FRESH PERSPECTIVES/6

www.ietm.org

MIXED REALITY AND THE THEATRE OF THE FUTURE

Arts and New Technologies

picture from Terranova by CREW_Eric Joris (© courtesy of Stefan Dewickere)

Joris Weijdom

March 2017

in partnership with HKU university of the arts utrecht

ISBN: 978-2-930897-13-4

IETM is supported by:

Flanders State of the Art

Co-funded by the Creative Europe Programme of the European Union

The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Mixed Reality and the Theatre of the Future

Fresh Perspectives on Arts and New Technologies

by Joris Weijdom

Published by IETM - International Network for Contemporary Performing Arts, Brussels

In partnership with HKU - University of the Arts Utrecht

Original edition: March 2017 (pdf version)

Editing and general coordination: Elena Di Federico, Nan van Houte (IETM)

Proof-reading: Sophie Thompson

Table of contents

About

This issue of IETM's Fresh Perspectives series has been in our plans since 'new technologies' emerged as a key topic debated during IETM meetings. A few years later it sounds strange to keep calling these technologies 'new', but we now feel more and more comfortable talking about mixed reality.

While artists in different countries certainly have different levels of expertise , resources and equipment available, it is true that many performing arts professionals increasingly see themselves as 'creators of experiences'. This, combined with the fact that theatre has always played with different levels of 'virtual reality', creates the conditions for an interesting reflection on the theatre for the future - a future that is already here.

The hefty text that follows is divided in two parts.

In Section 1 the curator of this publication, Joris Weijdom - himself a researcher and designer of theatrical mixed reality experiences - takes you on a playful but serious tour along the issues at stake when designing a mixed reality experience. Using a witty style and practical examples, the text is appetizing for both total beginners and advanced users.

In Section 2 fellow practitioners from different countries share their own experiences, give practical insights into their practices, and share their learnt lessons, tips, and possibilities for development and collaborations.

IETM has explored this topic through a series of publications and discussions. After an article on 'Who is afraid of the digital?' (2015), a mapping of 'Live performances in digital times' (2016) and the IETM plenary meeting in Amsterdam (spring 2016) focused on those same topics, this Fresh Perspectives issue hopes to take the discussion to the next level.

Are you ready to play with us? Join the discussion at the next IETM meetings and on the IETM website by commenting on this publication and start discussing on IETM Members' forum!

Acknowledgments

IETM and HKU University of the Arts Utrecht are extremely grateful to the contributors for the time and care they took to share their experiences:

pvi collective: kelli mccluskey & steve bull with steve berrick & chris williams; Abel Enklaar, Marieke Nooren, Gable Roelofsen; David Gochfeld and Javier Molina; Simon Wilkinson; Maria Lantin, Athomas Goldberg, Ken Perlin, David Lobser, Thecla Schiphorst; Sander Veenhof, Rosa Frabsnap, Marloeke van der Vlugt

Special thanks go to the Professorship in Performative Processes at the HKU University of the Arts in Utrecht, the Netherlands, our partner for this publication, and in particular to Debbie Straver for the invaluable assistance to the publication.

IETM

IETM is a network of over 500 performing arts organisations and individual members working in the contemporary performing arts worldwide: theatre, dance, circus, interdisciplinary live art forms, new media. IETM advocates for the value of the arts and culture in a changing world and empowers performing arts professionals through access to international connections, knowledge and a dynamic forum for exchange.

HKU University of the Arts

offers advanced education in the arts and media and is a driving force in training and innovation for the creative industry. HKU University of the Arts Utrecht is a university of the arts that aims to forge new links with society and develop new applications for social issues. With almost 4,000 students, HKU is the biggest university of the arts in the Netherlands and among the top of its peers in Europe.

HKU Professorship in Performative Processes, led by Nirav Christophe, researches creative processes in all the arts that have a performative nature. The research responds to the current situation, where former performative practices are being replaced by new forms, in which the borders between disciplines, media and platforms are no longer a defining factor. The goal of this research is to generate acceleration, liberalisation and innovation in creative processes within and outside the arts.

JORIS WEIJDOM

Joris Weijdom is a researcher and designer of theatrical experiences using mixed reality technology. He is the founder of the HKU Media and Performance Laboratory (MAPLAB), which enabled from 2012 until 2015 practice-led artistic research on the intersection of performance, media and technology. He works as a researcher at the Professorship in Performative Processes and teaches at several BA and MA courses at the HKU University of the Arts Utrecht.

In April 2016 I was asked to give a keynote lecture at the IETM spring meeting in Amsterdam about emerging technologies and how these could impact the field of theatre. In this keynote, called Mixed Reality and the Theatre of the Future, I teasingly questioned if theatre as a traditional art form would actually have a future in the light of developments such as the Internet of Things, Transmedia Storytelling and Mixed Reality. In the last few years, technological developments like Virtual Reality (VR) and Augmented Reality (AR) have been accelerating at an incredible pace, enabling new experiences. I am strongly convinced, not only that theatre has a future, but that it is actually an essential field of expertise in the development of these technologies, especially in its role of exploring their artistic potential and depth as a possible 'new stage'.

01.
INTRODUCTION

Let me start by acknowledging that many theatre groups have in fact been pioneering this field for quite some time. Well-known names like Blast Theory, Punchdrunk, Rimini Protokoll, and many others have produced works that can easily be characterized as theatrical Mixed Reality experiences. In the book 'Performing Mixed Reality'[1] Steve Benford and Gabriella Giannachi offer clear insights into how to look at these types of experiences. This book was published in 2011, just before the latest VR and AR technology wave started, so most examples do not refer to these latest developments. Going back further to look at how digital technologies have already changed the landscape of theatre, it is recommendable to have a look at, for example, Steve Dixon's thorough overview in the book 'Digital performance'[2] from 2007.

However, in allowing ourselves not to know what a meaningful Mixed Reality experience actually is, we can freely discuss our own attempts to create one, without the pressure of justifying the design strategies we have chosen for our explorations or the need to compare these explorations with other well-known works and famous artists. For this reason the contributors of this publication were asked to focus on sharing their creative process, rather than a description of the final product. We especially encouraged them to elaborate on their questions and failures, instead of giving us a polished success story, so that we can all learn from each other's professional experience.

All contributors have made a serious investment in their articles to share openly their experiments at various stages of their artistic design processes. As a reader it is very important to realize that these projects are very different in their artistic goals, disciplinary composition of the team, stages of development, availability of resources, forms of presentation and target audiences. In this context these processes are incomparable when judged by their outcomes. In my opinion however they do all give a rare insight into the many aspects that need to be taken into consideration when designing MR experiences that are firmly rooted in theatre tradition.

It is not at all the purpose of this publication to attempt to give an overview of the field of theatrical Mixed Reality experience design, or in any way to deliver some collection of 'the best of'. On the contrary, the artistic design processes shared in this publication represent a selection of current projects which explore the potential of Mixed Reality technologies, in the context of theatre and performance, in their own unique ways. It is in its multiple disciplinary and artistic perspectives that this collection of articles hopefully provides an interdisciplinary and polyvocal approach to this seemingly uncharted territory. I do believe we are still figuring out how to design mixed reality experiences, and how to make them meaningful. I sincerely hope we'll never get to the point where we definitely 'know', because that would mean the end of our shared journey of exciting explorations, glorious failures and inspiring new experiences.

I would like to thank my colleagues at the Professorship in Performative Processes of the Utrecht University of the Arts for their help, expert advice and unconditional support, and the publishing team of the IETM for their trust and practical effort for making this publication possible.

It's our sincere hope that this publication will inspire you to start or continue to deepen your own Mixed Reality experiments and feel encouraged to share them too.

Joris Weijdom

1 *S. Benford, G. Giannachi, 'Performing Mixed Reality', MIT Press, 2011*

2 *S. Dixon, 'Digital Performance', MIT Press, 2007*

SECTION 1

Mixed reality and the theatre of the future

02.

WHAT IS MIXED REALITY AND WHY THEATRE SHOULD CARE

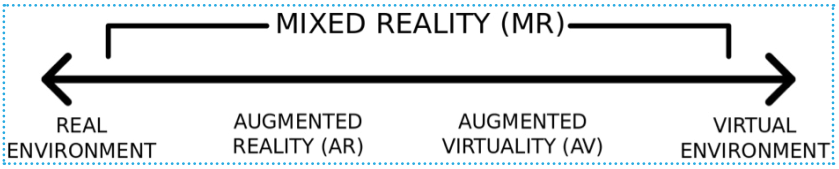


Image by Giovanni Vincenti – Wikimedia commons

Let me start this article by acknowledging that a theatre play is in many ways already a Mixed Reality experience, and in that sense one could ask what is new about this subject matter. What can be considered reasonably new are the various kinds of emerging technologies that enable possibly unexplored types of experience. They are changing the perspective of the audience in many ways, and enable them to physically participate and interact through innovative interfaces. They also offer novel ways for performers to manipulate mediated spaces in real-time, potentially changing their range of possibilities for artistic expression. These factors do have an impact on the artistic design strategies and types of expertise that are needed in a team. Whether you choose to let these developments have an impact on your practice depends on the degree to which you would like to explore the artistic potential of these technologies yourself. This impact also depends on how open you are to the possibility that this could lead to new experiential forms, and how much you allow these technologies to have an ongoing dialogue with the artistic design process.

So what is Mixed Reality?

Depending on how broadly the term 'mixed reality' is defined, it could essentially encompass everything we experience; but this definition is of course not very helpful. The best way to understand the term is to see it as a scale on the 'virtuality continuum' as developed by Paul Milgram and Fumio Kishino in 1994. This scale ranges from 'the completely real environment' all the way to 'the completely virtual environment' - see picture above.

A full-blown discussion of what is 'completely real' or 'completely virtual' is not the goal of this publication. In this article the 'real environment' is understood as the physical space in which our bodies are situated, where sensory input offers a mental experience of what we consider reality. The 'virtual environment' is interpreted as a mental space in which the 'imagined world' is experienced, which can trigger physical reactions. In the context of VR and AR technologies one could also consider the real environment as the 'analogue space' and the virtual as the 'digital space'. However physical and mental, or analogue and digital, are so much intertwined in the experience of reality, that it is difficult to make a clear distinction in a philosophical discussion on what can be considered completely real and what cannot.

This model is simply introduced as a reminder that the type of technologically enhanced experiences we are trying to design and discuss in this publication, are situated somewhere on this scale as a certain experiential mix of real and imagined reality; hence Mixed Reality (from here on indicated by its abbreviation: MR). The MR experience of a participating audience can shift back and forth on this scale for the duration of a piece, and can cover a wider or smaller range within any given production. Especially technology driven VR and AR experiences can easily be placed on this scale. When we design an environment whereby the majority of the perceived and partly mediated 'mix' leans towards the physical environment we can speak of Augmented Reality (AR), when leaning the other way we can speak of Augmented Virtuality (AV). The latter is not used much, and often replaced with the common term Virtual Reality (VR); although this term doesn't acknowledge a certain mix, and implies that the experience of a 'total virtual reality', without the physical body, could actually exist.

It is remarkable that VR and AR experiences are live, embodied and performative; terms that the theatre is very familiar with. Also, they deal with designed mixes of real and virtual spaces, and question our perception of reality and our understanding of presence. These are again concepts that the theatre has been dealing with for at least a few hundred years. Having experienced quite a number of VR and AR productions and experiments myself, and heard discussions on how these platforms could be used for storytelling, I have noticed that the dominant voices seem to come mostly from the world of technology, filmmaking and game design. So I, among others, have started to invite theatre-makers to join this discussion on how to design MR experiences, and offer their much needed expertise. One of the things I did to facilitate this dialogue was co-organize a special event at the VR Days Europe in October 2016, bringing people together from the field of VR/AR, media, games and theatre to discuss and brainstorm new concepts for meaningful experiences. A second development was the request of the IETM to co-author a publication on this subject matter, for a more in-depth exploration of what this means for artistic design practice. This became the publication you are reading now.

Four questions

For this publication we posted a call for contributions on the IETM website, inviting everybody to share their projects within the context of one central question: **How do you design a mixed reality experience, and how do you make it meaningful?**

This question implies that we already know what a Mixed Reality experience is, and what experiences could commonly be agreed upon as meaningful. This is clearly not the case in either instance. The question is simply intended as a general invitation to share professional experience on design practice. The term 'meaningful' is used to encourage a shared purpose to look for experiential artistic depth beyond the initial 'wow-effect' of the relevant technologies.

To structure this focus on the artistic design process we asked four questions in four design categories:

1. **Scenography of mixed reality environments:**
How is the scenography of mixed reality environments constructed, in which multiple physical and virtual spaces simultaneously exist and possibly seamlessly blend or purposely contradict?

2. **Dramaturgy of multiple audience perspectives and levels of participation:**
How did you consider multiple perspectives as part of your experience design, and incorporate several degrees of participation for the audience?

3. **The role of mixed reality technology as an integral part of the experiential artistic design process:**
How was mixed reality technology incorporated in the experiential artistic design process itself?

4. **The dynamic of an interdisciplinary collaboration, especially with non-theatre disciplines:**
How did the collaboration with multiple disciplines develop over time, and what influence did it have on the artistic design process?

In this article, each category will be discussed in relation to examples from the contributing articles, as well as several external sources. When I refer to another article in this publication the title is shown in blue and links to the article. When I refer to an external source, an external hyperlink to online information is provided and the linked word is underlined.

03.
SCENOGRAPHY OF MIXED REALITY ENVIRONMENTS

How is the scenography of mixed reality environments constructed, in which multiple physical and virtual spaces simultaneously exist and possibly seamlessly blend or purposely contradict?

MR experience designs are compositions of multiple simultaneous physical and virtual spaces that can be linked to each other in many ways in space and time. As mentioned before, this is not new; an audience can experience this simultaneity of physical and virtual space in a traditional theatre play as well. A theatre play can be considered a virtual space, being an imagined world, and the theatre venue as the physical space, generally considered as the real world. In this case all aspects of the physical space that don't belong to the agreed 'virtual reality' of the play are purposely ignored or otherwise interpreted by the audience and performers. This includes the corporeal presence of the audience itself. These separations between mind and body and between audience and performers are artificial. The audience can decide to ignore all sorts of physical input and mental interpretations, in a so-called 'willing suspension of disbelief'[1]. But they are inevitably inseparable from their bodily responses to the real physical environment and their possibly physiological reactions to the experience of the virtual play. The separation of audience and performers through the non-existent so-called 'fourth-wall' is nothing more than an unspoken agreement that everybody involved conforms to for the duration of the play.

In more post-dramatic forms of theatre and performance art these artificial separations are questioned, deconstructed and in many ways explored as an integral part of the artistic considerations and overall design of the experience. Audience members are activated to make ongoing changes in their decisions on where to focus their attention, and continuously reconsider the reality of the theatre play itself. This potentially results in layered experiences that can often consist of simultaneous conflicting realities. Especially when audience members are invited to be active participants in the performance, it is impossible to deny the presence of their bodies in the actual space. Through the body's interconnectedness with the reality of the space itself, and possibly even the larger reality of the world in which the space is located, it is always part of the experience. This is especially important when public spaces are purposely used as an acknowledged part of the stage.

Inside AND outside

The theatre experience blackmarket, as described in its respective article in this publication, is a good example of having the audience participate in their fully acknowledged bodily presence, as well as in its mix of indoor theatre-space and outdoor public space. In this piece from 2015 by pvi collective, the audience is asked to play a role within the imagined near-future world. Their interactions with each other, or characters played by actors, have to follow clear rule-sets. The whole experience is guided by a custom-designed app on mobile phones handed to each participant. Even in this highly embodied interactive experience the participants are asked to suspend their disbelief and play by the rules, in order to achieve a consistent and collectively shared imagined world. Especially when entering an outdoor public space, with a large degree of uncontrollable elements, maintaining this shared illusory experience becomes a real challenge. In the case of blackmarket it helps that the fictional context of the imagined world fits within the real world without much friction, because of its probability as a near-future doom-scenario. For this reason the public space can be infiltrated by performers and participants without immediately being noted by the general public. It becomes harder to mix spaces when the imagined reality becomes very different

1 *As explained in Wikipedia referring to:* a willingness *to suspend* one's critical faculties and believe the unbelievable; sacrifice of realism and logic for the sake of enjoyment. *In this article I use this idea mostly from the perspective of making a willful decision to focus on those elements that are considered to be part of the chosen aesthetic experience, and a conscious effort to purposely ignore everything else.*

from the physical world which we consider to be reality.

Many recent immersive VR productions are targeted at creating experiences that people don't usually have in their everyday lives. These range from extreme but still possible real-life experiences, like climbing Mount Everest, all the way to the impossible, like exploring alien worlds in other galaxies. These VR experiences often don't pay much attention to the design of the physical space, other than incorporating safety boundaries for a participant and the spatial layout of the technological infrastructure. In a way they seem to hold on to the traditional idea that the aesthetic experience of the designed work needs to happen only 'inside' the virtual world. The technologies that are often used are designed to fully engage our major senses, like sight and hearing, and to direct the focus fully onto the virtual world. Even if the participant is focused on this 'inside world', when asked to physically interact with the virtual space and objects, a connection is made with the body and thus the external physical space. On top of that, when these interactive VR installations are presented in public spaces, outsiders will often watch participants going through the experience. The participants thus become performers on a stage that does not in any way relate to the artistic context of the experience.

As described in the article about To be with Hamlet, a research-based project by David Gochfeld and Javier Molina, a theatre play is performed live by actors in a so-called motion capture (MoCap) studio. This is a high-tech environment that most people might know from the film industry, where 3D computer characters are brought to life by capturing the full-body motion of physical performers in special suits with typical ball-like markers. In the case of To be with Hamlet, the motion of the actors is captured by a large number of special infrared cameras hanging in the studio, connected to a lot of cables, computers and screens. This data is interpreted in so-called real-time by computers and sent to virtual characters in a 3D computer generated world. This enables the physical actors to puppeteer their virtual avatars live to an audience with VR helmets on. In the first described test sessions the audience was present in this very same studio, which was also the first space they saw before putting on the VR helmets. Having to ignore such a particular high-tech space and actors in their MoCap suits seems to be quite a challenge, especially as the virtual space was such a contrast, being a fictional outdoor space with a castle on the background, a virtual Hamlet and a ghost in full medieval armour nearby. Although immersive VR technology is designed so that the user cannot see or hear much of the actual physical space once the helmet is put on, the audience seemed to remain aware of the nearby physical presence of the actors and each other, possibly with a lingering echo in their mind's eye of the high-tech environment which they last saw.

Connected spaces

MR technologies give artists the opportunity to create experiential spaces that would be impossible to create in real physical locations. They can also stretch the experiential distance between real and virtual spaces much further. Spaces that are in different physical locations can be inter-connected through the Internet when using networked MR technologies. With the MoCap and real-time 3D technology used in To be with Hamlet the actors and audiences can be in different physical locations while the performance MoCap data is streamed live over a network. This feat was also used in the dance performance Worlds, a collaborative project from 2015 by Pepper's Ghost New Media and Performing Arts Collective, SFU's School of Interactive Arts & Technology (SIAT), ECUAD's S3D Centre, and the Computer Research Institute of Montreal (CRIM), as described in the article Moving between worlds. In this case, however, not only the audience but also the performers were distributed over three distinct physical spaces. Two of them in the Emily Carr University in Vancouver and one at CRIM motion capture studio in Montreal, Canada. The music was also performed live and streamed to the three locations. This particular piece was performed at the end of ISEA2015 in Vancouver, and I was lucky enough to experience it myself. The first performer I saw was a lady performing dance-like acrobatics in a suspended ring while wearing a MoCap suit. Her virtual avatar was at the same time visible on a large screen in the physical space where she performed. Another person functioned as a live cameraman holding a tracked device controlling the real-time perspective of the virtual world shown on the screen. When the cameraman zoomed out a bit, you could see the avatar floating in the virtual world, in a large virtual pyramid shape. Later we were taken to a second, and larger, physical MoCap studio where three dancers were performing their choreography while holding two glass pyramids. Both dancers and objects were tracked by the MoCap system and shown on several large screens in the room offering multiple perspectives of the virtual scene in real-time. In the virtual world the three dancers looked like enormous gods holding virtual pyramids, in which, to my delight, I could see the avatar of the dancer in the suspended ring doing her dance-like acrobatics. Other avatars were visible dancing inside the other pyramid, and I understood that these must be the dancers performing live in the MoCap studio in Montreal, on the other side of Canada. Not needing to wear a VR helmet, I was able to watch the live performers and see their avatars on screens at the same time. I was also allowed to move around a little at the edges of the physical space offering different perspectives of the performers and my fellow audience members. Also, all the technology and the people needed to keep this networked MoCap performance running properly were part of the space and clearly visible. This setup thus required an active spectatorship on my part, since I had to make choices where to focus my attention.

In spite of its technical challenges and inevitable glitches, this project was very impressive and showed quite convincingly the possibilities of connected performances through networked MoCap technology and real-time 3D computer graphics. Especially the artistic choice to scale two of the performance spaces into the much smaller size of the tracked physical pyramids, was a clever example of the infinite flexibility of 3D virtual space combined with the tactile reality of a physical object that could be moved around by the dancers. It did, however, make a huge difference

to me that I physically experienced two of the performance spaces, to appreciate and accept the 'presence' of the dancers in the virtual world from the third space in Montreal. The challenge with mediated networked performances is of course the lack of physical presence of the remote performers. Having seen and been physically near the performer in the suspended ring in the first performance space, I connected this memory of her physical presence with seeing the avatar inside of the pyramid in the second performance space. Having connected the first two spaces physically I was also much more willing to accept the third mediated presence of the performers from Montreal.

Creating transitions

In the VR industry the ultimate goal is to create a sense of full immersion, leading to the sensation of so-called presence inside the virtual world. This is not exactly how this term is used in theatre, where it refers to the immediacy and dramatic action of a performer in relation to the audience. VR enthusiasts interpret the state of presence along the line of the following definition:

'**Presence** (a shortened version of the term 'telepresence') is a psychological state of subjective perception in which even though part or all of an individual's current experience is generated by and/or filtered through human-made technology, part or all of the individual's perception fails to accurately acknowledge the role of the technology in the experience'.[1]

In VR development a lot of time and money is currently spent on the apparent necessity for this technology to be so good that our brains can no longer make a clear distinction between what is real and what is not. The underlying assumption is that in tricking the brain, we can create the 'perfect illusion', whereby anything imaginable can be experienced as reality[2]. Nevertheless AR technologies, like the HoloLens and soon to be revealed technologies of Magic Leap, are much more focused on the integration of the virtual in the physical world. MR technologies will gradually start to incorporate the body, and physical space, even public space, as part of its experience design. However, these developers also seem to be looking for the perfect illusion by focusing on the seamless mix of the real and the virtual in their development of this technology. Whether an MR experience is using these highly immersive VR technologies, or more mixed AR forms, all spaces, both physical and virtual, are part of the experience. And they need for that reason to be considered an integral part of the scenography, especially when some form of audience is present.

In The Cube, a theatrical VR performance by CIRCA69, completed in 2016, a participant is asked to come to a specific location to have a VR experience. As described in the article, from the moment he or she enters this location the MR experience has already started. When greeted by an actor the participant is informally questioned and told about a mysterious disappearance that happened in America in 1959. When the participant is asked to put on the VR helmet he or she sees the same room in which they sit reconstructed in 3D. In approximately the same location as the physical actor, a virtual avatar can be seen whose head is a television screen. The participant is taken through a reconstruction of the disappearance story, whereby actual facts and media from the case are used. During the whole experience, fact and fiction are constantly interwoven. This is reinforced by moments when the participant is asked to take a virtual object from the avatar, whereby sometimes a real object is there to grasp and sometimes there is nothing. In the end the participant receives a letter to take home, connecting the experienced story to the real world.

In the context of the scenography of mixed reality, The Cube seems to be designed to facilitate a smoother transition from the real-world to the virtual, by blurring the border on where the play has actually started and where it ends. It also cleverly makes use of an existing mysterious disappearance case to further blend the real and virtual, or fact and fiction. Finally, the same room in which you are physically present is reconstructed in the virtual space, and connections between virtual and physical objects are explored. In this case, the physical and the virtual world are designed to strengthen each other's roles in conveying the story and its impact. By constantly blurring the boundary between what is real and what's not, the story becomes connected to everyday life and is literally taken home through the offering of a physical letter. Instead of aiming for the perfect illusion in The Cube the virtual world is fully acknowledged as a simulacrum, but at the same time used to tell a story about something that could be real, belonging to the reality of the world in which the participant lives.

Perfect illusion AND conflicting spaces

From a dramaturgical point of view one could question if a perfect illusion, or a realistic experience of a singular consistent virtual world, is artistically very interesting. Many times beyond the initial wow-effect of attempted perfect illusions in VR, one is left with a certain sense of emptiness, or lack of connection. Possibly because it seems to fail to connect to something real, something personal. Learning from theatre forms that have explored the artistic potential of seemingly conflicting parallel realities, it is in the inconsistencies and possible conflicts that the spectator is really challenged to engage. By the necessity for the spectator to make constant decisions about what he or she considers important, consistent or true, an active and personal relationship to the artistic material is created.

Our brains are wired to spot anomalies in perceived reality to make sure we recognize potential danger before it becomes fatal. It is this mechanism that will keep us alert for as long as the offered input doesn't match an understandable pattern. In this context the theatrical MR experience called Terra Nova from 2011, by the exceptional pioneering group CREW, is a very good example of how this principle is used as part of the design of the experience. In this piece the audience is divided into several groups, one of them being offered the opportunity to put on VR video-helmets. These provide the possibility to switch between a live video view through an embedded camera,

1 *M. J. Schuemie et al., 'Research on Presence in Virtual Reality: A Survey', CyberPsychology & Behavior, Vol. 4, No. 2, April 2001 (pp. 183-201)*

2 *See for example the lecture of Michael Abrash, chief scientist of Oculus, at 'Oculus connect' in 2014 and 2016.*

and a pre-recorded 360-degree video through which the audience member can look around. Each audience member, or as CREW calls them 'immersant', is assisted by a helper that is part of the team. The helper will start to execute all sorts of manipulations on the immersants' bodies, synchronized with the 360-degree pre-recorded video that is being played inside the VR helmets. For example, in the film you see somebody approaching and preparing your left arm to take blood with a big syringe lying on a table nearby while at the same time the helper is touching your physical arm, rolling up your sleeve and cleaning your skin with a damp piece of cotton-wool. Having experienced this piece myself I was confronted with a helper who sometimes performed in perfect synchronicity with the video, but sometimes just missed the right moment by a fraction, thus destroying the intended perfect illusion. After the performance I spoke to the artistic director, Eric-Joris, to point out that he really should train his team better to make sure these inconsistencies don't happen. He told me, to my surprise, that these 'mistakes' were in fact made on purpose, because they realized that the brain would fall asleep after a while if the input given through the video was constantly perfectly matched to the bodily manipulations. It was a very conscious decision to, in some moments in the experience, purposefully create an inconsistency between what the immersant saw and what he or she felt through their bodies. The inconsistency of visual input and sensory skin responses to touch wakes up the brain, which needs to make sense of these conflicting signals. This ensures that the next time these signals are consistent by perfect synchronization, the impact of the created illusion is much stronger.

This example of Terra Nova focusses on the physiological aspect of perception and how to make use of it in the context of a designed MR experience, not unlike some of the physical interaction choices made in The Cube. But also from a dramaturgical point of view, this piece offers many insights into the artistic potential of conflicting spaces. For example, during the whole time a part of the audience was going through this VR experience, another group was watching the procedure as part of the overall theatre experience, knowing they were next. A feature also used in To be with Hamlet where audience members without VR helmets could follow what was happening in the virtual space on large screens. However, unlike To be with Hamlet, in Terra Nova the physical space in which this all happened was also carefully staged through dramatic theatre lighting, the costumes of the helpers and the design of the devices used to move the bodies of the immersants around in the space. The technology was not hidden, or in conflict with the experience, but integrated into the overall design. A third group was first led into another room to witness a monologue while watching glowing traces being made on a fluorescent floor. All the realities; the two staged physical spaces and the diverse pre-recorded virtual environments, were in many ways very different from each other. In the case of Terra Nova the audience was not asked to play a role, like in blackmarket, but they did become part of the performance while being watched by others. Not needing to play a role also strengthened the ever-present understanding that you, as an audience member, are just participating in a theatre play, wondering what will happen next. All these worlds combined made up the total experience, although they did not necessarily all work together seamlessly. This was actually a quality which in its dramaturgy and scenography was questioned by theatre critics. In my case however, back in 2011, I was left with a general feeling of having indeed experienced 'new ground', as the title of the piece Terra Nova suggested, relating to ways of creating a theatrical MR experience, and questioning the understanding of my own perception of reality.

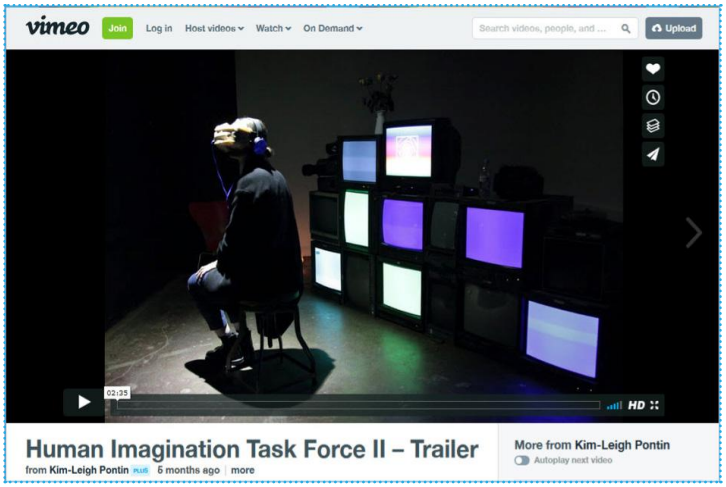
Image from Terra Nova by CREW_Eric Joris (© courtesy of Eric Joris)

Power of suggestion

When designing the scenography of MR environments it is important, as it is in theatre in general, that multiple realities are taken into consideration; both in the design of mixed spaces and in the experience of the audience, especially when asked to participate. It is not right or wrong to aim for the best illusion by trying to synchronize or seamlessly mix physical and virtual worlds. It is only questionable whether a perfect illusion can be achieved, and whether that would be the most artistically interesting solution. In any case it is not possible to ignore the reality of the physical space where our bodies reside and interface with whatever is offered. It is also not necessary to try to hide the technology used, as long as there is a certain transparency about why it is there, or how it relates to the experience. Finally the experiential mix of multiple simultaneous physical and virtual spaces can be achieved by creating smooth transitions, and blurring the boundaries between realities. Or through hard shifts

of attention, whereby spaces keep their simultaneous presence in possible contradiction of each other, forcing the participating audience to make decisions.

That the actual experience of a virtual world, or the illusory perception of an MR environment, is not only mediated by technology, is nicely illustrated in Human Imagination Task Force II from 2016 by Kim-Leigh Pontin. I had the pleasure of experiencing this ten minute experience myself at the Reality Research Festival in Budapest. Welcomed by an actress, I was asked to follow her into a room with many monitors and two chairs. She told me that I had to find the lost and purposely erased memory of my sister inside my own head, through the usage of a 'special device', a VR helmet. When I put on the helmet at first a live video feed was given of the room in which I was physically located. But quite soon all sorts of digital and partly distorted virtual spaces were shown, giving glimpses of a mysterious woman, who was supposedly my lost sister. After a while the live video feed of the room returned and an augmented view was given of a virtual 3D model of the woman floating in the physical space. Meanwhile the actress was starting to tell me with some urgency that something in the system had gone wrong, and that I immediately had to take off the device, or else I would somehow be 'lost in the system'. I enjoyed this mixed view and let it go on for a while, but eventually decided to follow the repeated and mildly panicky instructions of the actress to take the helmet off and put it on the other chair. In order to do so, I had to get up from my chair and walk past the actress. When I had put the VR helmet on the second chair and turned around, I was expecting the actress to look at me and move on to whatever came next. To my surprise however, she continued looking at my now empty chair and repeating the instructions. While I was standing next to her looking at the empty chair I just very briefly had the experience of existing in a parallel reality that looked and felt as real as the one I had come from when I first entered the room. The VR and AR technology used had certainly functioned as an experiential transition from the real to the virtual world, and back again. But it was the suggestive performance of the actress in the end that made me experience the illusion that I had somehow physically 'returned' to a parallel reality. A reality in which she didn't acknowledge my physical presence, and in which I couldn't see my other self, who was supposedly still sitting in the chair. Like Terra Nova this was an experience in which I questioned my own perception of reality. But this time the powerful moment of full immersion in a mixed reality environment was totally embodied, consistent and without any technology mediating my perception.



Screenshot Human Imagination Task Force II

04.
DRAMATURGY OF MULTIPLE AUDIENCE PERSPECTIVES AND LEVELS OF PARTICIPATION

When designing MR experiences, how do you consider multiple perspectives as part of your experience design and incorporate several degrees of participation for the audience?

Audience perspectives

As discussed in the previous chapter, MR experiences consist of multiple simultaneous physical and virtual spaces that can be linked to each other in many ways, in space and time. Audience members can be positioned in these spaces and can be offered a multitude of perspectives. These can be analogue, mixed, or fully digitally mediated, whereby the audience can actively manipulate this perspective by looking and possibly moving around. After putting on immersive VR technology, audience members are in two places at the same time, both in the perception of the virtual world as well as in the physical space where their bodies reside. Watching somebody in this situation from the outside has a particular paradoxical quality to it, because the observed are at the same time vulnerable and empowered. Their vulnerability is strongly connected to the limitation of their sensitivity to the physical space, caused by the visual and auditory obstruction of the VR technology, while their possible empowerment exists in the mental possibilities and perspectives they are given in the virtual space. This paradox of disabling and enabling has strong theatrical performative potential, ranging from the dramatic all the way to the tragic. So the audience perspective is not limited to being inside either a physical or a virtual space; watching an audience member being 'inside another space' has dramaturgical potential, whereby the participating audience member becomes a performer.

The so-called VR Opera Weltatem, a collaborative project from 2016 by De Nederlandse Reisopera, Het Geluid Maastricht, Wildvreemd and many others, is a good example of audience members becoming performers. As described in the article, the audience is partly witnessing a live opera performance by professional singers in a staged physical space, while having an immersive VR experience in which they are encouraged to sing themselves. In this piece the audience become performers by swapping roles from witness to VR participant halfway through the theatrical experience. For the witnessing half of the audience, watching the VR participants as performers is enhanced by physically mixing audience and trained opera singers in one staged space, creating many perspectives and lines-of-sight. Furthermore, the use of immersive VR helmets redesigned as theatrical masks adds to the performativity of the audience members wearing them. In this case the normally disabling effect of becoming partly insensitive to the physical environment is actually used as an advantage. Putting on the mask lowers the impact of 'being watched' by others, and makes audience members feel less inhibited when asked to make sounds and perform quite expressively with their untrained voices. Having experienced this piece myself I can say that the VR exercise did indeed feel like it was taking place in a private space, even while knowing that I was being watched. And watching others making uninhibited sounds, increasingly synchronized, was to me touching in its collective, mildly insecure, effort of self-expression. It is however very important to understand that every participating audience member is different in their tolerance and desire to be exposed both to others and to new technologies. An older lady, for example, who was standing in front of me, was clearly anxious about losing her sense of physical stability when she put on the VR helmet. This in fact is not an unreasonable fear, because this technology can be very disorienting to people experiencing VR for the first time, especially when physically standing up. In Weltatem the mixing of professional performers, with the audience divided into two roles in the same staged space, served a second important purpose in this context. The professional performers also acted as personal assistants to the participating audience members by helping them put on and remove the VR helmet-masks. In the case of the old lady, the assistant held her hand while she was going through the VR experience, offering her physical stabilizing reinforcement. Next to its practical side this unintentional 'scene' was to me touching in its simple theatrical fragility and heart-warming spontaneous connection between strangers. Another intriguing account of performer-audience-merging.

As mentioned before, when using networked MR technologies, spaces that are in different physical locations can be interconnected. This also means that audience and performers don't necessarily have to be in the same physical location to have a live shared experience. Especially in the project Worlds, described in the article Moving between worlds, where not only the audiences are distributed in several physical locations, but the performers are too. This not only offers an incredible multitude of audience perspectives on the theatrical performance, but also creates opportunities to play with different performer perspectives and inter-relationships. The article discusses a wonderful diversity of possible configurations in several projects, and raises interesting design questions concerning the performers' ability to be aware of each other while situated in different physical spaces. It also discusses how mediated audience perspectives can differ from those offered to the performers, creating dramaturgic layers of artistic possibility.

Live interactions

Through their embodied nature and potential for real-time responsiveness, MR technologies are designed to be inter-active, or at least re-active, which means that participants can influence the immediate multimedial output through live physical actions. The most basic function, in the case of immersive VR, is the ability to look around 360 degrees inside the mediated virtual space. When so-called real-time 3D computer graphics are used, an audience member can also freely move around within

this virtual three-dimensional space[1]. This is a technical possibility that most people know from its application in so-called 3D free roaming computer game-genres, where the player can move around and interact with the virtual world, objects and characters through a controller. It is this familiarity with 3D games that might also explain the expectancy for user-interaction when audience members are offered game-like interfaces in a theatrical context. In To be with Hamlet this effect was even so strong that it became a challenge to keep the audience focused on the play, because they were allowed to move and look around the virtual set. At the same time the article mentions that the impact of certain story elements and dynamics of the text, like the sense of remoteness and danger, are enhanced by making them palpable through this embodied experience of the virtual scenery. Another element explored in this research project, is the relationship between performer and remote audience. Particularly questioned is the perhaps obvious, but in VR often ignored, fact that audience members want to be acknowledged in their presence when enabled to participate.

Designing interfaces to interact with the virtual world can also be an artistically, and potentially dramaturgically interesting aspect of a theatrical MR experience. The Third Life project, an international arts-based research collaboration initiated by the artists Milan Loviška and Otto Krause in 2015, is a good example of this principle. As described in the article, expressive physical interfaces are explored as part of the performance itself. Here audience members are just spectators, but the performers are challenged to navigate the virtual space through physical contraptions like a trampoline and tracked analogue objects. The performers need to work together and synchronize performative actions in the staged analogue space in order to look around with the virtual camera, or walk and jump in the virtual space, visible on a large projection. The decision to let the performers say their instructions out loud to each other, to enable synchronized actions to negotiate the 3D world, amplified the dramaturgic importance of the inherent game-play offered through the physical interfaces and their controlling mechanism in the virtual world. The whole aesthetic and association with game-like interactions was even further acknowledged by the use of the free roaming 3D computer game environment of Minecraft as the virtual stage.

To enable performers and audience to influence their perspective and position in a virtual world is a derivative of the natural mobile state of our bodies in the physical world. When it comes to embodied immersion it is only natural for the audience to be able to move around in a staged space. In the theatrical MR experience blackmarket, audience members become active participants in the play. They are free to move around, and given a mobile phone to receive user-tailored information and instructions for desired actions. However, the more freedom participants get in their choice of where to go and what to do, the more complex the control over the overall theatrical MR experience will become. It is very difficult to design how participants are directed to do what they need to do, within a certain time-frame, while giving them the impression that they are making their own decisions. This is especially complex when the staged space is not just inside a controlled environment, but also takes participants out into a public space with many uncontrollable elements. The custom interface of the mobile phone app in blackmarket is carefully designed to give clear instructions to the participants about what to do and where to go, while at dedicated locations trained performers facilitate the core interactions. Next to the pragmatic advantage that the mobile phones allowed the makers to literately keep track of the participants, the performers would bring a corrective control-mechanism to the experience in their ability to improvise, parallel to their clear artistic function as characters within the theatrical world. So when participants would need some subtle guidance, or unwanted elements in the public space would start to interfere too much, the trained performers were there to jump in and make any necessary corrections without breaking the illusion of the theatrical experience. Within, of course, the given boundaries of the audience's 'willing suspension of disbelief'.

But what happens if the theatrical MR experience is completely executed by the participants themselves, without any trained performers to facilitate complex interactions and improvise subtle directive actions? Can MR technology alone be enough to direct participants through a fully designed experience? And how responsive and adaptive does this system need to be in order to do this? These design challenges are discussed in the article about Cyborg dating, a collaborative project by the artists Sander Veenhof and Rosa Frabsnap from 2014. In this theatrical MR experience, two participants with radically differently mediated perspectives negotiate an improvised walk through a public space. At the same time they perform prescripted characters, receiving live instructions from the technology used. The article about this project clearly points at the difficulties of creating a pre-written storyline while at the same time needing to be able to adapt to the timing of the participants, their actions and their physical location. In these highly participatory pieces it is very important that the participants get a clear idea what the 'rules of the game' are, including the boundaries in which they are allowed to express themselves. In the case of Cyborg dating these rules were set quite clearly from the beginning, both through instructions given by a volunteer at the start, and by the on-screen textual instructions on the given devices during the experience. However, instructions became confusing when the artists were trying to incorporate a so-called dramatic turn by changing the rules halfway through the piece.

Levels of participation

When designing forms of interactivity for participants it is important to keep in mind that not every audience member wants to fully participate in the performance, or at least not necessarily all the time. When talking to Anette Mees, a pioneer in immersive theatre and former co-director of the British theatre company Coney, she explained the necessity for 'levels of

1 *Although recent developments like the HypeVR camera rig enable stereoscopic 360 film recordings to also become partially suitable for actual physical movement by using a Lidar laser scanning device mapping the depth of the recorded images.*

participation' in the design for interaction with the theatre experience. These levels can consist of a multitude of participatory modes where audience members can decide for themselves how inter-active, or rather influential, they want to be in relation to the theatrical experience. This dynamic approach allows audience members to choose both their perspective and active relation to what is theatrically happening, with the option to change these modes during the piece.

Creating a highly participatory theatrical MR experience, however, doesn't always mean it has to focus on interaction, or the degree of influence an audience member can have. I recently experienced an extreme example of this point in Situation rooms, a 'multiplayer video piece' by Rimini Protokoll[1]. In this work, twenty participating audience members are given a tablet on which stories are told through video about people who are involved in different ways in the international arms trade. The stories are told from a first-person perspective and seem to be based on interviews with actual people. Each participant is positioned in front of a different physical door giving access to a completely staged life-size labyrinth of physical rooms and hallways, built within the theatre space. Clear instructions are given to each participant to copy exactly what is shown on the tablet. So, for example, when waiting in front of the door I saw on my tablet a video of the same door and a hand opening it. At the same time an icon appears on the screen indicating for the participant to copy this action by opening the physical door themselves. For the next hour and 20 minutes I followed the actions shown in the video on my tablet while wandering through the different rooms and hallways, listening to and watching the story of one of the people involved in the arms trade. Every few minutes the story on the tablet would change to a new story from the perspective of a new personage, ranging from a weapons manufacturer to a child-soldier.

Situation Rooms by Rimini Protokoll (photographed by Jörg Baumann /Ruhrtriennale 2013)

Through its exceptionally well timed construction, all twenty audience members were moving around in a tightly synchronized system. In this way other participants physically represent the personages from the stories because they walk, sit or carry out actions precisely at the same time as shown in the video. At some point I was following the story of a hacker and given the instruction to flip a switch at a physical fuse box mounted on the wall in one of the hallways. When I flipped the switch the physical light went off, the video instructed me to flip the switch again to put the light back on. Having copied the instructions for quite some time already, at this moment I was tempted not to follow the video and leave the light off. I felt the need to see if my decision would actually make a difference, but then I noticed another participant watching me and looking at her tablet at the same time. Of course I was also representing some character in the story she was watching, and through this realization I felt responsible for the success of her aesthetic experience by sticking to the plan. I quickly switched the light back on and continued following the instructions, getting more and more frustrated with this system of predefined tightly timed actions. Afterwards I asked the artists of Rimini Protokoll why they had made the decision to leave no room for participants to question the actions they were required to perform and consider their consequences in order to perhaps create more agency. They answered that forcing everybody to follow continuous instructions without space for reflection or autonomy was actually a core dramaturgical decision, inspired by the stories of the people they had interviewed. All the people interviewed seemed in their own way to be trapped in the large system of weapon industry and international politics, in which there was little to no room for autonomy or divergent choices without serious consequences. And although I felt little agency or empathy for the stories told, simply by having no time to let it affect me, the experience did indeed give me a sense of feeling trapped in a system you have no control over, leaving you little room to reflect. In this way Situation rooms is highly participatory and hardly interactive. Whereby the only autonomous choice I had was to stop following instructions with the 'serious consequence' of breaking the theatrical experience all together, which I didn't want to take responsibility for with respect to my fellow audience members.

But what if you do want your audience to participate through interaction, or give them a certain influence on the experience? Taking the full extent of inter-action

1 *Although originally from 2011 it was shown in Amsterdam in February 2017 as part of the Brandstichter Festival, showcasing several works of Rimini Protokoll.*

seriously one should even consider the degree to which participating audience members can actually generate their own content in the context of the theatrical experience; and how this user-generated content is incorporated into, and even changes, the actual experience. Allowing this extreme form of interactive participation as part of the design of the MR experience a full spectrum of 'levels of participation' becomes manifest; from passive audience member to active and 'full-blown' co-creator, with a fluent scale of indefinite states in-between.

Story-telling AND world-building

The idea of participants becoming co-creators raises a whole new range of design challenges. Interactivity and participation impact traditional understandings of linear storytelling and the performance of characters through the rehearsal of pre-scripted text and actions. Even if audience members are only given the choice to move around and choose their own perspective, automatically multiple-story lines are required or at least experienced. How can participants become part of a linear story and interact with it? In blackmarket the theatrical MR experience does have a fixed time-frame and story-driven dramatic arc, but at the same time considers the 'writing of the story' an exercise in world-building. Instead of writing a linear text they start by describing and designing a world in which participants can act as character-types through a clear rule-set. In this way the design of the experience is much more focused on the participants creating their own unique story lines within the overall directed story-world and controlled time-frame.

Talking about this subject of storytelling and world-building in relation to audience participation would require a full article in itself, but it is important to point out that much can be learnt from game-design and transmedia storytelling discourses. More specifically, seen from the context of physical interaction in actual spaces, it is helpful to also look at developments like Alternate Reality Gaming and ART LARPS.

Again, all this should not suggest that theatrical MR experiences have to be inter-active. One could argue though that in using MR technologies, with their embodied nature and potential ability for real-time responsiveness, it is important to make conscious decisions concerning a world building approach to facilitate a degree of interactive co-creation. The argument for designing 'levels of participation' also applies to the notion of co-creative participants. As said before not all participants want to be actively creating something as part of the experience, or at least not necessarily all the time. This relates to the 1-9-90 rule, an insight coming from Internet culture, whereby in the case of a Wiki for example 1% of a given group actively participates in generating new content, 9% sometimes edits existing content and 90% only views the content. One could, based on this general rule, wonder why it is worth putting such an incredible amount of effort into designing modes for co-creation with an audience, if only 1% really participates fully by generating original content. But, learning from Transmedia storytelling discourse, the important thing is that 99% of the audience knows that 'one of them' is in fact influencing live the course of the collective MR experience. Whereby 10% actually tries to verify if this is true and 90% considers it as proof. In designing theatrical MR experiences this principle means that not everybody will try to change the content of the designed story-world, but some space should be carefully offered for a few to make a difference. And it should be clear for everybody when this has happened and how it has changed the experience for everybody. It is for the full 100% of the audience to know that, if they wish, they can inter-act and thus change the experience. This fact acknowledges their unique presence and changes the relationship to the experience completely, whether they choose to act or not.

05.
THE ROLE OF MIXED REALITY TECHNOLOGY AS AN INTEGRAL PART OF THE EXPERIENTIAL ARTISTIC DESIGN PROCESS

How was mixed reality technology incorporated in the experiential artistic design process itself?

Theatre forms have always made use of technology to enhance the experience for an audience: artificial light, projection techniques, audio amplification and stage mechanics. The digital revolution made a lot of separated technologies suddenly communicate with the same binary language of zeros and ones. This enabled us to connect and let interact everything with everything. The steep increase of processing power made it possible to have these connections and interactions operate in real-time, meaning with such low delay that we perceive its performance as immediate - and thus live. Network protocols and infrastructure make it possible to connect multiple spaces around the globe, allowing a shared experience across huge distances. Miniaturization of microelectronics enabled mobile and wearable technologies, combined with satellite GPS and wireless communication resulting in the possibility to create mediated personalized experiences anywhere in the public sphere. At the same time projection and screen technologies are capable of generating huge controllable light surfaces indoors and outdoors. Finally recent VR and AR technologies are rapidly creating interfaces for our bodies to relate to fully immersive or augmented virtual realities. All of this hard- and software is becoming easier for non-technical users to use, and more affordable by the day.

The above summary is by no means a full account of current technological developments, these are just the regular ones that are already having an impact on artistic

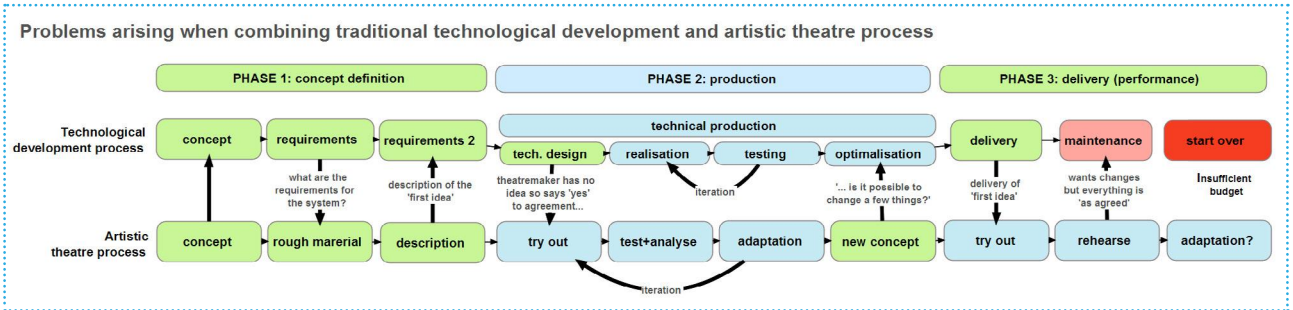
design processes and outcomes of theatre productions. It is however hard for artist to keep up because of the incredible acceleration in possibilities and needed know-how. Many theatre groups and spaces still struggle in their transition to becoming fully digital with their regular theatre technology equipment and infrastructure. These traditional theatres are often organized towards a central point of control, where all technologies come together at one physical point in the space to be controlled by a technician. But what if live input coming from the performers is controlling the light situation? What if the audience is allowed to interact, somehow influencing the medial output on stage? What if the stage itself, the building or its environment, becomes sensitive and responsive? What if these spaces and possibilities become interconnected over huge distances? It is in these kinds of different approaches to who controls what, that traditional theatre technicians are not necessarily trained to offer suitable solutions. Also, other theatre professionals such as directors, playwrights, performers, stage-designers, light-designers and dramaturgs are traditionally not trained to grasp the full extent of the artistic challenges involved. They often lack specific technological know-how that is needed in the wake of decentralized, digital, interactive and globally networked technologies. But even if they were trained, it is still impossible to predict all the consequences, both artistically and technologically, of implementing new forms of technology as part of the artistic design process and resulting MR experience. Especially in cases where audience members are invited to participate.

Design iterations, learning to prototype

What theatre and technology have in common is that they both have methodologies to test concepts in practice. In theatre, many ideas can immediately be tested out 'on stage', and later on with audiences in so-called try-outs. One could even argue that in theatre, every single performance in front of an audience is a test where adaptations and improvements can be made based on the analysis of 'how the performance went'. In technological development concepts can be manifested in so-called prototypes, which can be tested in practice and further improved on the basis of 'their performance'. In both cases the analysis of what can be improved will depend on what is considered the goal of the given performance. The cycle from concept to prototype to user-test to analysis to an adaptation of the concept and design of the next prototype, can be identified as a design-iteration.

Unfortunately, often, when a theatre production has a strong technological component, the artistic design process and technical development follow their own parallel design iterations. This could in the worst case lead to badly implemented technology, or limited artistic depth in the final result. When a theatrical MR experience is designed, it is for this reason advisable that artistic and technological development go hand in hand – preferably right from the start of the process, sharing design-iterations as much as possible. There are of course phases in the artistic design process in which combining both worlds is counterproductive: for example when the technology is not yet ready to produce anything that live performers can play with, or audience members can test. In such cases, some stand-alone technological development time is still necessary.

In the Third life project, many novel interfaces for the performers to interact with the virtual world were conceptualized and needed to be developed first. This research project brought together representatives from the performing arts and specialists in human computer interaction and computer science, coming from several Universities in different countries. The technical crew started to create specific components for these novel interfaces in their own respective departments. As mentioned at the end of the article the technical teams worked mostly together by video conferencing once a week. The whole team, including the performing artists, only met physically two times during the whole project: one week to put together the technological components to work in unison, and one week, several days before the premiere, to rehearse the actual performance. Having not been a part of this process, it is impossible to have an opinion whether this approach to the phasing of the technological and artistic development was a successful one. This research project does however illustrate that ideas for new technological interfaces, meant for artistic performance, do need to



Technical and artistic development iterate in separate parallel processes with the risk of becoming disconnected

be built first before they can be tested on their artistic potential. However, in this case, there seemed to be very little time to adapt both the technical possibilities, and their artistic potential through many shared design iterations.

Long term technological development, creating performance tools

There is a difference between testing how to use existing technology in an artistic context, and developing new technologies to enable possible novel forms of artistic expression and experience. Within theatre productions it is understandable that technological development is mostly focused on enabling a particular artistic idea. The problem with this project driven and short-term problem solving approach is that the resulting technological application can only do exactly what it was designed for. This can already be a challenge within the theatre production itself, if the developed technology is offered in a stable form late in the creative process, while being based on an early artistic idea from the beginning. In taking time to develop a technical solution without staying in touch with the artistic development, there is a risk that the artistic concept has already dramatically shifted in another direction. This could make the offered technical 'solution' immediately obsolete due to the disappearance or shift of the artistic 'problem'.

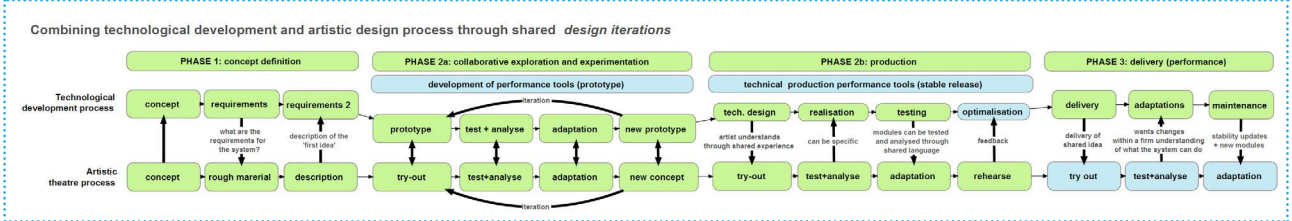
Another way of approaching this challenge is to think of building technological tools for performance that can be used in multiple ways and constantly adapted throughout.

The article Moving between worlds illustrates this development of performance tools in a wide variety of applications and artistic needs. It also shows clearly how some developments spread over several projects, slowly building more features, stability and adaptability into the system. This may result in the open-source release of several of these systems, for other creatives to use in their own artistic explorations. These development trajectories can even end in commercial products that can be bought as stable and supported tools. Many of these available tools are designed to do a specific thing or cater to a specific discipline. For example, software targeted at a light designer is often different to that of a video designer or audio designer. In my practice-led research in the last ten years we have developed our own performance tools for art-based research and education, which were required to be multi-medial, modular, non-hierarchical, networked, low-latency and adaptable in real-time. These tools were also designed to be controllable through user-friendly customizable graphical interfaces that can be understood by non-technical professional artists and students alike. In my research I worked with a team that started carrying out this development with the basic assumption that technology should be able to facilitate a creative process in a performative context, and at a very early stage of concept development, while most of the artistic content is still being explored through experimentation or improvisation.

In theatrical MR experiences you will need this approach to your technical system to enable the artists themselves to try out their ideas in practice in many design-iterations. This needs to happen within a certain creative flow in a constant dialogue with the technological possibilities and limitations. A system that can do anything, anytime, without crashes or effort, does not exist, but an increasing set of good systems start to emerge that at least facilitate this workflow to a certain degree. One such performance system is for example the software Isadora, developed by Marc Coniglio. He started to build his own technical system out of his own artistic need for using interactive media in his dance performances with Troika ranch. This software has been in constant development since 2002, but was developed for years mostly by Marc alone, making its progress very slow. Recently however the software has been given a huge boost in its core performance, usability and cross-system compatibility and interconnectedness. It is now being developed by a team of programmers, has several ways to extend its possibilities with personalised custom modules and is supported by an ever-growing user-base of interdisciplinary artists.

In spite of its modest OpenGL 3D modules Isadora is not a real 3D engine or full MoCap ready software environment, and for this reason seemingly unfit to facilitate many of the MR experiments that are described in the articles of this publication. When however the MoCap data needs to be linked to output other than a virtual 3D world, connections can be made[1] to control the lights, sounds or video projections in the physical space. This type of software can function as a bridge, or controllable connecting environment, between technological systems

1 *For example through OSC*



Technical and artistic development iterate in partly shared processes through added phases staying attuned to each other

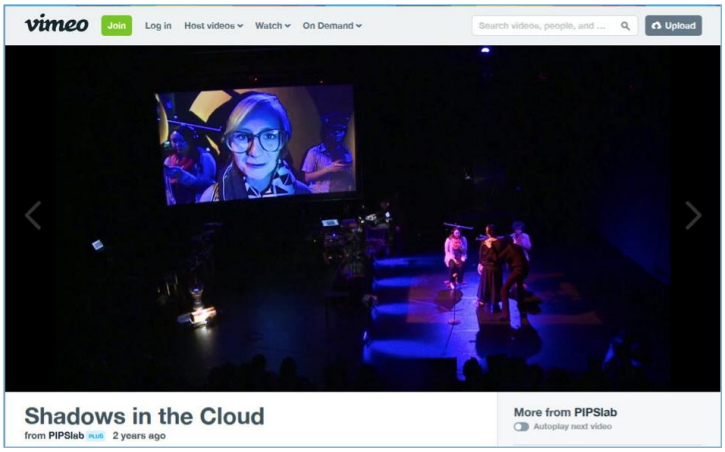
delivering in- and output in the physical and virtual space.

Again, it is understandable that theatre companies don't have the resources, know-how or will to embark on long-term technical development to create their own performance tools, as larger institutes like Universities do. For a theatre-maker, having a technical specialist come up with a technical solution to their short-term artistic problem is an obvious choice, rather than spending a lot of time having to think about complicated systems with unknown impact. But maybe there is some middle ground where existing technologies can be used in smart configurations, whereby the technology is at least set up to be more responsive and adaptable to the creative process itself. And those few technological solutions that need to be developed, because they simply do not exist, are developed with longer-term use in mind. More substantial collaborations with Universities, or other research-based technological development organizations, could also be explored.

In any case, it might help to consider technical development in the context of performance, as for example developing an instrument with which you can make new music, which you may not even have composed yet, instead of a music box that can play a fixed set of tunes perfectly.

User testing AND paper play

When it comes to audience participation in theatre, or the handling of a given technology by a partly unknown user, the worlds of theatre and technology have even more in common in their shared challenges relating to interaction-design and usability. It is already quite a challenge to create technological tools that are suitable for performers to express themselves artistically. It is even more complex to design tools for audience members that you haven't had time to work with, and who are very diverse in their desires and abilities. As in Third life project one could start by making the tools first and then test them on users. In this case, actors explore the tools' artistic performative potential within their technological limitations through improvisation. But what happens if you test on audience members who need to be somehow guided through an experience, without much time for practice and experimentation? In this case, especially with a limited technological development budget, it is advisable to test the interaction design of the tool, without actually building the final technological tool first.



Screenshot: Shadows in the cloud – PIPS:lab

A good example of how to approach such a process is described in blackmarket, where a custom phone app needed to be developed as one of the core technologies to guide the participating audience, both indoors and outdoors, through the experience with personalized content and instructions. An excellent way to develop such an app and its user-interface, is by starting with paper based mock-up screens and interaction scenarios. When done properly an early so-called paper-play test will give a huge wealth of information on what could potentially work and what doesn't, before any kind of technology is actually developed. Then in several design-iterations sketch-based prototypes can be developed and further tested on user-groups.

Another approach to simulate user-interactions is the use of a hidden human controller in the context of a theatrical and participatory MR concept. In the years that we have trained ambitious art students and experienced professionals alike, I always advise them to try out complex technological interactions by creating a modest manual control system first. By enabling artists to directly respond to a test-subject by manually changing whatever it is in the physical or virtual space that needs to change, they can immediately test their assumptions on what works and what doesn't. These changes can be made through simple controls like buttons, sliders or a mouse, and this can be done from a location hidden from the attention of the test-subject. Our brains, combined with our senses, are the most advanced computational machines we have, being able to interpret complex behaviour and adapt to most subtle or unpredictable input. It also carries contextual memory and can improve responses through experience. These are core-features that are some of the hardest things to achieve in automated technical systems. In order to approximate the incredible flexibility of the human brain, technological development will soon involve areas of expertise that deal with artificial intelligence and self-learning systems. Once they have tested several design-iterations of their prototype setup by creating more and more complex interactions through manual control, an artist is much better prepared to build an automated version of the setup; or give much clearer instructions to a specialized technical developer on the logic and adaptable behaviour the system needs to have. However, we have often seen that artistic ideas, wildly complex from a technological

point of view, suddenly became irrelevant when tried out manually first. In all cases, through this manual experience, the artists were much better equipped to translate their own embodied mediated responses into logic that technology can follow, and that would still make sense to participating audience members.

Technology will fail

Technology is part of the world we live in, and, as everything in this world, it is imperfect and susceptible to failure, especially when it is new and underdeveloped. Established theatre technologies are built to be stable and consistent for the simple reason that 'the show must go on'. The more systems become open, multi-functional and adaptable, the larger the risk that something goes wrong at some point, either through their complexity or through ineffective use of their hardware. Add unpredictable input coming from performers and participating audience to that already unstable system, and the recipe for disaster is complete. There are several ways of looking at this inevitability that technology will fail. One way is to use unstable open systems for the duration of artistic explorations through experimentation and improvisation, and later shift to a complete remake of a dedicated system once it is clear what the theatrical MR experience should be. Another way of dealing with this is to accept that technology fails and create backup-systems and fall-back scenarios that can be quickly switched to, should an error or full crash occur during the performance.

In all cases it is possible to look at the inherent failure of technology from a dramaturgical point of view to explore its artistic potential within its limitations. This can be done in many degrees of control and technological glitches can even be faked, as mentioned in several of the articles. A most radical approach to the acceptance that technology will fail can be found in the Dutch experimental theatre collective PIPS:lab. Their work can be best described as a combination of theatre, audience participation and crazy technological inventions. From the very beginning the collective decided that all media that is used needs to be generated live in the performance itself, leading to some form of narrative. They do this with an endless array of self-made high-tech tools that can track, record, play and manipulate image, sound and 3D data in real-time. Both in their concept development, technological innovations and rehearsals, they always seem to look for the exact point where everything is still working but near the critical threshold of collapse and chaos. In their performances this creates a very powerful tension as to whether 'the system' will hold, all the way through the content creation part and unfolding of the narrative. When I experienced the piece Social fiction 2: shadows in the cloud, I did not only feel this tension as a substantial part of the dramaturgy, but also in fact witnessed full system crashes in front of a large audience. Instead of trying to hide this event, PIPS:lab completely acknowledges this fact as part of the performance, and starts to reboot the whole system to discover what is left of the gathered materials and, if need be, start over. One could argue this radical approach would be unsuited for many forms of theatre, since breaking the delicately constructed experience at seemingly uncontrollable moments could completely destroy artistic intent. On the other hand, to me this approach only makes more tangible the inherent vulnerability of the live performing arts in general; in their possibility of failure at any moment, which is one of the core distinguishing qualities that sets it aside from all other forms of art.

06.
THE ROLE OF MIXED REALITY TECHNOLOGY AS AN INTEGRAL PART OF THE EXPERIENTIAL ARTISTIC DESIGN PROCESS

How did the collaboration with multiple disciplines develop over time and what influence did it have on the artistic design process?

Theatre has always been an art-form where multiple disciplines need to work together to create a multi-sensory experience for an audience. Historically theatre has integrated knowledge from writing, physical performance, light and sound design, music, projection techniques, fine-art, architecture, moving image and stage-craft related technologies. With the emergence of the digital revolution, and many technological possibilities to have performers and audience members actively manipulate medial output in a theatrical context in real-time, the need to expand the already existing multi-disciplinary knowledge becomes evident. In this context theatre can potentially learn a lot from specialists operating in the field of interaction- and game-design, media technology, ICT, microelectronics and many types of creative coding, just to name a few.

When new artistic ideas lead to the need for disciplinary knowledge that is not available within the familiar group or associated network, new specialists from other fields need to join the team. Depending on the type of artistic organization, multiple disciplines work together in different structures ranging from very hierarchical all the way to loose collectives. In all cases it is essential to realize that when a new specialist joins a team, specifically when coming from a field other than theatre or the arts in general, a substantial amount of time needs to be invested into getting to know each other's work-culture better. As a simple example it is very illustrative to look at the word

'performance'. When a technological discipline uses this word it is quite likely they mean something in the line of 'the degree of efficiency and stability with which the technology is doing exactly what it is designed to do'. Not necessarily the meaning a theatre discipline would give to the same term. From a disciplinary perspective this means understanding each other's language, methodologies and phasing of the process of creation.

Design the interdisciplinary process

When designing theatrical MR experiences it is not sufficient to put several disciplinary specialists, from different work-cultures, together in a multi-disciplinary process, assuming they will automatically work together effectively. Understanding each other's language, methodology and phasing of the process means a form of interaction between the disciplines needs to happen, whereby all disciplines are partly changed through the exchange. For this reason one could call such a process interdisciplinary. It doesn't mean that specialists will suddenly do something else, it means their specialist knowledge and methodology will expand and change through their interaction with others. It also means that a shared, or hybrid, language emerges through this exchange, that is needed to conceptually bridge and incorporate all the know-how involved. It also provides an essential shared platform of understanding, from which to analyse what is considered a successful artistic design choice and what is not.

As described in the previous chapter, the worlds of theatre and interactive digital technology need to phase the process in such a way that they can meet in a shared creative experience, preferably through several design iterations in prototyping and user-testing techniques. The earlier these disciplinary worlds can meet in a shared process, the faster misunderstandings concerning language and methodology can arise and be resolved. Some might think this iterative artistic design process approach requires more time and resources, and that this more research based approach is hard to sell to traditional theatre funding schemes, which focus mostly on the production of successful end-results. However, in our practice-led research activities over the last ten years we have often found times that having interdisciplinary misunderstandings and creative development challenges arise very early in the process, through shared iterative design cycles, actually made the rest of the production increasingly effective, and produced much more integrated and novel MR experiences.

Who is directing what

In the articles of this publication, many forms of disciplinary collaborations are described within many different organizational contexts and structures. When an artistic organization is structured in a hierarchical way, creative decision making can function very effectively as long as the artistic director has a clear vision and understanding of how to get all disciplines involved to work together in creating an MR experience. A collective, however, offers more space for equal responsibility for each specialist to contribute with creative ideas and unconventional strategies, possibly leading to new experiential innovations. In any case, when a theatrical MR experience is developed, it is essential that know-how on designing and directing an interdisciplinary creative process is present within the team. In the context of theatre, each individual discipline should also ask itself to which degree this is the case. It is also important to reconsider who should be in charge of what, when the collective's desire is to innovate, to create something new. The position of director can be given to multiple people, or could be a position that shifts among several team-members on the basis of what disciplinary know-how should be in the lead for a given creative situation.

The role of a dramaturge in these kinds of processes could also expand considerably when whole new areas of expertise are added to the group dynamic. One could, for example, think of a 'technical dramaturge', who would be responsible for building and voicing conceptual bridges between the artistic theatrical idea and creative potential of given technologies. This person also needs to be able to translate these conceptual bridges into practical suggestions on what kind of technical test-setup could provide an experiential means to explore their creative potential.

In the new field of VR productions it is often very visible from which disciplinary tradition the given leading director is coming. In the worst cases it means that filmmakers make films, game designers make games and theatre makers make theatre inside a VR platform. This seems to be a common first step in the emergence of a whole new medium, just like the first films were in fact just static recordings of a theatre play. Film as a new medium began after somebody started to move the camera and cut the film into segments, suddenly creating a whole new range of professional know-how and disciplinary specialists like cameramen and editors. But more importantly, it changed the way, or at least created new possibilities, for how we tell stories and create experiences for audiences. Very recently, first steps are becoming visible in new forms of experience and storytelling in VR, whereby know-how from very different disciplines is successfully integrated into a more interdisciplinary process.

Concluding this article, just as in my keynote speech at IETM plenary meeting in Amsterdam (spring 2016), I would like to ask again in this context if theatre makers should only try to incorporate new media and technologies into their already existing conception of a theatre experience; or rather offer their theatre knowledge to an interdisciplinary team trying to make an MR experience that is unlike anything we already know. I certainly hope you will do both, and get inspired by the brave creatives who have tried to do this themselves, and shared their experiences with you through the articles in this publication.

SECTION 2

Experiences from the field

7. BLACKMARKET

photo by James Brown

Project title: blackmarket

Makers/collaboration by: pvi collective

Text by: pvi collective

Country: Australia

Website/link: http://pvicollective.com/projects/blackmarket/

Lessons learned:

- Build the world of the work as fully as we can before starting to build the tech around it
- Situate ourselves as audience. put them first. the work is for them and doesn't work without them.
- Program with the lowest common denominator user in mind (i.e someone who has never used a smartphone)

07.
BLACKMARKET

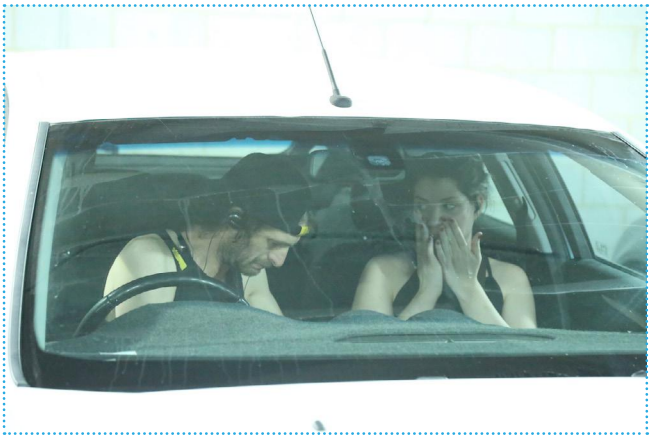
pvi make participatory artworks that aim to creatively disrupt everyday life in public spaces. Artworks aim to affect audiences on a personal and political level and are geared towards instigating tiny revolutions.

We seek out alternative solutions for an unstable future, aiming to not just make things, but to make things happen, using appropriated games, emerging and familiar technology and diy tools.

Our works invite audiences to become active participants, exploring often difficult subjects like privacy, terrorism, consumerism and disaster capitalism within immersive, intimate encounters in crowded streets. We see the city as our playground and over the years it has become an increasingly contested space that requires some deviation from the norm. because we believe, without deviation, new possibilities will not emerge.

We think about our audiences not as art consumers or a ticket buying public, but as creative comrades. we are in this together and play is our weapon of choice.

The blackmarket induction (photo by James Brown)



The blackmarket stimulant service (photo by Bohdan Warchomij)

blackmarket

blackmarket presents audiences with a dystopian near-future, where a global economic collapse is just around the corner and citizens are beginning to notice a disturbing slippage in their comfortable realities. The sense that dark and foreboding forces are pushing us to consider a new period of the human journey, feels close. The realization that we may need to arm ourselves with new skills in order to survive the oncoming clusterfuck, has for some, become urgent.

blackmarket is part audio-driven intervention, part mixed reality app on a smartphone. Situated on the city streets at night, blackmarket invites you into a dark underworld of unlicensed street selling and entrepreneurial trading, in order to rediscover your true worth after the global economy crashes.

In the world of blackmarket, the global financial crisis has arrived, and using smartphones as your survival tool, you must fight for survival as a 'hustler' within pvi's black market economy. As an audience member, you are exposed to an underground economic structure – goods and services are available but cash has no value. The blackmarket app gives you 80 minutes on the city streets to trade your possessions in return for our survival skills and services.

Trading with the goods you bring with you that night, you find yourself hustling with shadowy figures down darkened alleyways, arranging rendezvous points in the city and peddling your wares in order to get what you think you need to cope with an impending societal collapse. Using the smart phone app, audience and performers phones have to be kissed together to activate the audio instructions. Each interaction plays out as an audio choreography, with traders hearing one set of instructions and hustlers hearing another.

From psychological coping mechanisms to urban survival skills, weaponising garbage to learning compassion, blackmarket is highly immersive, physically stimulating and perversely fun.

Creating the world of the work

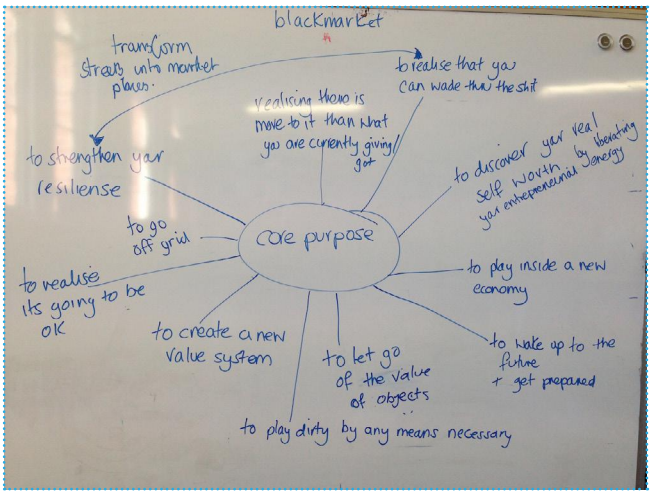
When we are making immersive performance work, we spend a great deal of time constructing the world of the work, not in technical terms, but thinking holistically about its basic infrastructure and mapping out what events occurred to lead us to this particular point in time.

World building is such a useful process for us in this respect. It allows us to drill down into levels of detail that can later feed into all aspects of the work including the voice-over script, costuming, sound design and app development. World building has its roots in science fiction writing, where writers construct densely layered imaginary worlds in order to locate their story within a certain context. It is a technique that is also popular in video gaming, film and role-playing board games.

For blackmarket, the world building process involved working with an economist to understand the basic philosophies of neo-classical economic theory (sounds boring, but it was pretty amazing!), research into alternative economies and real life economic crashes, work-shopping doomsday prepper scenarios, urban survival tactics and generating a back-story series of events that would make sense in the world of blackmarket.

The main principle that worked for us was to think through overarching elements like mood, tone, personality, use of language, color scheme, time-frame, smell and sound, then map those out so that we knew some fundamentals like:

- it needs to take place at night
- there needs to be a sense of urgency to get through the work
- it needs to offer participants actual survival skills [albeit slightly warped]
- it inhabits negative areas of the city like bus stops, alleyways, underground car parks, and activate dead zones like dustbins and public toilets



blackmarket world building diagram (photo by pvi)

- it needs to feel like you are in a real-life movie
- it needs performers who can lurk, loiter, blend in and embody the blackmarket world

From these broad brush strokes, we write the entry into the world from the perspective of the audience stepping into it for the first time. In blackmarket this meant establishing:

- the rules of the game - understanding what the parameters are for our audience
- the countdown sequence – how the audience enters the psychological headspace of blackmarket
- the blackmarket trading floor - audience induction process

The rules of the game

As the work is participatory in nature, we need to be able to convey the parameters of the work to audiences fairly quickly before they begin to play. this is a tricky process, as there is a lot of information to convey and you don't want audiences feeling confused or inadequate, but empowered and energized. For blackmarket, this meant enabling audiences to get their heads around the concept of blackmarket and their role in the work as 'hustlers'. They also need to understand how to use the phones and feel confident about stepping out onto the street *before* their experience actually begins.

For us the rules of the game for blackmarket were established performatively and always 'within the world of the work'. We made a short 'how to play blackmarket' video and utilized our performers as 'induction staff' upon audience entry to the show to try to cover all bases. Before they left, performers had a checklist to ensure they knew the following:

- their mission objective - exchange your goods for our services. choose your own adventure.
- how to make a trade - for those who weren't sure, performers would give a demonstration
- know it's a solo journey, but we have their back out there - show the help screen and emergency call feature
- how to navigate the app - recapping on the 'how to' video
- re-enforce the time limit - adding a sense of urgency and showing them

their on-screen countdown clock

- keep headphones on at all times - to stay in the world of the work.

The help screen on the app gave screen grabs to recap on all instructions. The emergency call number was programmed into all phones in case audiences got lost or needed assistance. The admin back-end of the app also allowed production staff and performers to geo-locate every player thru a map view screen, so they were able to intercept them or locate bad map readers.

The countdown sequence

As the work is primarily audio driven, the voice over for blackmarket is introduced early, so that you are familiar with it. The female voice that is in your head for the duration of the work is polite with a slight 'don't fuck with me' sense of authority. She sets the scene with the countdown sequence as you exit into the streets and provides instructions for all blackmarket services. She is the voice of the blackmarket app.

The countdown sequence is a short piece written for audio narration that aims to paint a bleak picture of how the global economic crash happened pre-blackmarket. This text was based on real life accounts from citizens and alternative media outlets in Argentina, Greece, Iceland and Uruguay during their own periods of economic crisis.

Countdown audio: (as audience exit the trading floor, they hit 'play' on their phone app)

'keep moving hustler.

you need to hear this before you begin to trade.
as you head out there, you need to know how it will happen to you.
I am going to count slowly from ten to one
with every word and every number you will feel a sickening sense of inevitability.
your life as it is now will fade and your future self will slowly come into focus.
on the count of one you will be ready to enter the blackmarket and hustle'

ten

after years of a corrupt government accumulating foreign debt, the financial burden is placed on the people and the situation explodes.

nine

your atm card stops working. the banks close their doors for good. cash is worthless.

eight

rioting and looting is commonplace. people are roaming the streets at night rummaging in bins with their bare hands. you fear for your personal safety.

seven

emergency services cease operation. the government holds crisis meetings. the prime minister resigns. the government collapses.

six

organised crime increases in wealthy neighbourhoods and ransom demands are commonplace.

five

there is a total breakdown of social order. you stop watching the news and start looking out your window as the crisis enters your neighbourhood.

four

a radical new order emerges. pedestrian thoroughfares become open air markets. swap clubs appear in the suburbs. small communities mobilise on the streets to provide essential services.

three

you begin to identify what you will need in order to survive

two

it's time to enact the history of the future

on the mental count of one, the hustling begins

The audience journey through the work

Upon purchasing your ticket and registering for one of three sessions each night, you are instructed to bring five tradeable items with you and arrive at the blackmarket trading floor 10 mins prior to your experience. The trading floor has so far been situated in an abandoned shop and underground car park.

- **The trading floor:**

The trading floor is split into two areas; induction and phone processing.

Gruff blackmarket traders greet you in the induction area, a quiet, orderly space with forms to fill in and numbered tickets to collect. Tablets are mounted hastily onto walls connected to headphones. The 'how to play blackmarket' video plays on a loop.

The trading floor is starkly different in look and feel. Loud, bustling with a sense of urgency, blackmarket traders beckon hustlers over one at a time to log the five items onto the blackmarket database, enter your hustler code name for the evening and issue your smart-phone and headsets. The floor is gridded with chalk, locating hustlers and blackmarketeers' items in a numbered square. Each time a trade is activated on the streets, items are physically moved around the trading floor.

A countdown clock ticks down. Makeshift counters have been hammered together and a pulley system shoots hustlers' goods overhead in cardboard boxes. A large video projection of the 'trading zone' is screened on the wall as a hacked google map with 'hustler icons' moving in realtime along the streets. Blackmarket traders are yelling out numbers, locations and trade deals as they run from square to square in response to what is happening on the streets.

You exit the trading floor back into the city, headphones on, slightly disoriented, blackmarket sound-score playing in your ears, with a heightened sense of awareness and nervous excitement.

- **Hustling with blackmarket traders:**

The city is experienced at night, with trading deals taking place down dark alleyways, abandoned car parks and shabby hotel rooms. Your blackmarket app guides you to rendezvous points where blackmarket traders greet you with a secret handshake and furtive glances. Once a trade is accepted, the two phones are kissed together to trigger a dual audio track to play on each device which instructs both hustler and trader on how to give or receive their service. The audio synching is crucial for the work, as it enables both audience and performer to keep to time, as well as playfully involving the audience in performative actions.

For example:

Hustler audio: 'Now raise your hand to signal your trader.'

Trader audio: 'Your hustler will raise their hand to signal you. Nod slowly and maintain eye contact.'

You choose which services you feel you may need the most and are curious about. They range from physical, mental and psychological challenges aiming to equip you with insights into the post-capitalist world. You may find yourself sniffing Belgian chocolate powder through a strange contraption in a parked car, weaponising garbage, undertaking basic acupressure training, being cradled like a child and sung a lullaby on the pavement or experiencing the almighty come-down from life without prescription drugs.

The blackmarket trading floor (photo by pvi)

The trading floor video projection displaying current trades in the blackmarket (photo by pvi)

- **Levelling up:**

After undertaking your third trade, the phone app enables you to 'level up' and start enacting survival services yourself. It calculates your choices so far and allocates a service that matches with your current survival traits. For example if you chose 'porn', 'stimulants' and 'compassion' the app would calculate the 'deception' service for you, where you would find yourself enacting micro facial expressions to other players, to help them understand when they are being lied to. These services can be undertaken anywhere and once you listen to an audio preview of your service, you hit 'accept' and your service goes live in the marketplace for anyone to experience. You can now choose if you wish to earn back your traded items [or other items in the marketplace] or carry on hustling for more services to enhance your survival rating.

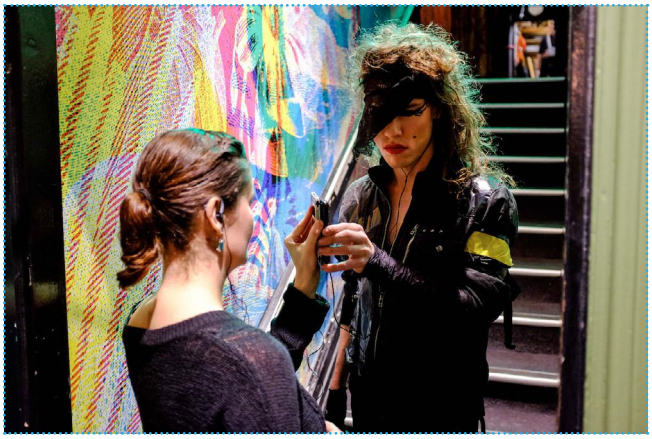
With only 80 minutes to get the wimp out of your system and improve your survival skills, you need to choose wisely. The more services you acquire, the higher your survival rating. All ratings are projected on-screen in the trading floor at the end of your session, so you can compare your efforts with your fellow hustlers' that night. Survivalist traits are accrued depending on the type of services you gravitate to during your time on the street. They range from 'situational awareness' to 'rat bastard cunning'.

The stakes feel high. Time feels precious and running feels necessary.

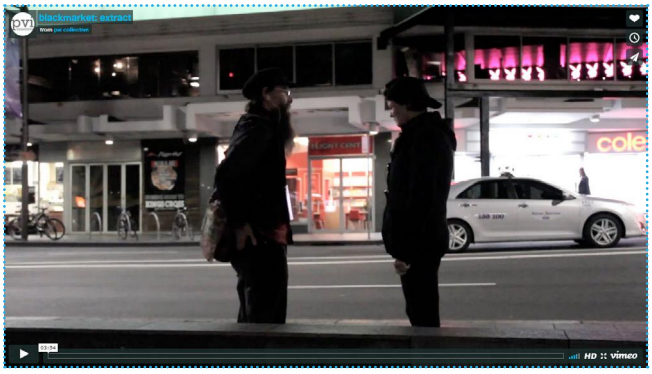
From paper to street

After developing the premise of the work in theory on paper, we decided we needed to put it into practice and test out the basic principle of 'exchange goods for a service' in the real world, to expand on its possibilities. As a performance company who undertake creative interventions in public, part of our process involves experiments on the streets. From joining the army reserves to infiltrating neighborhood watch groups, company members generate material by testing out scenarios and setting each other provocations in relation to the concepts we are exploring.

The seminal experiment for blackmarket was 'to survive for one day in the city without any money'. The rules were simple, armed with whatever was in our pockets that day, we were to assign ourselves special skills (compassion, emergency transport via piggybacks, bespoke neck massages, companionship) and hit the city of Perth, wallet free. What transpired was the realization that people were not only willing to engage in conversation about life without money, but to trade tangible items [we secured food, sage advice, drink, shelter and a whole host of clothing] in exchange for an ephemeral or live experience. The question was, what would they consider 'of value' if money was off the table?



blackmarket, Sydney, Australia, 2016. Kissing phones at the porn service (photo by James Brown)



blackmarket video01: documentation of the compassion service, Sydney, performance space, 2015

Key development stages

Soundscore development

Working with our long-standing sound artist (of 10 years) who is also a film-maker, we sent initial filmic references that had a similar dark and foreboding aesthetic, along with samples of music, and early extracts from the voice-over texts. From this, he developed a blackmarket theme tune that would sit as the audio bed for the entire work, then created each service soundtrack. With over 25 services, each needing a parallel track for the performer, he had the epic task of creating 50 bespoke soundtracks.

Each track has its own sound-score and a prelude 'journey audio' to set the mood of the service whilst the trader is travelling to the rendezvous point.

Prototyping

Working with a programmer who is also an artist within the core pvi team meant that we had a more iterative process to building the blackmarket app. Small workable prototypes were developed on test phones to allow us to experiment with types of interfaces for the marketplace, navigation processes, look and feel as well as basic functionality like how do you move through the app, how do you get back and how can we streamline the navigation to make it as

intuitive as possible. I guess we thought of it similarly to the design of a website, except we had to look at it more holistically in terms of what the blackmarket language is and how that can follow through from the voiceover and the live action into the app visually and sonically.

Some key development points and the time period that they took us are outlined in the table on the right, and illustrated by pictures.

The dos and don'ts of immersive experiences

The following points below are based on our experiences of making work in the public realm, where the city becomes the stage and you are never quite sure who is and isn't a player.

As makers, our main tactic has been to use play and interventions to explore alternative possibilities for the cities we live in. These possibilities may be future focused or enacted in the here and now by means of playful creative disruption.

In making work participatory, the audiences' immersion in the world of the work is an essential consideration for us. How they enter it will set the entire tone. How they navigate it needs to be intuitive and empowering. How they behave within it needs to be guided but not forced, enabling them to retain agency. And how they are extracted from it is so far removed from a traditional theatre experience, it needs thoughtful consideration and is often the hardest part to nail. These are some reminders for us, when making:

What we try to do:

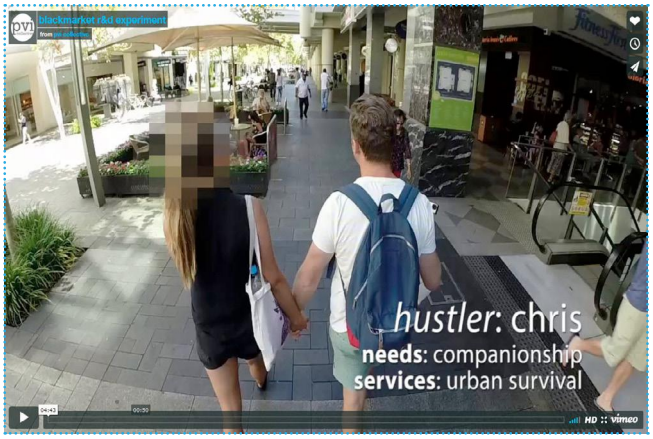
- Build the world of the work as fully as we can before starting to build the tech around it
- Situate ourselves as audience. put them first. the work is for them and doesn't work without them.
- Program with the lowest common denominator user in mind [i.e.

Task	Estimated timeframe
1. Initial conceptual research	24 weeks
2. Interviews, workshops, discussion, think tank sessions with specialists	4 weeks
3. World building exercises: writing, scenario setting, street experiments	4 weeks
4 . Rough blackmarket manual	on-going
5. Sound score development	6 weeks
6. Writing and devising blackmarket services	12 weeks
7. Initial concept designs of phone app interface	4 weeks
8. Wireframe design of the app navigation elements	4 weeks
9. Paper play of the phone app	2 weeks
10. Mapping the audience experience through the work	2 weeks
11. Phone app prototyping of the hustlers' goods in exchange for traders service	4 weeks
12. Site reccie and gps auditing	1 week
13. Scripting all services	6 weeks
14. Full app build backend	8 weeks
15. Shooting script of the 'How to play blackmarket'	1 week
16. Phone app final front end design	2 weeks
17. Film and edit of the how to play blackmarket	2 weeks
18. Final sound score edit	2 weeks
19. In-house testing / bug fixing	2 weeks
20. Test audience runs / bug tests	1 week
21. Final bug fixing	2 weeks
22. Final blackmarket manual	1 week

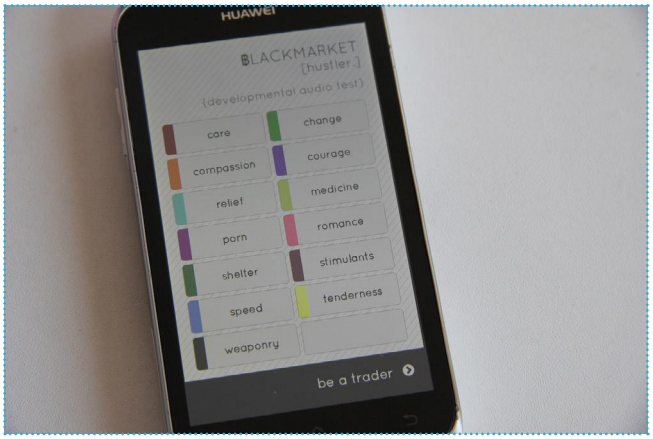
someone who has never used a smartphone]

- Research the site and allow it to inform the work as much as possible.
- Conduct gps audits of the space to identify weak signals on the street and places to avoid.
- Think about the expanded audience experience (passers by, security, shop owners). What do we need to be able to get away with in the public realm? Who needs to know what we are doing and how can the performers and production crew help facilitate this?

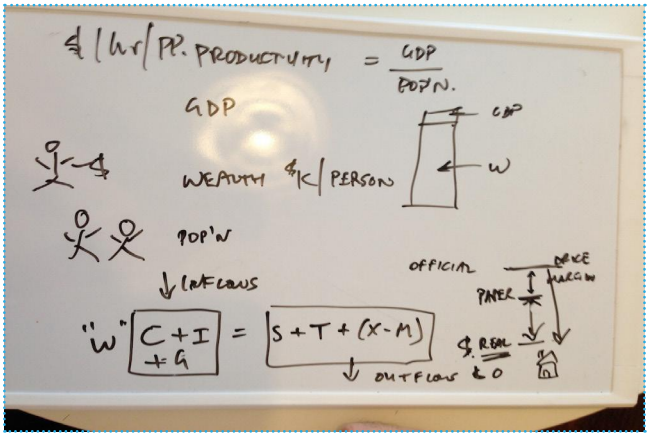
  For example: blackmarket's debut in sydney resulted in performers being rugby tackled to the floor and restrained by undercover police and one of our major props (a converted dumpster), removed by the bomb squad. This was because, although we were working closely with the local police to inform them that the show was happening, we didn't realize that federal police would also have to be notified, in case someone called the anti-terror hotline (which they did, during dress rehearsals!). We attempted to mitigate some of this by equipping performers with 'blackmarket business cards' which contained a number and a brief bit of info about the work. This ensured a quick getaway if confronted by members of the public during a trade, and also spruik (*promote*) the work to local businesses, so that they were onboard and able to play along. Production runners also had safety patrols around the playzone, ensuring each performer was happy and safe and able to report any incidents quickly.
- Paper-play as early as possible. making a paper version of each phone screen, then walking through it a step at a time reveals a lot of the flaws and foregrounds any assumptions we may be making about how audiences navigate their way through the work.



blackmarket video 02: documentation of pvi experiment 'living without money'



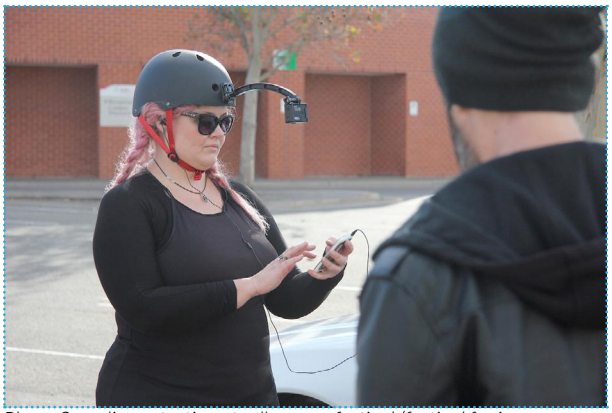
Prototype app designed for testing audio (photo by pvi)



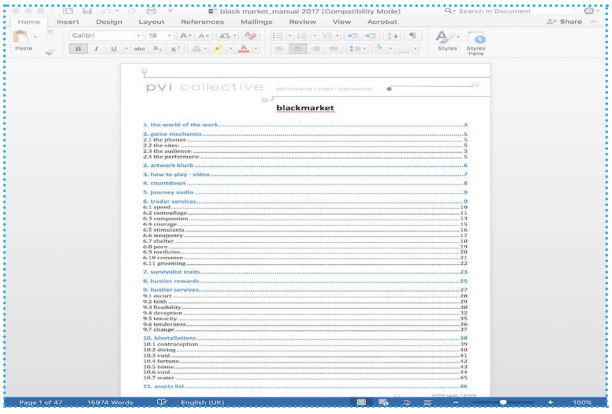
Phase 1: a diagram produced at a think tank session with economic expert, Michael Chappell from Pracsys, 2013

- Write and continually update a manual for the artwork containing background information, marketing material, an outline of the process of audience induction, audience and performer safety, risk analysis, performer roles, list of all the services, background tech info and the texts for each of the services.
- Program for one media device model and test the app on that one device thoroughly.
- Use technology as a tool to facilitate and aid the live experiences.
- Mapping exercises. we use post-it notes and string to map out multiple possibilities that one player might take.
- Be mindful of our duty of care for all involved. audiences may feel isolated out on the streets at night, but they are not alone. There is a team of watchers patrolling the routes and audiences phones are gps tracked back at base, enabling us to see if anyone is straying too far away from the play zone. Performers have exit strategies for unpredictable situations or confrontations they may find themselves in. Police are briefed. Shop traders are befriended and often enjoy being 'in on the act'.
- Always allow for agency & right of refusal. Audiences must be able to walk away at any point if they find the experience is not for them.
- Play test and bug test way ahead of the rehearsals with a full capacity audience (usually friends and peers). As works are often experienced one-on-one but mass distributed, we need to know if the back-end programming is robust enough to accommodate maximum capacity. If not, we're screwed.
- Keep it simple and not let the technology get in the way of the experience.

Phase 2: testing condensation traps for blackmarket (photo by pvi)



Phase 3: audience testing at adhocracy festival (festival for in-progress ideas), Adelaide, South Australia, 2014 (photo by pvi)

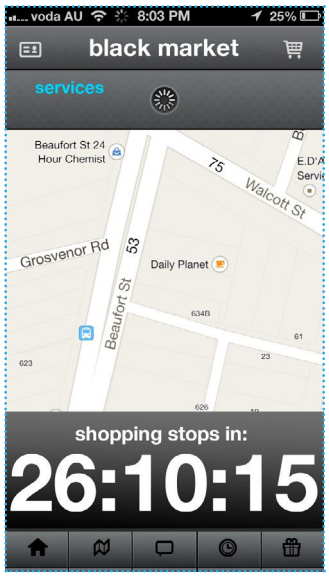


Phase 4: screen grab of the blackmarket manual index

What we try not to do:

- Make it too easy. Laying down a challenge that is enticing but difficult, encourages a competitive energy that helps drive audiences through the work. We apply the 'when in doubt, increase the difficulty' motto and it prevents us from trying to solve it all for the audience.
- Undertake last minute bug fixes in rehearsal stages. This in particular has been a huge learning curve for us and has led to some mighty stressful rehearsals!
- Get over-excited by tech possibilities and add unnecessary new features which will need additional coding requirements and lengthen the time frame for programming and testing, potentially adding in new bugs.

Phase 6: scratch night testing of audio narration for blackmarket services (photo by Amber Bateup)



Phase 7: screen grab of early design concept for the market place

Phase 8: screen grab of wireframe design using 'pop' ios app

Performance history

Debut season 2015 – performance space 'streetworks' series, Kings Cross, Sydney, New South Wales, May – June 2015. http://performancespace.com.au/events/streetworks-blackmarket/

Season 2016 – Perth International Arts Festival, West Australia, Feb 2016. Co-presented by city of Subiaco and Perth Institute of Contemporary Arts. https://perthfestival.com.au/whats-on/2016/blackmarket/

Creative development 2014 – Vitalstatistix theatre company's Interdisciplinary Hothouse Adhocracy Festival, Port Adelaide, South Australia, June 2014.

Creative team:

Devised by pvi collective – kelli mcclus-key & steve bull with steve berrick & chris williams

Economic consultancy by Michael Chappell

Sound pieces by Jason Sweeney

Voice overs by Kate ,eylon

Designed by pvi collective

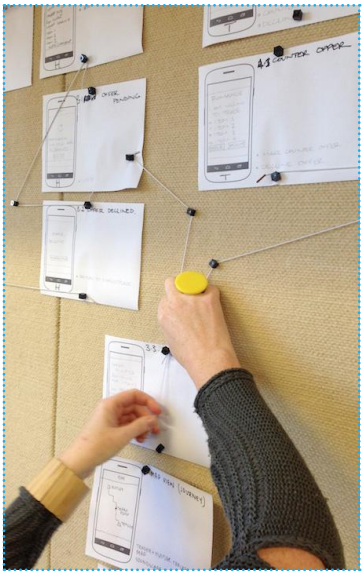
Development and programming by Steve Berrick & Chris McCormick

Branding and visual design by Chris Nixon

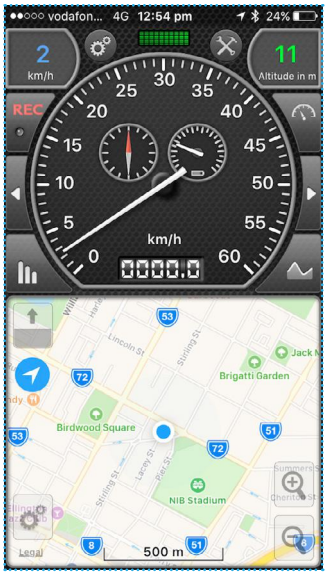
Special thanks to Michele Fairbairn & Lukus Robbins (Adhocracy Festival local artists creative team)

Perth season traders: Chloe Flockart, Finn O'Branagáin, Jacob Lehrer, Joe Lui, Julia Hales, Laura Boynes, Loren Kronemyer, Maja Liwszyc, Moya Thomas (trading floor), Paul Grabovac, Rachel Arianne Ogle, Ruud Hendrikx, Sete Tele.

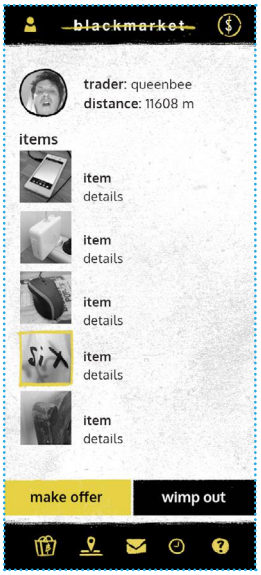
Sydney season traders: Aaron Manhattan, Dale Collier, Harriet Gillies, Julian Woods, Julie Vulcan, Kate Cooper, Leah Shelton, Liesel Zink, Scarlett O'Claire.



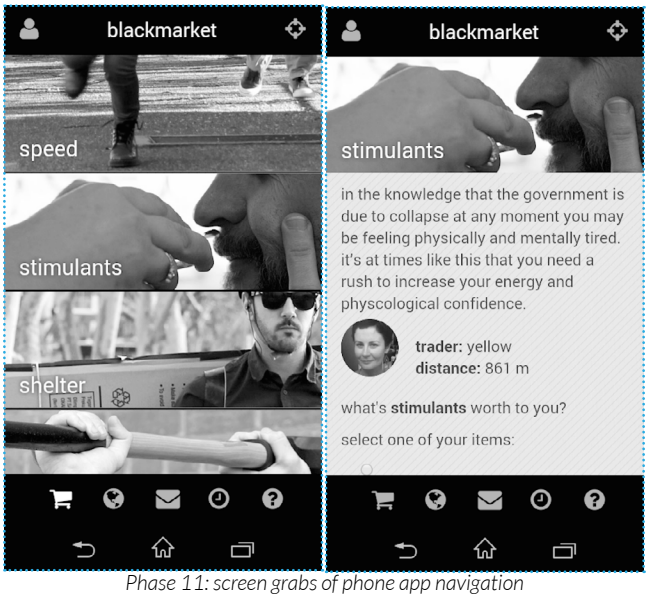
Phase 9: paper play of the phone app (photo by pvi)



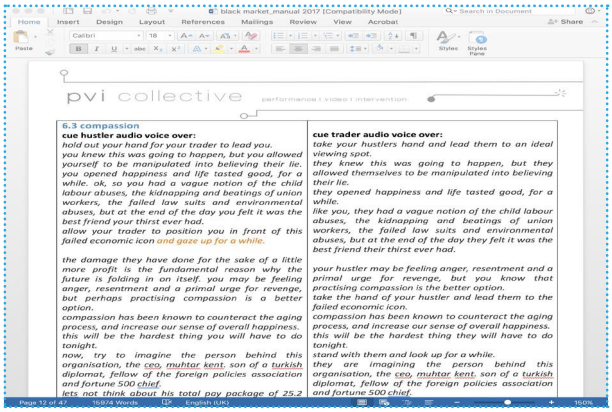
Phase 12: phone screen grab: Checking gps signal strength using the gps speed hd ios app. Areas of weak gps are avoided in the work.



Phase 16: phone app final front end design



Phase 11: screen grabs of phone app navigation



Phase 13: script of the compassion service displaying what is heard by the performer and audience member

Phase 17: blackmarket video 03: how to play blackmarket

8. WELTATEM

courtesy of the artists

Project title: Weltatem

Makers/collaboration by: De Nederlandse Reisopera and Het Geluid Maastricht
In collaboration with: Wildvreemd, Monobanda, Mush Design, KlangK, Spook FM

Text by: Abel Enklaar
Co-authors: Marieke Nooren and Gable Roelofsen

Country: The Netherlands

Website/link: weltatem.eu

Lessons learned:

- Even when working with exciting new technical possibilities, the audience still is there to experience one of the most basic and most powerful aspects of theatre: a genuine exchange between people. It is a necessity to not forget this unique force of theatre, also when you are creating individual experiences in VR.

- You have to understand your audience's experience starts in 'the real world' and traverses across multiple layers of reality. This is a journey you have to design for.

- To be able to work with such a multidisciplinary group of makers (from opera, theatre, gaming, VR) you all have to open to other disciplines, genre and matters of taste out of your comfort zone but on the same time trust on your instincts. Don't be afraid to push boundaries and create other things than you are expected to do. Naivety and not knowing about background, tradition can also be a good thing to work from and trust on.

08.

WELTATEM - A VOICE CONTROLLED INTERACTIVE VR OPERA EXPERIENCE

Weltatem is a music-theatre experience, in which the audience is invited to explore their own voice. Through an interactive VR experience the audience is taken on a journey. Starting with soft breathing exercises, moving into careful humming, and ending in a full voiced melody, the audience will feel as though they are experiencing singing together with a real-life choir. A second group of audience members watches the almost shamanistic process of people discovering their own sound. Afterwards, the groups switch, and everyone gets the chance to experience each viewpoint. Weltatem is a unique experience in which different worlds meet, aside from being a new way of introducing technology into the theatrical realm. It is also the first VR experience which is truly controlled by your own voice. A performance in which opera and the virtual world merge together.

A young audience member at Weltatem singing out loud

The idea of Weltatem.

Gable Roelofsen, director of Weltatem music-theatre production / music theatre Het Geluid Maastricht, explains:

'This project originated in a conversation with the German dramaturg Isabelle Kranabetter.

We talked about how VR could give a possible realization of Richard Wagner's dream of immersion. We discussed how his theatre in Bayreuth was a revolution in the way we experience theatre. We thought about how if we could bring the super-individual experience of VR to the realm of the collective experience of theatre and opera, we could possibly realize a new kind of theatre. Another of our goals was turning VR from a passive experience into an active experience. Soon it became our goal to get people to sing. Those became and stayed the parameters; from individual to collective, from passive to active, from VR to reality, to play around with these forces, and forge something that would be old as well as new, futuristic as well as ancient.

We found great partners in the Dutch Touring opera, WildVreemd, Mush Design, and Monobanda, spook.fm, and vocal coach and artist Kirsten Schötteldreier. With the last four of these organisations, we developed the idea and made it reality. This happened smoothly, since the core idea was solid and never changed. It only deepened. Kirsten taught the interactive designers, like Beer van Geer, a lot about singing, and everyone on the team was very open to interdisciplinary collaboration. This is what made our idea a successful venture into mixed reality work. The intuition and solid instinct of WildVreemd made it possible for us to meet the right partners. Het Geluid and WildVreemd worked together to bridge the divide between the different 'blood groups'. Set designer Marouscha Levy was invaluable because she has worked in both classical opera and VR. Sound designer Henk van Engelen of spook.fm has worked in both VR sound design, as well as opera and music education projects. The whole spirit of Monobanda and WildVreemd seemed to be to cross divides and integrate knowledge. All the people involved, besides being experienced professionals in their own field, are skilled in integrating new knowledge into their own practices.

Perhaps Marieke Nooren, Steye Hallema of WildVreemd and we at Het Geluid recognize this working mentality in others, and know how to quickly detect whether someone has the openness to enter such a process. For me, this experience was proof that having a strong core idea to work from and return to is central for a project to succeed.'

Weltatem premiered at the TechTrip Festival in Enschede, the Netherlands, November 30th 2016.

Phasing the experience, transitioning through different planes of reality

In the creation of the project we had to take into account the various phases of the experience the audience would go through.

The audience enters the church and is divided into two groups. The first group is guided by the choir onto the outer part of the circle, and given VR goggles and masks to put on. They enter the experience, while the second group is guided to the inner circle, where they become the audience of the first group and the choir. Afterwards, the two groups switch roles. In this way, it is an uninterrupted transition between real and virtual, singing and listening. The audience transitions from carefully trying out and exploring their own voices, to basking in the soothing and uplifting, angel-like soundscape of the choir.

The choir functions as the guides and caretakers of the audience, they help them feel comfortable and help them with putting on the VR goggles.

It was a very important consideration to ensure the performance doesn't just begin after the audience have put on their VR goggles, but to provide a frame for the total experience. We really took into account this design for participation. What does it take to get people to be on stage and take part in this experience? To go from being mere observers to full performers. The technology of the VR glasses was very important in this. By using this kind of technology, you can create an individual and private experience, since the goggles totally immerse you in the sound and visuals of this different world. This allowed the audience to feel more at ease, to dare to join in and take part, instead of feeling uncomfortable about being watched. But to get people into this state of mind we had to create the setting very carefully. This meant that we had to focus special attention on how to guide people when entering, being on stage, and putting on the VR goggles. Working with a choir of 30 people allowed each audience member to be personally guided by a singer.

An overview of the stage

The act of being in virtual reality while being watched by others provides an interesting dramaturgical context. The experience itself is very personal. But when done in synchrony with a whole group it becomes an experience in which a connection is made between the individual and the group; hearing others around you join in unison, singing in key, and becoming part of this virtual reality choir.

Because a second audience group was witnessing the first group having their VR experience, we looked for ways to make this theatrical by giving cues in VR resulting in synchronized performative real-world actions. If you position an object or sound cue below someone in virtual reality, this will make them suddenly look down. As the audience seeing this group of people suddenly move, sing, or breathe as if they are part of some ritual you don't understand, you can create a whole new layer of narrative. A new narrative which doesn't necessarily have to align with what is actually happening in VR.

During the process, everyone on the team worked on a text as a reaction to a base text written by the director on breathing and singing. This text connected the physical and virtual worlds, just as the singing did. To build on strengthening the connection between the live and the VR experience, we had a young boy on stage performing that text live, softly whispering on the origin of singing and its almost mythical qualities, creating one full coherent experience out of these different worlds. This text was carefully acted out over the sounds of the audience in the VR experience. Sometimes it seemed as if he was reacting to the sound of the people, while at other moments he would say something, after which the people inside of the VR experience would react. In getting this live text to seamlessly integrate into the whole, there was an intense collaboration between décor and sound design. This created a seemingly mystical world in which different spaces appear to exist on different planes of reality - some of these spaces digital, some physical, but at some points overlapping and merging with each other.

Designing the physical and the virtual. Asynchronous experiences and what to do with them

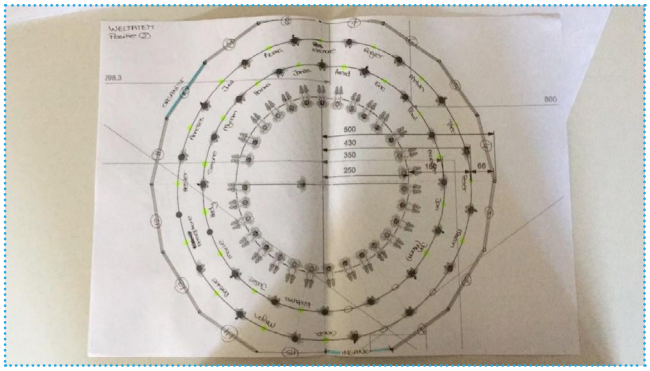
In the scenography of Weltatem we took into account the existence of multiple spaces. We had multiple bubbles of reality through which the audience would move. The audience would walk through the city centre to get to the location of the performance. There, they entered a church, which in itself was already a bubble; a symbol of worship in the middle of a busy market. Entering the church, people would line up and be taken onto the circle on our stage, and the choir. Then they would enter the VR experience, which is the most personal,

individual bubble.

To really create a different atmosphere in the VR experience we chose a black and white world filled with geometric shapes. At the start of the design process there were still talks about creating a VR movie in which we would have physical actors perform a scene that we could shoot beforehand, in the studio. However, as we thought about what we wanted to achieve, and the skills and experience of the team we attracted, we came up with the idea of creating the VR experience solely out of computer generated images. This would allow the audience to have as much control as possible - they could literally lead their journeys with their own voices. This experience was built in the game engine Unity. It allowed us to simulate physics and build interactive visuals that would react to voices. The user really experiences the impact they have on the world around them, creating a truly unique, personal print of the sound of their voice.

In the design of the play, we had to bear in mind that half the audience would already have seen others doing the VR routine, before getting the chance to experience it themselves in the second round. Here, the nature of the individuality of the VR experience really works wonders, since the audience is aware of the people watching this time, as well as of the larger scope of the performance. The challenge was to create a 'ludic' experience; something you just want to take for a spin and have fun with. In the end, we found we had little reason to worry. As the VR experience had its own distinct visual style and identity when compared to the physical reality, and through the control given to the audience member, an individual experience was created that entertains again and again. After the performance was over, many people were so impressed by the way they could interact with the sound and visuals, they would gladly have experienced it again.

And what about the first audience group, which now has to sit in the middle and watch others in VR? Since they have already interacted with the experience, they now get the time to connect with the bigger picture. They listen to the story which is being told, and contextualise their own interaction with the experience.



The stage setting of Weltatem. The black dots represent the audience, the yellow ones the choir.

A student who is hearing the choir while being still in VR

It was the search for a kind of gamification, but without letting go of an underlying narrative, that became one of the key dramaturgical challenges. How can you visualise a singing experience, and how do you get people to interact with the experience and truly open up to singing? How can you make them feel in control, while being guided through the directed experience? We decided to play a voice-over during the VR experience, which carefully takes the audience through the singing.

Interdisciplinary team players. Teaching singing to technologists and technology to singers

This voice-over is a good example of how the design process of the project worked. When we started out we had clear ideas of how the guidance in VR was going to happen. There would be some sort of 360 video in which an actor dressed as a shaman would talk to audience members and prepare them to take part in the singing.

When we started designing the singing parts, we set up various try-outs, with the team and some students functioning as a test audience. We immediately noticed the need for some form of guidance to get people singing, and that this couldn't wait until we had shot the 360 video. This way

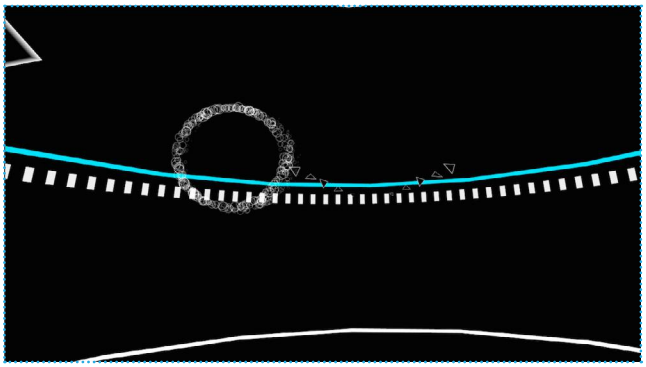
we started to drift away from the idea of an actor playing a shaman, towards a more abstract representation of the shaman; a voice that would hover around, like a ball of energy which would speak to you.

To perfect the VR experience the designers worked closely with Kirsten from KlangK, who was the voice coach for the project. They took the time to translate her style of vocal training into visual objects, thinking about the way that sound behaves, bounces back, and how she usually trains singers in visualising their voices. The visuals in the VR experience were tailor-made to suit the process of truly freeing up your own sound. Through this close collaboration, the VR experience became more and more real in a sense; surpassing the level of entertaining game to become a real singing experience. We also decided to use Kirsten's voice as the voice of the VR shaman. Her being part of the VR experience and at the same time present in the physical space of the play, created another bond between the different spaces.

The project was built on many different layers which all needed attention, and which all developed at different paces. It involved getting a choir consisting of locals to learn their parts, while at the same time choreographing their movements on the floor. Or building a VR experience with its own distinct visual style which at the same time ties in with real life singing exercises. Making the visuals interact with voices. Coordinating this experience with cues in the physical world, and also finding a way to synchronise 30 VR goggles so that we could time the experience exactly. Designing a stage setup to make optimal use of the sound, as well as ways to dress the VR goggles.

This can be seen as one of the big research outcomes of the project; working with live actors, a choir, a VR experience, and set design, all while taking part in a festival. All these things have their own considerations and you need a good understanding of what every aspect requires and when.

Part of the VR experience. A tower built by your own voice. On the left you see the shaman floating



Part of the VR experience. The blue line is controlled by your own pitch

We worked with a large choir, and had to take into account that most of them were amateur singers, part of the local community. Some of them were people who, sometimes because of their age, didn't have much experience with these new technologies. This meant that communicating with them about how and what to study, and giving them the opportunity to practice their parts, became a big priority. Working with new technologies, such as the VR goggles, ended up taking longer than expected. We have now built up extensive knowledge of how to guide amateurs in using the goggles properly, and how to set up, andtroubleshoot quickly. The most important thing we learnt was that it just takes time and patience. Asking a big group of often older people to delve in and begin to understand the nature of this new medium takes time. We created a how-to document and video material, detailing the technical handling of the material.

We also incorporated at least a few minutes of working with the goggles at every rehearsal. We called on the group to check themselves if they ran into problems anywhere along the road. We taught them to be self-reliant, and encouraged them to fix their own problems, but also to be aware that they could always fall back on a more experienced technical team. It is about integration of down-to-earth practice, making people feel at ease with what they are doing and helping them to understand the mindset in which they are supposed to work. Showing the group what it means to be put in VR gave them a better understanding of how they themselves would want to be treated, which they could translate into their own approach towards the audience. This gave the performance a very sensitive, honest atmosphere.

From concept to performance. How design processes differ between disciplines

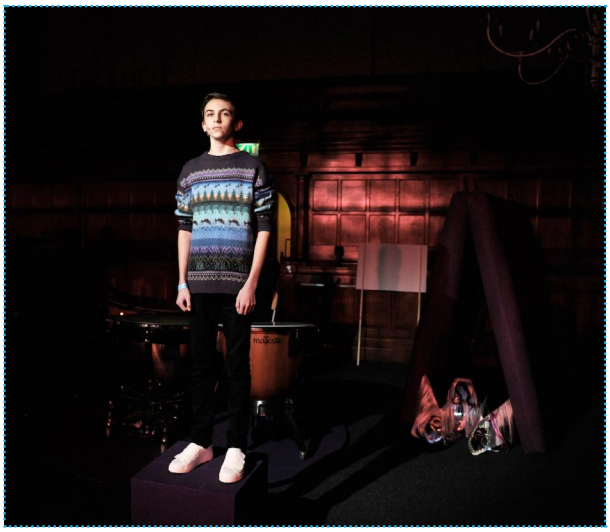
Working with the idea of a voice controlled experience, this being something very unique, meant that we had to develop the tools before we could actually focus on the aesthetic nature of the experience. However, once the tools had been created, we realised that they already dictated the aesthetics. This relationship between functionality and visuals is very important for understanding how a technical team can build a digital world. It is a difficult process, which is inherently linked to the design of the performance as a whole.

To avoid losing valuable time, we had to make sure the tools we developed were exactly in line with the original concept. Thankfully the people at Monobanda and WildVreemd had a feeling for the way we wanted the audience to interact and in what ways we could lead them through the experience. In one of their early prototypes they wrote and performed their own version of the voice-over. This was before we were even thinking about what the voice-over should be like, and we were incredibly surprised by the result they came up with.

Next to the artistic side of working with these new forms of technology there were also very practical concerns which had to be addressed, such as how long does one battery charge last, and how does the microphone need to be positioned to pick up the user's voice.

Our work with designing the VR experience can be seen as an iterative process. We took care in testing early and often. Are the visuals appealing? Do the exercises work the way we want them to? Alongside testing the performance on the original team, we also set out to do short presentations for new audience, giving them as few instructions as possible, and seeing how they respond to the VR experience. This way of working in very small steps, organising many quick work sessions combined with structured feedback enabled us to be sure the technology and game-play of the VR experience functioned as we wanted.

The choir standing on the outside of the circle, singing towards the audience



Anton Hafkamp, performing his lines near the end of the performance

But can we use this way of working to create a theatrical performance? While the VR experience developed step-by-step over time in a truly iterative process, the full theatre experience developed at a different pace. Planning rehearsals was difficult, and in the end we had only a few days to rehearse with the full cast and crew. Looking back at the project, and realising that the choir was made up of people from the local community who also had to work day jobs, you can see there was simply no time for the same stretched out, iterative process.

The final outcome of this project became something that incorporated the innate qualities of a game, text theatre, opera, church mass, art installation, all happening together without being classifiable under any one of these labels. This is because of the integration of all the production elements involved, but above all else because this integration always moved along two distinct pathways; one clear content oriented line and goal, and the other with multi-talented people who truly worked on connecting with others, and found new ways together.

9. THIRD LIFE PROJECT

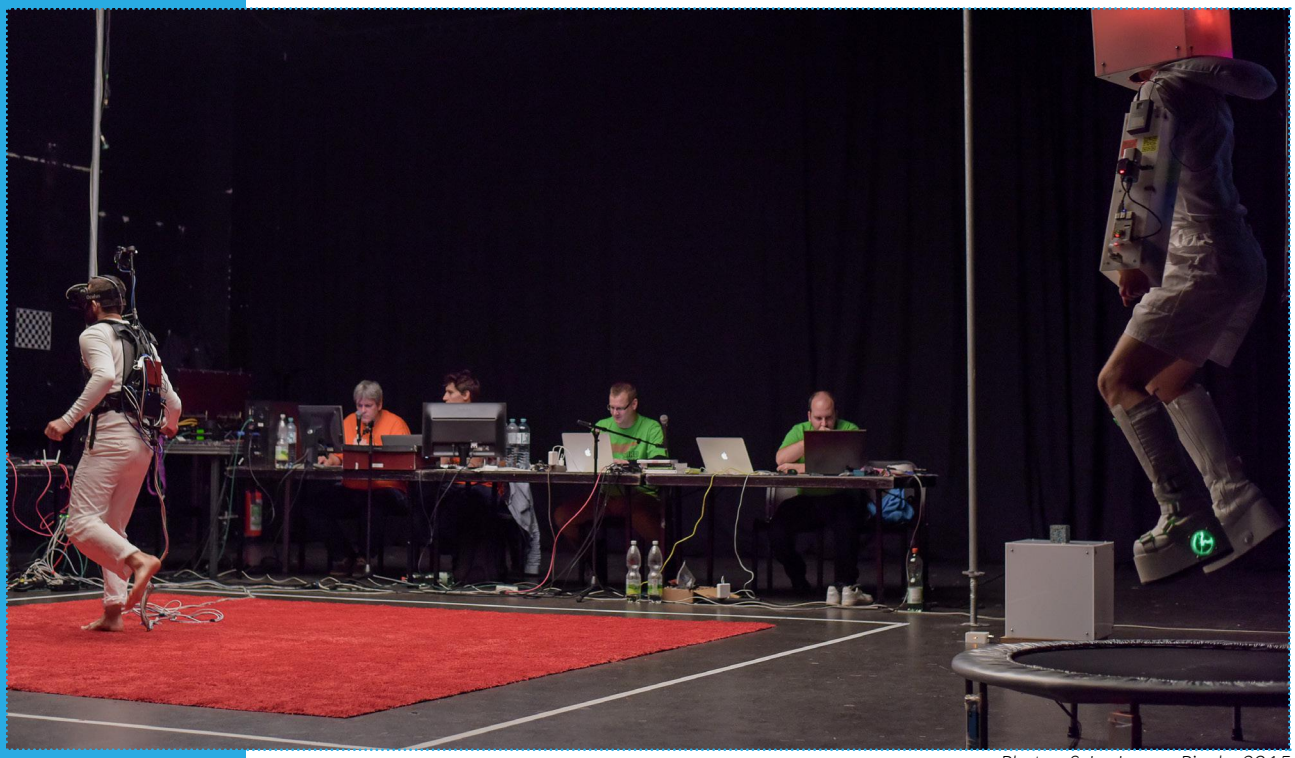


Photo: eSeL - Joanna Pianka 2015

Project title: Third Life Project

Makers/collaboration by: Territorium KV - Milan Loviška and Otto Krause, University of Duisburg-Essen, Simula Research Laboratory, Stellenbosch University

Text by: Milan Loviška, Otto Krause, Carsten Griwodz, Herman Engelbrecht, Gregor Schiele

Country: Austria, Norway, South Africa, Germany

Website/link: http://www.thirdlifeserver.org/

Lessons learned:

- Staging a real-time video game in a theatrical performance brings up for question and re-examination what is tangible and actual and what is immaterial and abstract.
- Interactions in virtual environments that are grounded also in physical world enhance intuition of both performers and spectators.
- Regular online video conferencing meetings afford numerous opportunities to establish the trust and reciprocal understanding, and the respect for different goals, practices, expertise and rhythms of work that are all together necessary for a rewarding interdisciplinary collaboration.

09.
THIRD LIFE PROJECT

Introduction

Working at the cutting edge of live performance, the artists Otto Krause and Milan Loviška have joined with their Third Life Project the 'emerging generation of artists that is turning to digital technologies to fundamentally transform theatre'[1].

This networked international arts-based research collaboration with a team of computer scientists and engineers explores the potential of virtual actions to perform real actions causing extravirtual physical effects on physical objects (output devices) and effects on the bodily and mental states and behaviours of persons (emotions, sensory impressions, beliefs, desires, bodily states, etc.)[2].

Its hybrid nature lies not only in the juxtaposition of real and virtual environments in live performance for a physically present audience, but even more in the work of inventing and implementing strategies and technology for direct engagement with elements of real environments through elements of virtual ones. The artists initiated the project in April 2014. Prof Carsten Griwodz, Dr Herman Engelbrecht and Prof Gregor Schiele joined them to form the core of the team. In October 2015, the team of eleven[3] presented the results of their work in three performance lectures at WUK in Vienna. The artistic idea behind the project emerged from the question of how to stage a real-time video game in a theatrical performance. The performance was not built on a narrative other than the loose narrative of the game Minecraft[4], and focused more on extravirtual avatar interactions with performers, and objects in the real world. The goal of the project both artistic and technological was to devise a distributed, hybrid and distinctive performance, while creating a platform for sharing knowledge between groups that might not have an opportunity to come together otherwise. Each performance was therefore directly followed by a discussion with the spectators to give an insight into how the artists and the experts work, and to exchange ideas about performing with mixed reality and ubiquitous technologies.

Figure 1: Walking through a part of the first world. Photo: eSeL - Joanna Pianka 2015

Designing Third Life

The technological interface of the project combined Minecraft environments, novel tracking technologies and connected objects of the Internet of Things (IoT). A computer server developed as part of the FiPS project was present on stage to host the Minecraft game. We chose Minecraft because of our previous experience with it, but applications in other types of virtual world would be possible as well. The blocky aesthetics of the game defined the overall aesthetics of the set design, costumes and ubiquitous objects embedded in the physical world. The artists developed two Minecraft worlds that contained two different virtual representations of the WUK performance venue. The exploration of the virtual environment started from and ended in the virtual WUK theatre, which served as an entry and exit point from the real world to the virtual one and back. To break the logic of the real world, the first world around WUK was an open space that featured a mash-up of greenery with a desert environment, and contained a village, a huge eyeball hanging in the sky above and programming code flying loosely in the air. In the desert, one could meet a giant server representing Kubrick's Space Odyssey 2001 monolith with a floating foetus inside. It contained a herd of non-player characters (NPCs), virtual pigs, which could be released and guided back to the WUK in the course of the presentation (Fig. 1).

The second world was darker and fantasy-like with mushroom forests, cobwebs, water and lava beams that one could observe while travelling in a mine cart. The long railroad passed along a virtual upside-down version of the Museum of Modern Art in New York City[5] and led to a discotheque, where the avatars could dance and afterwards be teleported back to WUK[6] (Fig. 2).

1 S. Benford, G. Giannachi, 'Performing Mixed Reality', Cambridge, MIT Press, 2011

2 P. Brey, The Physical and Social Reality of Virtual Worlds, *in M. Grimshaw (Ed.), 'The Oxford Handbook of Virtuality' (Chapter 2, 42-54), New York, Oxford University Press, 2014*

3 In addition to those already mentioned are Lilian Calvet, Jason B. Nel, Alwyn Burger, Stephan Schmeißer, Christopher Cichiwskyj and René Griessl.

4 Minecraft is a playground with no explicit objectives or story. Within its environment and events, it creates emotive situations in which players write their own personal stories.

5 Minecraft was added to the video games collection of the MoMA in 2013

6 M. Loviška, O. Krause, H. A. Engelbrecht, J. B. Nel, G. Schiele, A. Burger, S. Schmeißer, C. Cichiwskyj, L. Calvet, C. Griwodz, P. Halvorsen, Immersed Gaming in Minecraft, in 'Proceedings of the ACM Multimedia Systems 2016 Conference (MMSys '16)', Klagenfurt, Austria, May 10-13, 2016. DOI: 10.1145/2910017.2910632

Moving through different parts these worlds (desert, village, tunnels, rooms, travelling in a mine cart, etc.), visiting the virtual landmarks (giant server, MoMa, discotheque, etc.), and executing specific tasks at these various points of the journey were the implicit objectives that formed the experience for the performers as players of the game and for the observing audience. In practice, this intense sense of achievement and the emotional response as a consequence was what created the internalized narrative. Alongside the action, the team on stage was engaged in constant conversation throughout the performance about the progress and performers' experiences in the gameplay, while commenting on the artistic and engineering choices that had been made in the project development. The presence of the engineers onstage allowed us to expose the technology and the interactions of the performers to the observing audience, to reflect on performing with the technology in the course of doing so, as well as creating an opportunity to address and solve any potential technical or performance complications live onstage (see trailer at this link, and see Fig. 3).

In the remainder of this paper, we describe the dramaturgical consequences of some of the most compelling technologically driven interactions through the actual technological interface of the project and from the different perspectives of the two performers, engineers and audience. After that, we discuss the challenges and dynamics of our interdisciplinary collaboration and conclude with a few notes on the design process itself.

The head-mounted display Oculus Rift DK2 was used to enable one of the performers to view the virtual environment in a natural manner. Another motivation for using the Oculus was the existence of an open-source project[1] that had already modified the Minecraft client to support the Oculus. To interact with virtual objects, the off-the-shelf motion controller Leap Motion was mounted on the front of the Oculus and integrated into the Minecraft client. The engineers from MIH Media Lab in Stellenbosch developed the hand gestures

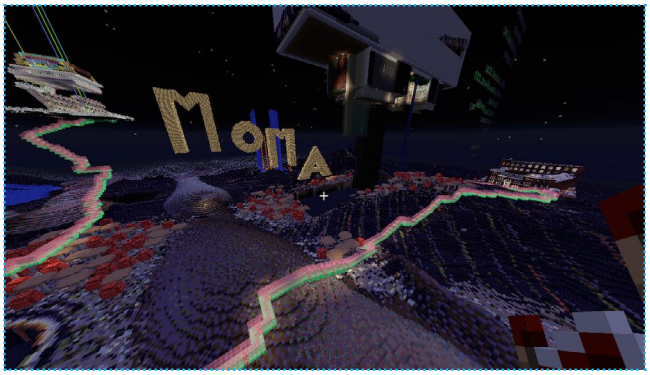


Figure 2: Aerial view of the second Minecraft world. Photo: Territorium KV 2017

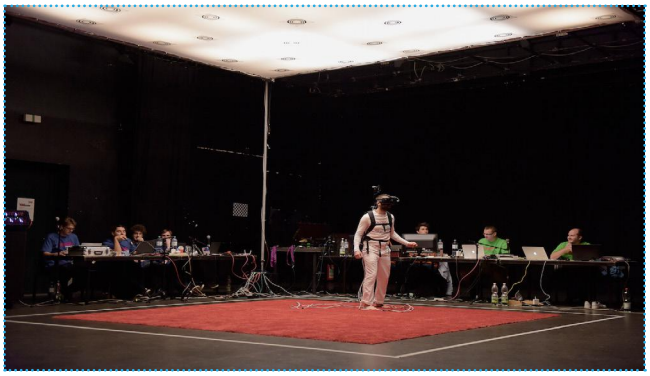


Figure 3: Engineers in live onstage action. Photo: eSeL - Joanna Pianka 2015

database specifically for the project. The performer's hand gestures were then recognized and mapped in a way that allowed him to select, place, break or otherwise manipulate virtual objects. This, on one side, effectively turned the performer into an input device in the technological interface, and on the other side, transformed his arm movements and hand gestures into an odd choreographic output for the viewing audience (see Fig. 4).

Moving in the virtual world by moving onstage had a similar function for the spectators. The Oculus enabled the performer to change his view of the world by simply moving his head. To translate his whole body movement in the real world into movement in the virtual world, we used a single camera worn by the performer, which observed a set of pre-installed markers. These markers are CCTags[2], developed by the engineers from Simula Research Lab in Oslo. The markers enable the camera to track the position and orientation of the performer's torso, and translate this into movement in the virtual world. However, the real-world movement is naturally limited by the demo space. We explored various approaches for moving longer virtual distances. In the end, the outer edge of the demo area was turned into what we named a *scrolling area*. When the performer entered this region, his avatar started to move continuously in the direction that he was facing. The performer could change the movement direction by turning his body and, to stop the continuous movement, he had to step back into the inner demo area.

1 https://github.com/StellaArtois/minecrift

2 L. Calvet, P. Gurdjos, V. Charvillat, 'Camera tracking using concentric circle markers: Paradigms and algorithms', 19th IEEE International Conference on Image Processing (pp. 1361 – 1364), Sept. 30 – Oct. 3, 2012

We defined the inner area by a soft carpet, distinct from the hard, flat surface of the scrolling area. Walking barefoot on the carpet provided the performer with haptic feedback for the transition from movement area to scrolling area and constantly reminded him of the borders of his physical area[1].

The carpet helped the fully immersed performer with his orientation and location in the physical space. Consequently, it became a principal scenographic feature that demarcated the physical space, objects and actions from the virtual ones by placing them seemingly next to each other. This way the audience could simultaneously watch both the real and the virtual world, or look back and forth from one into the other. Another scenographic element in our technological interaction design was the control of stage lights through the changes in daylight during the gameplay of Minecraft. When it was daytime in the virtual world, the virtual world area on the smart stage was lit, while the real world area remained in darkness. When the performer's avatar went to sleep at night, the lights in the virtual world area dimmed while the real world area lit up, allowing the other performer to perform (see Fig. 5).

Expanding on the aforementioned interaction techniques, we also experimented with shared avatar control by both performers at the same time, which allowed them to perform more complex avatar behaviours. While the first performer was fully immersed in the virtual world, the second one was present in the real world and experienced the virtual world using a traditional 2D screen. This gave him the freedom to move around quickly in the real world and perform activities that would be difficult or potentially dangerous for the one immersed in the virtual world. We chose the second performer to control avatar jumping and teleportation. To create a natural interaction, the avatar's behaviours were initiated by performing analogue activities in the real world. For example, to make the avatar jump, the second performer jumped on a real trampoline with embedded sensors.

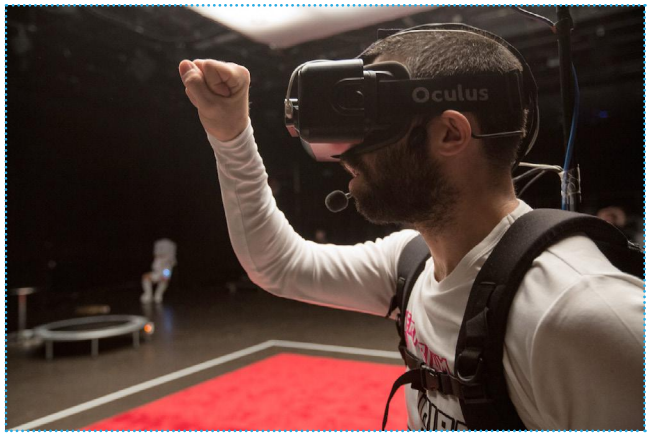


Figure 4: Performing a hand gesture. Photo: eSeL 2015

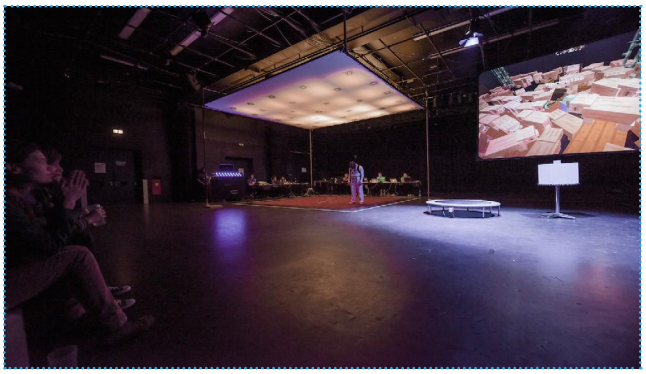


Figure 5: The mixed reality stage from the audience perspective (right corner front) in the course of the light change (left side is dimming – a night in Minecraft, right side is lighting up – a day in the real world). Photo: eSeL - Joanna Pianka 2015

We also used this trampoline to make the avatar dance. To teleport the avatar to different virtual world locations, the second performer carried a physical block to different locations with embedded sensors on stage, similar to carrying the avatar to different target locations on a miniature map[2]. The engineers from Embedded Systems at the University of Duisburg – Essen developed the collection of these sensing devices. Inside of each is either a tiny Raspberry Pi computer or an Arduino platform allowing the IoT devices to send and receive messages and perform actions via a computer network (see Fig. 6).

Overall, these applications opened up space for an interesting power dynamic between the two performers. Executing specific actions in the Minecraft worlds, the first one had the power to virtually activate all the connected physical objects on stage, which would stay otherwise unresponsive. The second one could act as a kind of guardian angel for the first one and help him to progress in the gameplay and as such in the actual performance. If the avatar got stuck in a hole in the virtual world, the performers could combine their actions to jump the avatar out of the hole. If the avatar could not get free or needed to get away quickly from a dangerous situation, the second performer could initiate a teleport. Clearly, we only conducted initial experiments, but

1 M. Loviška, O. Krause et al., cit.

2 M. Loviška, O. Krause et al., cit.

both the technological and dramaturgical potential for novel interactions in the virtual world as well as between performers is high and should be examined in more detail.

The performer's avatar also interacted with NPCs, which are the beings in video games usually controlled by the computer. In our case it was a herd of pigs and randomly generated hostile monsters. Their own behaviour and simple agency introduced a basic level of unpredictability and randomness into the performance. For example, in one of the performances an exploding hostile monster unexpectedly killed all the pigs except one[1]. Such a surprising event not only required a different and prompt response from the performers, but also changed the emotional experience of the observing audience.

Another way to increase the space for improvisation and unexpected situations would be to allow remote users to log into the Minecraft environments. Streaming the performances in the physical world online in real-time could then allow them to see how their virtual actions impact the overall performance. There were several reasons why the team decided not to do so in the performances in Vienna. Making streaming an essential part would have meant a high demand on the Internet connection bandwidth, and the team had no way of knowing whether the video streaming would be reliably available throughout the performance. Besides this, with the IP address of the Minecraft server being public, there was a risk of attacks that could shut down the server completely during the performance. Also, the dramaturgy of the performance was not built for potential manipulation of the virtual environment by remote users, intentional or not. A development like this would therefore not have been possible by simply adapting the performance, but would have required a whole new design starting from scratch.

One of the most important lessons learned in discussions with our audiences was that ruling out the presence and random activity of remote users might have contributed

1 *Originally, the herd of pigs was supposed to follow the performer's avatar from the giant server into the virtual WUK theatre.*

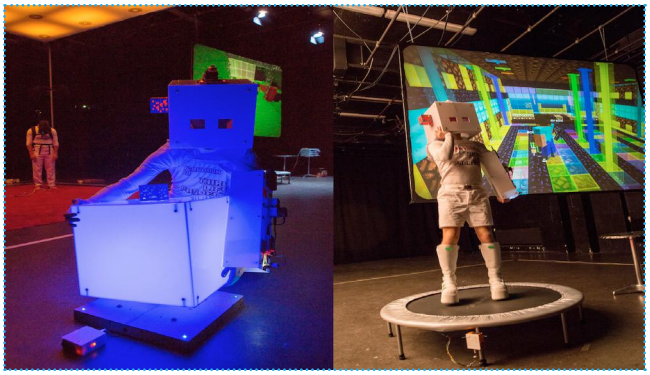


Figure 6: Performing teleportation (left) and jumping on the trampoline (right). Photo: eSeL 2015

to an uncertainty among a few of our spectators as to whether the gameplay was taking place in real-time or not. Some of the spectators also doubted the nature of the interactions between the virtual and real objects. Because the engineers sat behind the computers onstage, some spectators assumed that the engineers or theatre technicians were controlling the interactions. To support this assumption, one spectator even argued that everything in theatre is expected to be fake anyway. This was surprising and rather disappointing feedback, especially bearing in mind that we repeatedly stressed during the project development to the engineers that faking any interactions onstage was not an option, and doing so in technology-driven performances is even more problematic than in any other types of performance productions.

What could help to disperse such doubts is the incorporation of more direct interactions between the audience and the technology and virtual world during the show. In our case, the interactivity was reserved almost exclusively for the two performers, and the audience simply viewed these interactions, just as they might view any other type of theatre performance. The only exception were the two situations in which one of the performers read, with an embedded camera, some QR codes given to the audience when buying their theatre tickets, that allowed them to virtually appear as NPCs in the Minecraft worlds (Fig. 7).

The perks and perils of interdisciplinary networked collaboration

Naturally, there were financial, organizational, geographical and other limitations that influenced the project development and the decision making. In our case, most of the development was conducted via weekly video conferencing meetings, where we could share different perspectives on all the aspects of the process ranging from research topics, through organizational and financial constraints, questions of aesthetics up to the artistic choices and the engineering tasks behind the design of technologies, interactions and scenography. It is important to state at this point, that the artists discovered the scientists by searching online and sending over the concept proposal. One of the scientists approached, Carsten Griwodz from Simula Research Lab in Oslo, liked the idea and brought the rest of the computer specialists from the universities in Stellenbosch and Duisburg-Essen into the team. The whole team had never met before, and the artists and the scientists did not know the other party prior to the collaboration being initiated. Therefore, beside all the other challenges, we had to establish the trust and reciprocal understanding, respect for different goals, practices, expertise and rhythms of work in the process of the actual project development. As it is rare and rather a luxury in many collaborative practices to meet often and discuss everything in detail, this is where the

online meetings did us a great service. They afforded us numerous opportunities to get to know each other, to recognize both the possibilities and the boundaries of what we all actually can and want to achieve in the project, and encouraged us to undertake the risks associated with such a mode of production. This way, we had an appropriately shifting balance of control between the artists and the researchers in place. Despite the fact that it might be the artists who take ultimate control of the form and content of the work, the above stated shows that the engagement of the computer scientists in our project represented a significant measure. Both parties shared the responsibility, and treated each other equally, and that was reflected not only in the development, but even more in the act of actually performing together onstage in the final production.

Despite this, we found that each group working separately and only meeting online to be the most problematic part of the project, in the sense that we could not integrate and test the technology together. The team met twice in the real world, during the final months of project development. The first time was in August 2015 at Simula Research Lab in Oslo, where a furious week was dedicated to integration and testing. Seeing things from this perspective then enabled us to undertake some of the artistic decisions. This meeting shaped, to a great extent, the sequencing of all interactions in the dramaturgy of the performance, as well as the design of the Minecraft virtual environments. These could then more meaningfully support the technology that had already been developed. The second and equally productive meeting was in the few days before the premiere at WUK Vienna, to set up and rehearse the actual performance. Naturally, as this was the first and only time when everything needed was available, many workarounds and adaptations were still introduced during the rehearsals. Even so, thanks to the numerous online meetings and the physical meeting in Oslo, we were quite well prepared and went through these last days without any serious problems.

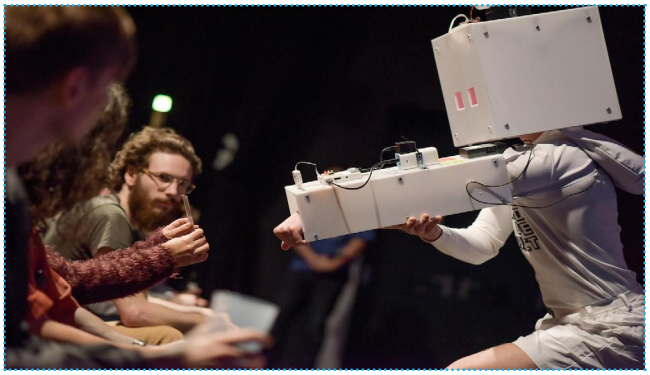


Figure 7: Audience interaction - scanning a QR code. Photo: eSeL - Joanna Pianka 2015

Conclusion

The design iterations went loosely through the following steps: concept and fundraising (2014), development, user - testing and evaluation (2015), with the last two being repeated several times, especially towards the end of the project. The project was not really pressured by any deadlines other than the two mentioned above; having the technology ready for the integration in Oslo and the rest finalized for the premiere in Vienna. The artistic ideas and the technology used were completely intertwined. One of the main design principles was that we only include the technology that actually enables us to build artistically relevant interactions, and at the same time that we exclude all those artistic decisions that we cannot support with the technology. This was related to another important design principle, that we design for spectating and as such we treat all the considered spaces, actions, roles, objects, events and interfaces as [potentially] performative. The collaboration has been very fruitful and enjoyable, and the team continues to work together on the next instalment of Third Life Project. This time the idea is to undertake a two-year long research with special focus on multiuser cooperation and audience participation in mixed reality interfaces.

Acknowledgments

Third Life Project was co-produced with WUK performing arts in Vienna and supported by City of Vienna's Department of Cultural Affairs, the Arts Division; the Arts and Culture Division of the Federal Chancellery of Austria; the FP7 project no 609757, FiPS; the H2020 project no 644874, POPART; Stellenbosch University in South Africa. The authors thank the LABO Mixed Realities and the University of Bielefeld for their contributions.

Project team

Milan Loviška - Territorium-Kunstverein, Austria, milan@loviska.com

Otto Krause, Territorium-Kunstverein, Austria, info@ottookrause.com

Herman A. Engelbrecht, University of Stellenbosch, South Africa, hebrecht@ml.sun.ac.za

Jason B. Nel, University of Stellenbosch, South Africa, jason@ml.sun.ac.za

Gregor Schiele, University of Duisburg-Essen, Germany, gregor.schiele@uni-due.de

Alwyn Burger, University of Duisburg-Essen, Germany, alwyn.burger@uni-due.de

Stephan Schmeißer, University of Duisburg-Essen, Germany, stephan.schmeisser@uni-due.de

Christopher Cichiwskyj, University of Duisburg-Essen, Germany, christopher.cichiwskyj@uni-due.de

Lilian Calvet, Simula Research Laboratory, Norway, lilian.calvet@gmail.com

Carsten Griwodz, Simula Research Laboratory & University of Oslo, Norway, griff@simula.no

Pål Halvorsen, Simula Research Laboratory & University of Oslo, Norway, paalh@simula.no

10. TO BE WITH HAMLET

To Be With Hamlet (courtesy of the authors)

Project title: To be With Hamlet

Makers/collaboration by: Hamlet VR, in collaboration with NYU Tandon School of Engineering

Text by: David Gochfeld and Javier Molina

Country: USA

Website/link: hamletvr.org

Lessons learned:

- Theater is a useful model for storytelling in VR
- VR can be used to shed new light on canonical theatrical texts by giving the audience a more visceral experience of the world of the play.
- VR has potential as a medium for live, immersive performance for remote audiences, but....

  - Telepresence complicates the feeling of presence.
  - Audience agency may distract from content.
  - Live VR performance calls for new performance styles.
  - Audiences want their presence to be acknowledged.

10.
TO BE WITH HAMLET

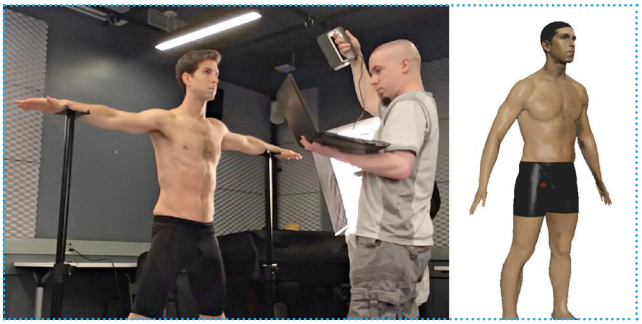
Project Description

To Be With Hamlet is an investigation into creating virtual reality theater by incorporating live performance into shared game-engine VR.

The goal is an experience where audience members anywhere in the world can put on a VR headset and enter the world of Shakespeare's play. They will be able to explore a fully 3-dimensional computer rendering of Hamlet's castle, and watch the characters living the story around them. The characters are 3D avatars controlled in real-time by actors performing live on a motion capture stage - similar to the kind used to record animated action in video games and motion pictures, but broadcasting the actors' movement and speech immediately to all of the viewers' headsets. Audience members will also be able to see each other, rendered as simplified avatars, as they move around the space.

In essence, we are attempting to capture the immediacy and intimacy of live performance, the communal audience experience, and the magic of immersive theater and VR, in a medium with the potential mass-audience reach of a live broadcast (or live-streamed) event.

We began with a brief excerpt: the part of Act 1 scene 5 where Hamlet speaks with his father's ghost. We have used this to build a prototype and prove the viability of the technology: we now can have viewers in remote locations enter into the VR scene and watch the live performance. We are showing the scene to test audiences and exploring the research questions that are driving us: how to capture the energy and dynamic of a live theatrical performance in VR; what must be considered in terms of dramaturgy and stagecraft to create a successful narrative production in this medium; what degree and type of agency gives the audience the best experience of presence within the world of the play; and, finally, how presenting a theatrical production in this medium can uniquely illuminate aspects of the character and story.



Using 3D scanning and photogrammetry to create an avatar of Zachary Koval, the actor portraying Hamlet in To Be With Hamlet (photo by Zachary Koval)

Viewing the scene from a distant vantage point: audience members are free to wander and explore the setting of To Be With Hamlet while the performance continues (screen capture copyright 2017 To Be With Hamlet)

For many, VR has a similar appeal as the imaginary realities created in a Halloween haunted house, or theme parks like Disneyland, or immersive theater productions like Punchdrunk's Sleep No More. The participant/viewer is immersed in a fictional world (which they can usually explore freely, at their own pace) and events happen around them and, sometimes, to them. In VR the imaginary world is presented to the viewer digitally, through stereoscopic displays directly in front of their eyes, but the illusion can be just as persuasive.

Our hope and belief is that, by allowing the audience to be immersed within the world of the play, and to feel present with the characters as the scene is playing out, they will find a different and deeper understanding of the story and the characters' inner states. There is a debate in VR circles about what may be called the 'empathy effect' of VR, but reactions to our test scene suggested that giving an audience more information about the characters' environment and more direct access to their lived experience enhances the viewers' ability to imagine more vividly how a character perceives the events of the play, and even to viscerally relate to that character's responses and actions.

For example, our test scene begins with Hamlet chasing a phantom that resembles his father. His companions have warned him not to pursue it, fearing that it may be a demon and that it might lure him to leap

off the cliff on which the castle sits. In most productions of the play, the urgency of this fear is lost because the audience can never perceive the physical danger; and so the desperation that leads Hamlet to chase after the Ghost is diminished. But if we stage the scene (as we have) on the farthest ramparts of the castle, on a platform surrounded on three sides (and far below) by the ocean, and allow the audience to walk to the very edge of the castle walls and look down at the water, the sense of remoteness and danger is made palpable. A viewer looking over the parapet may even experience vertigo. At any rate, they can see for themselves that Hamlet has chased the Ghost to the edge of the play's world, and one false step could make him a ghost himself. Allowing the audience to explore the scene on their own becomes a dramaturgical choice to heighten a dynamic in the text that is often overlooked (in this case, the danger to body and soul that Hamlet braves in order to hear the Ghost speak.)

As the actors (Zachary Koval and Roger Casey) perform in the mocap studio, an audience member watches their performance in VR in real time, during an early demo of To Be With Hamlet (photo by David Gochfeld, Screen capture copyright 2017 To Be With Hamlet)

Technology

Most (if not all) interactive VR experiences are built using a game engine. Game engines are platforms that allow for the creation of navigable and interactable 3D environments such as those in many modern video games. They handle the complex computations required to simulate real-world lighting and physics, allowing the game designer to construct a set out of 3D models and specify what kinds of interactions the player can have with the world. This makes building a VR world feel almost like constructing a theater set. We are using the Unreal Engine, which is free to use and provides a very solid platform on which to work.

Our motion capture system (by Optitrack) is composed of a set of cameras that project infrared light onto the stage and then detect reflections back from small reflective markers worn at key points on the performers' bodies, and software that assembles the markers into a skeleton. In most motion capture applications the movements of that skeleton are recorded, and then imported into the game engine as animations for the avatars. In our case, the skeletal motion is being streamed directly into the game engine to animate the avatars in real-time. This is one of the pioneering aspects of our work.

The other major component of our project is a telepresence platform, which was developed by our colleagues at Mediate. It allows multiple people to occupy a virtual space together, and to see and hear each other in real time. The biggest technical challenge has been adapting this to support the live streaming of our actors' performances from our studio to all of the participants, while continuing to allow for the audience members to see and hear each other – which is key to retaining the social, communal aspect of a theatrical experience. Mediate's lead programmer, Bas in het Veld, spent countless hours integrating their platform with the live motion-capture pipeline we use, and building the functionality that we needed for our experience.

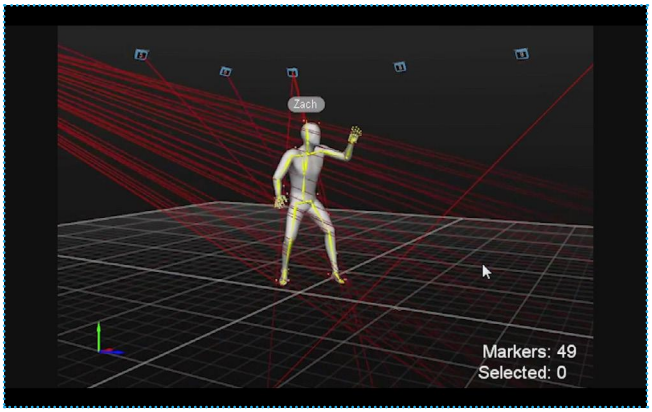
Mediate allows for the voice of each character (and each audience member) to be attached to their avatar and localized in the 3D space. Sound is hugely important in establishing a sense of space, and hearing the character's voice coming from where his avatar appears is key to supporting the illusion of virtual reality.

Finally, the VR headset itself is the endpoint through which the audience experiences the performance. We are using the HTC Vive because it allows the user to physically move around, mapping their movement in real space to their movement in the virtual space. This enhances the feeling of presence in the virtual world: of actually being there, as opposed to just looking in from one perspective.

Each audience member will have an application running on their computer that is, essentially, a video game containing the scenic models, the actors' avatars, and background audio. What is streamed from the motion capture studio is the movement data from the actors and their live audio. This means that the amount of data being broadcast, and thus the bandwidth needed, is minimized.

Process

We began with the question: how could we apply theatrical techniques to telling stories in virtual reality? The use of cinematic techniques in 360-video VR generally yields results that are, to us, mostly unconvincing, and we had already concluded (along with others) that storytelling in VR has more in common with theater than film or any other medium. Cinematic techniques of framing, montage, and camera movement don't work well in VR, and can even detract from the experience. Instead you have to approach storytelling spatially and with extended continuous action. For this, theatrical techniques of blocking action and drawing focus are very useful. Aristotle's unities of time, place and action are almost more relevant to VR than to contemporary theater.



The Motive application captures data from the Optitrack cameras to assemble a virtual skeleton for Hamlet in To Be With Hamlet (screen capture copyright 2017 To Be With Hamlet)

Javier Molina and his colleague Todd Bryant had already been refining their technique for live motion capture into the Unreal Engine. They used this to stage a show called The Return at the Metropolitan Museum of Art, and teach the techniques in a class at NYU. Javier had begun to experiment with using a 3D scan of an actor as an avatar in Unreal. The actor, Zachary Koval, became our Hamlet.

Our colleague Ken Perlin originally suggested trying to stage a scene from Hamlet, referring to Janet Murray's 1996 book, 'Hamlet on the Holodeck'. He inspired us and two other collaborators, Clara Fernandez Vara and Owen Bell, to begin exploring approaches to staging some part of this play in VR.

Before we could animate Hamlet's avatar in a 3D set and watch it in VR, some work had to be done by 3D modelers and the technical crew to put everything together. So we began working with Zachary in the real world, in a regular workshop rehearsal process outside of VR. We explored various possible approaches to performance that might work, considering similarities or differences between mask technique, puppetry, film acting, and naturalistic stage acting. Soon we were able to watch the scene on a screen while Zachary performed in the mocap suit.

But it wasn't until we were able to watch in VR that we could really begin to learn about performance techniques in this medium. It is similar to the difference between directing stage and film: when first directing for the camera it is invaluable to be able to watch the performance through the camera. Similarly in VR, you can't know what a performance will look like in VR until you can see it in VR. Since we are specifically trying to develop techniques that will carry the actor's presence through the system to the viewer, we particularly needed to watch his work this way. (We will discuss what we've learned so far in more detail below.)

We soon brought in our second actor, Roger Casey, to play the Ghost. To save the expense and time of doing another full-body scan, we took the textual cue from Shakespeare and used an off-the-shelf avatar of a knight in full armor. In the text the Ghost wears 'his beaver up', exposing his face. For expedience, we left our Ghost's face hidden by his armor, but this has the benefit of allowing us to compare the effect on the audience of having a character in a mask versus a character with a more realistic face.

We made a choice early on to use scale as a way to enhance the supernatural quality of the Ghost: his avatar is more than twice the size of Hamlet's. This would be difficult to accomplish in a theater, but in a computer generated VR world it is easy. It is also very effective: in VR the difference in size is palpable, lending a powerful sense of otherworldliness and menace to the Ghost.

Scenography is a critical component of any VR experience, and even more so of our proposal to create a world that supports a story. With the help of some student modelers we began by placing Hamlet in a relatively abstract setting, but soon realized that we would need to work with a more specific and realistic environment in order to transport the audience into the world of the play. Fortunately, we found an existing 3D scene of a medieval fortress perched on a cliff overlooking the ocean, available for free from the Unreal Marketplace (specifically, the Infinity Blade: Grasslands asset) and with some modifications could adapt that to perfectly suit the scene we have chosen to stage.

As mentioned above, the most challenging aspect of the project so far has been integrating the telepresence platform, which allows us to stream the mocap data to remote headsets, as well as multiple audience members to see each other as they share the experience. There were many hiccups along the way but we finally got this working just before Christmas, and were able to have an audience in headsets in a different location than the actors in the mocap studio. We can now really begin to

explore the question of whether presence and liveness carry through to the audience when mediated through motion capture and CG avatars.

Dramaturgy of Multiple Audience Perspectives

Just as we make shot lists for film, or stage plays with consideration for audience members sitting at different levels of the theater, we have to design our VR world with awareness of what the viewer will be seeing at any moment. This is the hardest part about presenting a story in VR, because the audience member can look in any direction and wander freely around the set; and we want them at all times to remain connected to the world and action of the play. Ideally, what they see while they explore freely should help to deepen their understanding of events and identification with the characters. This is a tall order, but it gives us a powerful new set of tools with which to explore and express the themes of the piece. In designing the set we must fill out the world beyond where the scene takes place – so the audience can look over the parapet at the ocean below, or go exploring along the battlements to find the castle courtyard, for example. Taken a step further, when the Ghost describes his poisoning, the scene around the characters and the audience could fully transform into the King's orchard where the murder took place. Every element can help flesh out the world of the play for the audience, increase immersion, and, possibly, enhance identification with the characters' motivations and conflicts.

The scenography of the play is all within the virtual world we have constructed. But we must take into consideration the real spaces from which the actors and the audience participate. Since our actors are in a motion capture studio, we have to design the virtual set for a scene to correspond in size and shape with the real space of the studio. We also have to plan for how the character avatars enter and exit the scene where the actors have left the playing space in the studio but the avatars are still visible to the audience in the VR world. In addition, we are experimenting with physical set pieces in the studio that correspond to parts of the virtual set, to allow the actors to interact with the set in some ways.

Directing in VR: actor Zachary Koval and director David Gochfeld rehearse a monologue from Hamlet for the VR production To Be With Hamlet (photo by Brett Moody)

For the audience, we have to be aware that they may each be in physical spaces of different sizes and configurations, surrounded by real physical obstacles that could cause injury. Room scale VR has the convention of a grid or fence that appears when the player approaches the boundary of their usable area, and we need to include some version of that in the VR scene we create. However, one question is whether this can be designed to fit the world of the play, or whether it should be left as a clearly otherworldly, external user interface element.

We want our audience to be able to explore more of the world than is used for the scene itself, and beyond the area they can physically walk around in, so they need to be able to jump to other areas on the set. The HTC Vive has introduced the paradigm of teleportation, and we use that. It's another external UI affordance that could be intrusive or distracting, but it is necessary because of the disjunction between the virtual space and the audience member's real space. In practice, we've observed that even novice VR users have quickly adapted to using this to move around without it interfering with their immersion in the scene.

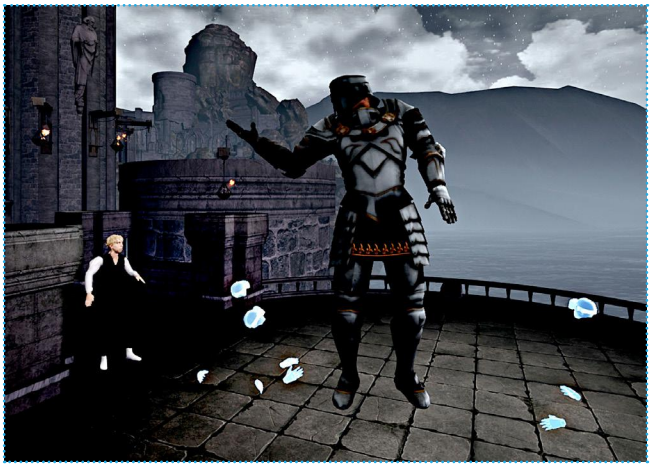
There is another audience perspective to consider. Before we had the broadcasting aspect of the platform built we tested and demonstrated the project with the actors in the same room as the audience. One audience member would watch in the HTC Vive while the actors performed around them. The rest of the audience (waiting for their turn in the headset) watched the performance and saw the VR world and avatars projected on a screen. This turns out to be a remarkably engaging and successful mode of presentation. When we propose to demonstrate at conferences, besides having stations for the VR headsets we always suggest a screen showing a live stream of the actors performing in our mocap studio. We have had inquiries from venues that want us to bring the Optitrack rig and actors to set up there, so their audience can see the performance unmediated as well as watch it in the Vive. In some sense, the experience is two simultaneous experiences: the live performance and the VR performance.

Clearly people really do want to see the man behind the curtain. Live performance is unquestionably engaging, and there is a strong 'wow' factor to seeing the tech pipeline working with your own eyes; the actor moving in front of you in unison with their avatars in your VR headset. While it is not our end goal, it has definitely helped build interest in our project. Ultimately, however, we want to enable the feeling of presence with the live actors without having to show them to the audience; and we want the 'wow' factor of the tech to fade into the background, letting the impact of

the story take hold. We hope to be able to demonstrate this as we continue to build the piece.

Lessons learned

As mentioned above, our primary research questions are: how to capture the energy and dynamic of a live theatrical performance in VR; what must be considered in terms of dramaturgy and stagecraft to create a successful narrative production in this medium; what degree and type of agency gives the audience the best experience of presence within the world of the play; and, finally, how presenting a theatrical production in this medium can uniquely illuminate aspects of the character and story. Based on our initial experiments and user testing we have a few pertinent observations:



How VR can replicate the social experience of theater: Multiple audience members (represented by glowing blue heads and hands) watch a scene from To Be With Hamlet, simultaneously (screen capture copyright 2017 To Be With Hamlet)

1. Presence

Can presence work with a completely mediated performance? There are many obstacles to creating a sense of presence, but here's one we hadn't considered in advance. As the audience members are in remote locations, and current VR technology doesn't provide for a haptic sense of materiality for the virtual world and characters, it is easy to be reminded that the characters are not actually there with you – you can walk through them. One member of our test audience specifically noted that this completely defeated the sense of presence for him.

We could avoid the problem of immateriality by restricting audience mobility to areas of the scene not used by the actors, but then we would lose one of the most compelling aspects of the VR performance: the ability to choose your own vantage point anywhere in the scene at any time. Several of our first round of testers said they'd found themselves watching just over Hamlet's shoulders, or standing between the Ghost's legs, and some said they would have liked even more mobility, such as the ability to watch the scene from overhead. One respondent said he wanted to be able to switch over to Hamlet's point of view – to be able to watch the scene literally through Hamlet's eyes. This suggests that restricting audience mobility would be the wrong way to go (and also gives us another affordance to implement and experiment with.)

2. Agency and Interaction

On the other hand, several members of our test audience found the ability to explore the world much more compelling than the scene being performed. They teleported around the world, tested exactly how close they could get to the characters, and how far away they could go, and paid no attention to the dialogue or the action of the scene. Some were unfamiliar with the play and had trouble parsing the language, which made the action of the scene less interesting to them. In other tests we have seen that the ability to teleport around and explore is very engaging to many people, and tends to distract from any particular action that may be occurring. This may arise from the feeling that one should be able to interact with the VR world – a product of immersion. Therefore, most people want to interact, and the only way they can do that in our scene is by choosing where they can go. The only way to exert your own presence is by moving around and exploring. One respondent explicitly said that they wanted to interact but moving was all they could do.

We have considered what other forms of interaction we can build in to the experience, without creating a mechanic whereby the audience can interact directly with the characters and affect the course of the story. One possibility is to allow them to interact with objects in the world: perhaps a lantern, a halberd, or other props. The difficulty is in choosing objects that support the world (and the story, if possible) and won't be too distracting for the audience to play with.

Another thing we noticed was the joy with which many of our testers greeted the other viewers in the scene. Other projects (and commercial VR products) have already demonstrated the allure of being able to experience a virtual space together with others, even if they are only present as virtual avatars. Our observations bear this out. What we don't yet know is whether the desire to interact with other audience members will inevitably be more compelling than the performance itself. The theater has clear and strong conventions for audience behavior, but social VR has no conventions yet. Even in live immersive theater, such as the Sleep No More production by Punchdrunk, audience behavior is monitored and sometimes actively controlled

by a team of docents. In VR, we will have to learn how to make the performance and the world command more attention than the other viewers.

Assuming, that is, that we want to maintain some distinction between the performers and the observers. Alternatively, we could cast the audience as characters in the scene, giving them a more active role in the experience and, perhaps, channeling their impulses to wave at each other into actions more appropriate for the scene. We have considered having audience members play the soldiers of the watch who first see the Ghost and bring Hamlet and Horatio to meet him. One could imagine a staging of a classical Greek play where the audience is the chorus. If we wanted them to speak, we could feed them lines directly through their headsets, as a sort of teleprompter.

3. Other observations

An important aspect of the VR experience that has not received a lot of attention so far is the transition from the real world into VR and back. In theatrical productions we often pay attention to setting the mood and establishing some sense of the world for the audience before the play starts. Putting on a VR headset and entering a virtual scene is a jarring transition, and as yet there is no convention for it.

At the very least, it seems that the audience needs some time to become acclimated to the virtual world, and perhaps even time to explore it, before the scene starts. We found we also needed to give some instruction to our users on how they can move around – both by walking within the room-scale boundary, and by teleporting. Many of our testers had had little or no experience with VR before, so they were not aware of what they could do. We offered explanations to some but not others, and the ones we did not explain teleportation to mostly did not discover it on their own. Just as video games usually provide a tutorial before the game begins, something similar might be necessary for a VR theater experience.

In our test we did not provide any advance explanation of the scene, the play, or the characters, and many of our testers said that they didn't know the play well enough to be able to understand what they were watching. This clearly impedes engagement. With the VR headsets it would be possible to provide live subtitles, so the audience could follow along with the text. It's hard to predict whether this would enhance engagement or further interfere with it – especially with language as dense as Shakespeare's.

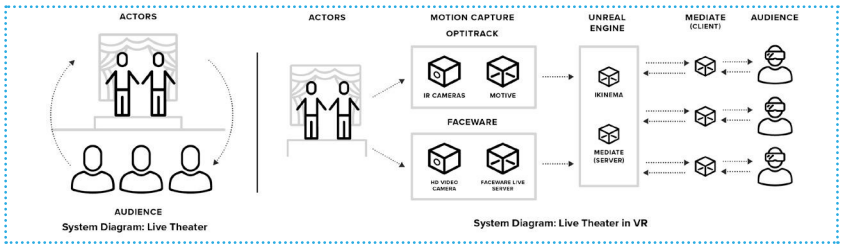


Illustration by Rebecca Lieberman

4. Notes on Performance Style

Working with motion capture requires a delicate approach to the actor's physicality. On the one hand, the actor must move, or the avatar appears dead. On the other hand, too much movement can cause technical problems with the tracking, and, more significantly, it can appear as gross overacting. Both our actors are experienced with motion capture, but we still had to experiment to develop a style of movement that works for this play in this medium.

There are limitations to the range of motion that the motion capture cameras can accurately detect: when the tracking markers are occluded, or come too close together, the system can become confused. Certain gestures, like hiding your face in your hands, don't read correctly.

Actors face another challenge: being in a small room instead of an auditorium, they may be inclined to 'act small', to constrain their motion and emotion as they would on a film set. However, because there is no feedback from the audience, there may also be a temptation to keep pushing, looking for a response. We have in some sense heightened this temptation by using an emotionally charged scene, and also by making one of our avatars appear around 5 meters tall, wearing heavy armor. It's hard not to want to ham it up.

As anyone who has worked with masks on stage knows, one of the keys is the fixed point – a stillness, from which deliberate movement can arise and be clearly perceived. If the mask moves too much, the audience can't connect with it. Operating a puppet is in many ways similar to mask performance, but it helps to animate the puppet with the subtle movement of breath (a technique also applied to the animation of characters in video games.)

From our work so far it appears that both of these are applicable when live puppeteering a VR avatar with motion capture. We want the VR avatar to feel constantly alive, but we must also avoid extraneous movement. The movement must be deliberate and proportional. Unsurprisingly, Hamlet's advice to the players is as apt here as anywhere: 'Suit the action to the word, the word to the action, with this special observance, that you o'erstep not the modesty of nature.'

A crucial element to establishing the presence of the actors is creating the sense that the avatars are really looking and seeing. This is more difficult than it should be. Lining up the avatars in the videogame world with the placement of the actors in real space turns out to be imprecise, and it is made harder by having avatars of different scales. In the mocap stage our Ghost actor must be looking at Hamlet's knees in order to appear, in VR, to be looking at

his eyes. Because of the scale, one stride of the Ghost moves his avatar much further than Hamlet moves with one step. That means that they are only really lined up relative to each other in one small area of the stage. Our actors are still learning to cheat their gaze further to one side or the other depending on where they are in the room, when they want to appear to be looking directly at each other.

Next Steps

We are still exploring whether, and how, we can use live motion capture and real-time animation to create the immediacy and impact of a live performance in a game-engine VR world, and maintain this when broadcast into headsets far away from the actual performance. We have much more to learn about how live performance can work in VR, and also how to apply theatrical techniques to VR storytelling. Here are some of the things we intend to try in the coming months.

1. Facial motion capture

At present, our avatars' faces are rigid masks. A few members of our test audience said this impeded their ability to connect with the scene, and even felt creepy. Others reported that it did not detract from the performance, and some didn't even notice it. Our Hamlet avatar's face is in fact very expressive, despite being immobile. It was made using 3D scanning and photogrammetry, which makes it feel fairly real. But if it were animated so that the mouth moved when he spoke, and his face could show different expressions, it is possible this might greatly enhance the sensation of the actor's presence.

2. Actors being able to see the audience

A key element to live performance that we are missing is the feedback between audience and actors. In our present setup, the actors can sometimes see a projection showing the VR scene, but it doesn't give them much while performing the scene. In between runs, we observed the actors using this projection to play with the audience, who were in headsets: the Ghost, for example, would try to stomp on an audience member. They were clearly having fun even though they were in different rooms and the actors could only see the audience on that screen. We'd like to be able to establish that connection during performances too.

Some of our audience members commented that they wanted to feel as if the characters were responding to their presence. Our project is not conceived as an interactive narrative where participants can have an effect on how the scene plays out, but one of the magical elements of live performance is when audience and actor are aware of each other's presence. So far, we have not been able to recreate that sensation, but we will be experimenting with possible approaches.

One possibility is to place more screens on all sides around the actors, so that wherever they look they will see a view of the scene and the audience. We also plan to experiment with having the actors in VR headsets as well, to see if this can help, and how it compares. There are two obstacles to the latter in the near term: 1) the cables for the Vive headset restrict the performers' movements, and 2) we won't be able to do facial mocap while actors are wearing headsets. It seems likely that neither of those will be issues within a few years.

3. A more complete story

While we continue to experiment, part of our upcoming work will be to build a more complete experience. Our vision is a piece that is between 30 minutes and an hour long, containing a complete story arc derived from the full play. We will build out additional locations within the castle where scenes can take place, and spaces where the audience can explore. We also have a fair bit of work to do on sound design for the experience (including ambient sound fx and music). And we will look for ways to accommodate more active interaction from the audience, without detracting from the performance itself. In doing this we hope to develop a compelling example of a new approach to storytelling in VR and a new kind of venue for live theatrical performance.

11. THE CUBE

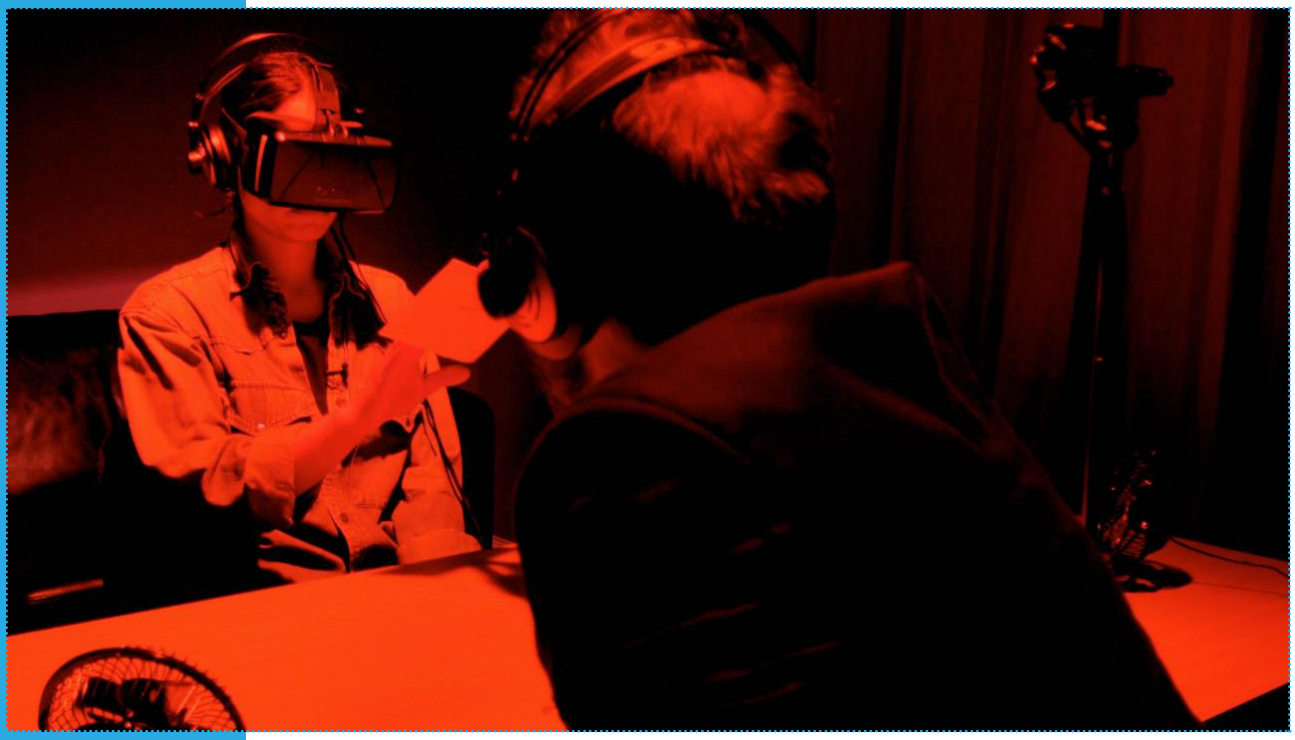


photo: courtesy of the authors

Projects title: The Cube

Makers/collaboration by: CiRCA69

Text by: Simon Wilkinson

Country: UK

Website/link: www.circa69.co.uk

Lessons learned:

- The audience transition from real world to virtual reality is a delicate one which needs considerable thought.
- Virtual Reality story telling does not involve a linear script but a constructed environment loaded with potential narrative interactions.
- An understanding of how human attention operates is key to making interesting and effective virtual reality.

11.
THE CUBE

Incorporating non-linear technologies into Live Performance

In September 2017 a new promenade theatre experience entitled Whilst The Rest Were Sleeping will premier as part of Brighton Digital Festival at The Old Market theatre in the UK. The show will take over the whole of the venue for four hours a night; the bar, the main auditorium, the dressing rooms, the basement storage areas and a maze of interconnecting corridors all included. Audiences will be free to roam these physical spaces in search of the story, following their own path to solve the narrative puzzle as it unfolds around them.

Unlike most promenade pieces, however, the vast majority of the performance and audience experience occurs not in the venue itself, but in a far less defined non-place somewhere between the real world and a simulacrum of it. The performers and the sets are both real and virtual and it is between these states that the audience will be asked to explore, communicate and collaborate together in search of answers. Virtual reality, as a technology, enables the complete immersion of an audience member through use of a headset. In this case we will be using Oculus Rift and HTC Vive which offer the users differing levels of ability to walk around and interact within the virtual world. Augmented reality, on the other hand, does not necessarily require a headset and for this show audiences will access the AR content through their smartphones. Augmented reality allows the user to view the real world through their smartphone camera with additional content imposed on top. A good example of AR is the suite of tools on Snapchat which allow the user to impose a variety of animated digital masks over their own face.

All audience members for Whilst The Rest Were Sleeping will have installed a smartphone app before arriving, which will unlock AR / VR content as they navigate the space. In addition, they will find 15 virtual reality headsets hosting ten fully volumetric / motion tracked VR installations in various rooms around the building. These installations will combine VR with live performance, with multi-channel 3D sound and kinaesthetic physical effects such as touch. Finally, at the end of the evening, they will all come together in the main venue space for a 40 minute live electronic music performance with projections. This electronic music performance coalesces all of the VR/AR content via a final part of the story told in voice-over, sound scape and video projections from inside the VR universe.

Throughout the evening audiences will have to go online and talk to each other to solve the puzzle that the story presents, and they will be able to keep engaging in that process after they leave the venue, continuing to access the work via the internet and the smartphone app.

Dealing with a new medium

All of this presents me, as the creator, with a whole array of problems, not only because VR / AR are totally new mediums in terms of the technology used to make and experience them, but also, more importantly, because their primary and most important qualities are those of agency and immersion. The audience member becomes a character in the narrative, which is not new, but also means that ideally that narrative needs to unfold according to audiences' decision making processes rather than being dictated by a linear script. Whilst the software to make VR/AR and the hardware to experience it have both become extremely accessible and effective in the past two years, there is still no handbook on how to tell stories in the medium because we are all still figuring that part out. There are no experts in this field, only people like me who conduct experiments on a regular basis.

I have been fortunate in that my route to VR/AR has been a comparatively unconventional one; a route which has perhaps meant I am less prone to approaching these new mediums as if they obey the same rules as film, theatre or gaming. I began performing in bands in the early 1990s, and whilst this was a very fertile era for music in the UK, I quickly grew bored of the formulaic way in which it was typically presented. By the mid 2000's my work was combining film, music and performance into one narrative with trails from that narrative leading audiences to websites to continue their experience. I was deliberately trying to de-linearize the story, to blur the boundary between reality and fiction, and hide the transitions between those two states. I was presenting the work in galleries, cafes, bars, in the street, in underground carparks or anywhere that somehow disrupted expectations of what the work was. In 2010 I collaborated with Italian theatre director Silvia Mercuriali to create a first person perspective film to be viewed through video goggles. This piece was an absolute cross pollination of film and

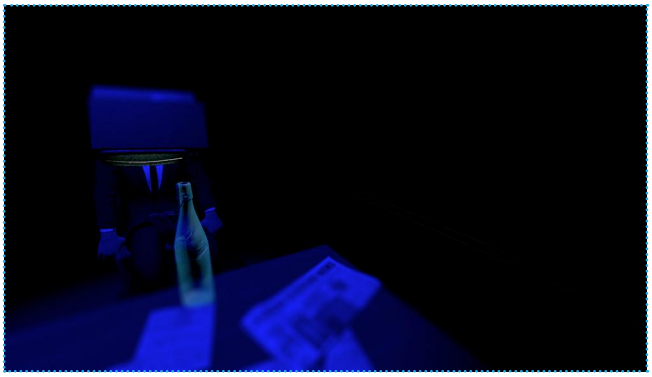
performance incorporating odours; physical sensations which augmented the pre-recorded and live elements. This show, entitled And the Birds Fell from the Sky, was comparatively successful, appearing at Tate Modern's Merge Festival in 2011 and enjoying a good amount of international touring. And so it was from this starting point, having already subverted the mediums of film and theatre, that I first approached the use of VR / AR in a live theatre environment.

Starting out in VR – The Cube

Several of the VR installations I have created for Whilst The Rest Were Sleeping have been touring individually since June 2015 as I test and observe how audiences behave within the virtual environments I have created. In this article, I am going to talk about The Cube. It was the first of the installations on our production slate, and therefore started out the most naively in terms of how I thought VR should be made. The Cube has already toured to 14 countries on 6 continents, and it is through the observation of thousands of audience members along that journey that I have gained a better understanding of how to make VR for performance, for non-linear storytelling, with physical kinaesthetic effects and a story that impels the audience to keep engaging with the work online once the show is over.

In the past 18 months I have created more versions of this one show than I could possibly count, continually responding to observations of how audiences behave within it, sometimes making multiple versions within a single run of shows, attempting to perfect the flow of narrative information within a non-linear environment in which the audience has a great deal of agency. This, then, is how that journey unfolded.

The subtext to The Cube and to the full suite of works is a series of questions posed by VR technology itself: What is real? How do we know what is real in a world so overwrought with such a complex system of untruths and how do we know who we are within that world? The dramatic composition and staging of The Cube needed to ask these questions in a very powerful way, and



still from The Cube (photo: courtesy of the author)

it needed to give the audience space to seek their own answers. It was clear from the beginning that to do this successfully the show, ultimately, needed to become part of the audience member's own real life.

I knew from the outset that I needed the audience member to enter the experience in a way that made the transition from their everyday real life into the world of the show as seamless and invisible as possible. Typically, audience members will be attracted to attend the show not from a brochure or advert but instead through a radio, TV or press article in which I'm talking about a mass disappearance that happened in Idaho in 1959. I explain that I read about this case when I was 13 years old and that I have been intrigued by it ever since. I made a rule, a few years ago, that when I arrive in a country or a city to perform a show, I am in character from the moment I first leave my hotel room on the first day. This means that when I am interviewed I am not talking 'about' the show, I am already performing it; the show has already begun whether the audience realise it or not. It means that when they come to the show it is already part of reality for them, there is no suspension of disbelief, just belief. If they choose to come to the experience The Cube, they will enter the venue and, as they walk around, find a dimly lit blue room with a person sitting at a desk. The person invites to them to sit down opposite them and asks their name. The person does not look or talk like a performer, they are very informal and very natural. The two engage in a short unscripted conversation which is steered towards the story of the mass disappearance. The audience member is invited to put on the VR headset. Once inside VR they find that they are sitting across the same desk in a dimly lit blue room, but that now the person opposite them has a TV screen for a head.

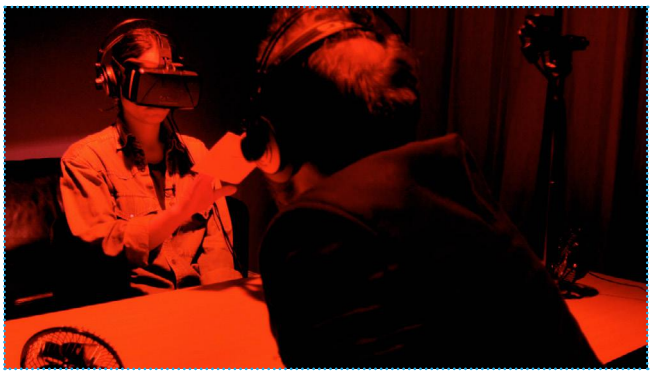
This entry point, you'll understand, was designed to fly the performance and the fiction under the radar so the audience member is never quite sure whether the conversation they're having is repeated for every audience member or whether, in fact, the performance they've paid to see is yet to begin. It follows a rule from film script writing, that if your story is going to take the audience to weird stratospheres then the best way to involve the audience is to bring them into the story at ground level, a place they recognise. In the film Children of Men for example the director Alfonso Cuarón managed to create a world which genuinely felt like our own everyday existence enhanced with some incredible yet realistic new technologies, and it was a world just as dirty and litter strewn as it is today. This framing creates an invisible bridge between us, the audience, and the fictional world into which we are being drawn. If you take the example of The Blair Witch Project then we see this idea taken to a new level of sophistication, with early audiences in the US believing the setup of the narrative to be based on fact. The opening conversation of The Cube, then, is also designed to give the impression that the story of the mass

disappearance is based on events in the real world, the same world they walked in from; that it is something they could look up on google, and that, in this sense, it is connected to their real everyday life.

The moment they place the VR headset over their eyes is a delicate one. They immediately see that the VR world is a simulacrum of the world where their body resides and that they are looking at that world from the same perspective both in VR and in reality. It is clear, then, that they are looking from a human perspective, and that poses the question 'who am I?'

There has been some very interesting research conducted into the power of the first person perspective at Sussex University in the UK, which demonstrates reliably that audiences who see the virtual world from a first person view are more embodied and less consciously analytical of their surroundings than those viewing the same space from a third person perspective. I didn't, however, want to go down the route of trying to convince them that they, themselves, were now inside this new world, rather I wanted to reassure them very quickly that they were seeing it from someone else's perspective, that they were embodying a character in a story.

We know full well that in order for audiences to connect with a character emotionally they need to understand that character's vulnerability. When looking out from a character's eyes we are given the opportunity to feel that vulnerability directly, without analysis or emotional filtering, within our own bodies even whilst understanding that we are still separate and distinct from them. Paradoxically, if I'd tried to persuade the audience that they were looking through their own eyes at this new version of the world, then logically it is immediately unconvincing, since they know full well that their real eyes are covered up. If, however, I communicate to them that they are seeing a version of events as it was seen by someone else in the real world in 1959, then it is entirely plausible that they are much more willing to accept this perspective as real. This may be surprising, given that what they are seeing are 3D computer game graphics, but can be easily explained by the very essence of how VR works.



still from The Cube (photo: courtesy of the author)

As I have explained many times in lectures on immersion, psychologist Daniel Kahnman talks about how human attention conforms to a model which is characterized by two states. System 1 attention is always active, cannot be switched off and is the state which the brain always uses first in trying to interpret any situation. system 2 attention is only ever invoked to bring critical analysis to any situation which the brain deems is unsolvable by system 1. In simplistic terms what this means is that if the brain believes its unconscious system 1 attention has interpreted a situation correctly, then it will not allow critical analysis of that situation to guide the body's response. In modern VR, user's head motions, and sometimes their hand motions, are tracked very accurately. When you move your head within a VR environment the world stays consistent and solid. For example, you can move your head towards an object and it will become larger just exactly as it would in the real world. Your system 1 attention, in this case, sends a signal to the brain to say that it has interpreted the VR world correctly and, therefore, your body will respond as if that VR world is real, even whilst consciously you know it isn't. It is for this reason that a VR roller-coaster will illicit the same bodily sensations of vertigo as a real one.

One of the great aspects of games engine technology and its ability to facilitate non-linear and/or branching storylines is that it enables me to create more than one version of the story. The technology used to create this type of VR involves games engine software, originally designed for the creation of interactive computer games but increasingly used by artists for a variety of interactive applications. With the games engine one does not produce a linear sequence of events but rather an environment loaded with potential interactions, each of which can alter the outcome of the story and, to further complicate matters, the outcome of each subsequent interaction. In the case of The Cube it enabled me to make a male version and a female version of the show. In practice the VR element of the show proceeds with the story only when the performer pushes a start button. I built The Cube so that there were two start buttons, one that proceeded with a female, and the other with a male voice over. This decision actually came about due to audience feedback from And the Birds Fell from the Sky in 2010. In that show the first person perspective was driven by a pre-recorded video, and it was not possible to switch between male and female versions since the show was for two people at a time both driven by one video feed. We received feedback on a number of occasions from female audience members that having a male voice over from a character they were meant to be embodying broke them out of the experience by dislocating their association to the character. Here, then, is a perfect example of how the 'real time' nature of games engine VR technology allows a flexibility which pre-recorded video does not. It

is important to understand that this type of VR is a 'live' event, that the CG environment loaded with potential reactions is responding in real time to the actions and decisions of the user or audience member.

It was important to create an entry into The Cube which saw audiences immersed not just by catering to their eyes and ears but also through an idea: 'my body and my senses are in different places, but what I am experiencing with my senses happened in the same world in which my body is sitting'. It is an idea which is reinforced at various points throughout the performance and yet which, at various junctures, is teased, prodded and challenged.

At one point, for example, the virtual character holds out an object for the audience member to take; nearly everyone reaches for it and, obviously, it isn't there. Many people laugh at this point, they are laughing at their own foolishness, maybe even in embarrassment because they know that a performer is with them and witnessed their error. Yet shortly after they are persuaded to reach out again, and this time the object is present. They take it in their hand and drop it, causing a loud noise. Throughout the experience, they hear the voice of the main character 'Stevie' reading a letter. Through this letter we hear Stevie begin to abandon any attempt at explaining the world in any concrete terms, as if saying to us that words, in themselves, are at best flawed and at worst a total distraction from the nature of the world around us. S/he tells us, 'I want to stop talking but I can't. My friend Manfred was autistic and stopped talking, remember, maybe he'd understand... I don't know... maybe Jesus knows... or Elvis. These words perform the same function as the bottle (mentioned above), they tell us that nothing can be trusted. When Stevie says 'I'm not promising truth, how could I, honesty and truth are entirely incompatible', s/he is telling us that even when we say something with full commitment and belief, this honesty should never be confused with truth.

The performer in this show is me until the VR headset is placed over the audience member's eyes. At that point someone else replaces me. It is another element of deceit; they believe me to be present throughout, tending to them, interacting with them, but when they remove the headset they find that I have abandoned them. The other performer is one of several who have been trained to operate The Cube, to respond to the audience member with appropriate interactions. They attend a one day training and rehearsal session in which they learn the intricacies of the show; these performers need to be very attentive to the audience, they need to read their actions and respond accordingly, and they also need to be confident with technology.

Within the construct of the VR world, audiences find themselves, at one point, stepping outside and feeling the wind on their faces as they do so. They obviously assume (correctly) that I have hidden a fan in the room to be switched on at precisely the right moment to give the impression of a breeze. No single audience member will be consciously fooled that they have actually stepped outside, of course, and yet the existence of the breeze will still affect their body and its perception of what is unfolding in a profound way. Again, it is Daniel Kahnman's system 1 attention which is facilitating this deceit and which, again, prods the audience with the subtext of the show; when they grip the table to prevent themselves falling into the abyss, when they instinctively jump back to avoid a collision, when they feel vertigo in their stomach and gasp at the sight of planet Earth spinning in the blackness of space – all whilst sitting at a table in a very ordinary room in a performance venue. The intention is to question your perception of reality; because we know how to deceive you, we know how to make you think the unreal is real and vice versa, and we are getting better at making you feel like you are the ones making the decisions because we know how to deceive your System 1 attention.

Understanding that your audience's attention operates in this way further compounds the uselessness of a written script in creating truly immersive experiences. Throughout the duration of The Cube the audience member's body will, at the behest of System 1 attention, change temperature, release adrenaline, move to avoid collisions and hazards; all instinctively and all whilst being consciously aware that the stimuli causing these involuntary reactions are a digital mirage.

In The Cube this situation is continually investigated by the narrative, with questions designed to provoke thoughts about what this all means when the headset is removed. Is the so-called real world any more genuine than the VR world this artist has created for you? Or is it the case, instead, that we navigate our lives imprisoned by what Robert Anton Wilson called 'reality tunnels' created by other kinds of narrative artists: PR agencies, propagandists, marketeers, journalists, advertisers and, in a far more subtle way, by the commodification and posturing of individuality through social networking. The Cube is not a piece of work which is critical of any of this. It proposes, in many ways, that we may have stumbled upon something wonderful which turns our perception of the world on its head.

In quantum mechanics the exact status of a particle cannot be determined until it interacts. We fire particles around the Large Hadron Collider at unimaginable speeds in order to crash them into one another so that we can fix them down to a single measurable point of reality. What The Cube hints at in both the narrative and the immersive way in which that narrative is experienced, is that perhaps reality can never be defined by words. Perhaps words are only a symptom of and a reaction to a moment of interaction. In that sense, words are tombstones to moments of reality which have passed. It is notable, then, that I have mentioned here a number of times that a written linear script is not the right way to begin telling a story in VR. You could, if you wanted, write down what happened to you in VR, to explain it to someone else. But in creating a narrative experience what one is actually designing is a world of potential interactions, each of which add layers of information inviting interpretation. If one can build more potential interactions than can be experienced by a single audience member then, naturally, the story will be different for each audience member. In that case, the story will resist simple conclusions, will require further investigation and discussion. In this sense, VR can be

made to mimic RR (Real Reality).

The words we hear in The Cube are from a letter left behind by Stevie Steele, a 17 year old who went missing in 1959 with his teacher and seven friends, none of whom have ever been found, and whose disappearance has never been explained. The letter is part of a collection held by the Burley Historical Society in Idaho, 15 miles away from the town of Albion where they went missing. In the last moments of The Cube the audience are floating through space when a Xerox copy of the letter appears before them. Almost everyone reaches out for the letter despite the fact that it shouldn't be there, and they find that it is. They take the letter from the VR world to the real world, they take it home with them, and most read it. The letter is a collection of words which indicate that something happened, something which your body responded to as if it were real, but was it?

In some ways the audience are teased by this question. A large percentage of them remove the headset and cannot put the question to bed, 'is it real? Did it happen?'. In a way, this is the most interesting aspect of how The Cube is immersive. We know, because we measured, that 63% of audiences go online to try to find an answer immediately after leaving the show. This measure was recorded by observing spikes in activity on a number of websites around performance days. We compared the number of attendees with the number of new visitors to those websites and estimated the transfer rates between the two. The majority of those who go online browse a selection of wiki pages and websites dedicated to the story, a minority take the unusual step of emailing The Burley Historical Society and other such organisations to find out more. One website with a password entry system has been hacked four times by audience members who need to understand. Some of them end up contributing to the body of words dedicated to the story online through blog posts, journalistic articles and essays, lending weight to its validity. I personally cannot honestly give you an answer to the question of whether the story in The Cube is real, but it occurs to me that as more people interact with it, it is at least becoming 'more' real.

The Challenge of Social VR

When Whilst The Rest Were Sleeping premiers in September, audiences will find themselves presented with more opportunities to interact with the story, but they will do so together, interacting with one another in search of an answer. Making VR content social is a challenge which often crops up in conversation amongst creators and it is an issue we want to tackle for a number of reasons. Firstly, we know that making content social in nature makes it more enjoyable for users to engage with, and we also know that reaching more people means we have a bigger cash budget to make the work larger in scope. But also, I personally am very interested to observe how this changes perception of the work; will consensus play a big role in dictating an outcome like it does in the real world? As The Cube has toured I have observed individuals investigating the story on their smartphones and computers. So what happens if we put all those people in one space at the same time? Will they help each other? Will that collaborative effort lead to a more interesting or enjoyable experience?

I have created two other VR installations since production of The Cube was officially completed eight months ago, and many new lessons have been learnt as I continue to experiment with VR and AR in completing Whilst The Rest Were Sleeping:

- It is impossible to predict, at this stage, how audiences are going to behave in a VR environment, therefore it is essential to test the work with real audiences thoroughly.

- In testing the work, do not simply ask audiences what they thought of the experience, it is far more useful to observe their behaviour and make notes.

- Design your narrative elements so that it is impossible for audiences to get things wrong, so that each element and interaction can happen when and how the audience chooses without breaking the story.

- Audiences should leave talking about the story, not the technology employed in telling it. Make the story interesting enough that they are still thinking about it a week later.

- Design the real environment within which VR is experienced carefully, give it a lot of thought and make it appropriate to the story.

- Give a lot of thought to how audiences transition from real world to VR.

I recognise that these last two points are what sets The Cube apart from the vast majority of VR works I've experienced. All too often one finds oneself crashed from real world to virtual world without any transition or time to adapt. In the worst cases one is left feeling vulnerable and unsure of the real world to such an extent that one cannot feel fully immersed in the VR, and one very soon starts feeling twitchy to take the headset off.

What has remained in place as a result of making The Cube is an understanding that immersive theatre is about much more than the technology employed in creating or experiencing it. A few years ago in an interview I said that I made theatre without a stage. The Cube has helped me realise that this is incorrect, that the stage has always been the attention of human beings, and that the technology employed in making theatre, from lighting and microphones to virtual reality headsets is designed, primarily, to facilitate immersion.

12. MOVING BETWEEN WORLDS

worlds - Aerial hoop performer in Emily Carr University Concourse Gallery (photo: courtesy of the authors)

Projects title: The Return; Worlds; DUAL; Manipulation; FLOCK

Makers/collaboration by: Emily Carr University of Art + Design (ECUAD), Pepper's Ghost New Media and Performing Arts Collective, Simon Fraser University (SFU), New York University (NYU)

Text by: Maria Lantin, Athomas Goldberg, Ken Perlin, David Lobser, Thecla Schiphorst

Countries: Canada, USA

Website/link: s3dcentre.ca - www.peppersghost.org - http://www.marialantin.com - movingstories.ca

Lessons learned:

- Mixed Reality performance brings out the interplay between performer, performed, and audience in challenging and unexpected ways.
- Augmenting the physical presence of the performers through costumes, amplified movement, and material props enabled the artists to create additional layers of meaning and connection between the real and the virtual, significantly enhancing the audience experience.
- In recent years there have been an explosion of sophisticated technologies for virtual and augmented reality that can serve as enabling technologies for mixed reality performance. Because almost all are repurposed from other applications and industries, custom work is required to create the flexible software/hardware frameworks needed for iterative creative authoring in a live performance environment.

12.

MOVING BETWEEN WORLDS - ADVENTURES IN MIXED REALITY PERFORMANCE

Fig. 1 - Manipulation - Act 2 - Cloud Opera (photo: Alan Goldman)

Approach to Mixed Reality Performance

We describe the process of integrating motion capture and virtual reality technologies into performative and interactive experiences. Throughout we will refer to a few pieces developed by the authors that explored mixed reality with dance, theatre, and interactive art. All used motion capture technology to create a link between bodies, objects, and virtual layers. The performances were collaborations involving the Pepper's Ghost New Media and Performing Arts Collective, Emily Carr University of Art + Design (ECUAD), Simon Fraser University (SFU), and New York University (NYU).

The Pepper's Ghost New Media & Performing Arts Collective was founded in 2014 in Vancouver, British Columbia, Canada, with the goal of creating mixed reality performances combining live performance with real-time computer animation. In these performances, the motion of human performers and analog props are tracked in real-time to control the appearance and actions of computer-animated characters, objects and environments. While a considerable amount of work has been necessary to tailor these technologies to meet the creative and expressive needs of performing arts in front of live audiences, the Pepper's Ghost approach to performance is not about envisioning or creating a 'Theatre of the Future'. We use existing digital media technologies that are fairly ubiquitous in video games, computer animations, and motion picture visual effects, but that have seen only limited use in live theatre. By taking full advantage of the expressive qualities and capabilities of these technologies, without relying on their novelty, we aim to create something meaningful and appealing for the audience, something that can truly be called a 'Theatre of the Present.' Pepper's Ghost is fully committed to creating tools that are open and can be used by other groups with similar goals. Because a significant amount of work goes into creating these tools, it's important that we grow a community that contributes to shared resources and shares their collective wisdom.

In contrast, NYU's Holojam mixed reality platform tries to envision and create a 'Theatre of the Future'. Whether using adapted off-the-shelf technologies, or new technologies developed specifically for Holojam, the goal is to understand what theatre will be like in a future somewhat like that described in Vernor Vinge's novel 'Rainbows End', where ubiquitous cyber-enhanced eyewear will allow both performers and audience to see the physical world around them visually transformed in whatever way is desired. The goal is not novelty but rather an embodied investigation, from a human and aesthetic level, of how performers and audiences will experience theatre in the future. Imagining a world where everyone is cyber-enhanced, Holojam focuses on experiences where the audience becomes a participant in the performance via shared spaces and game-like interaction techniques. There is equal consideration to developing future technologies and performative techniques, with experimentation in both influencing the other.

Collaboration is key to creating the kinds of performances described in this article. In particular, the collaboration between University research labs and theatre professionals give the latter access to advanced technologies such as motion capture systems that are typically not available to most theatre or dance companies. In a mutually beneficial partnership, the research lab can use the production process as a method to give insight to a research program that has a much longer term view. Most labs are funded by a number of private and public funds. In the case of Canadian labs, there has been a growing emphasis on knowledge mobilization, or the spreading of the knowledge and experience gained in research labs to the community at large. Collaborations with performing arts organizations have a clear benefit to the public both in terms of the actual performance produced and the additional expressive forms made possible. Because of this benefit, some research funds can be directed toward production to supplement funds raised by the theatre or dance company. There are challenges of course such as the different timelines of the institutions, and the management of the often necessary volunteer labour. We have found that as the collaboration matures, the institutional hurdles are fewer because the benefits become clearer and the pathways get codified.

Throughout the text we will be referring to a number of performances created since 2015. Short descriptions of these performances follow:

The Return (2015): A collaboration with theatre director, Reid Farrington and the Metropolitan Museum of Art that was performed in the museum through the month of July 2015.

The Return used real-time motion capture to enable a live performer to animate a digital representation of Tullio Lombardi's Renaissance statue of Adam, created from detailed laser scans of fragments of the broken sculpture. The virtual statue interacted with another performer (playing the role of a museum docent) and museum-goers to tell the story of the statue's creation, catastrophic damage, and reconstruction.

worlds (2015): A collaboration between Pepper's Ghost New Media and Performing Arts Collective, SFU's School of Interactive Arts & Technology (SIAT), ECUAD's S3D Centre, and the Computer Research Institute of Montreal (CRIM), worlds was presented as the closing night performance for International Society for Electronic Art's (ISEA) 2015 conference in Vancouver, British Columbia.

With the use of real-time motion capture, high-speed networking and the Unreal 4 game engine, worlds brought five dancers on three stages in two cities (Vancouver & Montreal) separated by 2300 km into a shared virtual environment in which they performed together simultaneously before three different audiences each given a unique perspective on the events unfolding within the digital world. The music for the piece was performed live, and broadcast to each of the 3 locations.

DUAL (2016): A collaboration between ECUAD's S3D Centre and NYU's Future Reality Lab, DUAL was presented as part of the Scores+Traces exhibition (Regina Miranda, Curator) at ONE Art Space in New York City.

Using real-time motion capture two dancers, wearing untethered virtual reality headsets and holding tracked wands, performed with each other in a shared virtual space while creating a world of visuals and sounds projected on a screen for the audience. The experience possessed an interesting asymmetry in that the dancers could both see and interact with a virtual world, a sort of 'VR backstage', which was invisible to the audience. Live crystal bowl sounds further layered the sonic landscape.

Fig. 2 - Manipulation - Act 3 - Cause 'n Effect (photo: Alan Goldman)

Manipulation (2016): A collaboration between Emily Carr University, Pepper's Ghost New Media and Performing Arts Collective, Cause & Effect Circus, and Moth Orbit Object Theater, Manipulation was presented at the Vancouver Fringe Festival 2016. It consisted of three one-act plays, each developed by a different creative team and exploring a different mix between physical and virtual performance.

Manipulation is an exploration of autonomy, influence and control through the use of real-time motion-capture, wireless sensors, video game engine technology, electronic sound, and stereoscopic projection. The onstage performers manipulated physical objects and each other using a variety of techniques drawn from physical theatre, circus arts, dance and puppetry, to control the characters, objects, effects and music that were projected onto a screen that acted as a 'window' into the virtual world.

FLOCK (2016): A collaboration between NYU's Future Reality Lab and the Future of Storytelling Festival. The project premiered at The Africa Center in New York to an audience of over 700 people during the course of the three day festival.

FLOCK turned viewers into performers by immersing them in a shared virtual world. Participants could see each other represented as birds as they moved around freely in a 1200 square foot space. Their interactions with the world and with each other became both the content and the performance.

Exploration Through Process

The development of each performance interweaves technical and aesthetic considerations in a collaborative way, and the success of each of these works derives, in no small part, from the interdisciplinary experience of the participants involved. While it may not be essential that theatre-makers interested in incorporating mixed reality into their practice have pre-existing expertise with these technologies, having domain experts involved early in the creative process is essential. Having a set of custom

or adapted tools to facilitate quick prototyping of environments and mixed-reality techniques gives directors and performers an idea of what is possible and an opportunity to have creative play sessions toward a finished choreography and script. The tools we use were developed incrementally to support certain aesthetic and production goals, and used in performance to provide an infrastructure for partially automated events such as scene changes and sound cues. A flexible prototyping environment allows us to pursue different aesthetic relationships between audience, performers, digital representations, and investigate the link between the material and digital realms.

Using a game engine like Unreal or Unity, coupled with a motion capture system for real-time performance is clearly not the intended or common use of these systems. Even though they are quite mature technologies, they come with embedded assumptions around what needs to be optimized both in terms of authoring and real-time performance, and what other technologies they recognize and support out-of-the-box. Most systems provide ways to customize for certain uses, and sometimes even provide pre-made hooks to link to other systems. Having technologists on the team who understand the limitations of the systems involved and can adapt them to the needs of theatre, dance, and other real-time performances is crucial. Creating these tools as open source plugins for others who may wish to experiment with them and further adapt them, is a goal of the Pepper's Ghost collective.

Working iteratively and collaboratively, each performance yielded inspiration for the next in sometimes unexpected ways. A summary of some of the more surprising insights follows.

- ***Aesthetic Explorations***

1. Relationship Between Performers and Digital Representations

The relationship between a performer and their digital representation can take many forms. One way to think about it is to define the role of the performer for the audience.

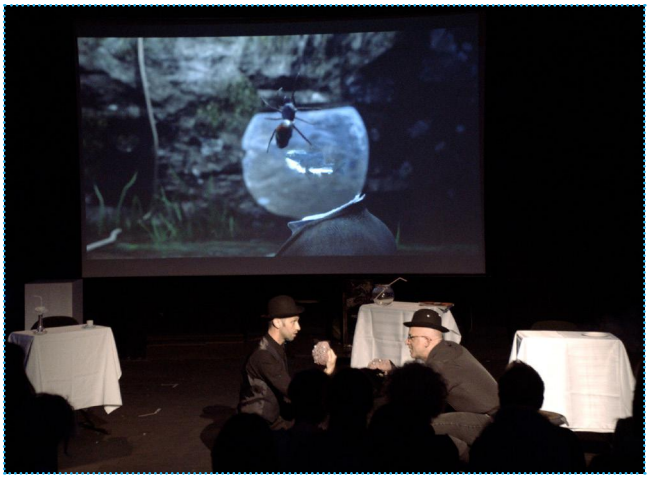


Fig. 3 - Manipulation - Act 1 - Moth Orbit (photo: Alan Goldman)

Fig. 4 - DUAL (photo: Ash Tanasiychuk)

Are they manipulating a digital representation of themselves that has more importance than their physical presence for the audience? Or are they equally present in the space with their digital representation? These questions are similar to what might be asked of a traditional puppet performance where the puppeteer may take more or less of the stage than the puppet at different times during the performance. In mixed reality performances, it is possible to have digital representations that are quite distinct in shape and scale from the tracked performer or objects. This introduces the need to learn to move like the digital character and develop a relationship that respects the presence of each. For example, in Manipulation, one of the performers was mapped to a giant hat with legs (Fig. 1). Exaggerated physical movements were necessary to express the hat's emotional state. Even if smaller movements had sufficed, the presence of the performer in the space was meant to be as important as the one on screen so greater physical expressivity was preferable.

Manipulation contained many different instantiations of the relationship between physical and virtual representations. In one of the acts the performers (jugglers) acted out a childhood scene and brought

forth an imaginary world on screen using their bodies and objects that conjured magical digital representations such as underwater and space worlds (Fig. 2). In this case, the digital representations were being used to externalize an internal state. The performers were kids in the physical world, and their imagination was enacted on screen. In another act the performers had a comparatively lower physical presence and used themselves and objects as drivers for characters within a complex digital stage, following a more traditional puppetry model (Fig. 3). In DUAL, the dancers had two representations, one within their headsets and one for the audience. In the headsets, they could see each other as a mask and a wand. For the audience they were represented as 'black holes' or radiating discs, from a top-down perspective (Fig. 4). The simplistic representation of an oriented mask and wand was enough to create, for each dancer, a powerful sense of presence and intention of the other dancer, which allowed both dancers to move in unison even though they saw only a highly stylized representation of each other. The headsets prevent the dancers from seeing the audience, and the boundaries of the performance space directly. As you would expect, this does influence the choreography by limiting the movements so as not to lose the headsets or stray out of bounds. Also, only knowing the position of one of the arms of the other dancer necessitates a relatively large safety zone, preventing touch for the most part. Dancers are normally quite aware of the position of their bodies in relation to the audience. Removing that awareness, we found, created a kind of orbiting performance where the performers were more concerned with each other. This worked well in the context of two orbiting black holes and in general it can be interesting to integrate technological constraints into the choreography. FLOCK goes further into a shared virtual perception in a physical space, erasing entirely the distinction between audience and performer. In FLOCK, the audience members *are* the performers. Participating audience members saw the physically shared space only within a shared virtual reality. Others saw a group of people wearing headsets and feathers on their arms, moving about each other (Fig. 5).

Fig. 5 - FLOCK - Group Interaction (photo: courtesy of the authors)

Fig. 6 - Manipulation - Cloud Opera costumes with motion capture markers (photo: Jerome Kashetsky)

2. Motion Capture Suits and Costumes

Optical motion capture is a technique where a set of specialized cameras are arranged around the stage to provide 360-degree coverage of the performance space. Small, reflective markers are affixed to moving objects and as long as at least 3 of an object's markers are visible to at least 3 cameras at all times, the object's position and orientation can be tracked continuously over time. When using optical motion tracking technology, there are some constraints on the costumes and objects based on the visibility of the markers. In worlds, this was not a big issue because the dancers only had virtual costumes and could wear simple and practical outfits, specially designed for use in motion capture. With Manipulation, we wanted to explore an expanded stage presence for the performers and used costumes more extensively. In practice, we found that we were able to design costumes that were aesthetically pleasing and integrated the markers in a way that was less obtrusive than one might expect (Fig. 6). Many of the costumes were modular so we could do rehearsals without getting into full dress. The objects were actually more tricky to apply markers to because their handling could obscure key markers and disrupt tracking. In addition, when many objects need to be tracked simultaneously, they must be given distinct marker patterns that will still differ from each other where there are occasional occlusions. This constraint was particularly acute for the third act of Manipulation which featured a

juggling act with tracked performers, balls, pins, boxes, and rings. The objects being juggled had to be markered carefully as the markers could not interfere with the weight balance or significantly alter the surface of the objects. For some of the objects (such as the juggling rings and balls) we used simple circular reflective tape with no protruding marker. The NYU group has devised a quite elegant modular solution for the tracking of multiple GearVR headsets that minimizes the possibility of patterns being mistaken for each other. They use a set of 4-6 rods of different lengths screwed into a hemisphere adhered to the headset (Fig. 7). Even with all precautions, there are always interruptions in the tracking during the performance, either through occlusion or fallen markers. These failures can be handled through software compensation (e.g. hiding an object), or by improvising during the performance (e.g. mimicking the movement of an erratic virtual object). In some cases it can even be appropriate to trigger a tracking failure. In one of the acts of Manipulation, the performers deliberately obscured markers to depict a chaotic scene involving two virtual characters. Another way to use a deliberate interruption in tracking is to hide the markers with another object. In the Moth Orbit act of Manipulation, a tracked brain object is on the head of one of the performers, hidden by a bowler hat. At the right time, the bowler hat is removed and the virtual character being puppeteered by the brain appears on screen. In FLOCK it was decided that only the heads of audience members would be tracked. Aesthetically this means that the movement of the performers is 'from the head', giving them a sense of flying with their heads as guides. In general, the parts of the body that are tracked tend to lead the movement which is something to play with during production, investigating how those movements will be seen by the audience and how they will be mapped to digital representations. If tracked objects are held during the performance, special attention must be paid to their orientation with respect to the virtual camera, which further changes the quality of movement of the performer.

Fig. 7 - GearVR modular marker system

3. Asymmetric Views and Embedded Worlds

One of the advantages of a mixed reality performance is the ability to play with different views of the virtual worlds. In DUAL, the dancers saw a quite different representation of the virtual world than the audience. They experienced quite a sparse space where they were able to select audio-visual brushes to draw strokes on a virtual dome which then played back sonically as a music sequencer swept through the dome. They co-authored a layered visual and audio scape as they moved and added to each other's creation. While the audience and dancers share the same audioscape, the audience sees a different (top-down) view of the virtual world, with the dancers represented as radiating black holes. Exploiting the difference in views during the performance, certain movement guides were shown to the dancers but not the audience, leading to synchronized and precise movements (like tracing an object) that appeared unprompted from the audience perspective. There are many areas of exploration for improvised movements that could appear magical to an audience by virtue of an asymmetric view. For example, if each dancer had the possibility of always perceiving the other dancer as though they are standing directly in front of each other, regardless of their actual location in the space, mirrored movements become possible no matter where the dancers are physically located.

In worlds, there were three different sites each with their own motion capture system and mapping between physical and virtual worlds. The two worlds from the distant sites were rendered in miniature inside virtual pyramids which had physical tracked counterparts (Fig. 8-11). In this way the performers could 'hold' the other worlds embedded in their world. The possibility of worlds within worlds is a rich space to explore. In this case we were embedding separate spaces but it would be equally possible to scale up or down any part of the stage or particular characters, for effects such as capturing a moment in a capsule or deliberately carrying a live version of one part of the stage into a performer's hands. As a performer, the feeling of holding a miniature version of a live world is quite potent, at once feeling the vulnerability and power of the alternate positions. The worlds performance also played with the idea of embedded or parallel worlds by moving tracked screens within the space, which

acted as windows into the virtual worlds or filters of the performers and tracked objects. This technique was also used in glassdance, a previous performance, where a tracked iPad mounted on a wheeled tripod acted as both a dance partner and a view into the virtual world.

4. Audience as Performers

Another approach to mixed reality performance is to put the audience in the role of performers. NYU's Holojam platform was built with this purpose in mind and has enabled a number of experiences which have a group of people wearing headsets and sharing a physical and virtual performance space together. In some cases, as in Dia de los Holos, headsets are shared and the performance is seen by some as abstracted movements, and by others as actions on a float in a Day of the Dead parade. The emphasis is always on the shared social experience of physically being in the same space and sharing a virtual world. In FLOCK, up to 20 participants can don headsets and enter a shared world where they become birds chasing fanciful procedurally generated bugs, ever more complex as the chase intensifies (Fig. 12,13). Visual and sonic feedback are important for creating a magical feel for the experience. FLOCK's primary concern is to encourage participants to physically move around in the space and interact with each other based on audio-visual cues and incentives. One interesting technique used is a non-linear scale applied to the birds as they get closer. This gives an early warning signal to avoid collisions, thereby promoting more adventurous play and movement within the space. As well as wearing a headset, the participants wear a pair of 'wings' velcroed onto their arms which serve the dual purpose of creating a visual interest for an external audience, and giving sensory feedback to the participants should they get close to each other (Fig. 14). For the non-participating audience walking by or waiting for their turn, the group behaviour is visually interesting and enticing with lots of movement and the occasional squeal of delight. The bugs are programmed to appear in locations that nudge certain kinds of crowd behaviour (flocking or segmenting) and this dynamic behaviour further enhances the visual appeal from the non-participating audience perspective. While Holojam has focused on shared virtual spaces with audience acting as performers, we can envision a hybrid form where the sharing of physical and virtual space is given more equal importance and the performance is compelling in both forms, given an impetus to the audience to take their headsets on and off as they are performing.

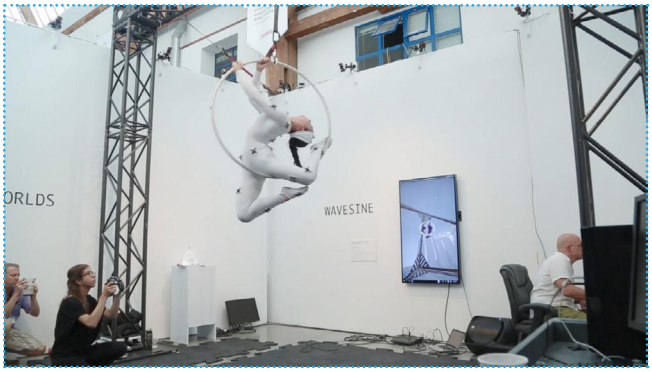


Fig. 8 - worlds - Aerial hoop performer in Emily Carr University Concourse Gallery (photo: courtesy of the authors)

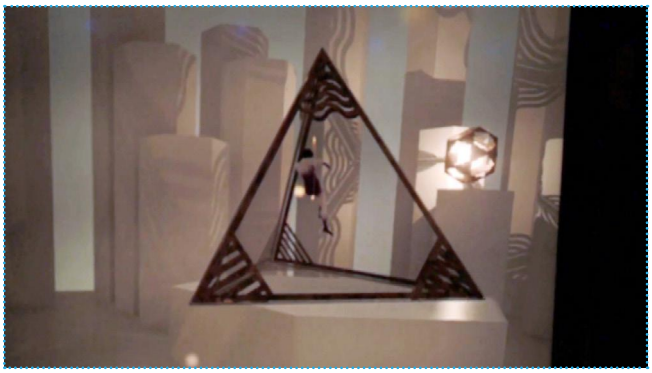


Fig. 9 - worlds - Avatar of aerial performer rendered in miniature inside a pyramid (photo: courtesy of the authors)

- ***Off-the-shelf and Custom Technology***

1. Motion Capture and Inverse Kinematics

One of the complexities of working in mixed reality is how things are tracked and how they are mapped to digital assets, particularly articulated ones. In motion capture, a rigid body is an object that does not change shape. It can change its location and orientation only. A skeleton is an object (typically a human body) with articulated limbs. Data from a tracked skeleton needs to be calibrated to every digital representation it will be mapped to in order for the virtual character's movement to look natural. We have had experience with three different kinds of motion capture system: Vicon, Natural Point, and Organic Motion (markerless). Each of these have pros and cons and have different ways of dealing with rigid bodies, skeletons, and real-time data communication. The time between when an object moves and the information is received by interested parties (like a VR headset) is called latency. If latency is too long, objects appear to lag and the virtual world looks like it's 'swimming' or just not stable. Over time this becomes uncomfortable. Latency

is caused by delays in the tracking (skeletons are generally harder to track) and in the routing of the information. With some experimentation we have been able to reduce the local tracking latency to an acceptable level for mixed reality. Non-local transmission of data for multi-site performance (as was used in worlds) introduces additional needs for remote connection stability and speed which we have not fully solved yet. Often it is not desirable or even possible to have a fully markered performer tracked as a skeleton to articulate a virtual character. If that's the case, a performer can be tracked as a reduced set of multiple rigid bodies. The full movement of the body is then inferred by the location of the rigid bodies (e.g. hands, head, wrists) in a process called inverse kinematics (IK). For example, in the case of Holojam's shared drawing experience shown at SIGGRAPH in 2015 there is no time to fully marker a participant and calibrate the mapping to a skeleton every time a new person comes to try out the system. In that case, only wrist and ankle markers are used to drive the limbs of a virtual character using IK techniques (Fig. 15). Holojam developed a custom procedural IK technique for this purpose, optimized for maintaining natural virtual character movements, no matter the size or body type of any participant. Pepper's Ghost used IKinema's Live Action plugin for Manipulation as it allows for complex and highly configurable mappings between performers and virtual characters, giving us the ability to generate expressive and believable movements for characters that are not of human form or scale.

Fig. 10 - worlds - Avatar dancer holding the miniature avatar of aerial hoop performer. (photo: courtesy of the authors)

Fig. 11 - worlds - Dancer holding a miniature world using pyramid proptic

2. Digital Puppetry and Proptics

Central to both Holojam and Pepper's Ghost activities has been the link between analog and digital. We coined the word 'Proptic', a portmanteau of Prop and Haptic, to indicate objects that are tracked and have a digital counterpart. Both Holojam and Pepper's Ghost have developed a set of tools and client/server protocols to track proptics and broadcast their position and orientation to all headsets and displays in real-time. In addition, Pepper's Ghost has developed a set of plugins and scripts for the Unreal Engine whereby an object (puppet) can easily be added to a scene and linked to an external proptic. Specialized puppet modules have been developed to deal with cases such as a spider puppet which always needs to stick to the nearest surface, or puppets 'on rails' - constrained to move on a fixed path no matter where the proptic is. The rail technique was used to great effect in the opening scene of the Moth Orbit act in Manipulation where the performer walks across the stage while his virtual counterpart emerges out of a lake. Other plugins help link wireless sensors and actuators to the scene via OSC (Open Sound Control, an open-source communication system similar to MIDI) messages. This infrastructure has been invaluable for quick prototyping and brainstorming of characters and interfaces.

3. Queuing System

With each new work, the sophistication and complexity of the dramatic sequences and digital effects has increased considerably.

Over time, systems for controlling lights have evolved from banks of dimmers controlling individual lighting channels, to computer-based sequencers capable of controlling the timing of hundreds of independent instruments and effects, while retaining the ability for the operator to respond, in real-time, to subtle changes in timing and motion in each performance. For The Return, we built a MIDI-instrument-based control system that would enable the performers to trigger and control lighting, sound and visual effects within the virtual world and the real world simultaneously (Fig. 16). With Manipulation, we had to support three completely unique one-act performances, each of which consisted of a series of independent scenes, containing dozens of lighting, camera and visual effects cues, and changes of scenery, often simultaneously, in response to one or more performer actions. To support this, we built an extensible queuing system, using OSC messaging, inside the game engine, which would enable us to control the timing, sequence and duration of any aspect of the virtual world. This was paired with an iPad app, built using TouchOSC, to enable an operator during the performance to activate a sequence of cues over the course of the performance, while at the same time retaining the ability to activate individual effects (or collections of effects), or camera changes in a more improvisational manner (Fig. 17). Freed from the constraints of a large table-top midi control panel or desktop computer, the operator had the mobility to move about the auditorium and the stage during setup and rehearsal, making it easier and more efficient to verify and adjust viewing angles and other location-dependent issues.

4. Speech-to-Text and Sonification

A sonification engine was developed that allows for the manipulation of text within virtual environments. We use the IBM Watson speech-to-text cloud service to create words in real-time in virtual space and then use granular synthesis to replay the word under different kinds of manipulation such as scrubbing through a word, stretching, twisting, bouncing, etc. Each of these actions have a different kind of sonification. This creates a kind of concrete

Fig. 12 - FLOCK - Bird avatars chasing after bugs (photo: David Lobser)

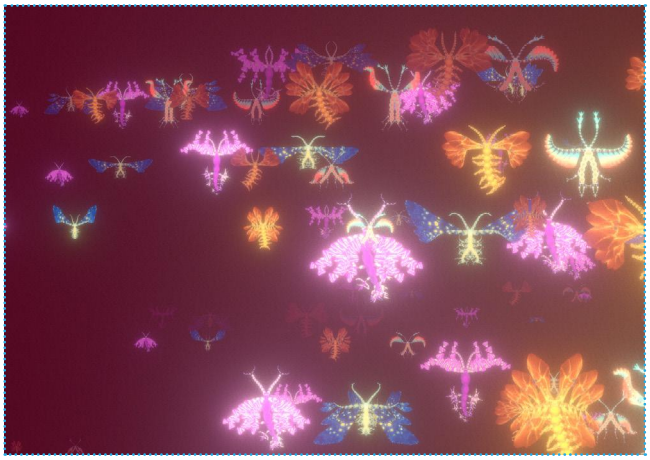


Fig. 13 - FLOCK - Examples of procedurally generated bugs (photo: David Lobser)

Fig. 14 - FLOCK - Wings worn by participants (photo: Tyler Pakstis)

poetry system where words are used as sculptural objects and sonic instruments. We used the sonification engine in Manipulation, as a way of engaging the audience in improvised wordplay. Despite some technical challenges, there were enough sparks of creation to point the way to a standalone performance which could be structured around words, sounds, and movement. One of the limitations to the current sonification engine is its heavy computation requirements which constrain it to run on a desktop machine as a remote service. We are currently investigating solutions that could run on a mobile phone giving each user a unique experience without the need for a full server infrastructure.

Conclusion and Future Explorations

Mixed Reality performances offer opportunities to investigate the relationship between audience, performers, and virtual worlds. Within these relationships questions of engagement, immersion, mappings, interactivity, and performativity drive the exploration of different kinds of stage configurations and storytelling. Through a number of performances and less formal experiments we have worked within the disciplines of dance, theatre, circus arts and shared social spaces. Each of these present specific aesthetic and technical challenges that spur the development of supporting tools and creative choreographic techniques. Moving forward, we are focusing on stabilizing networked multi-site performances, and the refinement of the relationship between physical performers and virtual worlds particularly around circus arts (juggling, clowning), and dance. The integration of audience as performers, and performers in headsets will also continue and benefit from new inside-out tracking techniques which can minimize the need for full motion capture systems.

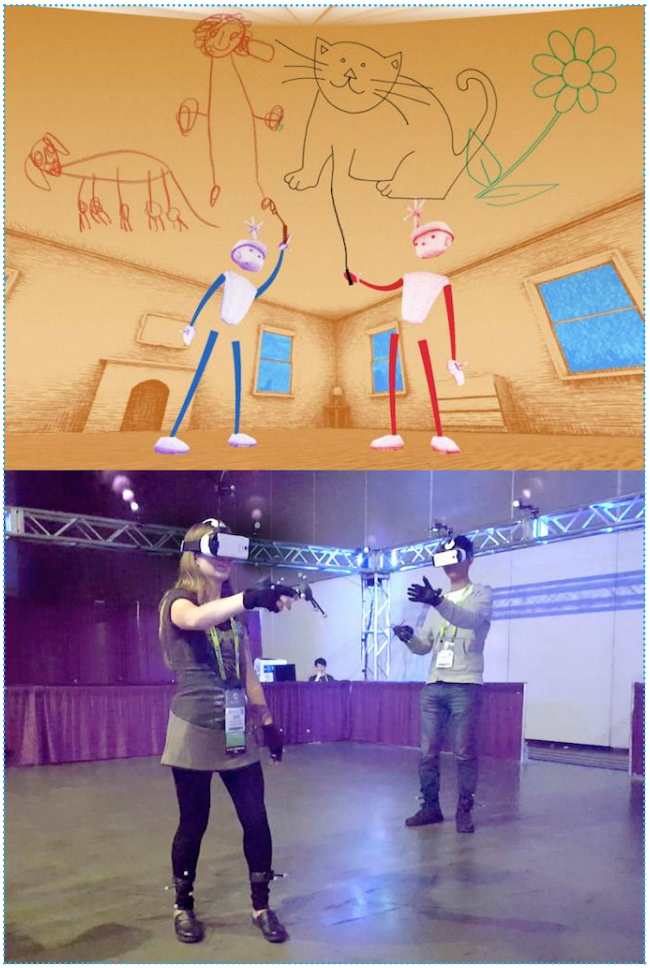


Fig. 15 - Holojam - Inverse kinematics being used to articulate avatar using only head, wrist, and ankle motion capture.

Links

http://www.peppersghost.org/

https://holojamvr.com/

http://movingstories.ca/

http://marialantin.com/portfolio_page/dual/

http://dlobser.com/flock

Acknowledgments

This research was supported in part by the Social Sciences and Humanities Research Council of Canada.

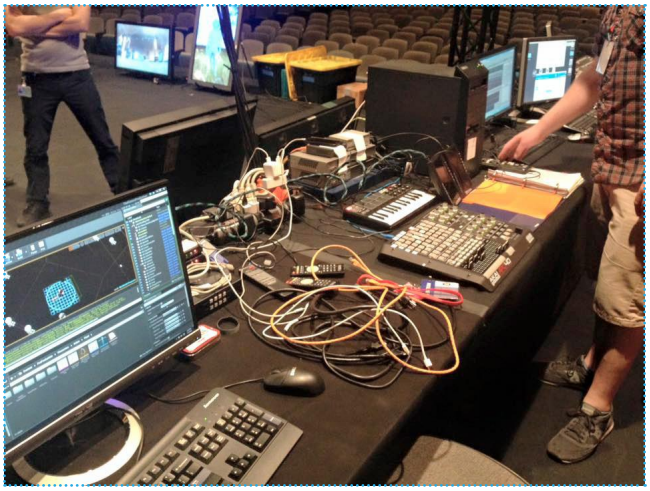


Fig. 16 - The Return - MIDI controller to cue lighting, visuals, and sound effects (photo: Athomas Goldberg)

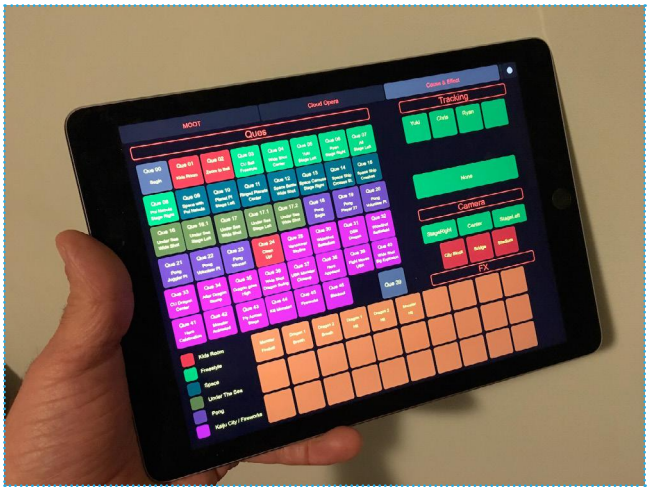


Fig. 17 - Manipulation - IPad application to cue scene changes, and sounds (photo: Athomas Goldberg)

Social Sciences and Humanities Research Council of Canada
Conseil de recherches en sciences humaines du Canada
Canada

13. CYBORG DATING

picture: courtesy of the artists

Project title: Cyborg Dating

Makers/collaboration by: VR4two - Rosa Frabsnap and Sander Veenhof

Text by: Sander Veenhof, Rosa Frabsnap, Marloeke van der Vlugt

Country: The Netherlands

Website/link: cyborgdating.com

Lessons learned:

- Make your participants co-responsible for the live experience.
- Hi-end realistic graphics are not necessary to create an immersive VR experience.
- New opportunities appear when one participant leads another participant through a VR narrative in public space. However, it's quite a challenge to let this happen without being there to assist.

13.

CYBORG DATING

CYBORG DATING is a mobile 'VR4two' experience: one person wears the VR headset and is guided through the physical environment by the other person, using his or her smartphone.

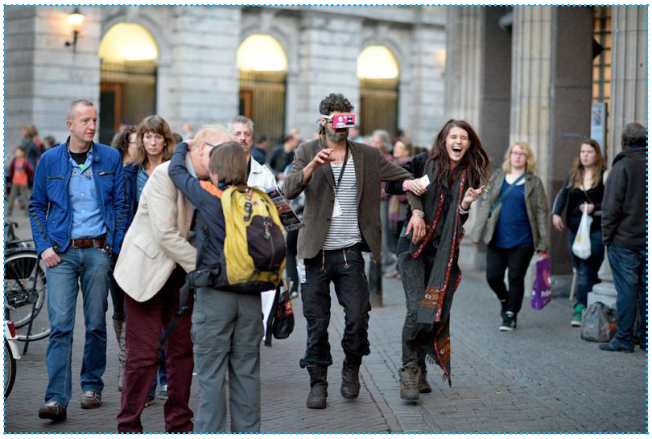
In CYBORG DATING the participants are asked to perform a role. The one with the headset becomes the Cyborg, the other stays Human. As a result, a conversation is triggered about the impact of new technologies on our communication, specifically during a date..

CYBORG DATING was co-created by Sander Veenhof and Rosa Frabsnap. Sander Veenhof is a hands-on researcher, turning his thoughts about the future of technology into prototypes that can be experienced in the present.

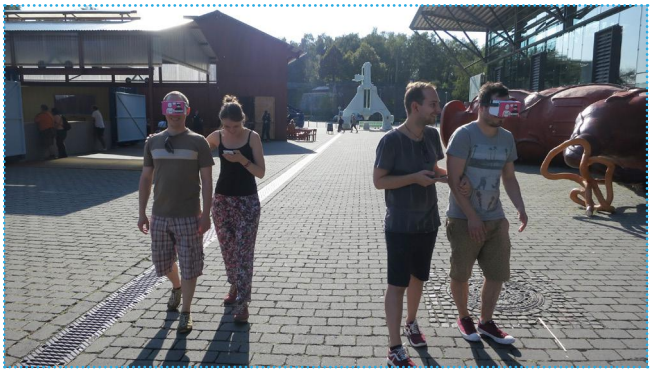
As an interactive performance designer, Rosa Frabsnap focuses on social interaction through game design, creating play in unconventional (public) spaces. She is always trying out new ways to tell interactive stories.

The project was launched at the Impakt festival in Utrecht in 2014 and reworked to a version '2.0' for the Ruhr Triennale in 2015. This article describes the second version and proposes ideas to develop the work.

Remarks



Cyborg Dating (picture: Pieter Kers | Beeld.nu)



Cyborg Dating (picture: courtesy of the artists)

The core of the experience CYBORG DATING is the dialogue between Human and Cyborg:

> *The human permanently attached to its phone, and a human from the future who lives entirely in a virtual, efficient, reflection of the world. Both life forms resulted from the man with his tool. Thanks to the application built by Cyborg Dating, communication between you two will be entirely flawless (text taken from script).*

A similar active form is chosen to set up this article. The text depicts the two makers talking to each other about their thoughts during the process of making, while considering the relevant topics for this publication.

At the same time they reflect on the actual presentations illustrated by parts of the written script: the pre-conceived dialogue between the two participants performing their roles of Human and Cyborg.

Like this, we hope the reader feels invited to alternate between the makers' and the audience perspective in order to vividly imagine and contemplate the questions and choices of creating a mixed reality performance.

Introduction

ACT 0A – STORY INTRODUCTION

Situation: Two players are seated at the CYBORG DATING desk. Two employees of CYBORG DATING are seated on the other side of the desk.

A computer generated voice starts talking (listen here):

Welcome to Cyborg Dating.

In the near future, technology will be seamlessly integrated in all aspects of human existence. Today, in Cyborg Dating, one of you gets the chance to date a Cyborg from the future! The Cyborg will be wearing the high tech CYBORG DATING headset. A device imported from that FUTURE. Wearing this headset will give the cyborg the opportunity to be the best version of itself, guaranteeing a great, successful date.

The other person will be using a recognizable device that is currently already a big part of daily life: A cellular phone. This android model is equipped with an application that makes direct communication from the cellular phone to the brain of the cyborg possible.

Decide now: which of you will become the Cyborg from the future, and who will be the regular human. Decide now.

Sander: We 'invented' this VR4two Cyborg Dating as an answer to our initial question: can virtual reality be used while walking outdoors, in public space, for instance by using a Google Cardboard device?

Rosa: Yes, we came up with the idea of introducing a human guide to avoid crashing into things, since obviously you can't see the world around you while you're wearing a VR device.

But how can we make this human guide an integral part of the experience and the story?

S: A date?

R: A date with a cyborg! A fictional cyborg from the future, which has gradually digitized all of the human senses, including vision.

Cyborg Dating (picture: courtesy of the artists)

S: It will actually be a date between two cyborgs then, because we humans with our smartphones are already cyborgs.

About: LEVELS OF PARTICIPATION

ACT 0: Tutorial

Situation: Two players take their devices outside. The cyborg is wearing a Google cardboard VR-device. The human is carrying a phone on which the Cyborg dating application is running. The two players get their final instructions from the application:

[.....] During your date you will be followed by a Cyborg Dating Employee. He or she is only there for observation purposes and will not interrupt the date unless absolutely necessary. We ask you to ignore this employee as much as possible.

These are your instructions:

- Take your device.
- Go outside.
- Put on the cyborg headset.
- When you are both ready, press start on the Human cellular device.
- Keep moving forward to unlock more dating content. Eventually, the system will tell you when it's time to follow the footsteps back here.

Thank you for your attention. You are ready to go outside. Please enjoy Cyborg Dating.

If you have any questions you may now ask the two people behind the desk.

Rosa: We built a phone application that enables the Human to send questions to the Cyborg.

Sander: The Cyborg immediately answers, but in a pre-scripted manner, the answers are given to him on autocue within virtual reality.

R: This way, the Cyborg has the perfect answers. I mean, dating can't stay this complicated forever, right?

S: And they both become performers: the Human asks the questions given on the phone app, and the Cyborg answers by speaking out loud.

Questions (Human > Cyborg)	Answers (Cyborg > Human)
1.1. How are you doing?	GREAT --- HOW ARE YOU?
1.2. Where are you from?	I AM FROM: CYBORIA TWO_POINT_O THE SERVER IS LOCATED IN: HAMBURG: GERMANY AND WHERE ARE YOU FROM?
1.3. What is your name?	MY SYSTEM ID IS: CY-BO THREE_SIX ONE_ZERO BUT YOU MAY CALL ME: ROBIN NICE TO MEET YOU

S: We needed a script, like in theater, because I believe it's important to stimulate the players to start performing.

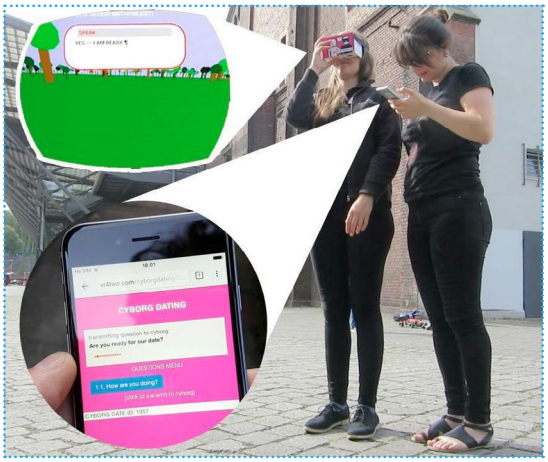
R: A non-linear, partly interactive script, in which pieces are activated by the actions of the human player.

S: In order to accomplish this, we invited the playwright Rudolf Buirma to help us.

R: He worked on the dramaturgical line and on the actual dialogue. How the text is written and displayed on the screen is meant to help the players to perform. For instance, the use of spacing and punctuation in the Cyborg's text gives it an 'automated/computer' vibe. Just by looking at it, you are prompted to speak the 'Cyborg Dialect'.

S: And the questions in the first scene are set up like classical 'first date' questions, recognizable and as such also meant for the players to get into their roles.

R: Yes, because in the end, how the players perform is defining the mutual experience.



Cyborg Dating (picture: courtesy of the artists)

Questions (Human > Cyborg)	Answers (Cyborg > Human)
1.4. What do you do for a living?	I PROGRAMMED MYSELF TO BE A --- LEVEL SIX: BIG DATA ANALYST --- SPECIALISED IN: HUMAN SOCIAL INTERACTION HOW ABOUT YOU?

Tip for other makers

As this is an experience executed by the two participants themselves - there is no actor or collaborator who can help - they need to be made responsible. Our way of doing this is by giving them an active role in the experience: next to the formal role of keeping the other safe, we invite them to perform! This is a risk though, because the quality of the experience is severely influenced by the performative effort of the two participants. There was one occasion where one of the players refused to say his lines, and as a result, destroyed the entire experience for the other player. However, we also saw the opposite happen. Another couple was completely immersed and started to perform like actors on steroids. As soon as they had read the first autocue, they started to walk and talk like robots, stiff, upright and in sync with each other.

About: SCENOGRAPHY

Questions (Human > Cyborg)	Answers (Cyborg > Human)
2.1. What does your world look like?	RIGHT NOW: CYBORIA IS A BRIGHT AND LUSH WORLD: FILLED WITH MANY TREES HOWEVER: I CAN CHANGE IT WHENEVER I WANT IN WHATEVER I WANT

Rosa: The first act is focused on explaining how the futuristic world looks like and how it is experienced by the Cyborg.

Sander: I created a very minimalistic representation of the world for the person wearing the VR headset. It consists of a green plane with some brown cylinders and green spheres. In combination with the solid ground under the players' feet, however, it appeared to be convincing enough to become a believable forest.

R: Yes, as we were following the participants, we regularly overheard conversations like:

Cyborg: We have to go there!
Human: Not possible, we will walk into the canal.
Cyborg: Hmm, no, that's not true, I see where we need to go, straight on!

S: The couple traverses the VR world and the physical world at the same time. They are free to choose their route, because I kept the border of the VR forest - based on GPS coordinates - rather wide (see map below). I took an easy-to-walk distance of 80 meters in a circle around the point of departure. The only directional instructions were given to the Cyborg: 'walk to the border of the forest'.

Cyborg Dating (picture: courtesy of the artists)

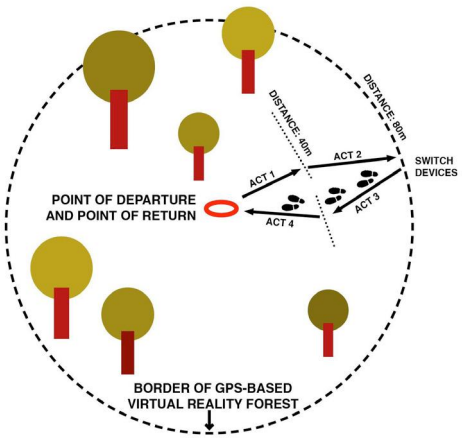
R: However, players tend to get very creative in finding their own objectives when you give them a sandbox-like frame. For instance some people just walked back and forth, they didn't understand they needed to move on and walk the 40 or 80 meters to change scenes.

S: The questions that appear on the mobile phone are linked to time and space. That way the app reacts to people's behavior, like standing still, running or strolling. As a result the story becomes a dynamic experience: instead of going from one GPS point to another, participants go through various scenes based on distance walked.

R: In order for the App to react to the players' behaviour, we divided the questions into two categories; mandatory and optional. Mandatory questions are necessary for the story arch to develop. These questions don't leave the screen until the Human has asked them.

S: 'Question 2. What does your world look like?' (on top of this page) is an example of a mandatory question.

R. Questions 2.1 and 2.2 (next page) are examples of optional questions.



Questions (Human > Cyborg)	Answers (Cyborg > Human)
2.2. Do you ever miss the real world?	THE HUMAN WORLD: OR: REAL WORLD AS YOU CALL IT: IS A BUSY PLACE FILLED WITH MANY PEOPLE: WHO OFTEN FIGHT OVER THEIR LACK OF SPACE THE WEATHER IS RANDOM: AND THE DAYS ARE SHORT WHERE ALL NEED MONEY: SO THEY ARE FORCED TO WORK
2.3. Why do you like your world?	I LIKE CYBORIA VERY MUCH EVERYTHING IS SERENELY CALM HERE AND I AM IN FULL CONTROL OF EVERYTHING

R: This kind of questions provides a more 'in depth' story world for players to explore if desired.

S: They disappear from the screen if over-ruled by temporal or spatial limits. Like this, they react to the players' behavior. When people walk fast and take little time for interaction, the optional questions don't show up.

Tip for other makers

Although the design of the virtual space was kept rather abstract, the participant Cyborgs didn't question the idea that they were walking in a forest. In fact, we overheard a Cyborg trying to convince the Human to follow 'his' virtual directions, suggesting that the digital space even became more trustworthy than the analogue space. We think this is due to the fact that we didn't try to create a VR world that imitates the 'real' world. We deliberately chose to visualize the VR forest in a minimalistic but recognizable manner. As a result the participant can easily let go of any lifelike expectations of the VR world and start to use other senses to legitimate 'realness'. The fact that the player's pace and physical sensation of moving in the analogue space corresponds to the pace and movement in the digital space supports this. In other words, co-ordinating physical sensations in both digital and analogue spaces stimulates the immersion in VR.

About: INSTRUCTIONS

Sander: After the 'getting to know each other' scenes, we asked the participants to switch devices. This swapping of devices was added after the first version of CYBORG DATING because we noticed that *both* players wanted to have the VR experience; obviously the more unique and unknown form of gameplay.

Rosa: That's why, for the second version of CYBORG DATING, we integrated this swapping into the concept.

S: The storyline induces the Human to ask the Cyborg questions about the VR world. This way, the Human's curiosity is exposed to both performers and the Cyborg can react to this.

R: From the perspective of the Cyborg, of course he wants one last opportunity to visit old-fashioned physical reality!

S: The exact moment of exchange is triggered by this piece of dialogue (see table on top of the page):

Questions on mobile (Human > Cyborg)	Answers in VR (Cyborg > Human)
3.1. What does the future look like?	I COULD TELL YOU**** BUT I COULD ALSO SHOW YOU

S: This is the moment the players exchange their devices.

R: But they are supposed to continue performing in their given character…

S: The couples had to stand still and carefully observe the briefing that explained them the new context.

R: From then on, questions could also come from the Cyborg interface. At these moments the Human is told to pause for a moment and listen.

Questions on mobile (Human > Cyborg)	Answers in VR (Cyborg > Human)
3.2. Do you like the virtual world?	Q: ?? DO YOU LIKE THE VIRTUAL WORLD ??**** //SAY_EITHER:**** <YES> / <NO>
3.3 Could you describe what the world looks like?	Q: ?? DESCRIBE WHAT THE V.R. WORLD LOOKS LIKE ??**** //SAY_EITHER:**** A: 'IT IS BEAUTIFUL: I ENJOY THE SPACE'**** B: 'I DO NOT THINK I CAN DESCRIBE IT'

S: This was confusing. The participant now holding the smartphone was the former Cyborg. Being used to an interface that told them how to respond, we now had to almost 'force' them to answer the questions.

R: And the former Human, now Cyborg, needed to understand the hybrid mix of predefined answers and suggestions to improvise. They didn't get to rehearse this new rule and the change didn't work out well.

S: We found that both participants started to read out loud all the texts, including the A or B answers *and* the questions to improvise!

R: It was clear the players needed more information and time to adjust to the new situation.

S: That's why, at the starting point, we sit at the table throughout the introduction.

While the audience listens to the introduction text, we observe them to monitor if they understand everything. But we didn't implement this clear instruction + monitoring tool for the switching point.

R: Even though we follow them outside, we couldn't just step in to explain the new interaction, as it would break the performative experience for the players.

Tip for other makers

It's a real challenge not to overwhelm people with textual instructions. We noticed that people tend to be impatient readers. Give them just enough information to make sure they know what to do.

Be careful with changing the rules halfway through the experience. This kind of interactive/multiplayer/outdoor VR experience is quite unknown. There is no familiar set of rules the players can follow. They need to be given time to adjust and practice the rules of the game.

It is best to teach the players how to interact at the beginning of the experience. It seems like the only logical moment. Changing the rules in the middle – as we tried to do by switching the devices – can be difficult. Maybe the switching of devices could have been presented as a new 'beginning' with a strong visual or audio alert, and a radical change of style. We will try this next time. Additionally we will build a clear tutorial for both participants and give them time to adjust and rehearse the new set of rules.

About: TECHNOLOGY

Rosa: After the exchange of devices, the Human wears the VR set. Being unable to see, he can't guide them back to the starting point.

Sander: Fortunately, the path is traced digitally. At this point, digitally visualized footsteps appear in the VR world. Now the new Cyborg can safely guide them back.

:: UPDATING INTERFACE :: PLEASE STAND BY ::	Your cyborg date will now guide you	::SYSTEM MESSAGE::	PLEASE DATE RESPONSIBLY**** ALWAYS FOLLOW THE FOOTSTEPS

R: How does this technically work?

S: Per scene, a secondary timeline with events runs invisibly in the background, based on time spent in each scene. An initial form of AI is being developed to analyse movement (or non-movement) to let the story engine control the situation in an appropriate and meaningful manner. However, in this version of CYBERDATING, the system only reacts to triggers that I programmed beforehand.

R: Yes but by programming the system like this, we were able to control the dramaturgy of the experience in order to figure out what was possible.

S: Well yes, we tried to control it, but of course we couldn't completely supervise how the technology behaved or how the performers performed. These smartphones are still not reliable… and people are always unpredictable.

So the question for me at this point is: do we want the experience to be available for two people anywhere in the world? Every time they feel like going on a Cyborg date?

R: We will need to do a lot more play testing before that would be possible: to observe where the duo could get stuck and then propose a variety of solutions.

S: More Artificial Intelligence could be incorporated to increase the dynamic experience and intensify immersion. Monitoring progress by checking if buttons are being pressed is not enough. The system needs to understand what's happening beyond the interface. What do the sensors of their devices tell us about what's going on?

Tip for other makers

Thanks to the massive spread of smartphones and Google cardboards, this experience could potentially be presented anywhere in the world, even without us being there. We have VR glasses and mobile phones to send instructions and autocue texts. However, our influence ends where the software ends. We have to rely on dramaturgical choices that are made beforehand, and we can only influence the ongoing performance indirectly, through one participant saying something to the other and vice versa. More Artificial Intelligence might be able to make the experience more immersive, but may also generate unforeseen situations or mistakes and subsequently a loss of content.

About: THE END

mobile header	mobile text	VR header	VR text
:: BUTTON ::	Activate Night Sky		< night sky appears >

Smartphone	VR headset
4.2. Are you happy to live in the 21st century?	Q: ?? ARE YOU HAPPY TO LIVE IN THE 21st CENTURY ??**** //SAY_EITHER:**** A. <IMPROVISE>**** B. <IMPROVISE>

Rosa: Scene 4 focuses on the story of the date again. The former Cyborg activates a night sky in the virtual reality.

Sander: A date between two individuals from two epochs is fiction, but nevertheless the experience gives a hands-on glimpse into the future of dating.

R: Already now, people meet their dates online, before getting connected in other ways.

S: Will the future of dating become an activity based on data, analysis and scripted encounters?

4.3. What do think of when you look at the stars?	Q: ?? WHAT DO YOU THINK OF WHEN YOU LOOK AT THE STARS ??**** //SAY_EITHER:**** A: 'MANY THINGS --- LIKE: WHAT WILL MY FUTURE LOOK LIKE?'**** B: 'I DO NOT KNOW...'**** C: <IMPROVISE>
5. Do you like me?	Q: ?? DO YOU LIKE ME ??

Questions for other makers

More experiments are needed to develop this genre of VR experiences. The bottleneck for experimentation at this moment is the hardware. The VR devices and smartphones need to work flawlessly at all times.

However, all factors considered, VR4two is exciting to explore and we will continue to do so.

We do invite you to join us in our thinking about this format, so we have formulated a few questions for you:

Could VR4two become an autonomous genre? Is the added value of walking untethered through public space more than just an alternative for VR systems with a limited tracking area?

Should it be our next challenge to turn our insights and experiences into a content creation tool?

Can you imagine other concepts or stories that fit the idea of a joint journey through a VR world?

Let us know!