of the virtual character would move in response to tracking information generated by the Kinect, so as I moved, the virtual camera displayed a new rendered viewpoint from the head of the virtual charter in its new location. At the same time when I moved my head, the tracking generated by the HMD would also alter the rendered viewpoint. The combination of the two sets of tracking information resulted in a swaying and jittering of the presented point of view whenever I moved. In addition, tracking errors from the Kinect produced sudden jumps in the rendered viewpoint adding to the discomfort and feeling of vertigo. The video on the research blog {20} conveys these effects to a degree but is substantially different from the stereoscopic experience delivered in the VR headset of the viewpoint from a first-person perspective moving around in a three-dimensional environment.

However, despite the perceptual discomfort when moving in the space, when I stayed relatively still, I found accomplishing the tasks from the first-person perspective extremely easy and much more natural than from the previous second-person perspective. Due to time constraints and the vertigo produced by the system being potentially hazardous, only solo enactments were carried out.

The images below illustrate the task of knocking the book off the table from the first-person perspective. In the enactment, a high degree of manipulation of the book was achieved, making the book stand on its end (Figure 51) and then pushing it over (Figure 52).

Figure 51: Manipulating Book

Figure 52: Pushing Book Over

The final task, accomplishing the task of knocking the chair over, is illustrated below first by kicking it (Figure 53) and then by pushing it over with the hand (Figure 54).

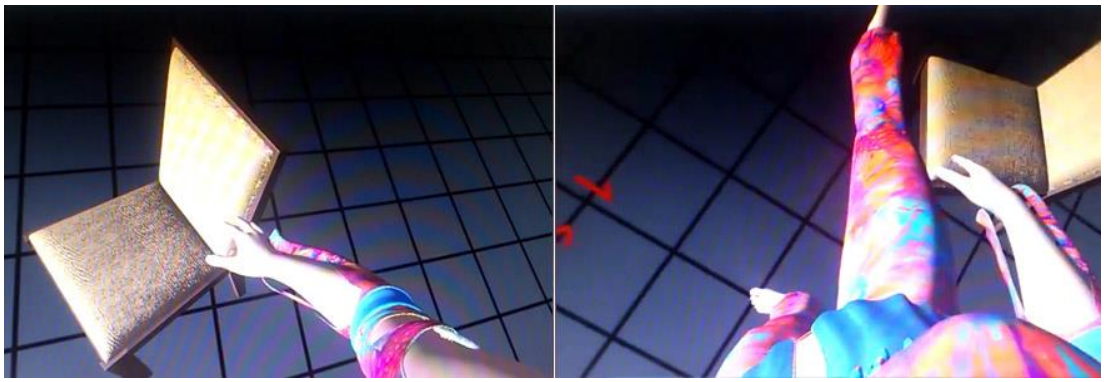

Figure 53: Kicking Chair

Figure 54: Pushing Chair

The enactment demonstrated that the accomplishment of tasks is facilitated when the sense of self-location is from a first-person perspective. Colocation between the virtual hand and the virtual prop was enhanced due to the additional depth information from the stereoscopic rendering in the HMD, thereby supporting the sense of agency. The sense of body ownership was challenged due to visuo-proprioceptive incoherence resulting from morphological dissimilarity, especially the difference of height between the virtual body and the biological, whilst the sense of self-location was challenged as a result of the tracking issues negatively affecting the visual perspective presented in the HMD.

Although the enactment was designed specifically to evaluate performative interaction from a first-person perspective, I noted that my experience of body ownership was substantially different to when the viewpoint is from a second-person perspective. When the sense of self-location is from a first-person perspective I was aware of observing what I could see of the virtual body, mainly the hands and limbs rather than the perception of the complete virtual body being observed from a distance when the sense of self-location is from the second person perspective. My observations tally with a number of VR studies that note how the sense of body ownership is affected by changing the perspective of how the virtual body is conveyed to the participant (Bertrand et al. 2014; Cleland 2010; Ehrsson 2007).

5.12 Summary of Results

The research has shown that the presentation of the sense of self-location from a second-person or a first-person perspective impacts differently on virtual embodiment and performative interaction.

The sense of self-location from a second-person perspective enables the performer to witness their virtual embodiment as if from the viewpoint of another person, the virtual embodiment is perceived from the perspective ‘self-as-observed’ and prioritises the perception of the virtual body. In contrast, the sense of self-location from a first-person perspective, ‘self-as-observer’ prioritises a world view where the perception of the virtual body is secondary.

The enactments presented in section 5.8.2 illustrate that prioritising the perception of the virtual body, where the sense of self-location is from a second-person perspective, impacted on performative behaviour, especially when embodied in opposite gender. In contrast to watching others perform, when performing, participants experienced a sense of embodiment, specifically the sense of body ownership and the sense of self-location

Accomplishing interactive tasks where the sense of self-location is from a second-person perspective were found to be problematic (sections 5.9 and 5.11.1) and easier to accomplish when the sense of self-location is from a first-person perspective (section 5.11.2).

The sense of self-location from a first-person perspective assists with colocation, the virtual hand can be located spatially in relationship to the virtual props. Stereoscopic rendering of the virtual scene provides additional spatial information in the form of depth perception and further assists in colocation.

Where the sense of self-location is from a first-person perspective, the spatial information is known and familiar, thereby supporting the accomplishment of interactive tasks. In contrast, the sense of self-location from a second-person

perspective presents unfamiliar and inverted spatial information and challenges the accomplishment of interactive tasks.

Navigation where the sense of self-location is from a second-person perspective was found to be problematic. In order to navigate out of a virtual scene the performer needs to see where they are going and not where they have been. In order to navigate out of a scene, the presentation of self-location from a first-person perspective enables the performer to see where they are heading, whilst the audience is presented with a second-person perspective displaying the scene receding. The necessity of two perspectives suggests the rendering of two separate viewpoints: one for the audience and another for the performer, identified as an area for further research in section 6.2.2.1.

The enactments in sections 5.9.2 and 5.11 revealed visuo-proprioceptive and colocation issues that are likely to affect the sense of embodiment (SoE) and its subcomponents, the sense of body ownership, sense of self-location and sense of agency. Section 2.3.4 of the theoretical framework notes that little is known about the relationships between the subcomponents or whether one dominates another in the enhancing of the SoE (Kilteni et al. 2012: 380). It was recognised that an in-depth study to ascertain the impact of visuo-proprioceptive and colocation issues on the subcomponents of the SoE was beyond the remit of this study.

In summary, the presentation to the performer via the HMD of a first-person (self-as-observer) or a second-person perspective (self-as-observed) impacts differently on performative interaction and the virtual embodiment experienced by the performer. A first-person perspective enhances effective performative interaction, whilst a second-person perspective enhances the performer's experience of virtual embodiment. The differing perspectives affect the conveying of a sense of embodiment and impact differently on its three subcomponents, the sense of self-location, sense of body ownership and sense of agency.

Through encompassing both a first- and second-person perspective, the Embodied Performative Turn then resolves the tension between performative interaction and virtual embodiment resulting from a fixed perspective.

5.13 Practice and Process

The last section presented a summary of the results generated through the practice-based methodology of evaluating enactments investigating performative interaction and virtual embodiment on the augmented stage. In this section, before moving to the conclusions, I present an account of the challenges, problems, benefits and rewards I experienced during the practice-based process.

One of the benefits resulting from practice-based research is its ability to generate new and surprising findings. The process of practice, through making and enacting can reveal new knowledge and new discoveries that were not planned or expected. The discovery of the creative use of system glitches for example, occurred when moving from solo enactments to group enactments (5.6.3).

In addition to the generation of new findings, this discovery also informed my practice through recognising the benefits of sharing and working with other performers and practitioners. For example, through collaboration with other practitioners, the Performance and Games Workshop (5.7) generated new application ideas for *iMorphia* as an 'Exquisite Corpse' game and a performative training system. Two further examples of new ideas emerging from working with other performers are the use of *iMorphia* to host a 'Festival of Fools' (5.8.4) and the notion of having a performer act as a 'narrative guide' (5.9.1).

Another benefit from working with other performers is the validation or challenging of observations made during solo enactments. In terms of my practice, I recognise having other views on a subjective experience can not only nuance that experience but also present completely new perspectives, challenging inherent assumptions that otherwise might have gone unchallenged.

For instance, my experience of the *MikuMorphia* solo enactment (5.4) I found to be stimulating and enjoyable, if not somewhat uncanny. I was therefore surprised by some of the expressions of uncomfortableness made by male participants when virtually embodied in the opposite gender (5.8.2).

In the discussions afterwards it was suggested that feelings of uncomfortableness experienced by male participants appearing in opposite gender might also be due to not wanting to appear foolish, one of the participants commenting, *Dressing in the clothes of the opposite gender is a foolish notion.*

In terms of the analysis of the results generated by the practice-based methodology, participant feedback served to validate many of the embryonic ideas and observations I had formed from earlier solo enactments. Many of these are summarised in the previous section (5.12), including: the effect of the visual appearance of the virtual character on performative behaviour, the distancing effect when viewing the virtual body from a second-person perspective as an observer, the problems of realising effective performative interaction with issues associated with visuo-proprioceptive coherence between the virtual body and that of the performer.

In summary, the process of practice-based research greatly benefitted from the inclusion of other 'performer-practitioners' not only as a means of validating solo observations, but also as means of providing alternative perspectives on the research and generating new ideas and discoveries.

The next chapter addresses the research questions proposed in section 1.2, referencing the theoretical framework in the analysis and contextualising of the findings from the practice-based research.

Chapter 6 Conclusions

In this chapter I revisit and answer the research questions through referring to the results generated by the practice-based research analysed through the lens of the theoretical framework. The discussion raises a number of questions and issues, presented in section 6.2 as areas for further research. The innovative concepts and new knowledge resulting from the research are identified in section 6.3. The thesis concludes with a reflection on the research journey as a result of the practice-based methodology.

At the beginning of the thesis four research questions were posed:

1. How might an augmented stage be realised enabling performer embodiment and performative interaction with virtual scenography?

2. What is the nature of embodiment on the augmented stage and how does this relate to embodiment in Virtual Reality and gaming?

3. How can embodiment be made manifest for the performer and the audience and how are they different?

4. What is the impact of differing visual perspectives on performer embodiment and performative interaction?

In order to answer the research questions, I first present a series of bullet points summarising the findings from the practice-based research, analysed through the lens of the theoretical framework.

6.1 Research Findings

i. The practice-based research enquiry revealed a tension at the intersection of performative interaction (PI) and virtual embodiment (VE) - the altering of the presented perspective to the performer via the HMD between a first-person perspective and a second-person perspective impacts differently on performative interaction and the virtual embodiment experienced by the performer.

ii. A first-person perspective enhances effective performative interaction, whilst a second-person perspective enhances the performer's experience of virtual embodiment.

iii. Through encompassing both a first- and second-person perspective, the Embodied Performative Turn resolves the tension between performative interaction and virtual embodiment.

iv. The sense of self-location from a second-person perspective enables the performer to witness their virtual embodiment as if from the viewpoint of another person, the virtual embodiment is perceived from the perspective 'self-as-observed' and prioritises the perception of the virtual body. In contrast, the sense of self-location from a first-person perspective, 'self-as-observer' prioritises a world view where the perception of the virtual body is secondary.

v. Accomplishing interactive tasks where the sense of self-location is from a second-person perspective were found to be problematic and easier to accomplish when the sense of self-location is from a first-person perspective.

vi. Visuo-proprioceptive coherence between the body of the performer and the virtual body is regarded as important in supporting a sense of body ownership and enabling effective performative interaction. Without a full empirical study, the affect of visuo-proprioceptive issues on the sense of embodiment and its subcomponents is not known.

vii. The enactment evaluating navigation identified the necessity of rendering two perspectives of the virtual scene, a second-person perspective for the audience and a first-person perspective for the performer.

viii. Performer agency is manifested in two ways: firstly, the performer has agency in that their body controls the movements of the virtual body; secondly, the performer has mediated agency in that the virtual body has agency through interacting with the virtual scenography.

ix. In witnessing performative interaction, the audience perceive the mediated agency of participation and navigation as ‘expressive’ and the control of the virtual body as ‘magical’.

x. Congruent projection mapping of a virtual character onto the body of the performer presents a three-dimensional image of an embodied virtual character to the audience.

6.1.1 Question 1 (Augmented stage)

How might an augmented stage be realised enabling performer embodiment and performative interaction with virtual scenography?

The prototype augmented stage provided a platform by which the questions concerning performer embodiment and performative interaction were addressed through the evaluations of performative enactments.

When presenting the performer a sense of self-location from a single perspective, the findings revealed a tension in simultaneously realising effective performative interaction and virtual embodiment. The tension is addressed through the Embodied Performative Turn encompassing both a first- and a second-person perspective.

Performative interaction with the virtual scenography is realised through the mediated agency of the virtually embodied performer.

The findings also revealed performative interaction was supported by a sense of self-location from a first-person perspective and enhanced by depth perception through stereoscopic rending of the presented viewpoint to the performer. Performer embodiment was the reverse in that it appeared to be enhanced when the sense of self-location is from a second-person perspective.

Visuo-proprioceptive coherence between the body of the performer and the virtual body was found to an important factor in supporting a sense of body ownership and enabling effective performative interaction.

Realising the prototype augmented stage acted as proof of concept, demonstrating the feasibility of presenting performers as projected mapped virtual characters able to interact with projected virtual scenography. The prototype system represents a technical framework which may inform the design of future systems suitable for larger scale productions.

The practice-based evaluation of the prototype highlighted technical issues that would need to be addressed if the prototype were to be developed into a robust platform suitable for live performance. Human Computer Interaction (HCI) issues raised by the investigation of performative interaction on the augmented stage would also need to be addressed if the system were to be used in a live performance setting. The technical and HCI issues are used to identify areas for further research presented under System Development in section 6.2.1.

6.1.2 Question 2 (Nature of Embodiment)

What is the nature of embodiment on the augmented stage and how does this relate to embodiment in Virtual Reality and gaming?

The nature of embodiment is understood in the context of virtual embodiment realised by conveying a sense of embodiment, which in turn is presented as a synthesis of its subcomponents: the sense of self-location, the sense of agency, and the sense of body ownership.

In VR the sense of embodiment is conveyed via an HMD presenting a sense of self-location from a first-person perspective coupled with visuo-proprioceptive coherence where the world view aligns in response to the orientation of the participant's head.

In gaming, the participant views a screen, where displaying the active avatar enhances the sense of embodiment, with players identifying with the avatar as their "exteriorized or doubled body image" (Norgard 2011: 2). In both cases the view presented to the participant is a computer graphics rendering of a virtual world.

On the augmented stage, the view presented to the performer via the HMD may be from a first- or second-person perspective. When the view is from a second-person perspective the virtual body is prioritised thereby enhancing the sense of body ownership and the resulting sense of embodiment. The congruent projection mapping of the virtual character onto the body of the performer conveys the sense of a three-dimensional embodied virtual character to the audience and is qualitatively different from watching a computer rendering on a screen or through an HMD.

6.1.3 Question 3 (Manifesting Embodiment)

How can embodiment be made manifest for the performer and the audience and how are they different?

Embodiment is made manifest to the performer by the conveying of a sense of embodiment via the HMD. The sense of embodiment is conveyed through its three subcomponents: the sense of self-location, the sense of agency, and the sense of body ownership.

The sense of self-location may be from a first- or a second-person perspective, both impacting on the sense of body ownership and hence the sense of embodiment conveyed to the performer. When the sense of self-location is from a second-person perspective, the virtual body is prioritised thereby enhancing the sense of body ownership.

The sense of agency conveyed to the performer is twofold: the performer has agency in that they control and inhabit their virtual embodiment, which in turn has agency in that it can interact with the virtual scenography. The performer interacts with the virtual scenography through the mediated agency of their virtual embodiment.

The audience witnesses the virtual embodiment as a result of the congruent projection mapping of the virtual character onto the body of the performer. The audience also witnesses the agency of the virtually embodied performer interacting with the virtual scenography.

6.1.4 Question 4 (Visual Perspectives)

What is the impact of differing visual perspectives on performer embodiment and performative interaction?

A first-person perspective prioritises a world view and enhances effective performative interaction, whilst a second-person perspective enhances the performer's experience of virtual embodiment as a result of prioritising a view of the virtual body.

Conversely, a second-person perspective prioritises the perception of the virtual body and challenges effective performative interaction, whilst a first-person perspective reduces the performer's experience of virtual embodiment as a result of prioritising a world view.

In conclusion, the research questions have been answered by referring to the findings generated by the practice-based research, analysed through the lens of the theoretical framework in evaluating performative embodiment and interaction on an augmented stage.

The practice-based process revealed many potential areas for further research, some of which are as a result of technical issues, others representing new lines of inquiry as result of discoveries made in the course of the research. The next section presents a summary of these areas as topics for future research.

6.2 Further Research

The topics for further research are grouped into two subsections, system and conceptual development. The system section identifies hardware and software developments that are needed to be made to the prototype system if it were to be employed in a live theatrical or performative context. The conceptual section describes theoretical concerns and issues identified during the research that merit further research.

6.2.1 System Development

This section describes hardware and software aspects of the system that during the course of the research have been identified as warranting further development.

6.2.1.1 Projection Mapping

- Body

  Projection mapping on the body was achieved using the Kinect to animate a virtual character such that it mapped onto the performer's body. The development and application of alternative technologies to the Kinect would enable more accurate and rapid body tracking. For example, a wireless motion tracking body suit would deliver accurate limb co-ordinates and also present a suitable surface for the projection of the virtual character. Body tracking is further described in the next section on HCI.

- Face

  Face mapping was not implemented in the prototype and would enhance the performer's ability to convey facial and emotional expression. The research website illustrates examples of face mapping using infra-red markers on the face and via real-time feature recognition.[44] The face mapping technology could be incorporated into a face mask which would also present a projection surface for the face of the virtual character.

- Scenes and props

  The background virtual scenography was realised using front projection onto a screen, resulting in the casting of shadows by performers.

  The development of front projection of the virtual characters and back projection of the virtual scenography would remove this problem.

  Multiple front projectors of the virtual characters could also be employed to produce a wider field of view for the audience.

  Stage props might be further augmented through the use of dynamic projection mapping of virtual props onto physical objects.

6.2.1.2 Performative HCI

- Body Tracking

  The tracking capabilities of the Kinect were found to be prone to errors and time lags, tracking of multiple performers is also problematic, though Kinects can be networked. Alternative faster and more accurate tracking systems using wireless bodysuit or infra-red marker based tracking systems would alleviate the tracking problems and provide a scalable solution to enable tracking of multiple performers.

[44] http://kinectic.net/motion-capture-face/ and offline via /kinectic.net/index.html in the accompanying ZIP file archive, kinectic.net.zip

Accurate tracking of hands, possibly with haptic gloves would enable a high degree of fidelity such that performers could interact with the virtual props using their hands. Performers might then be able to pick up virtual objects, pass them to each other or turn over the pages of a virtual book.

- Gesture and Voice Recognition
  Gesture and voice recognition provided by the Kinect was problematic being slow to respond and prone to recognition errors. Alternative systems would need to be deployed for live performative use. Microphones inbuilt into the performers' headsets would be essential for voice recognition on a large stage with a sound system.
  Additional motion recognition could be employed to enable the natural performance of navigation through motions of walking and body orientation.

- Visual Feedback
  Light-weight hi-resolution stereoscopic wireless headsets would provide performers added depth perception and assist in performative interaction and enhance the performer's sense of embodiment on the augmented stage.

6.2.2 Conceptual Development

This section describes conceptual areas for further research, identified as a result of issues encountered during the research or as potential research strands emerging from the research.

6.2.2.1 Multiple Viewpoints

The research evaluated two viewpoints: a second-person perspective prioritising the view of the body and thereby influencing performative behaviour, and a first-person perspective which priorities a world view and supports performative interaction.

Other perspectives such as a bird's eye view or a third-person perspective were not evaluated and may also influence performance on the augmented stage. For example, a bird's eye view displaying the relative positions of the performers might assist in realising co-ordinated group performances.

Section 5.9.1 identified that the facilitation of navigation necessitated the rendering of two perspectives: a first-person for the performer and a second-person perspective for the audience. This suggests the rendering of multiple viewpoint streams for the performers and audience.

Different perspectives might then be presented to performers during the course of a show so as to enhance performer embodiment or performative interaction. The selection of the visual perspectives relayed to the performers could be under the master control of a show director, controlled by the performers or automated in response to a computer-controlled script of the show.

The differing perspectives presented to the performers might also be incorporated in the production, presenting the audience with alternative and multiple viewpoints so as to create alternative perspectives on the unfolding narrative and multiple strands of simultaneous action.

6.2.2.2 Performative Interaction

The modes of conversation and collaboration were not addressed in the research as the modes of navigation and participation proved sufficient in evaluating the impact of visual perspectives on performative interaction. However, it is recognised that there is scope for further investigation of different types of performative interaction on the augmented stage.

Dixon suggests that for conversation to take place between participants and an interactive artwork there needs to be a relationship involving trust, cooperation and openness (Dixon 2007: 585). These qualities are similar to those that facilitate improvisation - being open, offering, giving and receiving (Johnstone 1979: 106).

In relationship to the ludology of computer gaming, the modes of conversation and collaboration share similarities to the activity of paidia or play:

> Video games, on the whole, tend to be organized around game structures and mechanics that are more ludus than paidia.
> (Fron et al 2007: 3)

In contrast to ludus orientated gaming, Fron describes children's games of 'dress-up' and costumed role playing as open-ended game playing involving free improvisation. The development of open-ended and improvisational conversational and collaborative modes of interaction might then capitalise on the performer embodiment of costumed role-playing facilitated by *iMorphia*.

In the enactment investigating navigation in section 5.9.1 it was noted that the creation of navigable spaces resulted in a narrative space that brought character and action together. It was suggested that one performer might act as a guide, leading the other performers through the landscape taking on the role of narrator or storyteller. These notions resonate with computer-based adventure games, which are often large, open spaces involving role playing as different characters.
Performative navigation in large open spaces may then facilitate costumed role playing, improvisation, collaboration and conversation between performers play acting in the virtual scenography.

6.2.2.3 Control and possession

The observation concerning whether a performer was controlling the virtual character, or it was controlling them led to the idea of character imbued with behavioural dynamics. A virtual character in the form of an older person for instance might only be able to move slowly, thereby controlling how the performer moves.

Further research would be required on the design of virtual characters imbued with behavioural dynamics and the design of coherence feedback to the performer relaying how accurate their movements are in comparison to those imbued in the virtual character.

This could be achieved by presenting the performer a visual display showing the difference between the locations of the limbs of the performer's body with those of the virtual character. Further research in the design of coherence feedback and characters imbued with behavioural characteristics might then find application in the development of training programs for the learning of stylised movements, for example, Tae Kwando or Tai Chi.

6.2.2.4 Gender and Identity

The research has shown the impact of visual appearance of the virtual character on performative behaviour, especially when changing the perceived gender. Literature on the subject indicates gender swapping is common in virtual worlds and online gaming (Hussain & Griffiths 2008, Rosier & Pearce 2011, Pearce et al 2015: 100). The experience of becoming different virtual characters in online virtual worlds enables the exploration of gender and identity (Fron 2007, Childs 2011). Other research suggests the potential value of virtual gender roles for those experiencing gender dysmorphia (Pearce et al 2015: 108). It is suggested that further research of performer embodiment exploring gender and identity on an augmented stage has potential value in the development of applications that support health and well-being.

6.2.2.5 The Uncanny

The uncanny is regarded as something to be avoided in the design of human-like virtual characters and robots where the aim is to positively engage, rather than disturb the human recipient. It is suggested that the uncanny has potential theatrical and artistic value, creating scenarios specifically designed to provoke a sense of unease. There are a wealth of papers and research in the literature on computer animation and robotics focussing on how to avoid the uncanny and how to detect and measure its occurrence in the human perceiver (Geller 2008, McDorman et al. 2009, Pollick 2009, Tinwell et al, 2009, Mori et al 2012). Several recent papers focus on the importance of appropriate dynamic characteristics, highlighting human sensitivity to gestural movements and facial expressions in connection with the mirror neuron (Tinwell et al, 2011, Saygin et al, 2011).

It is suggested that this research might be exploited to create performances on an augmented stage where the manifestation of the uncanny is used purposefully to create a sense of unease in the audience.

6.3 Innovation and New Knowledge

The embodied performative turn encapsulates a number of innovative concepts:

i. The production of a ‘digital body mask’ inhabited by a performer through the projection of a virtual character onto the body of a performer such that the movements and actions of the virtual character are congruent with those of the performer.
ii. The conveying of a sense of embodiment via an HMD so the performer can see themselves from different perspectives. A second-person perspective producing the embodiment of ‘performer-as-observed’, whilst a first-person perspective results in the embodiment of ‘performer-as-observer’.
iii. The production of ‘interactive virtual scenography’ through a combination of game engine technology (Unity), video projection and body tracking (Microsoft Kinect).

New knowledge has been revealed through the impact of visual perspectives on performer embodiment and the resultant implications regarding performative behaviour and performative interaction. The research indicating that performative interaction is better supported through a first-person perspective whilst performative behaviour is influenced by the second-person perspective, ‘performer-as-observed’.

6.4 Research Journey

In this section I present a personal reflection on my experience of research through practice. The aim is to present insights resulting from the 'behind the scenes' activities of the practice-based research inquiry.

The research commenced in 2013 with a broad remit examining intersections between performance, computer science and theory associated with improvisation (Lockford & Pelias 2004, Tanenbaum 2008), liveness (Scott 2012, Auslander 2008) and intermediality (Bay-Cheng et al 2010, Rajewsky 2005).

As a result of the broad remit the practice-based research methodology resulted in the exploring of a number of potential research directions. At times it was difficult to focus and to decide on which path best to follow. To compound the problem, reading the literature associated with potential research paths, such as improvisation and intermediality tended to expand the horizon rather than narrow it down.

The research blog presents a diary-like account and illustrates the many avenues the research took and potential paths the research uncovered. The first enactment in November 2013 {1} resulted in the uncanny becoming a focus of the research. This was followed be a period in 2014 where improvisation, liveness and intermediality led the research. The interest in liveness and improvisation resulted in two enactments being carried out to evaluate whether two performers might facilitate improvisation {9} and a comparative study of *PopUpPlay*[45] and *iMorphia* {14}. Through a process of critical reflection, it was recognised that improvisation represents a complex mode of interactivity and shares features associated with Dixon's modes of conversation and collaboration. An investigation of computer assisted conversation, collaboration and improvisation on the augmented stage represents an area for research beyond the remit of this thesis.

[45] Vear & McConnon, 2017.

Nelson advocates periods of critical reflection throughout the research, periods of time where theory and practice mutually inform each other (Nelson 2013: 29). Critical reflection was assisted by the production of 'complementary writings' which proved to "enhance the articulation and evidencing of a research inquiry" (Nelson 2103: 20). The complementary writings I produced were in the form of short documents and potential conference papers describing the relationship of theoretical ideas with the practice, dealing with topics such as improvisation, intermediality, gender and the uncanny.[46] The concept of the Embodied Performative Turn emerged as a result of critical refection and focussed the research towards the concerns of performative interaction and virtual embodiment presented in this thesis.

Practice-based research represents a powerful research method, but it also can run away with itself, practice begets more practice and the research can begin to spiral out of control. Periods of critical reflection, complementary writings, the use of journals, or a website blog all help in the process of distillation and identifying the discoveries and new knowledge brought about by practice.

[46] http://kinectic.net/research-documentation/ and offline via /kinectic.net/index.html in the accompanying ZIP file archive, kinectic.net.zip

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Appendix 1: Workshop Transcripts

This appendix lists transcripts of video documentation and audio recordings of discussions from four participatory workshops held between 16/4/2014 and 18/4/2014.

A total of fifteen participants took part in the workshop of which fourteen performed in the video documented enactments. Feedback from a survey of the participants indicated interests in theatre, performance, gaming and digital technology. The fifteen participants were comprised of eleven males and four females: four research students (3 male, 1 female), five academic staff (4 male, 1 female) and six practising performers (4 male, 2 female).

The enactments utilised three virtual characters, two stock characters from Daz3D Studio: a male surfer, a female in a dance costume and a MakeHuman bikini clad female. The first exercise involved participants controlling the characters whilst the 'following exercise' required participants to follow a character performing a sequence of motion captured movements.

Workshop 1

Participant coding:
MS1: male research student, MP2: male performer, MS3: male research student, MS4: male research student, FA5: female academic.

Enactments

MS1 in female character

MS1: My first thought was I want to dance – the content effects the way I feel and want to behave. There is a lag, I want to adjust to it, to follow the avatar rather than control it. There were moments on the last task when I could not tell whether the avatar was moving or whether it was my arms. There was one moment when I thought I was lowering my arms when my arms were up high.

MP2 in male character

MP2: The mirroring thing is quite.. you are not looking in a mirror, it's still fine, feels strange – I feel like I have a very different body – is that a representation of me?

MS1: It's strange having been there – it looks more joined up when you are in it. It's different being inside it from watching it. I like the fact that the projection takes on some of the 3D form.

MP2: I can't see my arms, I've lost sense of where my body is, it requires a lot of concentration.

MS3 in female character

MS3: That is very weird, I'm expecting it be like a mirror and it's not. I lost track of which hand is mine then. You lose track of which hand is which, you choose the projected one, you follow. I keep thinking it's my hand and it's not. The stronger contrasting colours work, you see less of the suit, its better visually.

MP2 in female character

MS3: you look quite sinister actually – laughter… the position of the face on your head, looks like a hood, FA5 comments: yes a mask over your head.

MP2: (moves very quickly, avatar lags, audience laughter)

FA5: I wasn't quite sure which one I was watching.

MP2: (Lots of movement, bending side to side)

FA5: Brilliant!

MP2: (Moves arms in circles, laughter, jumps, character does not jump)

Following exercise

MS3 in male character

MS3: I'm very self-aware that I am not doing it right and I can see I am not doing it correctly.

MS1: the rest of the body moves out of sync as they focus on the arms.

MS3: On one arm I felt like this arm was following (points to arm), I felt like I was

controlling this arm but not the other. I concentrated on my arms and forgot the rest of the body. I really had to concentrate.

FA5 in female character

MS1: Those moments when it lines up nicely, it looks really good.
Following the avatar is perhaps a good thing, as it restricts the movements.
FA5: I can't tell if I am in sync or not really, her arms do something really weird at the top – the wrists.
MS1: Everyone twists to that side, there does not seem to be a reason, but everyone has done it.
FA5: If it was a performance you would know what to do… I am using the shadow to work out whether I am following, left and right it's a nightmare!

MP2 in female character

MP2: I feel like – which hand is it? One arm feels easier to follow than the other – which one – I lose track of which arm is which, then body goes skew. It would be much harder with a more complicated exercise.

Discussion

MS1: Watching other people doing it, as a performer it is different – it's not the same as watching a screen – the only comparable experience is a mirror. In the copying exercise - the mirror issue is more apparent. It's hard to tell which arm is which. Viewing the projection face on works much better – wonderful, fantastic when it synchronises – flips between enjoyable and frustrating. As a performer there is a period of learning what to do – afterwards I wondered why I did not try other things, it's a process of getting used to it.

MP2: I was unsure what to do. I wanted to test it to see what it can do by moving really quickly.

MS3: I felt challenged when projected with a female character; I did not know how to behave.

MP2: Robot behave like a robot. F1: Or react to it, make robot behave like a human.

FA5: Behave like a toddler – drama exercise – perceive yourself as a toddler.

MP2: How about random character changes – so the performer has to react to the changes?

FA5: I felt responsibility to be the screen – to be mapping closely so it looked good for the audience, I wasn't thinking about the character – only being a good screen. There are limits on the tracking ability – a person is moving fluidly but the digital character is not. There are technical limitations, how closely can it map without problems – there is a limited range of movements, the hands do not track.

MS4: Mixture of feeling I was controlling it, it was controlling me, being controlled by the lag – toing and froing - who is following who?

Workshop 2

Participant coding:
MP1 male performer, MA2 male academic observer, FP1 female performer, FP2 female performer.

Enactments

MP2 in female character

MP2: (Laughs, poses) I did not think the image would make a difference to the way you perform, hands on hip straight away, sportsman strike a pose, this is like, feels different.

MP2 in female bikini character

MP2: I feel a bit more responsible for her, you feel lascivious in female character. Like a bored performer, same old routine
FP1: There is something very interesting about the cleanness of the image.
FP2: The figure behind barely exists. It looks really different. The hands seem more expressive.

FP1 in male character

FP1: Poses – it is interesting how it immediately makes you adopt a stance.
Look at what I am doing with my hands and what it thinks I am doing with my hands, and where my arms are (behind back).

FP1 in female character

FP1: (Turns hands) If I do palms out? (testing hand movements)
Little hip movement I did there without moving my hips (laughs).
Very difficult to balance when you can't see.
Can it wave? The hand comes forward it seems bigger to us, problem coming forward, with the projection.
Does the face change? I feel as if the face changes.
MA2: the wrinkle as well and the tilt of the head.
(Poses, experiments with hands in front) It always stays at the same height. (Tries bending) That bend is potentially a very good gesture. (Tries moving head) Does it look up?
MA2: No.

FP2 in male character

FP2: When the face is fully realised on the head, your eyes stay on the body, when its off, you lose the rest of it, the key is recognising the head. The move over the creases changes the emotion of the face, interpret depending on the stance.
MA2: the intensity of the eyes – look at that (FP2 turn sideways). Look at that. Sinister; the figure behind, male skinhead, the teeth there – they are not though are they – does it open its mouth?
FP2: It's like the corner of his mouth goes up like a snarl. That weird thing when it doesn't recognise what you are doing, and it does something like it waves**.** It has a body of its own for a moment - it's like it has a mind of its own - merging of performer, human and avatar.

FP2 in female character

FP2: It's not a face that shows joy.

MP1: There is a sadness in it.
MA2: Phew the face is really expressing itself in all sorts of ways

FP1: Is it because we are wanting it to be sad?
MP1: We are looking more at the face now, the main thing to interpret.
MA2: I read them altogether.
MP1: The body gestures of the performer suggest you don't need a total fit, certain things have to work in a moment, it loses it when certain things just don't read.
MA2: The eyes are flashing left to right as if she were talking or thinking.

MP1 in male character
MP1: (Moves fast, laughter)
FP1: Do that fearful gesture – wondering whether it works as well on the male face. It looks angry – yes surprised and angry, it's the set of the mouth.
FP2: That's really weird, the hand that moves the hand.
FP1: It's like something trying to get out, that notion of a trapped other.
MP1: (Rotates arms fast – laughter)
FP1: We all made the assumption we would have to be slow.
FP2: looks more an accurate representation than the slower ones.
FP1: the movement takes the eye, we follow movement.
MP1: I'm totally focussed visually, the character doesn't seem disjointed at all, interesting how it looks, not as disjointed as I thought it would be, quite quickly it doesn't matter.

Following exercise

FP1 in female character
FP1: It's quite interesting how much faster it moves, quite difficult to work out what the hands are doing. Interesting how you move sideways without realising you've done it. If I focus on one arm I can sort of follow it. The other thing that is difficult is what I am looking at – it's a mirror image, actually it is very confusing, I did not think about it when it's following you. It's also very tiring, I think I got into my Tai

Chi – I hadn't thought – I'm doing martial art cos it's a game thing, what do you do with your arms when you stand still.

MP1 in female character

MP1: Trying to work it out, you forget you are copying, are you becoming more expressive, you can't work out what proceeds what, you kind of copy you forget you are copying and think it's copying you. I think I know where I am I think I am getting it really right.

FP2 in female character

FP2: This is so hard. I can't work out where I am supposed to be, it is very confusing.

FP1: It's a mirror, even when you know it you can't correct it.

FP2: Maybe you could make your brain adjust. When it was following me I could see it was working, I suppose you would get used to it.

FP1: Even though you know it's a projection it make you feel different in terms of adopting a posture, you adopt the character.

FP2: When you're a bloke I wanted the bandy legs of a bloke. I couldn't get it do the bandy legs of a bloke.

FP2: Tiny bit weird afterwards. Then being able to see normally

MP1 in female bikini character

MP1: There is confusion over which arm is which, this is a lot different, trying to make sure I am lined up, conscious of the suit I am wearing and when it appears in the glasses, whereas before I wasn't .

Discussion

FP1: what would it be like if we were three times the distance away – in an auditorium – taking place on a stage. Wembley arena – lose all the artefacts, imagine it performed on a stage with no background.

MP1: Avatar inhabiting another identity – body image – I felt I need to confront that.

The projected avatar is an interesting experience for both audience and performer. Is it in their responses? The female character – it's exactly the same artwork but we read it differently – the gestures – is it because we know who it is?

Audience perspective is intellectual, stepping into it becomes an emotional response, a feeling of responsibility, not want to behave in a gender stereotypical way. Initially, oh I can't to do that, looking at it intellectually. It's being on show.

FP2 (Discussing being male character): This chap swaggering down the street, bandy legged – I wanted to do that with that character, thinking of being that chap I had seen.

FP1 (Discussing being male character): I feel quite powerful, I like this – emotional response, if you behave in a non-standard way – stereotype how males and females behave – license to behave like this, getting away from traditional stereotypes – an interesting experience – when do you ever get to do that?

MP1: I wanted music to get out of myself, to get into the music, everybody had a different way of getting away from the selves and finding a way of being with the character. They all found their own way – everyone was different. Degree of building after watching previous participants – maybe a blind test instead. With old school friends, gesture is so much part of their personality rather than how they looked. People have their own way of moving. People had their own way of collaborating with the character, testing the character technically and expressing what you are feeling and what you are seeing become integrated, a difference between collaborative joining as well as distance.

MP1 (Discussing following exercise): Left right mirroring thing, difficult, making your brain follow.

MP1 (Discussing being female bikini character): Simplicity, clarity, hands crossing the body, how much more expressive and clear it was. Tendency to try and touch the

body, prod it and poke it. Touching the face, touch your head, slight distance in previous characters. One of the key things is a lack of delay.
No neutrality the way we read it.

MA2: People start behaving in different ways – masks – Pre-acting workshop stage, actors trying to inhabit the roles. Actors, clothing and props. Ways to inhabit the character. Play against type – how can I ridicule the stereotype I have in my mind, how can I push against it, how can I have fun with it? How does it feel to be that person – the tiniest insight of what it feels like to have a body like that to stand or behave in a cultural stereotype – very different from an actor which is all about imagination. Second life is looking at the screen; this is different, its looking at yourself.

MP1: Inhabiting characters suddenly it becomes very weird. Big difference between watching and being – what the tricks were to get the best results - I want to do well in this. You do not see yourself, in glasses, very different experience. I did not care about all the things when I was in suit, it was not about trying to do well or match up, it became something else. Even though you possess it possesses you.
I could not tell whether I was making the character move or it was making me move.

MP1 (Discussing making the character's body deform): Quite powerful in a destructive way I can do this to this body, can't do that with normal bodies, having license. The avatar having some sort of life you have to respect, this is me but it's not me – an uncanny thing!

MA2: What does it mean the uncanny? Freud – humanoid but not human – double take of interpretation, against our best knowledge what you are witnessing.

MP1: The uncanny is a warning signal, a jungle instinct. Not quite real – my senses tell me something but I feel there is something wrong about it. Uncomfortableness – It's not right – you have to know what's real and what's not – pleasure in feeling scared - enjoy being scared. I want to understand it.

(I ask: Is it preferable to choose a character or be given one?)

MP1: More useful to confront them with a stereotype. Change character halfway through. Start in one character then another you feel a real difference. Interesting about choosing and been given a character. Something I would not choose – I would not choose to be the surfer dude. How different it makes you feel.

MA2: The shape of the body matches shape of avatar like masks matching a person. That's you. Some people some performers fit certain masks better. Not quite stereotyping.

Workshop 3

Participant coding:
FS1 female PhD student, MA1 male academic, MP2 male performer.

Enactments

FS1 in male character

FS1: It's not following my head movements, I can't control my hands – plus you see a double hand. I can see my own hands really rather than the characters hands.

MA1 in male character

MA1: (Tests out the character, bending, legs, speed of movement)
Quite interesting effect really. Things that involve balance must be quite hard – whether they would feel balance as they normal do very wary about taking feet off the ground.

MA1 in female character

MA1: The body on this one works better, more sharply defined with the colours of the costume.

MA1 in female bikini character

(Attempts to cover the body with hands, laughter)
You can't cover up, there is no modesty to be had! It's a no modesty system.

Seriously quite interesting, in my head I expected I would be able to cover myself up. Something quite disconcerting about the wrinkleless of my skin – I'm looking a bit too wrinkly.
There is a lot of opportunity to play – is what it feels like.

Following exercise

MA1 in female bikini character

MA1: I think that I think that I am doing it far better than I am, I am fooled into thinking they are my arms but when I see the shadows – that's a really interesting finding – really hard to do, just think you are doing it. Mirror problem early on, I noticed it but I forgot it.

MP2 in male character

MP2: The impulse is to follow the image, but that is probably not the best thing to do. Playing with movement to find control, it works against you which make for quite an intriguing relationship like trying to get hold of one's life, things keep surprising you.

Discussion

FS1: I did not feel I was the character. I did not feel I was controlling the character, did not know whether I was in control or not. High fidelity of movement might be great. It was not following, it was catching up. The hands are not working. At times it worked, sometimes not lining up. When it does work that really nice, merging into the character, taking control. Sometimes being the character, being the puppeteer.

MA1: The individuality of the person gives each projected character something different – total body mask. Archetypes. The individual's expression coming out through a mask.

MA1 (discussing being bikini female character): I was very aware of how I looked where I might touch it, you felt naked, aware of being wrongly gendered – self-conscious.

MP2: Gender thing interesting – I run a workshop men playing women and vice versa – we use clothes a lot – here you get the body as well, like a total body mask. Limitations – want to take liberties want to take permission, limited hasn't got quite fluidity, when it come then it will be fun, it is about bringing out the other side of the person through performance, the journey is interesting.
This is a foolish exercise! Giving people permission – the fool is half in the world half outside the world. Everything gets reversed, it's a big tradition.
Dressing in the clothes of the opposite gender is a foolish notion – it gives you permission to behave in a certain way that provides a counterpoint to a purposeful kind of activity. A purposeful activity at some time will run aground the fool - something will come along to cause mishaps.
It not not purely tech play – it has a greater purpose that makes it ultimately interesting.

Workshop 4

Participant coding:
FP1 female performer, MP1 male performer.

Enactments

<u>FP1 In male character</u>
FP1: (Performs) Oh oh ohh!
MP1: Oh brilliant wow that's amazing (Laughter).

FP1: He can't bend – oh bless! (Laughter). He looks like he has been in an accident. He doesn't jump! You've got some work to do!

<u>FP1 In female character</u>
FP1: It seems more accurate and fluid - I seem to follow her I don't know who is

following who. The fact that she's a woman I behave differently, when it was a man I wanted to jump around, typical male acrobatics. I'm looking at the clothes what she's wearing. When would you wear those clothes, what social context would you wear those clothes?

FP1 In female bikini character

FP1: Kind of weird she's pretty much naked. It's difficult not to feel kind of vulnerable because she's naked, how would you move in front of an audience?

MP1 in male character

FP1: The boiler suits add to the formality and buys into the trust.

MP1: Its very ghost like. Definitely not quite real, I see projection and see myself. I am two people now – I really like the doubling and the shadows.

(Rapid arm movements)

Ah that is strange, I almost feel like Ganesha, the Hindu God

FP1: It's really graceful. MP1: Me or the character? FP1: Both!

MP1: Could I change gender?!

MP1 in female character

MP1: Oh I can see the face on my face through the cloth – wow, wow, (laughter).

I feel more sensual, the body shape, what she is wearing.

FP2: You look like you are really enjoying it.

MP1 in female bikini character

FP2: The projections look more real from the outside then when you inside.

MP1: This offers all sorts of possibilities, such as gender changes.

Following exercise

FP1 chooses male character

FP1: Hard to see own arms. Comments on facial expression and movement of hands, am I doing it or is he?

MP2: Do you think you are copying movements well?

FP1: I think so, I don't know, hard to tell. I can only see shadows. I just realised I had my mouth open all the time! (Laughter)

MP1 chooses female character

FP2: Interesting that we both chose opposite genders.

MP1: It's quite difficult to follow, hard to tell if you are going to fast or too slow.

Discussion

FP1: Participation was a lot of fun – confusion over left and right, I became immersed into the character – being cartoon like – a disjuncture – created a limit a boundary – my mouth was wide open all the time – it was a lot of fun. I felt more vulnerable as a female character – confronted by my own femininity, as a male character I was freer to move around, the females - what they were wearing – especially the bikini - I felt vulnerable exposed.

MP1: I felt the complete opposite.

FP2: the characters drew on certain stereotypes - probably put me off. The characters belong in a fantasy world, a male fantasy world.

MP1: I enjoyed the ghostliness more than how well it matched. Enjoyed the slight lag – the double. I felt more in my body than the rest of the time, being a female character was really good, it addresses how in the future people will be able to change their bodies from day to day, change gender, race, beyond surgical procedures, wish I could change into something else without surgery.

FP1: Philosophically, you feel whatever you imagine, like being on the top of a tower.

MP1: It is fun doing things you know you are not supposed to do, breaking the character, enjoy the projection on the cloth – quite psychedelic experience, creases in the cloth. Playing with the fabric to change the face.

FP1: Is it wishful thinking – we imagine dogs expressing – we need that connection. The power of suggestion – ooh it looks really sad. What we do with our minds and how we respond. This is more like virtual games – it depends how you present it.

MP1: I did not feel self-conscious in there, I felt really free and wanted to explore my proprioception. Wearing the mask and concentrating on the character enjoying movement more, outside of the real world with social expectation. I felt really free with the goggles and mask – probably why masks are really popular. I was not aware of the audience gaze.

FP1: It's a safe environment – looks formal, with guidelines, a games world – safe to play. There is only three of us, what would it be like with ten or fifteen?
We remain in adulthood, where do you start and end, performance art people seem freer - are they playing out fantasy stereotypes? A place where the character begins and where it ends. You become the builder character; you change how you move and how you behave. You react against that, conscious of how you react to stereotypes. Gender and looks, there are lots of issues and fears; immersing myself in the game I would be much more self-conscious.

MP1: My self-conscious went completely out the window! Took you into another space, absolutely, an out of the body experience – felt very sensual sexy in my body as a female.

FP1: I felt conscious about where I was putting my hand, it was like it was another person I did not want to touch.

MP1: It was my body!

FP1: I felt vulnerable, bringing life into those projections you are aware the audience sees the projection as you. I was aware of the audience, how is the viewer experience seeing the work? Very aware the viewer experience, I wanted to keep the distance between me and her – I would not touch or stroke her.