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CID-181 • ISSN 1403-0721 • Department of Numerical Analysis and Computer Science • KTH

Staged Mixed Reality Performance "Desert Rain" by Blast Theory

eRENA ESPRIT Project 25379 Workpackage 7 Deliverable D7b.3

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Report number: CID-181, eRENA ESPRIT Project 25379 Workpackage 7 Deliverable D7b.3

ISSN number: ISSN 1403 - 0721 (print) 1403 - 073 X (Web/PDF)

Publication date: August 2000

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Deliverable 7b.3

Staged Mixed Reality Performance "Desert Rain" by Blast Theory

ABSTRACT

The deliverable reports on the staged event Desert Rain by the performance group Blast Theory. This is a pioneering large-scale virtual reality theatrical work representing a synthesis of art and technology using innovative interface devices. As an electronic arena it presents a new approach to theatre that incorporates the functionality of a collaborative virtual reality environment (CVE), the technology of a physically permeable mixed reality boundary and a new relationship between the audience and the performers.

The technical infrastructure combines a number of technologies: a distributed virtual world, a projection environment, a user interface (the footpad), audio monitoring and feedback, and a card activated video replay.

Researchers from King's College, London, carefully evaluated audience participation in Desert Rain. Their study describes observations and findings regarding different forms of social interaction across the mixed reality boundary and elaborates on problems regarding the functioning of interaction amongst participants and performers. Drawing on these observations the study sets out implications for the future of a theatre of this kind, the design and display of media art and traditional exhibits, as well as for the evaluation of audience responses to such events and exhibitions.

| | |
|--------------------|---|
| Document ID | D7b.3 |
| Type | Report and Video |
| Status | Final |
| Version | 4.0 |
| Date | 16 August 2000 |
| Author(s) | Jeffrey Shaw, Heike Staff (ZKM), Ju Row Farr, Matt Adams (Blast Theory, London), Dirk vom Lehm, Christian Heath (King's College, London), Marie-Louise Rinman (KTH), Ian Taylor, Steve Benford (Nott) |

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1. Desert Rain

Heike Staff (ZKM), Marie-Louise Rinman (KTH),
Ju Row Farr and Matt Adams (Blast Theory)

1.1 Introduction

The deliverable reports on the staged event Desert Rain by the performance group Blast Theory. Desert Rain is a pioneering large-scale virtual reality performance installation representing a synthesis of art and technology using innovative interface devices.

Desert Rain is one of the eRENA's year three demonstrators that fully embodies its mixed reality research objectives. The main features of this electronic arena are:

- a new relationship between performers and audience which can be experienced by the interacting audience members within a collaborative environment
- a new form of staging that extends narrative possibilities by using virtual reality technologies combined with real theatre elements and video
- a new, physically permeable mixed reality boundary technology by means of a rain curtain - a curtain of water spray onto which images could be projected



Figure1: Participant navigating in the CVE

The successful premiere of Desert Rain took place in Nottingham on October 18th, 1999. A critic of the Sunday Times describes the event as follows: "Only six audience members attend each performance. They are led to a darkened waiting room, where each 'player' is given a magnetic swipe card and watches a series of instructions unfold on a TV screen. They are to find a target - whose name is written on the back of a swipe card. Then, one at a time, they are led from the waiting room and zipped into a fabric cubicle, where they negotiate a virtual desert projected on to a wall of fine water spray as they struggle to reach the name on their card. Once through, the game ends and they are led forward through the water and over a huge sand dune to a hotel room.

Here, there's a television set through which they swipe their card. If they find their target, the real person that name represents appears on the screen and talks about their experience of the war. There's a soldier, a journalist, a tourist, a peace worker, a television viewer and an actor who played a part in the Gulf war drama *The One That Got Away*. (...) As the audience leave, they pass a description of the shooting down of an Iranian airliner by a US ship. Their bags are returned and inside they find a bag of sand containing 100,000 grains. If you have trouble understanding casualties, the bag is meant to say, this is what 100,000 looks like.(...) It's a powerful piece and it excites curious emotions in the viewers."¹

The project was a collaboration between the performance group Blast Theory², and the eRENA partners University of Nottingham, ZKM, and KTH. Blast Theory is a London-based performance group of four inter-disciplinary artists. Since 1991 the group has created performances, installations, videos, and new media works, and they are considered as one of the most innovative performance groups in European theatre.

In addition to their experience with new media performance, Blast Theory also introduced the technology of the rain curtain to the eRENA project. While experimenting with water projections in 1997, they met with researchers from Nottingham who were researching various mixed reality boundary technologies. The idea of using the rain curtain as a permeable boundary in a Collaborative Virtual Environment was born, together with the first tentative performance ideas. In two longer working periods in 1999 at ZKM's media theatre all aspects of the piece were developed, tested and evaluated in internal and public demonstrations.³ The final result - *Desert Rain* - was premiered during the Now 99 festival in Nottingham from October 18th to 22nd⁴. The event was then shown at the ZKM Karlsruhe in November. During 2000 it toured to London in May, Bristol in June, Glasgow in July, and it will be presented in Stockholm in September.

This staged mixed reality performance deliverable builds on the earlier eRENA deliverable 7b.1 *Pushing Mixed Reality Boundaries*, namely part 5 "An early practical experience and demonstration of using a permeable mixed reality boundary in a performance"⁵. The current written deliverable is divided into four parts:

- Part 1 provides a general introduction to and a detailed description of *Desert Rain*.
- Part 2 evaluates the piece in terms of content and artistic form. It gives special regard to the artistic use of the mixed reality boundary and the theatrical character of the collaborative virtual environment.

¹ Stephen Armstrong: "Want to replay the Gulf war as a video game? Sunday Times, 31 October 1999; see Appendix C

² Blast Theory are: Matt Adams; Ju Row Farr; Nic Tandavanitj; Jamie Iddon. Toynbee Studios, 28 Commercial St., London E1 6LS. Email: blasttheory@easynet.co.uk. *Desert Rain* has been produced by Andrew Caley Chetty. It was co-commissioned by NOW ninety9 (Nottingham) and ZKM (Karlsruhe) in association with University of Nottingham, DA2 (Bristol) & KTH (Stockholm) with financial assistance from the Arts Council of England and the European Commission's Kaleidoscope Fund. It was premiered on Monday 18 October 1999 at Strella House Nottingham as part of the NOW ninety9 festival.

³ eRENA D7b.1 *Pushing Mixed Reality Boundaries*. Edited by Benford, S et al. 1999

⁴ see the flyer of *Desert Rain*, Appendix A

⁵ D 7b.1, pp. 42-70

- Part 3 describes and evaluates the heterogeneous set of innovative technologies that were developed and effectively integrated in relation to this project.
- Part 4 describes and evaluates Desert Rain in terms of audience participation. This study was undertaken by researchers from King's College⁶, London, who collected data from five locations where Desert Rain was staged and performed.

1.2 The preparation of Desert Rain

1997

The process of developing Desert Rain begun with an initial research and development phase of two weeks in 1997 under the working title of Virtual Rain. The project was a part of Artlab - a process orientated research and development programme - and took place at the Powerhouse in Nottingham, England.

During this time the properties of video projecting into water spray had been explored, using multiple projection (including the use of slide projection), projection from different directions, water being dispersed from a hand sprayer and from a small specially fabricated greenhouse spraying system, live presence within, through and around the water/projection (including live videoing and simultaneous projection), the use of computer generated image and text onto the water curtain and sound, both generated live and prerecorded.

On the last day an informal presentation took place to an invited audience. Blast Theory and Steve Benford (University of Nottingham) met and started afterwards their collaboration.

January 1999

In January 1999 a team of computer scientists, performers and social scientists spent a two week period at the ZKM experimenting with the rain curtain, including a public demonstration on 27th January. The deliverable 7b.1 "Pushing Mixed Reality Boundaries" reports on the work and the results of the workshop. The goal of the workshop "was to explore the use of a novel mixed reality boundary, a rain curtain, in the creation of a performance. At the same time, we have tried to show how the rain curtain represents a particular class of mixed reality boundary and have suggested how 'dry' boundaries with similar properties might be created and used in more everyday settings. This workshop has been one informative part of the process of developing a full public performance that will involve multiple participants interacting with performers."⁷

August 1999

Blast Theory together with computer scientists from Nottingham and ZKM technical staff⁸ in ZKM's media theatre shared a four weeks working period in order to develop

⁶ The researchers from King's College evaluated as well the audience participation in "Murmuring Fields" (see eRENA Deliverable 6.2 "Linking between Real and Virtual Spaces, ed. By Strauss, W. et al., 1999). Here they compare here different experiences in audience participation in eRENA projects.

⁷ D 7b.1, pp. 79

⁸ Boriana Koleva and Ian Taylor from Nottingham and Torsten Ziegler and Jan Gerigk from ZKM.

the final form of the Desert Rain performance. The main goal was to extend the number of users to six participants.

The design of the whole environment had to be installed and tested in the media theatre. The technology of the rain curtain had to be proved. The same with the surf-foot-pads in terms of size, of working in a wet environment, and of usability. The best position of projectors and cameras had to be found out. And finally, the whole collaborative environment with computer graphics and sound had to be set up and integrated with all other electronic means.

On the last day, an audience were invited to experience the whole performance which was yet not completely ready and had still improvised parts. Various smaller technical problems occurred which were to be fixed until the premiere in November. All participants completed a questionnaire of Blast Theory. This material led to further changes in computer graphics and sound and especially to changes concerning all informations visitors get before stepping into the collaborative virtual world.

1.3 Desert Rain – The Performance

1.3.1 Basic Settings

The Desert Rain performance lasts 30-40 minutes and 6 participants can experience it. The staged event consists of seven elements, six spaces and a couple of physical objects. The overall concept concerns modern warfare, represented by the Gulf-wars.

- 1) Entrance: The audience is picked up the theatre entrance.
- 2) The antechamber: the first station on the 'journey' where the ground rules about the piece and a plastic card containing the targets' name are supplied.
- 3) The cubicles: a 3D world is projected on a water screen, through which the participant navigates, while standing on a footpad.
- 4) The sand tunnel: a 2 metre long tunnel fenced off by high walls containing sand through which the participants walks, ending up in a hotel room.
- 5) The hotel room: the swipe-card is used to turn on a TV-set showing a number of video clips.
- 6) Nine sentences all connected to the Gulf-war are pasted on the wall near the exit.
- 7) And finally a little sandbox is left in the participant's pocket.

1.3.2 Order of events

Entrance and Ante-chamber

A performer dressed in a green parka with a fur-rimmed hood collected the public (six at a time) at the entrance outside the theatre. They were brought into an ante-chamber where they each sat down on a chair and then they were given some basic information about the piece by the performer who used a torch as the only source of light: The information is basically as follows: 1. how to communicate with other participants in the virtual environment, 2. how to use the footpad in order to navigate through the world 3. how to identify the other avatars in the 3D world and 4. how to find and hit the target. Finally they have to find the exit and the other participants and, then get out together. In short, each visitor is given a plastic card with the target's name on it (the

target is the person that has to be found). The visitors have twenty minutes to complete their task in the virtual world.



Figure2: The ante-chamber

They are then asked to take their jackets off, put them in the box under the chair and to put the raincoats on. The limited number of people creates an intimate atmosphere, unusual in traditional theatrical contexts. This change of clothes has a symbolic and ceremonial touch: it is like changing skin from one's ordinary life, to become part of the performance or ritual and then being introduced to the secret conditions. The room with its slight cave-like resemblance and the distribution of cards / missions recalls the interior of an aircraft in a war movie. It is silent and the participants may ask questions if they don't understand. In that moment the water is turned on. The swishing sound is very powerful and is accentuated by the humid breeze that hits the faces of the participants when they leave the antechamber one by one, together with the performer. The next halt increases the feeling of walking further and further into a cave.

Cubicles (and mixed realities)

Figure3: The six cubicles (with test projection)



Figure4: The hidden computer space

This part in particular is a Collaborative Virtual Environment (CVE). Behind a fenced-off area, six computers are placed, showing each participant's exact position in the 3D world. A performer / technician can "move" the participants without them knowing it, if someone becomes hopelessly stuck somewhere. The technology includes collaborative possibilities in the visual area and in audio.



The next space is hidden behind a green fabric wall of the same waterproof material used in tents, with six crescent-shaped zippers instead of doors and handles on the front. The inside of each cubicle is u-shaped and the visitor is placed with the back towards the "door", the thin, green fabric walls separating the visitors from one another. The open space in front of the visitor is the fourth wall, a water screen where images are projected. The visitor is then instructed to step up on a footpad placed in a low, water filled basin and to put on a head-set (including a microphone) and to wait for someone to tell them to start. The black rubber mat in the basin mirrors the images and the moving water gives an illusion of profound, almost vertiginous depths. Finally the performer who closes the zipper behind them carefully locks them all in.

Figure5: A participant

When all are in position and the headsets have been donned, they are instructed to start to move around and the play begins. To navigate through the virtual world, the visitor leans forwards, backwards, or left - right. The first image presented on the moving water screen is a motel room with a chair, a double bed, a lamp, and a TV- set with a show running. The visitor has to find the door and get out of the motel room into, or out to, a desert landscape surrounded by Arizona-like mountains. The strong, almost blinding light from the projector lamp might be taken for the hot, merciless desert sun. Once outside there are big, blocky arrows pointing to a sign "Exit here".

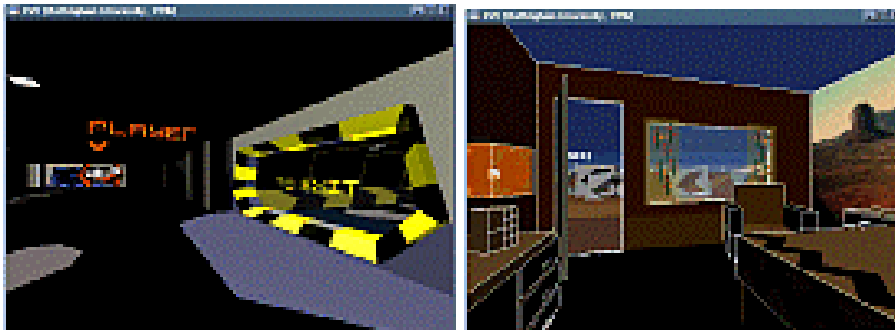


Figure6 & Figure7: Computer graphics - exit and hotel room

When passing through the yellow rectangular sign, the image shifts into a new landscape that, in a second or two, turns from bright daylight to darker. A short distance away, several inscriptions are visible, written in white on the black sky. The names of the different targets are written in white and when the visitor gets closer a voice says "My name is Sam" or what ever the name of the target is. Just underneath the name is a picture of the target or person. The visitor is supposed to walk right through that picture.



Figure8: Computer graphics - the target

The visitors are then supposed to look for the exit together. Eventually an agreement is made among the participants on who is going to search for the exit. The long tunnels have different colours in order to facilitate the description. A sign at the exit informs whether the rest of the group has found their targets or not. As soon the visitors are close enough to one another, they can communicate through the microphone. They can also communicate with each other in the "Live Link", a room with six numbered boxes, one for each visitor. When entering one of the boxes a live video image of the inhabitant of the box is seen and the two can communicate.

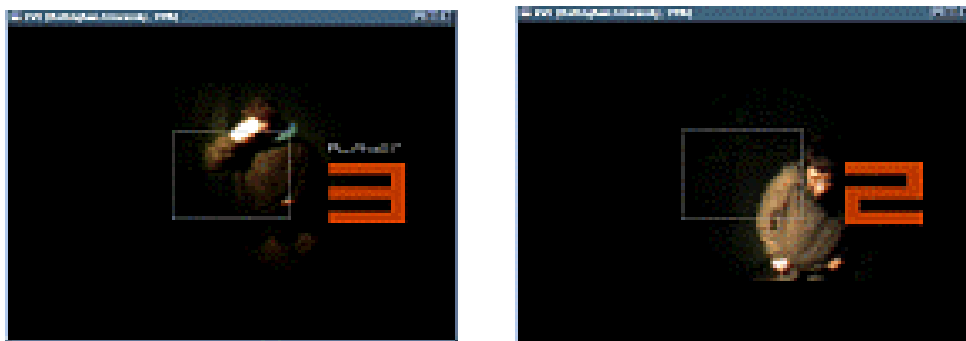


Figure9 & Figure10: The "Live Link"

If that is done correctly, the image on the water screen switches to a white spinning object with the following inscription: "Wait here". A huge shadow is seen blocking the projector light. It grows smaller and the shadow gets a real face and a performer eventually walks through the water screen. The furred hood on the green parkas gives a halo effect when a light placed in the ceiling illuminates the water on the fur. The performer asks for the card with the target's name and replaces it with a new swipe card.



Figure11: The performer crossing the rain curtain

After twenty minutes the water is switched off and the sound-scape changes. The visitors are told to take their headsets off, and to step down from the surf board. A black rubber doormat that has been placed in the water leads from the foot- pad to the other side of the basin to prevent the visitor from slipping and falling into the water. At the other side of the basin, they are asked to take their raincoats off. They are then shown into the next halt, a sand tunnel.

Sand tunnel

A two metre, hilly tunnel of sand framed by high wooden walls leads to the end station, a hotel room. The sand is prepared after each run through by the performers and is completely smooth and untouched, as if no one has walked there before. The performers are gone and the visitors are left alone in the tunnel. The silence accentuates the sound of the sand under the soles.



Figure12: The sand tunnel

Hotel Room

The room consists of four walls with huge photographs of a hotel room. It is blown up in life-size. The same as in the starting point in the virtual world? To the right of the tunnel is a TV with a perspex screen and beside it a swipe card reader. The participants who succeeded in finding their targets in the virtual world were given a swipe card instead of the "target card". Each one of the six swipe-cards corresponds to a video clip that starts when pulling the card through the card reader. The videos consist of three minute long interviews with all six "targets" (five men and one woman), each one affected by the Gulf War in one way or the other. The same hotel room, the same lamp and TV-set, as in the photos on the walls in the constructed hotel room in the installation, constitute the background of the screened interviews.



Figure13: The hotel room

The six persons in videos:

- Shona Campbell served in the Army for three years and is now a captain in the Territorial Army. At the time of the Gulf War she was suffering from colic and was confined to bed.
- Richard Kilgour is a peace worker who helped establish a peace camp on the Iraqi-Saudi Arabian border in December 1990.
- Glenn Fitzpatrick drove an Armoured Personnel Carrier in the Gulf War, collecting Iraqi casualties. He is currently studying Fine Art.
- Eamonn Matthews was one of the only journalists in Baghdad on the night the air war started. After a week he returned to Britain and resumed his post as deputy editor of Newsnight.
- Sam Halfpenny played Legs in "The one that got away", an LWT film of the Bravo Two Zero mission told from Chris Ryan's point of view.
- Tony Taras is an actor who was on holiday in Egypt at the time of Iraq's invasion of Kuwait.

The text below is pasted up on the wall outside the hotel room. It is the last space containing any visible information about the Desert Rain and in close connection to the exit:

"In 1988 the USS Vincennes was dispatched to the Persian Gulf to help Iraq, under Saddam Hussein, in its war against Iran.

The warship was equipped with AEGIS, the most sophisticated weapon control system yet developed.

It uses 16 main frame computers and 12 minicomputers to control up to 122 ship-to-air missiles and two 6 tonne, 6 barrelled automatic machine guns capable of firing 3,000 rounds per minute.

On July 3rd the Vincennes shot down Iranian Airbus Flight 655 killing all 290 on board (more than died in the Lockerbie bombing). While widely reported in the third world the incident received little coverage in the Western media.

The crew of the Vincennes had undergone 9 months of simulated scenarios prior to leaving for the Gulf, all of which were predicted on hostile encounters.

During the crucial minutes in which the airbus was flagged as a hostile F14, the crew ignored indicators that cast doubt onto the AEGIS interpretation of events.

Because the AEGIS automatically analyses incoming data there was no way to directly evaluate the radar blips.

The commander of the nearby USS Sides 'wandered about in disbelief' as the Vincennes prepared to fire but did not intervene with the vessel equipped with AEGIS.

On return to the US captain. William Rogers - commander of the Vincennes - received the Legion on Merit award for 'exceptionally meritorious conduct in the performance of outstanding service' in the Gulf War."

Exit and gift

All of those, who had left their outdoor clothes, a shirt or a cardigan with pockets in the antechamber, would find a small transparent plastic box full of sand in his or her pockets. The box bore the inscription:

Desert Rain

estimated at hundred thousand grains

"It's really not a number I'm terribly interested in." General Colin Powell
New York Times, March 23 1991 p. A4

The figures symbolise the number of Iraqi people that were said to have been killed during the Gulf war (the figures vary between a 100.000 and a million).

2. The Artistic Evaluation

2.1 "Virtual war" as the topic of an artistic environment

Mixed reality elements are used in *Desert Rain* in a double sense:

- as a new technological form of combining a collaborative VR environment with the direct physical communication between real persons and
- as a metaphor of mixing various layers of realities.

Very early, Blast Theory imagined the structure of the piece as follows: "Virtual Rain' (*the older title of Desert Rain*) will use a combination of virtual reality, installation and performance to explore the boundary between the real and the virtual. It will involve participants in Collaborative Virtual Environment (CVE) in which the real intrudes upon the virtual and vice versa. It will use the real, the imaginary, the fictional and the virtual side by side and will seek to juxtapose these elements as a means of defining them".⁹ In fact, the relationship between content and technology in *Desert Rain* is as narrow as possible. The technology provides neither the form, or the medial infrastructure, or theatrical effects, nor is the content at all conceivable without the specific technologies utilised.

It is the setting of the elements of such different characters which - collected in the mind of the participant - defines or creates the content. The beginning, when the participants are instructed, is pure theatre. What follows is a kind of collaborative computer game, where each of them has to find his or her personal target and which is based on somehow generally known VR technologies. The Virtual Reality then turns out to be a mixed reality: a real person crosses the "screen," which, by this time, turns out to be a permeable water spray curtain. By switching off the water supply, the participants can leave their somehow destroyed cubicles and walk through the wet zone to a dry sand dune. And again they have to leave the world of natural elements to experience another kind of "meta-world". They find themselves being brought to a natural looking hotel room, created by realistic photo prints on the wall. The only real thing is a TV monitor where people who are somehow linked to the Gulf Wars are giving their individual witness or opinion. Shortly before the exit, the audience reads an information text about an extraordinary incident in the first Gulf War. And having left the theatre they will find a souvenir in their pocket that symbolically reminds them on the high number of war victims in the second Gulf War.

The first thing which becomes clear is that the piece deals with war in general - without gun shooting and bombing noises, dead or injured persons, that is, without any naturalistic theatrical elements. There are allusions to a situation of threat in the antechamber and there are various hints in the graphical and acoustical design of the virtual world. Here the participants are starting their journey in a projected hotel room and leave this for a kind of desert space with entrances to bunker-like corridors and rooms. The topic war becomes explicit in the witness videos, in the text about the Vincennes incident, and - indirectly - in General Powell's quotation of on the sand box. After having seen and heard the Gulf War witnesses and after having read the information text, the audience member must go back in his or her memory of what previously happened, in order to create something like the statements of piece.

⁹ Blast Theory, A brief description of the project. Concept, January 1999, see Deliverable 7b.1, pp. 66-67

By putting all the elements together, one can say that the piece parallels the abstract experience of modern warfare, and hints at modern war reporting, and more generally speaking, questions the naive usage of VR technologies and their impact on real life. Having played within the Virtual Environment and then read about the Vincennes incident, various questions are going through one's mind: "Where is the difference between military training and military reality (= war)?" or "Can the responsible persons, the soldiers, still perceive the difference?" or "When so many things are automatically programmed in complex software environments, what is the role of human communication in making decisions?"

The whole piece is constructed around the contrast of technological and natural elements and it moves constantly between different layers of social reality, theatrical reality, media reality and virtual reality. The proper element of Mixed reality provides the strongest artistic moment of the piece: the minute in which the performer crosses the rain curtain, virtuality and reality are not longer separate realms. No theoretical discourse could ever achieve such mixed feelings about the difference between virtual and 'real' reality: surprise and fear, astonishment and suspiciousness. The realm of the real intrudes on the realm of a computer game. This is the most impressive moment of Desert Rain, repeated and mirrored in many other contrasts and shifts.

The critics of the performances in England and in Germany emphasised this aspect, as the Sunday Times did: "This change from virtual to real is remarkably sudden and strangely disconcerting. Previously, we have been within the well-accepted paradigm of the computer game. We know the rules. (...) If we had the power to shoot opponents or destroy buildings, it wouldn't seem strange to us. It's a computer game, after all, and in computer games, we are immortal. Computer games allow us back in the schoolyard to play Cowboys and Indians or War without connecting to the lessons of such encounters. In the mocked-up hotel room, the videos actually make that connection."¹⁰ The German journal "tanzdrama" speaks of a "convincing synthesis out of a spatially directed cyber computer game and a performance, in which the audience comprehends, while acting, the confusing overlapping of different levels of reality."¹¹

The doubtful nature of modern war reporting, that the whole world experienced during the second Gulf War, is questioned by the reports of the six video witnesses and their opinions on the number of victims and, more strongly, by the text about the Vincennes incident and its revelation that the western media did not report on the error which caused the death of 290 persons in a civil airplane. Only after the experience of the game-like synthetic world, the audience is confronted with the confusing statements of the witnesses and the historical information about real wars.

Blast Theory answered my question as to the choice of the Vincennes incident from 1988: "It was a background event to the Gulf War, possibly one amongst many. It provides a good example of Western Media coverage of events. They decided that this was less important news than the Lockerbie bombing, for example, even though more people were killed as a result. It suggests a faith in advanced technologies and knowledge/training with these systems over and above that of human ability to make decisions. For us this reflects upon ourselves as we control and operate Desert Rain,

¹⁰ ibidem (Footnote 1)

¹¹ Söke Dinkla, Vom Zuschauer zum vernetzten Teilnehmer, tanzdrama, 2/2000, p. 51

but also on the users' decisions within the experience. It is also of interest to us as the fetishisation of technology is something we are implicated in. As a result, people are commended for their dexterity with technology. We may use it but we are attempting to interrogate it too and do not embrace technology with open arms."¹²

Indeed, one of the starting points of the Desert Rain-concept was "Jean Baudrillard's assertion that the Gulf War did not take place because it was in fact a virtual event. Whilst remaining deeply suspicious of this kind of theoretical position, Blast Theory recognise that this idea touches upon a crucial shift in our perception and understanding of the world around us. It asserts that the role of the media, of advertising and of the entertainment industries in the presentation of events is casually misleading at best and perniciously deceptive at worst. As Paul Patton says in an essay about Baudrillard, *the sense in which Baudrillard speaks of events as virtual is related to the idea that real events lose their identity when they attain the velocity of real time information, or to employ another metaphor, when they become encrusted with the information which represents them. In this sense, while televisual information claims to provide immediate access to real events, in fact what it does is produce informational events which stand in for the real, and which 'inform' public opinion which in turn affects the course of subsequent events, both real and informational. As consumers of mass media, we never experience the bare material event but only the informational coating which renders it 'sticky and unintelligible' like the oil soaked sea bird.*"¹³

In the metaphorical sense, the "mixed realities" of Desert Rain provides a setting of personal and social experience in a virtual world and in a theatrically defined world with counteracting elements of informations in mass media style (or about the behaviour of mass media). On an artistic level, Desert Rain expresses a more complex understanding of how the virtual and the real are blurred than we find in everyday discourse about the impact of mass media and new technologies.

2.2 The "rain curtain" as a new mixed reality boundary

The eRENA project, namely the University of Nottingham, emphasises the research on new boundaries between real and virtual spaces, driven by concerns of supporting new forms of awareness and communication between the participants of collaborative environments. The rain curtain, as one type of boundaries between real and virtual spaces, is an example of a mixed reality boundary to support performance.

The eRENA deliverable "Pushing Mixed Reality Boundaries" defined the technical and artistic aspects of working with this boundary:

- a novel material for creating a mixed reality boundary. The rain curtain has a number of interesting properties, especially with regard to permeability, dynamics and symmetry.
- the use of the rain curtain in creating performances that establish new relationships between performers and audience.
- a fully permeable mixed reality boundary, i.e., one that was not solid and through which performers, audience members and objects could pass.

¹² quoted from a personal letter exchange between Ju Row Farr and Heike Staff

¹³ Blast Theory, Virtual Rain. A brief description of the project. Concept, January 1999, D 7b.1, p. 66

- an appropriate style of interaction with the rain curtain.¹⁴

After having experienced the performances of the final piece, we can now report on the artistic achievements of this mixed reality boundary. The expression "rain curtain" mirrors precisely the aesthetic quality of the projected image on the falling water spray. The spectator sees a clear but somehow unstable image of which the lower margin becomes wavy like the lower margin of a softly folded curtain. (Footnote: Please, be aware that this impression cannot be documented on video; one only realises the beauty of the projection in physical reality.) The specific physical quality of water spray vanishes from one's mind the longer one looks on the projected image. You forget that the thing you are looking at is not a screen, nor the fourth wall of the cubicle, but just something as unsolid as rain, made from water drops.

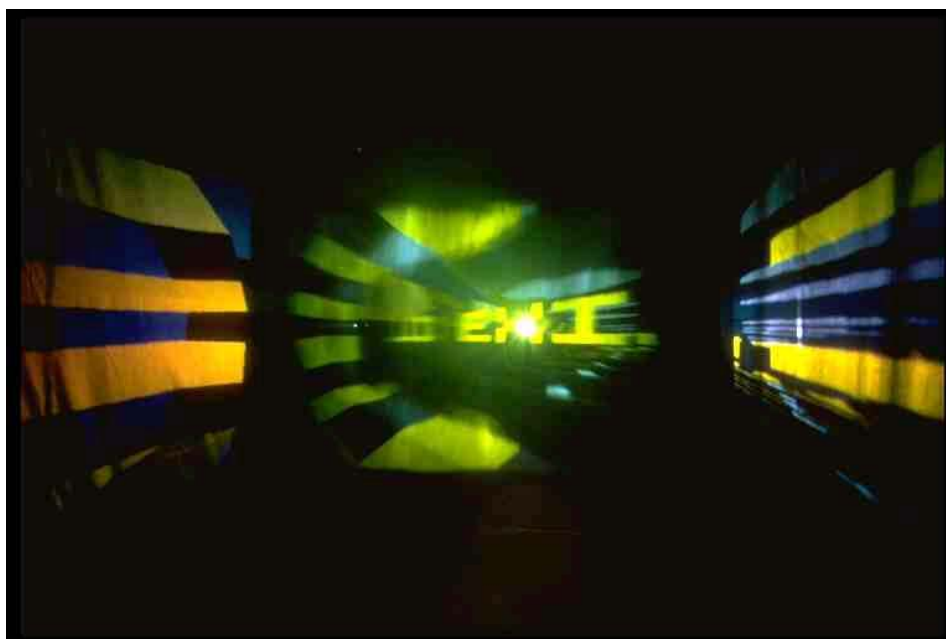


Figure14: The projection on the rain curtain and the two walls of the cubicle

Through this aesthetic aspect, which we might call a poetic one, the spectator's mind becomes open to all kinds of illusions. The suggestive power of the rain curtain provokes various associations¹⁵: it is water and you can think of rain, but it could equally be dust, a sand storm, or other particles suspended in the air. You know that it is an illusion, a mirage, a wet kind of Fata Morgana. And because it is beautiful, you easily accept and integrate even the technical aspects: the round light of the projector, which you see through the falling water, can be interpreted as the merciless, white sun over the desert. Even though you feel the illusionary character of the material on which the front images are projected, you are strongly disappointed the minute it stops: "something real seeming to last, but it really doesn't; somebody has turned a switch and it is all over".

Ju Row Farr from Blast Theory acted several times as the performer who traverses the rain curtain and she likes the tension of the moment, "when a performer goes through the water and the participant realises they are not alone in the cubicle, that the screen

¹⁴ eRENA D. 7b.1, p. 42

¹⁵ The collection of associations is based on statements by the artists and audience members.

isn't the end of their perspective and that something else is possible. This moment for me brings together all of the elements perfectly - mixed reality boundaries, the fusion of the real with the virtual, implication and communication. What is especially nice is that people often try to touch your hand, go with you, they speak to you and trust you. At this moment for me it is a performance, a game and an installation using new technologies. It is about trust, about deception or illusion, about the unknown person watching you and coming for you and you not knowing what happens next."¹⁶

2.3 The "journey" through the collaborative virtual environment

Traversing the rain curtain is for both the performer and the participant the most exiting moment of the piece. The journey through the virtual environment is the longest lasting phase, the central period of Desert Rain. Each of the six participants has been asked to find his or her personal target in the virtual world through which they are navigating, standing on footpads. Each one is standing alone in a cubicle and is equipped with a parka, a headset and a microphone. They can talk to the operators/performers and in certain spaces of the virtual world they can talk to each other.¹⁷

In regard to the topic "Gulf War", how are the rules defined in the computer game like CVE? Which are the artistic goals behind the definitions? "We were not interested in stressing or reiterating the macho, the gung-ho, the loner, the leader. We were interested in the joint experience, the communication between the players in the virtual world, in the headsets, in the real spaces, but especially when faced with a set of tasks and circumstances that needed to be negotiated," answers Ju Row Farr from Blast Theory on this question. "We are more interested as a group of artists in the social rather than the solo nature(s) of technological experiences. It would have been much easier to make a piece about a war, that was gamelike, competitive, using familiar structures of drama and conflict to create the narrative of the piece. However, for us and for Desert Rain that would have provided a set of criteria that we were not interested in exploring and it was not appropriate. We were not interested in who was best/strongest/quickest/the best fighter/gamer etc - the aspects of the Gulf War which reduce it to winners, losers, victims, victors and we were not interested in bringing these qualities out in users."¹⁸

Instead of this, she points out: "We were interested in how do you negotiate a situation with a group of people even though you can't see them but with whom you can communicate in some way. How does a real event and set of circumstances relate to an event that is represented by a virtual environment, a fictional scenario? Where is the line? This idea felt much more appropriate to us with regard to the Gulf War and came into play when making the rules of navigation. How do you find someone in a desert? You can hear them for a while and then you cannot, you can't see them, but you know they are out there and they know you are out there. And if you do meet up, how can you work together? How can you get somewhere and achieve tasks? From the outset, from the antechamber, everyone is on the same side looking for similar

¹⁶ quoted from personal letter exchange

¹⁷ see the detailed description in chapter 1.3 "Cubicles"

¹⁸ quoted from personal letter exchange

things, it is against the clock but not against each other. And the water curtain added its own set of challenges in order to complete the tasks."¹⁹

Nevertheless, it is obvious that there is a link between computer simulations, games and military training. As Marie-Louise Rinman stated: "Computer games and simulation games are widely used in military contexts as training devices. These games train and demand various abilities and faculties, such as strategic planning, logic calculation and memory. The US Marines, for instance, used networked 'Doom' in Bosnia to teach teamwork and tactics."²⁰

Ju Row Farr comments the experiences which the members of Blast Theory made with the real behaviour of audience members: "I think that it is interesting to be placed alone within a zipped cubicle, headphoned and miked up. Your own survival instincts or desire to succeed on the one hand naturally rises. This is set off against the tasks that you have to complete and the other five participants you know are a real part of it. Certainly as a performer on the headphones, our role was sometimes ambiguous in this area and we could inflect the experience accordingly - for example if the users had all found their targets and were close to finding the exit within the given time allowance, we could give them more information and heighten the sense of climax. Listening to users' conversations within the virtual world also revealed a competitive level which some people were bringing to the experience or which the experience was bringing out in some people. Certainly after users left the virtual world and took their coats off their conversations on the whole were about the competitive nature of the world - 'Did you find your target?', 'Did you find the exit?' etc."²¹

Also this potential contradiction, the rise of one's "survival instinct" and competitive behaviour and the reality of a game-like situation where one is supposed to communicate and to help each other, is an important aspect of the content of Desert Rain. Nothing has been shown or performed or demonstrated, but it is the carrying-out of one possibility of what we call "content production by audience participation".

2.4 Desert Rain - a theatre play?

Not only are the borders between the real and the virtual being blurred in Desert Rain, but the production also questions the traditional borders of art genres. Is it correct to call it a play or a theatre production or is "artistic environment" the more adequate general term? Is its character more dominated by the elements of interactive installations or by the performance aspects? In the flyer of Desert Rain, Blast Theory called it "a game, an installation, a performance"²². Stephen Armstrong from the Sunday Times takes it for "an intermeshing of computer game, installation, live performance and cultural polemic".²³

Modern art, and especially media art, generally questions the well-defined realms of traditional art genres. The interactive media usually changes the roles or the aspect of typical role behaviour of both parties, the creators - artists, technicians, scientists - as

¹⁹ ibidem

²⁰ Marie-Louise Rinman: The Desert Rain Performance. An exploration of the boundary between the virtual and the real, stage and audience, unpublished article, 2000, p. 8

²¹ quoted from personal letter exchange

²² the flyer of Desert Rain, see Appendix A

²³ Sunday Times (see Footnote 1)

well as the audience - visitors, participants, players. The members of Blast Theory act in different roles: as an actor in the antechamber, as a speechless performer at the end of the journey, as bodiless voices and as operators "back-stage". The audience behave as spectators and players and "interactors". They are the ones who are moving around. Climbing on the footpad might remind the one or other of being on a stage. When the rain curtain and the projection has been switched off, the audience might have the feeling of being in a cinema, where the film has ended the flashing lights are destroying the former illusionary world.

Desert Rain might be described as a defined tour through four installations, where the audience interact as players, walkers, spectators etc. Accordingly, Marie-Louise Rinman defines Desert Rain "partly as an installation through which the visitors can move around, not freely but according to a certain order and during a limited period of time. Desert Rain is better and more regarded as a performance though, because of the limited number of people let in at a time and the interaction between performers and audience. The latter are participating in a drama / play following a pre-written script, yet the outcome of it is to a certain extent unpredictable."²⁴

As so often in modern performances (in contrast to traditional theatre), here the stage is not any longer separated from the audience space; in fact, it is impossible to employ these terms on Desert Rain. Here, spaces have become transitional in their character. There is no space or place in Desert Rain that is not stage.

²⁴ Rinman, *ibidem*, p. 3

3. Technical Infrastructure

Ian Taylor (University of Nottingham)

3.1 Introduction

This section describes the technical infrastructure of the Desert Rain exhibition piece. A number of technologies were combined to achieve the finished result and these are described and illustrated, namely:

- **Distributed Virtual World.** This was run using seven PCs connected over a Local Area Network. Six of the machines acted as user clients whilst the remaining machine ran the world server.
- **Projection Environment.** Each client machine was connected to a video projector that back-projected on to the rain curtain. The 'player' then viewed the image from the opposite side of the water within a fabric cubicle.
- **User Interface.** To control movement throughout the virtual world, each player used a square footpad that responded to the player's shift in weight.
- **Audio Monitoring and Feedback.** A mixing desk was used to allow three main audio functions. Specifically;
 - Selective monitoring of each player's voice.
 - Providing assistance and advice to one or more players.
 - Enabling direct communication between players when entering the virtual 'video link'.
- **Card Activated Video Replay.** A player is awarded a magnetic swipe card when they have located their virtual target. When the player arrives in the physical hotel room, this card is used to activate the video of the interview with the person who was named as their target.

The following sub-sections provide more detail on these components, beginning with a diagram of the physical space .

3.2. Overview

3.2.1 Infrastructure

Figure 1. shows the physical layout of the entire Desert Rain environment.

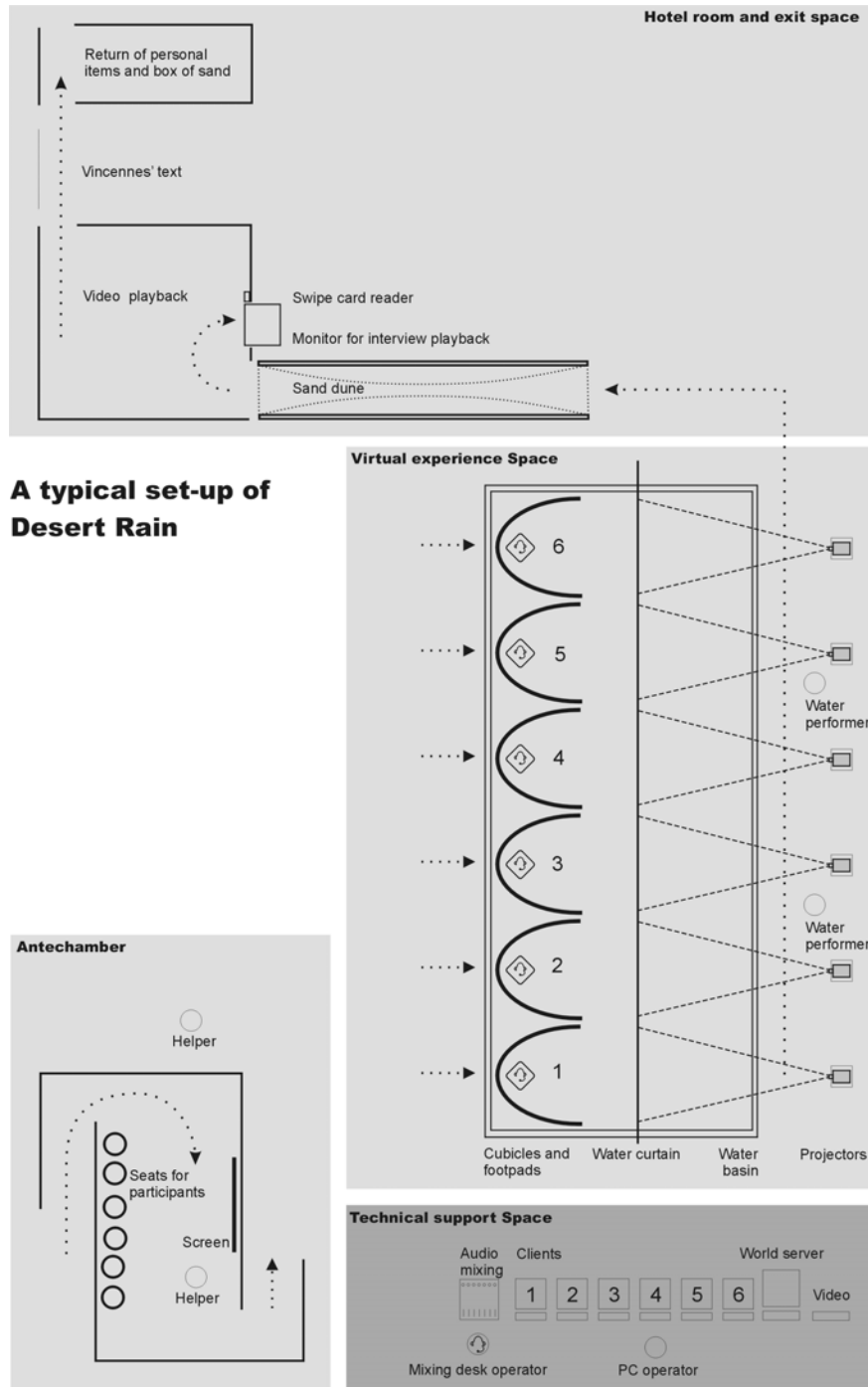


Figure 1. The complete physical Desert Rain space.

The layout in figure 1 is based on the set-up of the Nottingham event in October 1999. Subsequent events modified this layout according to space availability, however the inner-layout of the areas marked in grey remained the same. The function of each area can be summarised as follows:

- **Antechamber.** The room in which the players are briefed, handed overcoats and given their target card.
- **Technical Support space.** The area in which all software is run and monitored, and where the mixing desk operator resides.
- **Virtual Experience space.** The six cubicles in which the players experience the virtual world. The world is projected onto the rain curtain and navigation is achieved using a footpad.
- **Hotel Room and Exit space.** The final destination where the players use the swipe cards they may have obtained to view the pre-recorded interviews with the person named as their target.

Prior to discussing the technical implications of the virtual world and hotel room, we shall look at the core technical configuration in more detail. Figure 2 focuses on the set-up for a single cubicle, showing its relationship with other key components.

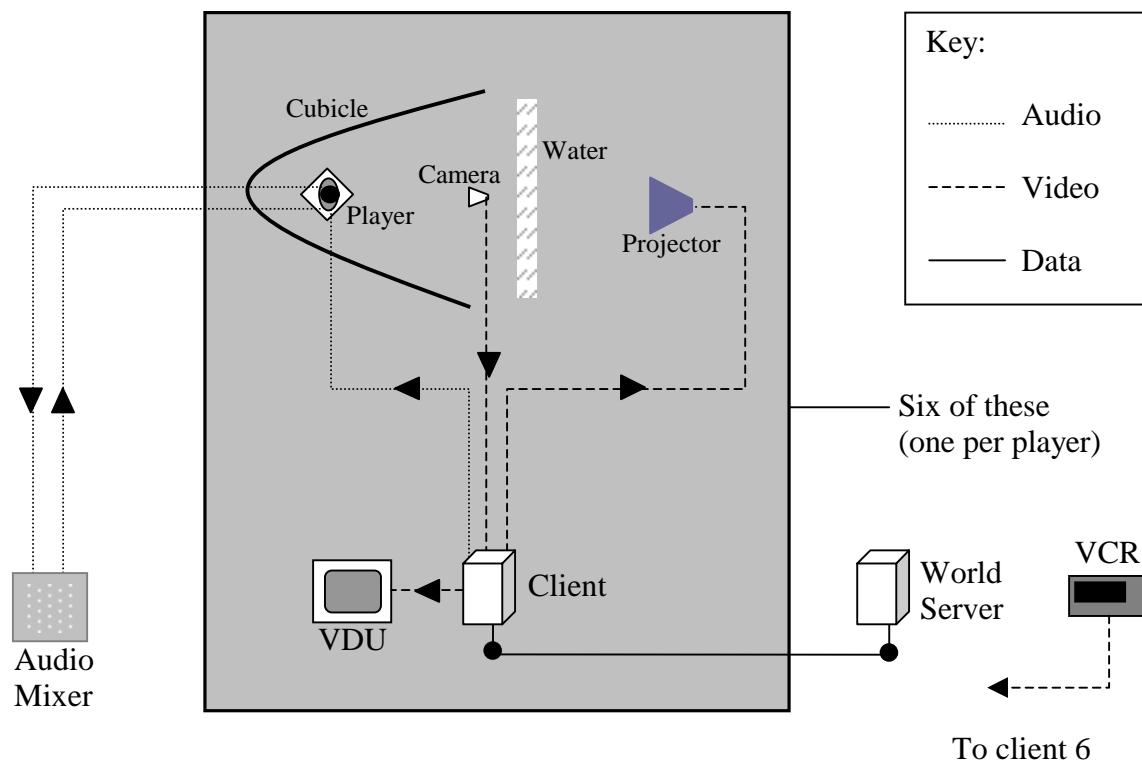


Figure 2. Desert Rain configuration. In the full set-up there are six sets of the components in the large grey box (see figure 1).

As shown in figure 2, each player makes use of a single cubicle that contains the footpad.

In front of the player is the projection surface that consists of a fine spray of water. Several feet behind the water curtain, a video projector produces the image of the client's viewpoint in the virtual world. This video signal is obtained from the RGB output of the client machine. Additional video is fed into the virtual world from a small camera in the cubicle and a VCR. The latter plays the footage seen on the television set in the virtual hotel room where the players are initially located.

In addition to the video signal, audio was fed to the player's headset from the line-out of the client PC. This is the in-world audio that consists of sound effects, music and voices from any players in close proximity in the virtual space. Each player also had a two-way audio link with the person acting as event monitor. By routing this audio through a hardware-mixing console, the event monitor was able to open audio channels that enabled players to hear each other when not spatially proximate in the virtual world. The event monitor is also able to selectively communicate with one or more players to provide instruction and indicate time remaining.

The remainder this sub-section provides an overview of the player interface and the monitoring environment.

3.2.3 Player Interface

To control movement through the virtual space, the player utilises a wooden footpad that supports movement in four directions. Figure 3 illustrates the pad and describes the possible movements.

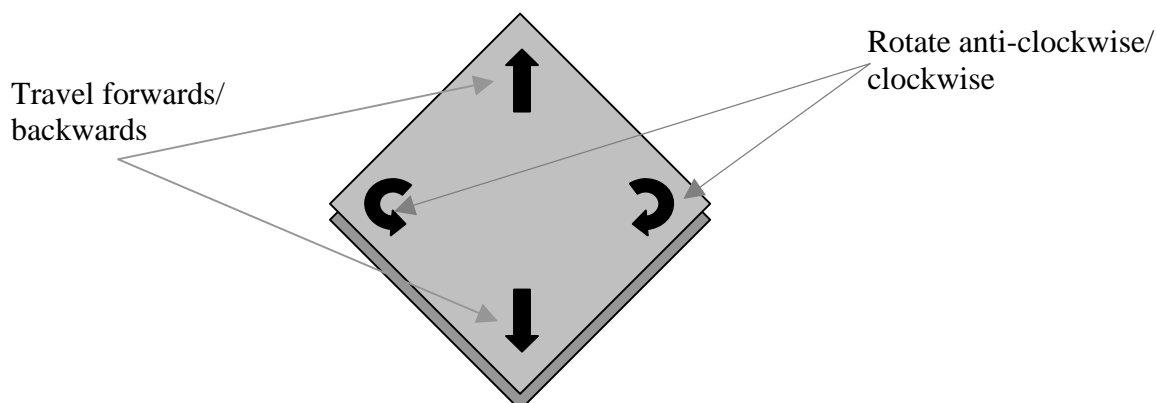


Figure 3. The footpad controller. A micro-switch is mounted on each corner and is activated when the user applies their weight to that corner.

The footpad electronics were constructed so as to emulate a joystick. This meant that the wiring could easily be adapted to plug into the joystick port of the client machine's soundcard.

3.2.4 Control and Monitoring Space

In order to monitor the progress of the Players, the client machines were connected to VDUs that were placed on a table next to the mixing desk, in order of player number. Figure 4 shows a photograph of this area during the Nottingham performances.



Figure 4. The mixing desk and PC area. The left of the photograph shows the mixing desk operator, towards the right can be seen the client views on six VDUs. Off to the right of the photograph is the world server machine and VCR.

With the exception of client six, each client machine had the same hardware configuration. Client six however, had two video inputs, one from the camera in cubicle six and another from the VCR. This was to allow rendering of the VCR data on to the television set in the virtual hotel room. The world was configured such that any video data passed to client six would be rendered on each television set. This meant that the VCR must be stopped before any player was to enter the Live Link (see section 3.3.4) of player 6, otherwise they would see the VCR output instead of the cubicle camera footage.

3.2.5 Preparation

At the start of the day a number of checks were performed to ensure all devices were operational. Also, all contingencies relating to the footpad were planned. Specifically cases of footpad failure, players being too light to apply the required weight (e.g. children) or a disabled player. A spare footpad had been built to cater for footpad failure. In the other cases (or when the spare footpad was already in use), a number of joysticks were available that had previously been tested.

The following section describes how the technologies discussed so far relate to the experience that Player has whilst travelling through the virtual world.

3.3. Virtual World

This section describes key locations in the virtual world that utilise any external system components or internal dynamic properties. This will show how the journey through the virtual world integrates with external actions/hardware or (in the case of the final exit from the virtual world) pre-programmed conditions that depend on the actions of other players.

3.3.1 Running the World

Between every performance a number of system processes must be shut-down and re-started. This is due to the fact that the world is irreversibly modified during a performance. This modification occurs when a player locates their 'target', which results in a deletion of the target and the removal of a part of the barrier to the exit (see section 3.3.3 for more detail). Therefore, the world process must be restarted on the server machine followed by the six client processes. Once the client is running, player movement is disabled until the game is ready to begin. This is achieved using a keyboard button that toggles client response to the footpad.

As an additional preparatory step, the VCR is re-played to begin video texturing of the film on to the virtual television set. Once the clients are running and the video has begun, the players are allowed to enter the cubicle, mount the footpad and put-on the headset.

3.3.2 The Hotel Room

The player's experience of the virtual world begins in the hotel room. Figure 3 shows their initial viewpoint.



Figure 3. The initial viewpoint in the virtual world. Towards the left of the image is the television set upon which the video source obtained from the VCR is rendered.

When all players have been placed in the cubicles and all staff (performers, mixing desk operator and PC operator) have communicated readiness, the game is started. Players are notified (via the mixing desk) that they may begin and the PC operator toggles the movement key to allow footpad control.

It is at this point that the client VDUs are closely monitored to detect any problems with the footpad. Navigational difficulties are usually due to unfamiliarity with the footpad interface, in which case the mixing desk operator offers verbal assistance. However, if it is felt that the fault is with the footpad, a performer tests the pad, and if deemed faulty it is replaced with the spare footpad. Should the spare footpad be in use, then a joystick is provided in its place. This involves a short delay in which the joystick is calibrated using software.

When all players have successfully found their way out of the virtual hotel rooms, the VCR is stopped and rewound in readiness for the following performance. The next point in the virtual world that requires intervention by performers and technical staff is the target.

3.3.3 The Target

As mentioned in section 1.3.2 each player is assigned a named target that is located in a large desert area beyond the hotel room enclosure. Figure 4 shows an example view from a session in which Player 5 is approaching their target.



Figure 4. Player 5 approaching their target. To properly locate their target, the player must move into the centre of the white area below the face.

Once the user has located and moved into the target, they are automatically placed in a space below the target containing a sign saying 'WAIT HERE'. It is at this point that the water performer walks through the rain curtain and hands the magnetic swipe card to the player in exchange the target card. To ensure the user player does not navigate out of this space and back into the desert, the PC operator immediately disables the player's footpad as soon as the player hits the target. It is only when the water performer has completed the exchange and left the projection space that footpad response is returned.

Moving out of the target causes its deletion so as to indicate completion of the target finding process. The corresponding exit barrier for the player is also removed from the world. This is achieved through the following pre-programmed properties:

- The exit is initially sealed by six solid cuboids of equal size, all of which occupy the same space.
- One cuboid is associated with a target.
- The cuboid is deleted when the target is deleted.
- Therefore, all six targets must be deleted before the exit is clear.

Although six targets exist in the desert, a player is only able to enter their own. This is achieved by pre-programmed access control that associates an integer identifier with both the client and the target. Only when these identifiers are equal are the players allowed to enter the target.

It was sometimes the case that less than six players would participate in the performance. This meant that targets could be present in the world that would not be given to players. Of course, the targets could not be left as the exit would never become open. To compensate for this, the clients for the empty cubicles were started with the following properties:

1. *Starting point inside the target.* This meant the target could be removed immediately without the need to navigate to the correct position.
2. *Null embodiment.* The client could be left running without a superfluous embodiment being seen by the players. This was desirable as quitting clients during the performance could cause software crashes.

The next point of technical interest that the player may encounter is the Live Link room.

3.3.4 The Live Link

Within the large desert area are two entry points to the underground complex area. One of these leads to a map room containing a static map geometry, the other contains video booths that allow the players to view the physical space of another player. This was known as the Live Link room. In this room were six video booths, each containing a video texture of the input from the small camera mounted in the corresponding player's cubicle. Figure 6 shows a player's viewpoint as he/she approaches the video booth of player 1.

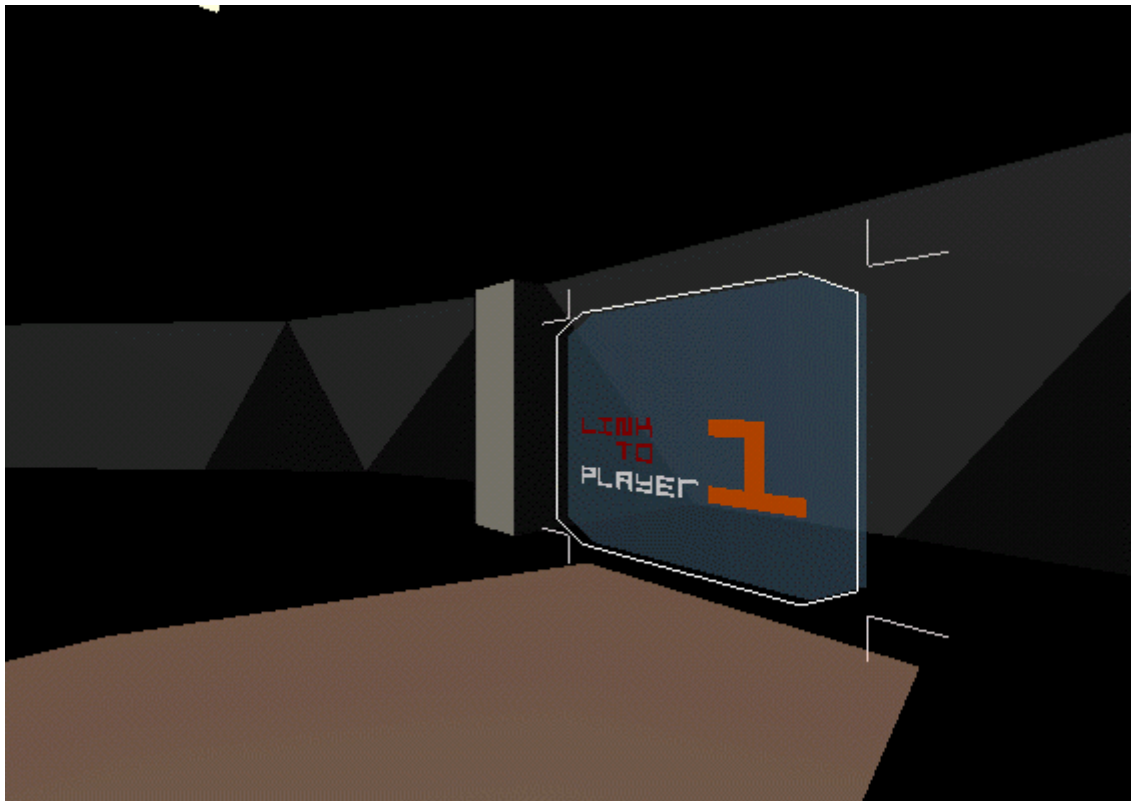


Figure 6. One of the six video booths. Upon entering this booth, the player would see live video of the real Player One.

Figure 7 provides an example of the video that would be seen by a player upon entering the video booth of Player 2.

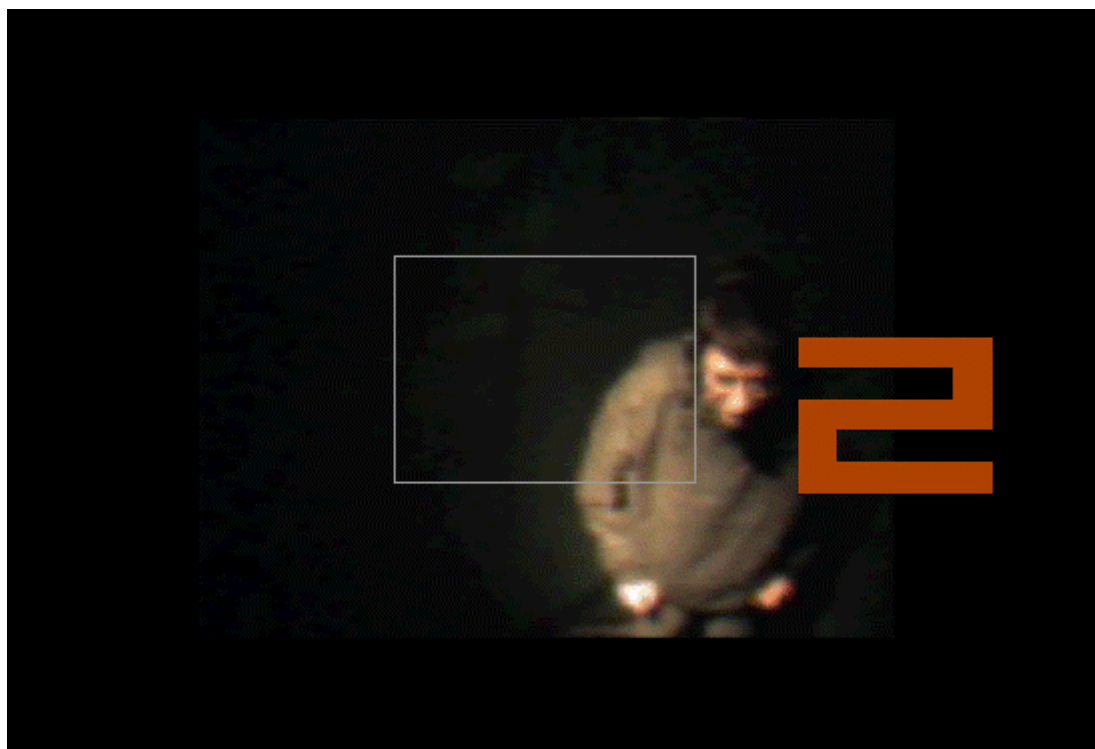


Figure 7. A still from the video taken in cubicle 2. This would be seen by any player entering the virtual video booth labeled 'Link to Player 2'.

As briefly described in section 3.2.1, each cubicle had a small video camera mounted in front of the water, facing the player. The camera for cubicle 1 was fed into the video input of client machine 1 and so on. Therefore, a single client was responsible for feeding the video data into the world for the corresponding player. The configuration of the virtual world allowed for the correct virtual booth to be associated with the video obtained from the client machine. The two-way communication between client and the world server meant that this video data could be distributed to the other clients and thus perceived by any inhabitant of the world. So in summary, this meant that the six video sources could be positioned in the world using the video input of the six client machines.

In addition to obtaining a video view in the Live Link, a player was granted audio communication with the player he/she could see. This is achieved by the method described in section 3.4.

3.3.5 The Exit

Ultimately, it is hoped that all players will locate their target and collaborate to locate and pass through the exit. If this happens before the time limit, the player's are asked to remove their headsets and walk through the rain curtain to be led into the sand corridor. However, this happened in a minority of cases and it was usual for players to locate their target but fail to locate the exit once open. If the user locates the target but finds it closed, they are encouraged to assist the player(s) who is(are) responsible. Figure 8 gives an example of a case where the exit is still closed due to one player not having found their target.



Figure 8. An example of the exit when closed. In this case, Player 5's discovery of their target will open the exit.

If a player (or players) find exit be room and the exit is open, but other players have not found the exit room, the player(s) receive advice to locate and help the other players. However, they may still choose to pass through the exit into the room beyond. Any players that do enter the region beyond the exit gate are granted audio communication with any players that are also present in the region.

Having understood the general overview and the technology's relationship to the virtual world, the remaining technical discussion provides more detail on the additional technical elements, namely the mixing desk and the hotel room card reader.

3.4 Mixing Desk Operation

An important part of the performance was to monitor audio from the players and provide feedback when appropriate. Also, the Live Link facility required a means of opening/closing audio communication between players during the performance. To this end, a mixing desk with sufficient inputs/outputs was obtained and configured for each event. A section of the mixing desk was set-up as illustrated in figure 9.

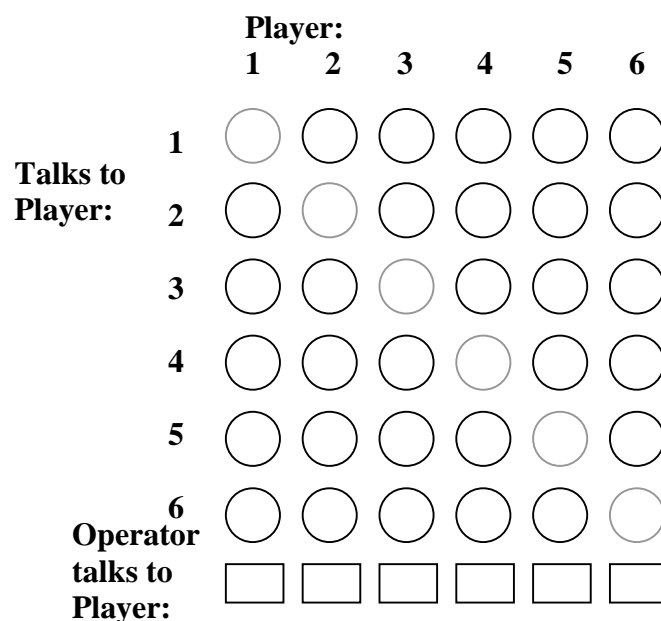


Figure 9. Mixing desk configuration. The circles are volume controls that allow the operator to set the level at which a player can talk to another player. The lowest row is a series of buttons that opens up audio to the player from the mixing desk operator's microphone.

To illustrate the operation of the mixing desk controls, consider an example in which Players 1 and 4 enter the live link of Player 2. The operator would look to the controls on the second row (for Player 2) and increase the levels from zero to maximum for the first and fourth knobs. Should any players then leave the link, the appropriate knobs would be reset zero volume.

The final row of buttons simply allowed the mixing desk operator to talk to one or more of the players. In the case when a single player was experiencing difficulty, the operator would select the individual to establish communication whilst ensuring all others were deselected. For broadcast messages such as notifications of time left, the operator would select all six buttons.

3.5 The Physical Hotel Room

The physical hotel room held the swipe card reader that triggered replay of the interview with the person named as the player's target. The video itself was back projected onto a small sheet of translucent plastic. This plastic was inserted into a square area that was cut into the hotel room wall. This area was framed by the photograph of the television set which formed part of the image on the hotel room wall.

4. Participation in Desert Rain

Dirk vom Lehn, Christian Heath (King's College)²⁵

4.1 Abstract

The study explores the installation Desert Rain developed in collaboration between the London based art group Blast Theory and the Communication Research Group (Dept. of Computer Science/University of Nottingham). By drawing on a mixture of social scientific research methods the study investigates how the participants collaboratively explore, experience and make sense of the installation, in which the navigation of a virtual environment plays a major part. Of particular concern for this study are the ways in which participants communicate and interact amongst each other and with performers across a rain curtain that serves as mixed reality boundary. The study describes observations and findings regarding different forms of social interaction across the mixed reality boundary and elaborates on problems regarding the functioning of occurring interaction amongst participants and performers. Drawing on the observations the study suggests possible implications for the objective of eRENA, future showings of Desert Rain, the design and display of new media art and 'traditional' exhibits as well as research and evaluation of audience responses to exhibit and exhibitions. Also, the study wishes to contribute to the design and deployment of exhibits and innovative technology into public places.

4.2 Executive Summary

This section of the deliverable covers a social scientific investigation into Desert Rain an installation collaboratively produced by the London based art group Blast Theory and the Communications Research Group (University of Nottingham). Desert Rain is one of the demonstrators produced as part of eRENA to explore novel ways to involve audience participation, and to provide means for new forms of interaction between performers and members of the audience.

Desert Rain uses a rain curtain as mixed reality boundary across which participants and performers can interact with each other and collaboratively produce experiences of the installation. The careful introduction of the participants into the use of the technology and the installation, the easy to use and reliable interface as well as dramatic appearances by the performers result in a very engaging novel work of art.

During the present study, we have observed participants' "journey" through the different stages of Desert Rain and carried out interviews with performers and participants. In order to compare and contrast these observations with visitors' actions and interactions in other art environments, we have conducted parallel research studies of 'Murmuring Fields', an artwork produced within eRENA by MARS (GMD), and in more 'traditional' museums and galleries such as the Courtauld Institute of Art, the Victoria and Albert Museum, the Science Museum (all in London), Green's Mill Science Centre and Djanogly Art Gallery (both in Nottingham).

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The general observations and findings from this study can be summarised as following:

- Blast Theory's Desert Rain is a novel new media artwork that based on innovative, reliable and easy to use technology that facilitates and engenders new forms of interaction between performers and participants as well as amongst participants.
- The success of Desert Rain is based upon interdisciplinary efforts between computer scientists, artists and social scientists, who in building upon each others' know-how have collaboratively produced, deployed and continually refined the artwork up-to its present state.
- Members of the audience are carefully introduced into the technology and the installation by performers so that participants' journey through Desert Rain can be smoothly accomplished.
- The evaluation of novel new media artworks requires flexible research methods, which produce observations and findings regarding participants' actions and interactions around the artwork that can significantly contribute to the design of artworks, which are intended to facilitate collaborative experiences.
- The present study also has produced observations and findings that are of relevance for studies on social interactions around 'traditional' artworks as well as on studies in HCI and CSCW, that is, they can make important contributions to the design of new technology that shall be deployed into public places.

With regard to the interaction amongst participants and between participants and performers we made the following observations:

- Carefully designed dramatic performances introduce participants to Desert Rain, and make possible the unproblematic use of the technology while participants experience the exhibit.
- When navigating the virtual world participants have only partial access to each others' actions and experiences, and can only glean limited information about each other. Therefore, it is difficult for participants to co-ordinate their actions with each other.
- Participants have difficulties to see virtual objects and avatars in relation to the virtual world. For example, the map cannot be seen in relation to the virtual environment it represents. Therefore it is difficult to use the map to orient in the virtual world.
- Participants who try to communicate to each other through the live-link do not have simultaneous access to each others' orientation in the virtual world. For example, a participant who sees another player in the live-link video image cannot see where this player is oriented to in the virtual world.
- When leaving the virtual world the performance seems finished and the flow of experiences is interrupted through participants' interaction with each other; thus, the final stage of Desert Rain in the Hotel Room, follows more as an appendix than as part of the performance.

Our observations and findings suggest implications for the objectives of eRENA, for future performances of Desert Rain and the design and development of other novel media artworks. They also bear upon the design and evaluation of 'traditional' exhibits and exhibitions as well as for the design and deployment of computer systems and studies in HCI and CSCW. Drawing on this study we have recently begun a collaborative study with artists and curators to explore how interaction and communication amongst visitors can be facilitated and engendered through certain

design features of exhibits and their spatial arrangements. In the continuance of this research we will to further investigate issues and concerns that have emerged from our involvement in eRENA, that is,

- investigating collaborative experiences of (novel) artworks,
- exploring ways to enhance interaction, discussion and debate amongst visitors, and
- contributing to the design and deployment of novel exhibits and innovative technologies into public places.

4.2 Introduction

The aims and objectives of eRENA include the development of artworks that in novel ways engage and involve the audience, and provide for new forms of interaction between performers and audience. In this light, the creation and use of mixed reality boundaries for the design of an artwork that involves social interaction across mixed reality boundaries is novel and innovative. In order to produce an engaging artwork that is based on a reliable technology, members of the public find easy to use and appealing to engage with, eRENA facilitates and encourages close collaboration between computer scientists, artists and technicians as well as social scientists.

As part of eRENA the Communications Research Group (CRG/University of Nottingham), the London based art group Blast Theory, social scientists from KTH (Stockholm) and King's College London, as well as technicians from ZKM (Karlsruhe) worked together to produce and evaluate Desert Rain, "a game, an installation and a performance that you must explore to find your target. Travelling through real and virtual spaces, visitors need to work together to search motels and bunkers, deserts and storms."²⁶ State-of-the-art computer technology is used to project a virtual reality environment onto a rain curtain, which is permeable and thus can become a boundary between the real and the virtual when being crossed by performers to interact with members of the audience.²⁷

The present study builds upon investigations we have conducted in various museums in the UK and abroad over the past two years. Observations and findings from these studies will help our understanding of the collaborative experiences participants produce in interaction with each other and performers, in Desert Rain. Through extensive field observations, videorecordings of actions and interactions inside the virtual world, interviews and questionnaires the study explores the different stages of Desert Rain the audience participates in.

4.4 Aims and Objectives

The objective of the present study is to investigate how in, and through, collaborations across the mixed reality boundary the experience of Desert Rain is produced. The study sheds light on the forms of interaction that occur across the rain curtain as mixed reality boundary. It explores how the audience is involved in the performance of Desert Rain, and which forms of social interaction occur amongst the participants and between participants and performers.

²⁶ e.g. Blast Theory flyer, see Appendix A

²⁷ see description of Desert Rain in Chapter 1 of this deliverable; for a description of the rain curtain see eRENA D7b.1; for discussions of mixed reality boundaries see Benford et al. 1998; Koleva et al. 1999, 2000

4.5 Background

4.5.1 Social Interaction in Museums and Galleries

Over the past two years, we have conducted a research project concerned with social interaction at, and around, different types of exhibit in various museums in the UK and abroad. The observations and findings of that project can be summarised as following²⁸:

Participation with Exhibits

When orienting towards exhibits individuals not only take regard to the features and properties of the respective object but they take into account that others both, those they are with and strangers act and interact in the same space. Thus, visitors collaboratively participate with artifacts and experience exhibits in, and through, interaction with each other.

Peripheral Participation

In their interaction around exhibits visitors not only take regard to actions and activities produced by their companions but also they are aware of occurrences and events in their 'perceptual range' and orient towards them. Apart from interacting with their companions, visitors orient towards behaviour conducted by strangers who just happen to be in the same space. They experience and learn about features and characteristics of exhibits by virtue of participating in actions and orientations of others in the same milieu.

Configuring Experience

When making sense of an exhibit in collaboration with others visitors perceivably animate their experiences. Visitors in 'perceptual range of the event' thus learn about features and characteristics of an exhibit through others' orientation towards and animation of the exhibit.

4.5.2 Visitor Studies in Museums and Galleries

Discussions and debates in Visitor Studies, a research area that despite of early experimental explorations by Robinson (1928) and Melton (1933/1972) emerged only since the 1960s, are preoccupied with individual visitors' responses to individual exhibits and their features. Investigations are conducted as case-studies mainly by psychologists with a background in the behavioural and cognitive sciences. Their principle interest is to measure the effectiveness of exhibits and exhibitions, that is, "a measurable change in viewer behavior produced by the exhibit, and consistent with the stated aims or objectives of the exhibit"²⁹. The primary measurements employed are "attracting power", the percentage of visitors stopping at an exhibit, "holding power", the average viewing time, and "teaching power", the exhibit's ability to convey the intended message to the visitors.³⁰

²⁸ for a more detailed discussion see vom Lehn et al. 1999

²⁹ Shettel 1968: x

³⁰ see also Bitgood et al. 1987

Research on visitor behaviour has widely acknowledged that museum visits are social events. Visitors come with companions and experience exhibits in, and through, interaction and discussion with each other; they meet people at exhibits who just happen to be there, and observe their activities and their display of experiences. Also, in reference to recent developments in educational and learning theory³¹. Visitor Studies as well as exhibition design more and more take into account that social interaction, discussion and debate enhance visitors' experiences of and their learning from exhibits. Research studies that have been undertaken in the recent past have largely concentrated on how patterns of interaction and communication at, and around, exhibits and exhibitions, are produced by differently composed groups.³² Only very few studies on visitor behaviour are concerned with the social organisation of actions and activities at, and around, exhibits.³³ Also, although the meeting of people who have not come together to an exhibition is an event that can often be observed in museums and galleries, research on visitor behaviour widely neglects social relation amongst 'strangers'. Apart from McManus's (1987) mentioning that "strangers" do not influence each other's behaviour until they have come into each other's reach (2.5metres) and studies on learning through "modelling".³⁴ Visitor Studies discard how experiences of exhibits are influenced by activities accomplished by other visitors in the same domain.

4.5.3 Blast Theory's Desert Rain

In comparison to the more 'traditional' exhibits and displays that feature in the investigations we have carried out over the past two years, Blast Theory's Desert Rain is a unique exhibit, in many ways rather different from exhibits on display in museums and galleries. Indeed, due to its size and set-up Desert Rain is organised as an event that is staged for fairly short periods, a few days up to two weeks, and only in venues that have rather large open spaces with access to electricity and water. Blast Theory did not produce a space for the audience to enter and to explore but also they carefully designed the introduction of participants into the performance to create an attitude towards the exhibit and the local environment.

After the introduction to the exhibit, participants are individually guided to cubicles, to stand on navigation boards they use for the orientation in the virtual environment; a headset is in place for the communication amongst the participants and between participants and performers. When all participants (players) are in their cubicles the game starts; from this moment on, the participants individually interact with a computer to navigate the virtual world and accomplish their task, finding their targets and the exit to the virtual world. On their journey through the virtual world they encounter avatars as representations of co-participants, with whom they communicate and interact. Thus, human computer interaction turns into computer supported co-operative work.

The unique set-up and design of Desert Rain requires the employment of particularly designed research methods in order to comprehend how through actions and interactions participants experience and make sense of the installation. Methods

³¹ e.g. Gee 1996; Billig 1996

³² e.g. Diamond 1986; McManus 1987, 1988, 1989; Blud 1990ab

³³ e.g. Hensel 1987

³⁴ e.g. Koran et al.1988; Borun et al. 1997

normally applied within the field of Visitor Studies, that is, for example, the measurement of ‘stopping power’ and ‘holding power’ are not suitable to obtain an understanding of participants’ experiences of Desert Rain. Indeed, it seems necessary that as the installation had to be adapted to the environment it was set-up in, the researcher had to employ a flexible set of various research methods (observations, video-recordings, interviews) to adapt to the circumstances the event took place in.

4.6 Case Studies – Data Collection

For the purpose of the study after a preliminary investigation into Desert Rain while it was ‘prototyped’ (Karlsruhe – January 1999) we collected different types of data at five locations where Desert Rain was staged and performed. The particular design of Desert Rain required an adoption of social-scientific research methods to the particular context of the performance and the objectives of the investigation.

- We studied the experimental phase of the exhibit in spring 1999, known as the ‘Virtual Rain Demonstration’. The rain curtain as mixed reality boundary was explored by technicians, computer scientists, artists, and invited members of the public.³⁵ The objective of our study was to gain an initial understanding of the mixed reality boundary, the exhibit and the intentions the design team pursued with its initial set-up as well as planned future developments of the exhibit. During this initial phase of our study into Desert Rain we observed the actions and activities of both, design team and visitors and conducted informal interviews with members of the design team as well as with visitors.
- In October 1999 Blast Theory’s Desert Rain was presented to the public for the first time in an old factory building in Nottingham. We conducted ten informal intensive interviews with groups of participants before and seven with groups of participants after their attendance. Also, we made extensive field observation at all stages of the performance.
- We attended the performance of Desert Rain at ZKM (Karlsruhe) in November 1999. At this occasion as before in Nottingham we conducted informal, intensive interviews with visitors, and observed their interactions amongst each other.
- At Blast Theory’s performance in London (Riverside Studios – May 2000) we asked visitors to complete brief questionnaires before they entered the installation and we conducted five in-depth interviews with visitors after they have participated in Desert Rain. The collected data were intended to give information about the (sociodemographic) composition of participants in Desert Rain, and to obtain more information about their experiences of the installation.
- At the performance in Bristol (June 2000) participants’ actions and interactions inside the virtual world have been video-recorded to explore how participants socially organise their actions and activities in the virtual world when being physically separated from each other. About six hours of video-recordings were produced from the perspectives of two of the participants.
- Currently, research is being undertaken at Blast Theory’s performance of Desert Rain in Glasgow.

Apart from these research methods and casestudies conducted to investigate participants’ experiences of Desert Rain, we have carried out two further case-studies

³⁵ see report in eRENA D.7b1

to compare and contrast Desert Rain with other exhibits and exhibitions. First, we investigated how in more 'traditional' museums and galleries such as the Courtauld Institute of Art, the Victoria and Albert Museum, the Science Museum (all in London), Green's Mill Science Centre and Djanogly Art Gallery (both in Nottingham) participants collaboratively experience and make sense of exhibits. And second, field observations and interviews have been carried out at the performance of 'Murmuring Fields' (MARS – GMD) at Fidenza 1999 in Bochum.³⁶

4.7 Key Observations and Findings

This section discusses and summarises the key observations and findings from the undertaken casestudies into Desert Rain. It concentrates on the key issues that came out of our investigations. First, we will explore how through the introduction into Desert Rain participants are prepared for the interaction with the technology and the experience of the installation (Section 4.7.1.). Second, we will describe the organisation of participants' accomplishments while they stand on the navigation board facing the rain curtain acting and interacting with co-participants utilising various technical means (audio-channel, visual representation of the virtual world and of co-participants) (Section 4.7.2.). And third, we will investigate how participants' leaving of the installation is organised and accomplished (Section 4.7.3.). In all three sections we will draw comparisons to our observations in the Courtauld Institute of Art and to 'Murmuring Fields'.

4.7.1 Design for Participation and Collaboration

Museum managers as well as researchers in visitor behaviour have long acknowledged that visitors attend exhibitions and encounter exhibits rarely on their own but normally while others both, companions and strangers are in the same locale. Despite the recognition that museum visits are social events, museum managers and designers of exhibits and exhibitions do hardly organise exhibitions that facilitate or engender collaboration and interaction. Desert Rain, by contrary, is specifically designed to provide for, facilitate and encourage visitors to participate in the exhibit and to experience it in collaboration.

The design for participation and collaboration is accomplished through a careful information policy towards the public (e.g. in leaflets, media presentations), and through a cautious introduction of the participants to the installation. Through the introduction to the exhibit the performer creates a mood and an attitude to participate in the installation while at the same time he encourages the participants to communicate with each other and to collaborate in exploring the virtual world. The organisation of this introduction into the journey as it is accomplished in the antechamber of Desert Rain, contributes to the creation of a specific mood that makes possible that participants 'believe' what they are encountering in the virtual world while they interact with a computer system. Of particular importance, hereby, seem to be the darkness in the antechamber, the changing of clothes, the separating and isolating of the participants, and the general tone of the verbal explanations by the performer in the antechamber.

³⁶ see eRENA D 6.2.: pp.78-83

Communication and collaboration is facilitated through the design of the virtual environment and the provision of technical means. The headset enables participants to talk to each other, and the avatars are positioned in the virtual world giving participants a sense of where the others are and where they oriented to in the virtual world. By virtue of these technical means participants have partial access to each other and each others' experiences of the virtual world, which seemingly encourages them further to explore through communication where they are in the virtual environment and what they are experiencing. However, it seems difficult to help each other out navigating the virtual world because the avatar design makes it difficult to recognise where participants orient themselves towards in the virtual world.

4.7.2 Experiences at the Exhibit-face

Studies on visitor behaviour conceive the experience of museum exhibits as series of individual encounters with individual exhibits. By contrary, Desert Rain is designed to facilitate collaborative experiences amongst visitors by encouraging them to interact and communicate with each other. The following three points summarise our key observations and findings regarding how participants co-ordinated their actions and interactions in the virtual world:

Participation and Co-participation in Desert Rain

Participants only have partial access to each other's actions by virtue of the audio-channel and the visual representation projected on the rain curtain. The co-participants cannot directly perceive each others' actions but they have access to them indirectly by means of the communication channels. The images projected onto the rain curtain allow participants to see the avatars of the others, where they are in the virtual world and where they orient themselves. Also, when avatars meet in the virtual world the respective participants are able to talk to each other. Participants have used this facility extensively and attempted to give each other directions in the virtual world. In interviews they said that the possibility to talk to each other has been very helpful to navigate the virtual world and also increased the feeling of companionship and even community. However, when asking them in more detail how talking to other people supported their ability to navigate the virtual world participants could hardly give us any information. Most participants were able to navigate the virtual world without major problems, which in part is made possible through the smooth operation and functioning of the technology, navigation board and rain curtain, and in part is helped by the performers who monitor and intervene in participants' actions and interactions.

The designers of 'About Time' on display in the Courtauld Institute of Art (Spring 2000) tried to intrigue visitors and to engage them in discussion and debate by juxtaposing drawings and watercolours with poems. Also, poems and drawings displayed on tables in the centre of exhibition space invited visitors to sit down and contemplate individual exhibits but also to engage in discussions with those sitting close by. Our observations indicate that visitors only rarely produced relations between juxtaposed exhibits and also only seldom used the displays on the tables. The findings from this study suggest that further cues are necessary to engender sequences of actions and interactions that result in a drawing of relations between certain exhibits. Or in more technical terms, there seems to be a need for 'traditional' galleries to develop interfaces that facilitate and engender certain sequences of actions and interactions.

'Interactive exhibits' as on display in the Science Museum in London or in Green's Mill Science Centre (Nottingham) attempt to involve visitors in interaction with exhibits by virtue of push buttons, touch screens, and the like. While through this type of exhibit they facilitate visitors' participation with the displays they largely localise and individualise activities around the interactive object and hamper social interaction and co-participation at the exhibit.

With regard to 'Murmuring Fields' our study has illuminated that in particular audience members had difficulties to understand the relationship between the actions on stage and the triggered sequences in the virtual world. It seems that 'Murmuring Fields' does not facilitate social interaction amongst participants and hampers co-participation with the exhibit because participants have problems to produce a shared point of reference; the small screen installed above the stage where the action takes place is not sufficient to allow participants to co-ordinate their activities with regard to the virtual world.³⁷

Blast Theory's Desert Rain is an attempt to allow collaborative experience between participants acting in remote, isolated locations. The carefully designed introduction into the installation and the explicit encouragement of collaboration and interaction between participants clearly mark this exhibit as novel and innovative. However, the design and performance of the installation also produce problems in participants' interaction with the technology, with each other and with performers. In particular in the beginning of the performance some participants have problems to use the navigation board and to move around in the virtual world. The continuous observation of participants by performers from the opposite side of the rain curtain and by designers and performers from behind the computer screens makes possible interventions in participants' actions. For example, through the audio-channel performers give participants instructions on how to use the navigation board, and by means of the 'arrow-keys' of the computers participants' avatars are surreptitiously moved through the virtual world in order to influence and shape their experiences. Thereby, the designers take particular care that the 'external' movement of a player remains unnoticed to the moved participants as well as to other players in the virtual world in order to sustain the consistency of the experience.

With regard to navigation and wayfinding problems in the virtual world, our observations indicate that only rarely the quality of the images on the rain curtain was the cause for the problems but rather the restricted possibility to orient towards virtual objects (e.g. map, avatars) in the virtual world. In particular, participants seem to have difficulties to interact with each other and to reference to virtual objects. Therefore, giving each other directions and helping each other out to navigate the virtual world is problematic, so that participants largely rely on the audio-channel to inform others about what to do and where to navigate towards. A typical solution for the problem to communicate directions in the virtual world is to take the lead and ask co-participants to follow the avatar in front.

The Map-Room

The map-room is enclosed by walls and thus separated from the rest of the virtual environment. The division of the virtual space in 'sub-spaces' is problematic for the

³⁷ see eRENA D 6.2

participants when they want to match the map with the virtual environment. The map is disembodied from the environment it represents and participants cannot relate landmarks indicated on the map to landmarks in the environment. Indeed, after a glance at the map participants leave the map-room and face the environment. Also, two or more participants meet in the map-room they hardly talk about the map and use it collaboratively as orientation device because it is difficult to establish a shared perspective on the map. It is worthwhile to mention that these difficulties do not arise from technical problems like the quality of images on the rain curtain but the problems come about through the design of the virtual world.

The Live-Link

The live-link is a sort of videoconferencing room one participant can enter to see a video-image of a particular player balancing on her/his navigation board. The system, however, worked only one way – except both participants have entered each other's live-link and could see each other on their board that was a very rare event if it happen at all. Also, once a participant has entered a live link (s)he does not have access to the virtual world anymore. The live-link, therefore, only allows conversations between two participants but does not support referencing to the virtual environment or monitoring other's orientation to the virtual environment. Also, the live-link does not allow participants to give each other instructions on how to use the navigation board or on how to navigate the virtual world because it does not support the creation of shared viewpoints, neither on the virtual nor on the real world. Also, we have quite often observed that participants access their own live-link facility and, then, when seeing a video-image of themselves balancing on the navigation board, did not know what the live-link was for. At this point, designers and performers regularly intervene and point out to the participants that they have entered their own live-link. From the observations, we would suggest that the use of the live-link in the present format is questionable.

The Rain Curtain as Mixed Reality Boundary

Our observations also give some information on the functioning of the rain curtain as mixed reality boundary. The asymmetric structure of the rain curtain as boundary between virtual and real world can be considered from two perspectives: first, it allows participants to view the virtual world projected onto it but it does not give them access to the real world beyond the curtain. In this respect the live-link seems to be an exceptional case where participants and their actions on the navigation board can be accessed. However, the visual accessibility of another player also has an asymmetric structure because the seen player can not see who is talking to her/him; (s)he just hears a voice on the headset and neither has a choice to switch it off nor can utilise the fact that (s)he is seen on the board as resource for her/his own accomplishments.

And second, performers can stand on the other side of the curtain and observe participants balancing on the navigation board without being seen by the participants. Blast Theory exploit the asymmetry of the rain curtain in two respects. Performers observe participants on their navigation boards and take their observations as resource to decide whether a player has problems to use the interface. And most importantly, the production of the dramatic crossing of the rain curtain relies on the asymmetric feature of the mixed reality boundary, because it allows performers to tie their real appearance into the players' navigation of the virtual world without being noticed. The asymmetric features of the rain curtain, therefore, serve to subtly manage and coordinate the performance with the participants' interactions.

Observations in museums and galleries give evidence that visitors co-ordinate their navigation of exhibitions and their approach to exhibits with each other. Visitors are sensitive to co-participants' orientations and glean information about others' orientation and projective course of actions from observations of co-participants' bodily conduct, movement and orientation. Also, it is difficult for participants to co-ordinate their actions and activities with each other. One reason for this inability to glean information about each others' actions and experiences results from the design of the avatars, which does only to a small extent allow to translate bodily comportment into the virtual environment. Designers of Desert Rain may reconsider the properties of map-room and live-link and how they may be improved to enhance participants' ability to co-ordinate their conduct with each other across the mixed reality boundary.

4.7.3. Creating a Shared Experience

The experience of Desert Rain is produced through different forms of interaction and communication amongst participants and between performers and participants at different stages of the "journey". In this section, we wish to complete the overview of the observations and findings we have made by investigating the actions and interactions of participants that occur when their exploration of the virtual world is completed.

Leaving the Cubicles

After the completion of the journey through the virtual world participants leave their cubicle to the front and meet again face-to-face. They take off the raincoat they have received in the antechamber and instantly begin to converse with each other about their experiences in the virtual environment. However, the leaving of the cubicles is not the end of the performance but rather an intermediary stage from where the participants are guided to the next stage, the hotel room. Unfortunately, it seems that the organisation of this stage of the performance interrupts its flow for the visitors. In particular, the pulling off of the raincoats seems to conclude the participation in Desert Rain, and makes it difficult for the participants to revitalise the specific mood they have been in just a moment before.

Hotel Room

In the hotel room there is a television screen with a swipecard mechanism by its side. Participants are supposed to swipe the magnetic card at the television screen, which will start the showing of an interview with the target each participant has looked for in the virtual world. Observations of participants' responses to the video indicate that the intense mood created by the organisation of the performance has been replaced by lively discussions amongst participants about their experiences in the virtual environment. The discussions continue throughout the showing of the interviews and also often when participants leave the performance altogether and go to the coffee-bar associated to the venue Desert Rain takes place in. It is particularly noteworthy that all participants of anyone showing engage in discussions and debates independently of the status of their personal relation prior to their participation in Desert Rain.

Facilitating and Engendering Discussion and Debate

Drawing on educational theory it is an important objective for museum managers, curators and others involved in exhibition design to engender discussions and debates amongst visitors during and beyond their visit to an exhibition. Various attempts are

undertaken to facilitate long-term discussion and debates, such as web-sites that provide further information on an exhibition, books and handouts often available in the museumshop, and other materials. However, it has proved difficult to investigate the success of these means in engendering discussions and debates. We do not have any information about whether or not people discuss their experiences long after they have left Desert Rain, and we do not know whether the sandbox hidden within the bags or clothes of the participants has any impact. However, our observations in the hotel room suggest that the design and momentary managing of the participants' experiences through designers and performers engender discussions amongst them when they meet after this stage of the performance. The following three features of Desert Rain seem to facilitate and engender discussions amongst participants:

- the temporary isolation of participants in cubicles,
- for the duration of the virtual reality experience participants have (only) partial access to each others' actions and experiences, and
- the representation of the co-participants' avatars in the same virtual environment seems to suggest that the others make similar experiences in the 'same locale'.

Our study in the Courtauld Institute of Art does not give any evidence of whether or not the exhibition has engendered discussions between visitors after their leaving of the gallery. Blast Theory's approach gives us some idea of how discussions and debates amongst visitors might be engendered. After the performance of Murmuring Fields a discussion about the installation has been organised. The liveliness of this discussion suggest that debates about the installation continued after the audience left the exhibition; however, we do not have any indication of this.

4.8 Summary and Implications

The key observations and findings from our study can be summarized as following:

- Carefully designed dramatic performances introduce participants to Desert Rain, and make possible the unproblematic use of the technology while participants experience the exhibit.
- When navigating the virtual world participants have only partial access to each others' actions and experiences, and can only glean limited information about each other. Therefore, it is difficult for participants to co-ordinate their actions with each other.
- Participants have difficulties to see virtual objects and avatars in relation to the virtual world. For example, the map cannot be seen in relation to the virtual environment it represents. Therefore it is difficult to use the map to orient in the virtual world.
- Participants who try to communicate to each other through the live-link do not have simultaneous access to each others' orientation in the virtual world. For example, a participant who sees another player in the live-link video image cannot see where this player is oriented to in the virtual world.
- When leaving the virtual world the performance seems finished and the flow of experiences is interrupted through participants' interaction with each other; thus, the final stage of Desert Rain in the Hotel Room, follows more as an appendix than as part of the performance.

The following paragraphs summarise implications our observations may have for the objectives of eRENA and exhibits produced in the context of eRENA, for future

performances of Desert Rain, for those involved in exhibit and exhibition design and evaluation (Visitor Studies) as well as for the design and evaluation of computer systems and their deployment.

eRENA

- Blast Theory's Desert Rain is a novel exhibit that on various levels engages the audience and encourages all members to participate in the installation.
- Desert Rain facilitates various forms of co-participation amongst audience members, and encourages them to explore the exhibit in collaboration.
- Desert Rain provides for different forms of interaction between performers and audience.
- The rain curtain as mixed reality boundary allows participants access to a virtual world, in which they can communicate with each other and participate in each others' experiences.
- The mixed reality boundary allows the performers to unobtrusively observe participants navigating the virtual world and to engage in a dramatic face-to-face performance with the participants, closely tied into their involvement in the virtual world.
- The close collaboration of the artists with computer scientists from Nottingham University (CRG) ensured a smooth operation of the technology, that is the navigation board and the virtual environment, which proved easy to use.

Desert Rain

- Desert Rain works very well in terms of audience participation as well as in terms of interaction amongst participants and between participants and performers.
- Participants' are not "thrown into" an environment in order to explore a pre-set order of events but the experiences are collaboratively achieved through communication and interaction between performers and participants.
- The introduction to the exhibit carefully designed by a performer as well as the continuous observation of participants and their orientation to the virtual world are critical for the production of the experience of Desert Rain.
- Participants do not encounter a computer system to interact with but through carefully produced actions the performer converts the visitor to the venue into a participant of Desert Rain.
- It seems, however, that the participation in Desert Rain is interrupted when the participants meet each other outside the cubicles to be guided to the hotel room.
- Finally, the isolation of the participants in cubicles and their partial awareness of each others' actions and experiences engenders lively discussions and debates between them as soon as they meet.

Museum Managers, Curators, Exhibit and Exhibition Designers and Evaluators

- Novel exhibits and exhibitions require novel and very flexible methods of display.
- The audience enjoys the collaborative nature of the experience of Desert Rain.
- Partial access to each others' actions and experiences engenders discussion and debates about each others experiences after the participation.
- Traditional methods to measure visitor behaviour cannot be applied to evaluate novel types of exhibits. By contrary, a very flexible use of research methods is necessary to explore participants' collaborative experiences.

- By virtue of observational and other research methods adapted for the respective exhibit sociological research can produce important information for those involved in the design and deployment of novel exhibits.

HCI and CSCW

- It seems worthwhile thinking about whether the display of computer systems in public spaces requires the creation of a ‘dramatic’ environment to introduce and lead people into the use of the technology.
- The dramatic introduction into Desert Rain contributed to the conversion of visitors to the venue into participants of Desert Rain and their use of the computer system. Indeed, the smooth and reliable process of navigating the virtual world helped to replace the barrier between user and system by the experience of the virtual world.
- The rain curtain worked very well as mixed reality boundary, and its asymmetric features stimulate the imagination for other possible applications as well as ideas for the use of different boundary materials.
- There are problems in mutually referencing and pointing to objects in the virtual and real world across the mixed reality boundary.
- For the design of future exhibits and performances using virtual reality technology a closer study of the performers interaction with the participants across the mixed reality boundary seems interesting.

Our observations and findings suggest implications for the objectives of eRENA, for future performances of Desert Rain and the design and development of other novel media artworks. They also bear upon the design and evaluation of ‘traditional’ exhibits and exhibitions as well as for the design and deployment of computer systems and studies in HCI and CSCW. Drawing on this study we have recently begun a collaborative study with artists and curators to explore how interaction and communication amongst visitors can be facilitated and engendered through certain design features of exhibits and their spatial arrangements. In the continuance of this research we wish to further investigate issues and concerns that have emerged from our involvement in eRENA.

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5. Summary

The Dessert Rain staged mixed reality performance is a paradigmatic eRENA deliverable that encompasses the principal objectives we had set ourselves for this project:

- a close collaboration between artists and scientists
- an opportunity for the majority of eRENA partners to make valuable and extensive contributions
- a demonstrator that is innovative and qualitative both in terms of its cultural and its technological achievements
- an exemplar of an artistically driven project that is able to provoke scientific and technological developments whose value extends into other domains
- an elaboration process that involved clear stages of research, implementation, presentation and evaluation, leading up to numerous (and successful) public performances that were also carefully evaluated
- a mature product that makes a real contribution to the social, cultural and scientific European landscape.

Appendix A

The Desert Rain Flyer

