e-Dancing: The impact of VREs in defining new research methodologies for embodied, practice-led research in choreography and performance.

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Abstract

This paper explores the impact of specific Virtual Research Environments to help define new research methodologies as well as aid existing practice. It takes an Arts and Humanities research example, specifically one within an arts practice-led research context. This on the face of it would seem to be one of the most challenging and potentially least suitable topics, to study the applicability and the possible benefits of the environment within a wider context. The case study central to this paper is *Stereo-bodies* a collaborative practice-led research project, whose aim was to explore the ways in which different VREs could provide the context for the development of new creative practice, as well as novel methods to document and analytically evaluate the resulting performances.

1. Creating a definition

JISC developed a range of tools and services specifically for researchers and their administrators, in their management through phase one funding for the programme Virtual Research Environments (VRE). This created a basic infrastructure and far more importantly a range of demonstrator 'ideas' that are there to help redefine existing research methodologies and processes, as well as create new ones. The latest definition of what a VRE potentially is has been stated by JISC[1] as:

"A VRE comprises a set of online tools and other network resources and technologies interoperating with each other to support or enhance the processes of a wide range of research practitioners within and across disciplinary and institutional boundaries. A key characteristic of a VRE is that it facilitates collaboration amongst researchers and research teams providing them with more effective means of collaboratively collecting, manipulating and managing data, as well as collaborative knowledge creation."

We are now at the cusp of funding both for the next phase 2.0[2], which has just commenced, and to start the extra dissemination and exploitation stage through phase 2.5. These new phases have requested a strong focus on the role of the user, but as they now only constitute four projects we should consider how a wide user base can be accommodated in other areas.

Installing a VRE of any kind needs to be easy and acceptable by the researchers themselves and essentially be of benefit to their own and their colleagues work. There is the marketing principle of the tipping point[3]; where key users take up a technology and – although possibly unknown – this is copied for beneficial reasons by the majority. For a VRE to be used by an expanding set of research communities, we believe it should also be focussed on the objective that it is there to help the development of new techniques and define new methodologies for research which may be unforeseen.

2. Issues from the data-rich and the technology-poor

For this paper we are going to consider an Arts and Humanities research example, specifically one within an arts practice-led research context, which on the face of it would seem to be one of the most challenging and potentially least suitable applications for VREs. This paper will consider the research project *Stereo-bodies*[4] and the ways in which this practice-led choreographic research utilised tools from a range of VREs. For this we are going to consider both software and hardware that was used to help define a new research categorisation and address the data manipulation challenges. The VREs chosen were the Collaborative Stereoscopic Access Grid Environment (CSAGE) project[5] that integrated the recording, portability and

projection of stereoscopic data sets; with the Arena recording system and the time-stamped (triple-store) non-linear mind-mapping tool Compendium[6] that were developed and integrated within the Memetic VRE project[7].

In this case study we consider the impact of the VREs on the research process in terms of the development of new methodologies and knowledge creation. In order to do this we focus on the recording and annotating of data and also specify and define the requirements of the performance space. We will first consider the data needs before the space requirements.

There are three phases of collecting data that constitutes research evidence. It is this data that is used to create new philosophies about the research, build new methodological processes, and disseminate within publications. Even more importantly it is used to deal with the administration of the project from the initial proposition, through all the key stages of reporting to the final exploitation. All parties from the active research members, the research support staff to the systems administrators, need access to relevant data. The three phases of data acquisition surrounding a practice-led research in dance can be simplified as;

- **Pre-performance process**: This involves all preparatory work, rehearsals, pre-meetings and discussions before a performance or event.
- **Context of the performance event**: During the event there are opportunities to record and annotate, as well as gather relevant statistics.
- **Post-performance process**: Finally after the event there are both post-discussion and analysis by the authors, reviewers and critics that need recording and analysing.

The arts and humanities, and practice-led research in the arts specifically, do not lack opportunities to gather this data, but it is often difficult to store, partially because of problems with handling the huge amount of data generated as well as the complexity of setting up multiple linked recording systems. For example the standard maximum file on a 32-bit windows machine is 2GB, which only contains 10 minutes of reasonable quality video (as stored on the standard Sony Camcorder encoding system).

The second issue is the performance space that needs to be defined, in terms of how it can help to both capture and project the data. Technology can both help to create a new compositional/performance environment, as well as aid in the recording of all the data capture needs for the research. Two areas need to be considered;

1. A new space built upon e-Science and natural sciences visualization experiences of increasing ‘presence’ within their data, enabling different ways to project data.
2. A new type of recording system that is non-linear and able to capture and annotate everything and at any time.

We are now first going to look at some of the outcomes of the VREs that can be used for performance documentation, and then consider how this was applied for full recording and research analysis within the *Stereo-bodies* project.

2.1 The art of ‘presence’ to create a new space

There are now many purpose built visualization centres for the natural sciences that have been constructed using computer controlled projectors onto a curved or flat wall, which when viewed aims to fill a large part of the visual field of the users. Different arrangements are possible from an enclosed cube, to large flight simulator sized spaces. When a virtual environment, either computer generated or video is projected onto this space the level of ‘presence’ achievable defines the extent users believe they are inside the virtual environment. Two important cues of ‘presence’ include maintaining objects at real-size and the inclusion of stereoscopic vision. These provide an environment where small group collaboration can occur.

Current advanced Access Grid (AG)[8] and video conferencing technology now allow for near real-sized interactions. A missing stage of progress is the inclusion of stereoscopic video standards to gain that extra level of ‘presence’. These new facilities are being supported via the Access Grid Support Centre, consisting now of more than 100 large scale AG nodes in the UK alone[9].

2.2 The cost of ‘presence’

In 1999 Manchester Visualization Centre constructed one of the first large scale scientific visualization spaces consisting of a 7m curved wall similar to a flight simulator. This allows scientific users to achieve a higher

understanding of their data, but it cost, including building work, over £750K.

Later one of the authors was working at De Montfort University to specify and manage a similar visualization centre. There more modern components were used which decreased the cost. A generally more frugal reconstruction brought the overall price in 2003 to just under £250K.

Then when the author moved to the University of Manchester, in 2005, an upgrade of a large Access Grid conference node, to equip it for stereoscopic visualization added only an additional £60K to the usual room rebuilding costs.

Now it is possible to build a small portable version based upon the GeoWall[10] principle using COTS (Commercial Of The Shelf) components for under £10K. Quality has been sacrificed at each of these stages, but these systems are now affordable across disciplines for a variety of purposes.

A similar story has occurred with the construction of large Access Grid room nodes where in 1999 multiple PCs were required to encode and decode the audio and video streams, and now a single high-end desktop machine can accomplish the task. This has seen the number of Access Grid users, especially on personal nodes, rise exponentially to over 20,000.

2.3 The future – a better and cheaper place; plus recordable

The future is progressively a more connected and cheaper place in terms of technology and with recent upgrades within the UK's education and research network (http://www.ja.net/ JANET) these facilities are available to a large percentage of FE and HE users. Current networking allows the new video conferencing facilities provided by the Access Grid to record dozens of video streams simultaneously, allowing multiple cameras to be used in multiple locations. Recording multiple streams requires multiple ways to access and annotate, which is also achieved through time-stamping all items of the process including the video, the audio as well as the marked annotations.

Appendix A describes the stereoscopic technology required for display and recording that the VREs employed and the following section describes in detail the specific case study that employed both multiple visualization spaces, as well as continual AG recording capabilities.

3. Stereo-bodies: a case study

Stereo-bodies was a research project that began in early 2006. Its aim was to focus on exploring the impact of the VRE on dance composition. In particular it looked at the opportunities that the VRE offered for considering the compositional possibilities of the interrelationship between real and virtual dance performance. The research questions and problems that drove the project emerged as the collaborators began to explore the interface between live dance practice and the VRE. Finally the research team identified a set of concerns that they wished to explore that capitalised on the distributed performance environment provided by the AG and the enhanced sense of presence provided by the stereoscopic video. They were firstly, the interrelationship of virtual spatial pathways created by the dancing body both in terms of spatial design and motion and how this could be explored compositionally between and across the virtual and the real embodied performers and spaces. And secondly, to consider the idea of physical 'contact', or more specifically the illusion of touch between the real and virtual contexts. The project participants in this collaborative research came from University of Manchester, University of Bedfordshire (formerly De Montfort University, Bedford) and professional dance company Ersatz Dance. The final performance outcomes, using real and recorded performers as well as a demonstration of post-annotated performances, were presented at the DRHA (Digital Resources for the Humanities and the Arts) conference at Dartington College of Arts 3rd-6th September 2006[11]. This was the culmination of a research process that involved a series of practice-led experimental workshops that took place over most of the preceding summer.

3.1 Recording and Annotation event

Each of the final experimental performance outcomes were about 1 minute, 12 seconds in length, but we wanted to understand the complete creative and development research process that occurred, and consider the impact of the VRE at all stages of the process. Therefore we recorded all the experimental, practical sessions and rehearsals. The final recording event took place with performers distributed over two physical locations involved spaces both equipped with full-size projectors and multiple cameras, and lasted a complete day.

A further key part of the process was the collection of the post-event annotation sessions in a stereoscopically enabled AG room at the University of Manchester; playing back the multiple streams from the recordings, as well as using the Compendium mind-mapping annotation tool. Figure 1 shows a screen capture of the three projector wall as seen by the annotators. All these windows and events were captured on the Memetic AG recorder. The central window shows dancer Amalia Garcia, performing with a stereoscopically projected 'virtual' dancer James Hewison. The windows on the right display James's viewpoint and cameras also record side views of Amalia's performance, views of the choreographer and the computer operator. In addition to the ten AG cameras a stereoscopically enabled pair of Sony camcorders recorded the performance from the audience viewpoint in higher-quality. The non-linear annotation system Compendium is shown on the right-hand side which links via colour coding with the time-line shown middle bottom, allowing for time-jumping to occur within the AG video streams.

From the point of view of the dance research aims this process was particularly interesting in terms of both developing new methodologies that emerged as a result of the new working environment created by the VRE. It also provided new knowledge concerning distributed performance and the impact of multi-perspectival spaces on live performance in terms of challenging the traditional audience/performer relationship.

3.2 Portable equipment used at DRHA

A portable PC Shuttle system including a dual projector (www.geowall.org) passive stereoscopic unit with a back projection screen was used at the Digital Resources for the Humanities and Arts 2006 conference. There was no internet access available, which is common in many theatres, so an archive of the recording from the server was copied onto portable hard-disks.

3.3 Preparations for the DRHA event

Workshops prior to the final performance

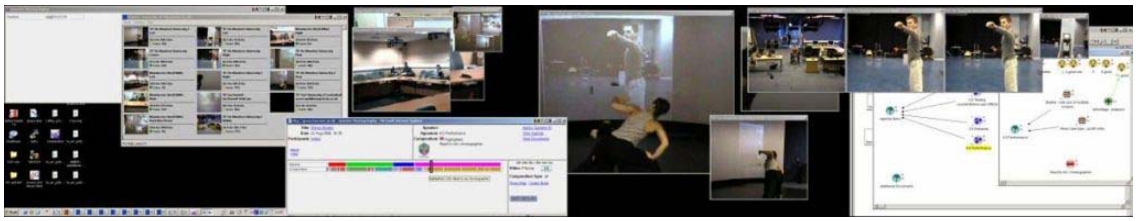

Figure 1: Screenshot of post-performance annotation session at the University of Manchester.

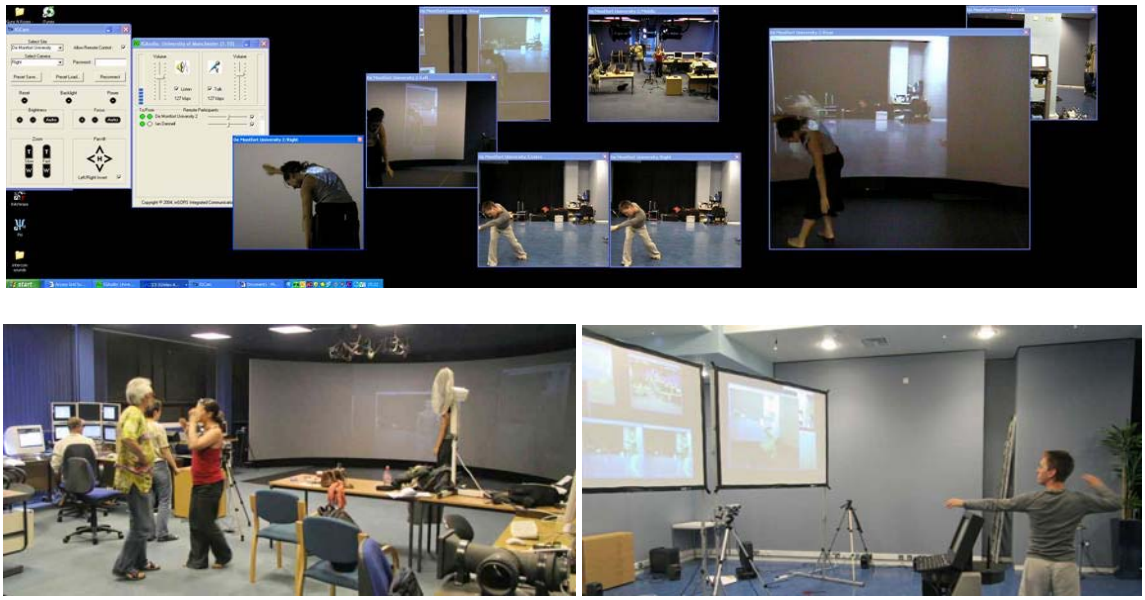

Figure 2: A screenshot of work in progress (top), and photographs of physical space one, the Virtual Environment Centre (bottom left) and physical space two, the Institute of Creative Technologies (bottom right); De Montfort University.

demonstration in September were held during March to August. There was a series of pre-meetings, rehearsals, and recordings, as well as the final recording of a complete series of experimental performance outcomes.

Practice Session – Null-Space Workshops Initially there were a couple of test sessions, exploring the role of dance improvisation in virtual environments as well as video recordings to experiment with different components. The first of these sessions was held in a dance studio at the Bedford Campus, University of Bedfordshire (formerly De Montfort University, Bedford) and the second was at the VEC (Virtual Environment Centre) at De Montfort University, Leicester.

First-Space Workshop July 24th-25th 2006 The first main workshop at the Bedford Campus created a series of pre-rendered stereoscopic side-by-side movies. This event created a set of duet and solo performances ranging from short demonstration studies, to master class set pieces as well as show-and-tell type performances. This did not involve the AG or the internet.

Second-Space Workshop July 27th-28th 2006 The second main workshop combined two different physical spaces to create three performances. Each performance was a combination of live dance with either computer generated visuals, pre-recorded video from the first workshop, or distributed live performance in which one live performer danced with a second performer, who was 3D stereoscopically transmitted and projected from a second physical space. All parts – preparation, pre-rehearsals, rehearsals and of course the performances were recorded both on the AG as well as using the stereoscopically enabled Sony camcorders. Screenshots of the work-in-progress and views from the two spaces are shown in figure 2; including photographs of the physical spaces; the VEC (Virtual Environment Centre) bottom left and the IOCT (Institute of Creative Technologies) bottom right.

Three sets of high quality stereoscopic video capture sessions were carried out during this session. Using the VRE there was a process of play-back and reflection during which the researchers were able to understand and construct the following five modes of stereoscopically enhanced choreography, creating a new classification process:

1. **Single stereoscopic recording of a performance.** Stereoscopic recording requires two synchronised cameras. This explores an additional mode of documentation for the recording and archiving of live dance performance as well as providing further possibilities for the creative use of visual technology in both screen-based and live choreography.
2. **Master class performance verification.** A common teaching metaphor uses accurate reproduction of movement material, copied from an expert in the learning and teaching of dance technique. This traditionally requires teacher and student to be in the same place in order to fully understand the spatial detail of the movement material. 2D video recordings distort the spatial relationship of the dancer to the space, therefore affecting the students understanding of direction, size, level etc. A novel use of the stereoscopic recording is to be able to playback side-by-side evaluations; for example from the teacher and the student.
3. **Improvised duet performance for dancer and computer animator.** Performing in front of computer generated 3D controlled animation scene. This particular experiment identified that there are actually two performers in action, the dancer and the computer animator who is driving the VR simulation. Therefore the experiment explores the concepts of ‘improvisation’ and ‘performance’ as interdisciplinary activities.
4. **Live performance of pre-choreographed material within a 3D recorded environment.** This is a version of the previous procedure but there is only one performer. It explores the effect that an interrelationship between performers can have on traditional understandings of both ‘liveness’ and space in a performance.
5. **e-Dancing across the network.** One performer based at a specific physical location is stereoscopically recorded and transmitted over the internet to a second performer, who is positioned in front of a stereoscopic screen with reciprocal feedback to the first performer.

In data terms we have dozens of hours of video from multiple cameras resulting in gigabytes of data, some of it indexed and time-stamped within the annotation system. Parts of this are fully available via the VRE across the internet through a simple web interface. In the future all this data needs to be available, time-stamped and archived, with the additional benefit of multiple post-performance interpretations.

4. Conclusions

The true benefits of using the VRE in the context of practice-led research in dance are many. This initial research has really just pointed up the myriad possibilities for further investigation in terms of the use of these tools creatively and analytically. In the context of practice-led research, the implications of the AG are enormous and could engender a new mode for both creating and receiving performance. The integration of stereoscopic projection enables further investigation concerning presence in performance and the interrelationship between the virtual and the real compositionally. The impact of these technologies in this context can also be keenly felt in the context of the documentation of live performance and for post-analysis of the data. This enables researchers to construct new research methods by analysing their creative process using the internet enabled tools of stereoscopic video recording, annotation and transmission to any AG node. The AG recording tools also allow for collaborative and continual annotation of the event that is still taking place.

Overall these techniques enable choreographers and other performance related artists to analyse and evaluate events in a whole new way.

Appendix A. Stereoscopic Technology

A.1 Displaying Stereoscopic Images

In normal life, depth cues are generated by the different perspective the two eyes have from their environment. The brain constructs a 3D view from the 2D images received by each eye.

With stereo projection the same is done; each eye receives one 2D image and the brain reconstructs the 3D view of the original scene. 3D projections must make sure that only the image meant for a specific eye is received by that eye. This is usually done by some sort of glasses, like anaglyph-glasses (red/cyan), polarized-glasses, or shutter-glasses. There are two ways of presenting the image to the user, combining and overlaying. In the case of anaglyph the two images are combined into one that is then split again by coloured glasses. This allows anaglyph images to be printed. The overlay technologies keep the two independent views (for each eye) “up to the screen”, where they are displayed on top of each other. The two main technologies are to use polarized light (polarization filters split the view) or shutter glasses (separate eye views are displayed at a very high frequency and only when the correct view for the eye is displayed will the glasses let through the light).

Figure 3: Sony camcorders ready for stereoscopic recording; including, fixed tripod mount, synchronisation LANC controller (black), USB web-streaming (white), high-speed tape download through fire-wire (red) and screw-fixable polarisation filters.

A.2 Recording Stereoscopic Images

For the recording of stereoscopic images two synchronized cameras are used to capture the two separate views. To produce a realistic looking 3D effect, the two cameras need to be mounted at approximately eye-distance from each other; if they are too close to each other the image would appear flat, if they are too far apart the stereo would be too deep.

It is very important to get the right perspective of the scene. To be able to replay the scene at a realistic size and shape, so the size of the screen onto which the images will be projected must be taken into account. In our case study, where a virtual person is dancing with a real one the perspective becomes very important. The illusion that these two people are dancing together in a shared space would not work, if the virtual dancer is unrealistic in size.

For the stereoscopic recording of stereoscopically projected images (plus additional content), we need to look back at the 3D displaying methods since we have to separate the eye perspectives again. In the case of polarization this can be done without major problem. All that is required is to filter using a polarizer at the camera in the same way the human viewer sees the images. This method has one disadvantage; the recording of the polarized light will appear dimmer than the original

recording as a lot of the light is filtered out. You could avoid this with the shutter technology but then you need to be able to control the shutter of the recording cameras. A complete recording system is shown in figure 3.

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[1] JISC VRE Virtual Research Environments programme, http://www.jisc.ac.uk/whatwedo/programmes/programme_vre.aspx

[2] JISC VRE programme: Phase 2 roadmap http://www.jisc.ac.uk/publications/publications/pub_vreroadmap.aspx

[3] M. Gladwell, (2002) *The Tipping Point: How Little Things Can Make a Big Difference* Back Bay Books

[4] *Stereo-bodies* performance wiki page http://www.kato.mvc.mcc.ac.uk/rss-wiki/SAGE/StereoBodies

[5] JISC CSAGE VRE 1.0 *Collaborative Stereoscopic Access Grid Environment* http://www.kato.mvc.mcc.ac.uk/rss-wiki/SAGE

[6] Compendium Institute, Open University http://www.compendiuminstitute.org/

[7] JISC Memetic VRE 1.0 *Meeting Memory Technology Informing Collaboration* http://www.memetic-vre.net/

[8] Access Grid http://www.accessgrid.org/

[9] The UK Access Grid Support Centre http://www.agsc.ja.net/

[10] GeoWall http://www.geowall.org/ and Manchester Computing's guide, http://www.mc.manchester.ac.uk/research/collaborativestereoscopicaccessgridenvironment

[11] H. Bailey, J. Hewison, M. Turner (2006) Stereo Bodies: Choreographic Explorations within Real and Virtual Spaces *DRHA Digital Resources in the Humanities*, September http://www.dartington.ac.uk/downloads/ils/drha06/piepp.pdf