

Rhizome of Western Han: an Omnispatial Theatre for Archaeology

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Abstract:

This paper investigates the integration of archaeological laser scan data inside the world's first 360-degree stereoscopic virtual environment (Advanced Visualization and Interaction Environment - AVIE). This interactive display system allows for fully embodied, omnispatial, omnidirectional and 3D visualization. Rhizome of the Western Han represents a process of archaeological re-contextualization, bringing together remote sensing data from the two tombs (M27 & M1) with laser scans of funerary objects, in a spatial context. The study of Han Dynasties (206 BC-220 AD) imperial tombs has always been an important field of Chinese archaeology. However, only a few tombs of the Western Han Dynasty have been scientifically surveyed and reconstructed. The prototype builds an interactive narrative based on spatial dynamics and cultural aesthetics that are embedded in the archaeological remains. This paper documents the principles of post-processual archaeological (embodiment, re-combinatory narratives, theatre) as they pertain to immersive display architectures. The discussion looks for a re-visioning of digital cultural heritage dialogues based on the concepts of cyberarchaeology, cybermapping and the rhizome. In addition, the technical implementation of the Rhizome of the Western Han inside AVIE is described. The work was undertaken in 2010 at the Applied Laboratory for Interactive Visualization and Embodiment (ALiVE), City University, Hong Kong.

Keywords: *Phenomenology, Immersive Systems, 3D, Western Han, Cyberarchaeology*

Introduction

The opportunities offered by interactive and 3D technologies for enhanced cognitive exploration and interrogation of high dimensional data still need to be realized within the domain of interpretive archaeology and digital cultural heritage. Most visualization research remains constrained to 2D small-screen based analysis. Furthermore, the number of pixels available to the user remains a critical limiting factor in human cognition of data visualizations (Kasik et al. 2009). This recognition is demonstrated

through an increasing trend towards research requiring 'unlimited' screen resolution (one could also say screen 'real estate'). This has resulted in the recent growth of gigapixel displays with potential for humanities and archaeological research (e.g. Powerwall, HIPerspace CALIT2, Manovich 2009), next generation CAVE systems (e.g. StarCave; see Levy et al. 2010), 360-degree 3D panoramic spaces (e.g. Advanced Visualization and Interaction Environment, Kenderdine 2010a) and platforms such as the Allosphere (UC, Santa Barbara).

This paper reflects upon immersive interactive 3D installations as examples of innovation in cultural heritage interpretation, interactive narrative and new cinematic technologies. The critique of cultural heritage visualization is often confounded by a lack of differentiation between immersive systems and small-screen applications (e.g. Rahaman and Tan 2010). Furthermore, it is known that ‘... a wide percentage of projects and applications of virtual heritage are never experimented and monitored with people, but they are born and die in digital labs’ (Forte et al. 2006, 68). However, there is growing recognition of potential of immersive large-scale display systems as places for invigorating modalities of interpretation for cultural and heritage (Kenderdine 2009; also see Rahaman and Tan 2009; Forte 2010). Simultaneously these systems provide situated experiences which allow not only mediation between the virtual and the real, but promote inter-personal dialogues between users and spectators stimulating (re)socialization in public spaces such as museums. As described by heritage researchers ‘interaction and feedback determine the virtual embodiment’ (Forte et al. 2006, 86) is a vital component to ‘the empathy factor really crucial for learning and communication’ (Forte et al. 2006, 4). Cyberarchaeologists Forte and Bonini (2008) reinforce the necessity for considering the cognitive learning models through enaction and embodiment, emphasising that ‘knowledge is enfolded in movement’ (Bonini 2008, 123). This is the premise for embodied or body-anchored and experience-based learning (see the analysis of PLACE-Hampi, Kenderdine et al. 2009).

This discussion references the prototype project *Rhizome of the Western Han* (2010) which has resulted in an interactive browser for large-scale laser scan data in the world’s first 360-degree stereoscopic interactive virtual environment the Advanced Visualization and Interaction Environment (AVIE, Fig. 1). The initial research challenge was to build a

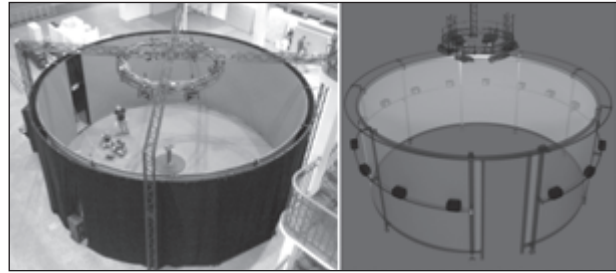


Figure 1. Advanced Visualization and Interaction Environment © iCinema Research Centre, UNSW/ Applied Laboratory for Interactive Visualization and Embodiment, CityU, Hong Kong.

browser for laser scanned datasets from *any* archaeological survey that would allow for full-embodied, spatially accurate, interaction.

Rhizome of the Western Han can be interpreted through several discourses such as post-processual archaeology and phenomenology; archaeology as embodied theatre, and cyberarchaeology. The project is experimenting with different codes associated to the mural paintings and the iconography of the monuments, in an embodied form. In this installation a 3D cybermap represents an attempt to re-elaborate the interpretation of the iconographic painting using non-Western codes and stressing the importance of 3D visual and narrative connections for a multi-vocal archaeological interpretation. *Rhizome of the Western Han* ultimately seeks to represent each tomb as a macrocosm, as a precursor to understanding the cosmology in the Western Han period by a visual language. The cybermap design builds a network of interpretation codes and cultural contexts not recognizable or understandable in a linear sequence. The implementation of the 360-degree stereographic application in AVIE is described in detail in section 4. In brief, the prototype application allows users of the system to enter tombs at 1:1 scale (Fig. 2) and activate the map of iconographic elements from the wall painting that are spatially related to each other. The relationships between specific iconographic elements that make up the cybermap are shown

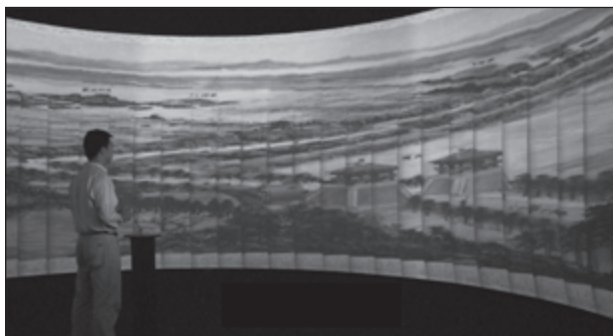


Figure 2. View *Rhizome of the Western Han* © Applied Laboratory for Interactive Visualization and Embodiment, CityU, Hong Kong.

in figure 3 and the in an activated state in figure 4 and figure 5.

To situate the *Rhizome of the Western Han* in a context of research into embodied interfaces for cultural heritage this paper will introduce two other works *Hampi-LIVE* and *Space of Mnajdra*, both developed for the AVIE system which demonstrate new modalities of narrative making based on principles of co-evolution and embodiment. These projects extend the domains of interpretive cultural heritage by asserting a primacy for *enaction* through their strategies of immersive/interactive architecture and respective content development.

Archaeology, Phenomenology and Interpretation Using New Media

Framing the works described in this paper with brief analysis from multidisciplinary perspectives helps place them within a trajectory of research encompassing archaeology, phenomenology and, digital heritage and new media aesthetics. What is interesting for archaeologists interpreting historic landscapes and extant material remains is the intersection between immersive, interactive systems (which offer a high degree of ‘presence’), cybernetics and recent post-processual archaeological theory related to embodiment and hermeneutics. Following fissures within the long-established practices of archaeology,

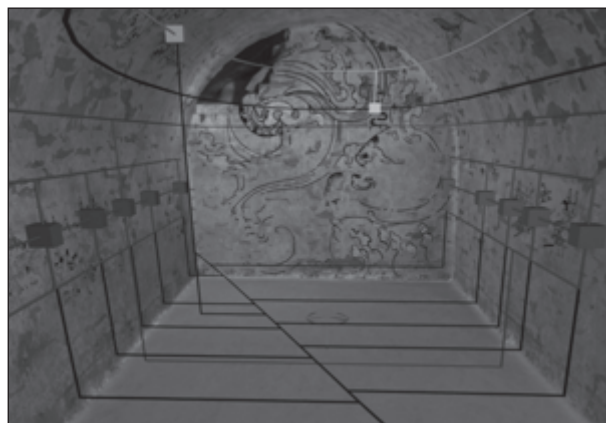


Figure 3. Cybermap *Rhizome of the Western Han* © UC Merced.



Figure 4. Activated *Rhizome of the Western Han 1* © Applied Laboratory for Interactive Visualization and Embodiment, CityU, Hong Kong.



Figure 5. Activated *Rhizome of the Western Han 2* © Applied Laboratory for Interactive Visualization and Embodiment, CityU, Hong Kong.

there has been a growing call to “contest traditional, predominantly textual modes of thought and action” and to “illuminate and expose the interpretive and artistic qualities of presentation and narration” using visual media (Cochrane and Russell 2007, 3). Similarly, advocates of media in archaeology (e.g. Shanks

2006; Webmoor 2005; Witmore 2004, 2006) suggest broader approaches to interpretation that move towards an archaeological expression of “recombinatory poetics” (Shanks 2006). The emphasis here is on the value of multi-sensory, kinaesthetic approaches to heritage interpretation in making the case for immersive digital environments as answers to some of the hermeneutic problems prevalent in ‘reading’ cultural landscapes.

Importantly post-processual archaeology theorists such as Christopher Tilley advance a phenomenological understanding of the experience of landscape. His arguments emphasise approaches to archaeological assemblages that go beyond their material manifestation. In his book *Body and Image: Explorations in Landscape Phenomenology* (2008), Tilley usefully contrasts iconographic approaches to the study of representation with those of kinaesthetic enquiry. In the context of analysis of it is useful to quote his discussion of the interpretation of rock art:

The potential of kinaesthetic approaches tell us something different... Iconographic approaches are usually primarily cognitive in nature. They grant the primacy to the human mind as a producer of the meaning of the images through sensory perception. It is the mind that responds in a disembodied way... Kinaesthetic approaches, by contrast, stress the role of the carnal human body. The general claim is that the manner in which we perceive, and therefore relate to visual imagery, is fundamentally related to the kinds of bodies we have. The body both limits and constrains and enables us to perceive and react to imagery in specific embodied ways (Tilley 2008, 18).

Archaeologists are coming to theorize and work upon the aesthetic and cognitive dimensions of archaeological assemblages, considering the affective component of art and style and social practice generally. This can be interpreted as part of wider project of embodiment and the influence of phenomenology in archaeology.

By suggesting that landscape studies are transformed by re-focusing on the kinaesthetic, Tilley stresses the autonomy of images to convey meaning. Imagery has a ‘direct agency’ (Tilley 2008, 46) that acts as one inhabits and moves through the landscape. Embodiment is a humanistic project of widening interpretation to include all dimensions of social practice or, better, experience — the cognitive and intellectual, physical, aesthetic and the affective. Embodiment is a project of rooting social experience in all the senses of the body. Such an approach to interpretation severely explodes narrative and other traditional modes of representation. If in fact embodiment is the experience of the world through all the senses of the body, then narrative strategies privileging one sense over the other, or emphasizing certain aspects over others, prove to be unequal to the task of embodied representation.

Crucial to the works described in this paper is the ways in which the embodied interface allows for new narrative potential. Narrative content and immersive architectures of the display system AVIE combine to provide a context for multisensory mediation between humans, virtual characters, cybermaps and virtual environments (e.g. Del Favero and Barker 2010; Kenderdine 2009, 2010a). Modalities of interaction can be described as forms of prosthetic vision, acoustic immersion, kinaesthetic activation, inhabitation and dwelling, travelling, driving and walking, and dynamic contemplation. In the cultural imaginary activated by immersive architectures, the sensory world of participants is tuned for encounter and thus emergent narratives become possible (see Kenderdine 2007a, 2007b, 2009, 2011).

The research also draws upon understanding the relationships between embodiment and representations of the material. Don Ihde, post-phenomenologist and philosopher of science and technology, promotes a *material* hermeneutics that “gives things voices where

there had been silence, and brings to sight that which was invisible” (Ihde 2005). The ‘things’ of Idhe’s visual hermeneutics are viewed through instrumental magnification of prosthetics, such as telescopes and microscopes, thus allowing perception to go where it has not gone before. Likewise, the immersive architectures described in this essay promote the visualisation of the material—of ‘things’ and aspects of embedded meanings found within those things. The prosthetic devices within the interactive display amplify the sensorial and allow the senses to go where they have not gone before.

Museum specialist Linda Young, in her review of *Handbook of Material Culture* (Tilley et al. 2007), provides comments on the somatic turn in material studies on a section of the book that deals with the body, materiality and the senses. Young says:

...[the somatic] confronts textuality and visuality as our culture’s dominant modes of understanding material culture, and suggests that the embodied subject and its multiple, concomitant ways of sensing, feeling, knowing, performing and experiencing, offer dynamic routes to different perceptions of the human relation to the material... Corporeality and sensuality open up to the concept of sense-scapes—an enticing notion (Young 2007).

Visual interfaces that amplify a somatic or corporeal response are found throughout many cultures (see Pinney 2004, 2006; Kenderdine 2007a, 2007b, 2011). The opportunity of the fully interactive and embodied virtual environment is to provide a setting to activate latent and embedded meanings found within the representation is what is being explored here.

Archaeology and the virtual theatre

In 2001, archaeologist Michael Shanks and performance studies theorist Mike Pearson collaborated to write *Theatre/*

Archaeology (2001), an examination of the points of convergence between contemporary performance theory and practice and interpretive approaches in archaeology. Invoking the notion of performance in archaeology helps to make sense of the matrix of association between archaeological materials – empirical, spatial, conceptual and metaphorical. For Shanks, archaeological interpretation should also emphasise the manifestation of archaeological materials, that lets “the material display itself” (Shanks 2004, 148). He emphasises performance, ceremony and ritual in relation to post-processual archaeology. This ties together “issues of signification, of the embodiment and corporeality of social actors, agency and the constitution of social structure and social norms” (Shanks 2004, 149). Shanks concludes that “performance is the root metaphor for social and cultural processes” (Shanks 2004, 149) and further, that archaeology itself can be conceived of as a performance “where the remains of the past are mobilised in practice, often conceived as mimetic, of representing or restoring behaviour” (Shanks 2004, 149).

Recognising the performative qualities of the human-computer interface McKenzie (1994) suggests “one might invent the computer as performance”. Media theorist Gabriella Gianacchi, in her analysis of virtual theatre, describes it as: “... one which through its virtuality is able not only to include the viewers within the art but also to distribute their presence globally in both the real and simulated virtual world” (Gianacchi 2007, 10). Most recently, Chris Salter’s book *Entangled* (2010) provided a detailed historical and technical overview of new media and performance. His thesis emphasises again the themes of embodiment, phenomenology and mediation. In addition, a number of media and cultural theorists make the analogy between new media artworks and all forms of theatrical genres. Digital technologies need to be contextualised within the historical frameworks of human experience and immersion in all types of media

and interactive and immersive cinema has clear links to performance, ritual, theatre, painting, the circus and painting (Burnett 2005, 129).

Recently the research by Shanks, artists and computer scientists (such as Mel Slater, renowned for his work on 'presence' theory and evaluation) has focused on issues of presence in a mediated virtual world and, the archaeological record. At University College London, the *Presence Project* used a CAVE to simulate environments, performances and encounters in experimental exploration and behavioural research into matters of presence while Shanks investigated aspects of historiography, the archive, chorography, archaeography and the presence of the past within this framework of immersive visualisation (see Presence Project; Giannachi et al. 2011).

Research Contexts

Applied Laboratory for Interactive Visualization and Embodiment (ALiVE)

ALiVE was established in 2010 as an interdisciplinary research initiative of the School of Creative Media City University of Hong Kong. Situated in a 1000m² facility at the Hong Kong Science Park, ALiVE is an incubator and innovations showcase for new forms of creativity at the cutting edge of digital media in society. Leveraging technological advances in cinema, games, and mobile, networked and participatory media ALiVE researches new modes of immersive interactive experience that are of major importance to culture, entertainment, education and industry. Its pioneering infrastructure is made up of unique display environments, production systems and computer graphics techniques.

ALiVE builds on creative innovations that have been made over the last ten years at the UNSW iCinema Research Centre, Sydney, ZKM Centre for Art and Media, Karlsruhe and at Museum

Victoria, Melbourne. Its challenge-led research programs act in response to the academic, cultural and industrial opportunities in Hong Kong and Mainland China. This is supported by partnerships with major digital media centres in Europe, USA, Asia and Australia. The Centre promotes an integrated scientific and artistic research strategy. Domain specialists work together at ALiVE to create unique technological and content rich solutions for cultural and industrial applications, in the public domain. This functional research addresses social contexts and its applications set benchmarks for interactive art, future cinema, situated gaming and digital humanities.

Advanced Visualization and Interaction Environment

The Advanced Visualization Interaction Environment (AVIE) is the UNSW iCinema Research Centre's landmark 360-degree stereoscopic interactive visualization environment space. Initially a passive stereo system (McGinity et al. 2007), an active stereo projection version of the system together with camera tracking is installed at ALiVE. The base configuration is a cylindrical projection screen 4m high and 10m in diameter, a 12-channel stereoscopic projection system and a 14.2 surround sound audio system. AVIE's immersive mixed reality capability uses camera tracking of visitors movements through infra-red video capture iTrack (voxel modeling) that articulates an embodied interactive relationship between the viewers and the projected information spaces. AVIE's multimodality contributes to the feeling of presence within the immersive environment. It produces a sense of space that is at once 'other', due to the logic of virtual images, but also familiar, as the human user can still see her own body, and move through the physical space, interacting relatively naturally with the characters or objects that share this space (e.g. Del Favero and Barker 2010, 3).



Figure 6. *PLACE-Hampi* © Kenderdine & Shaw 2006.

Hampi-LIVE

Hampi-LIVE (2011) builds upon the content of the interactive installation *PLACE-Hampi* (2006) designed for the PLACE platform (Kenderdine et al. 2007, Kenderdine 2007a, 2007b, 2011; Fig. 6). The research integrates the augmented stereoscopic panoramic application of *PLACE-Hampi* to the AVIE system (Fig. 7). *Hampi-LIVE* is centred on the concept of *co-evolutionary narrative* where machine agents and virtual humans have symmetrical or equal status in the interactive environment (see Kenderdine 2007a, 2007b, 2009, 2011; Del Favero and Barker 2010). Using AVIE's camera tracking system, the locations and movement of the visitors to the environment are known to the computer agents that inhabit the scene. These agents are allowed to interpret the moves of the visitors and respond according to a certain pre-programmed nature.

If a theory of interaction is to be focused solely on the experience and agency of the human user, our understanding of the aesthetic impact and process of MR [mixed reality] is severely undercut. For a space to be truly 'mixed' between the digital and the physical, a theory of interaction must be equally focused on both the digital and the physical, allowing the digital to affect the processes of the physical, through interactive deliberations, just as much as the physical can affect the processes of the digital (Del Favero and Baker 2010, 3).



Figure 7. *View of the panoramic clusters of PLACE-Hampi and Hampi-LIVE 3D environment. Visitors navigate and enter any stereoscopic cylinder* © Kenderdine and Shaw 2006/2011; *iCinema, UNSW*.

Hampi is a world heritage site in South India which has a vibrant contemporary cultural life focused on the Hindu faith. In many interpretations of the *Ramayana*, Hampi is Kishkindha, the kingdom of the monkeys. The mythological inhabitants have counterparts in the real world and in Hampi today, where the monkeys are revered by the faithful while also adventurous in their behaviour towards locals and tourists alike. In researching the first scenario in *Hampi-LIVE*, a tribe of computer generated (CG) monkeys was created who operate as autonomous agents in one of the stereo-panoramic scenes shot at Hampi (at a site located on Hemakuta Hill behind Hampi's main active temple) (Fig. 8). Through a camera tracking system, their behaviour co-evolves in tandem with the behaviours of actual visitors within the AVIE itself. The evolving, time-based development of behavioural interaction between real people and virtual agents is achieved by script-based actions of the CG animations (made from motion-captured sequences), linked to interpretive software (involving symbolic logic and high-level computer programming or artificial intelligence).

The software allows the machine-agents to act, observe the consequences of their actions in



Figure 8. *Hampi-LIVE's* monkeys © Kenderdine & Shaw 2006/2011 (*iCinema*, UNSW).



Figure 9. *Hampi-LIVE* tourist © Kenderdine & Shaw 2006/2011 (*iCinema*, UNSW).

the real world, and then formulate new actions according to certain goals that have been imprinted in their identities. For example, a mother monkey may prioritise the protection of her young and will take appropriate action to protect her territory from humans who come too close. Other monkeys are programmed with a drive to socialise with the human visitors (based on wanting food, interest in bodily antics or mere curiosity). The monkeys exhibit different temperaments (e.g. fearless, jittery, protective, paranoid, etc.). Registration of human actions is largely focused on group and individual spatial disposition and changing proximity to the screen (that is, the space occupied by the monkeys) and the nature of their movement, which can be interpreted as threatening (if abrupt) or inviting (if calm). An interpretive matrix provides the mapping of various articulations of human behaviours to the scripted and improvisational range of monkey behaviours that are time-sensitive enough to enable a 'narrative' development (and co-evolution).

In the second scenario of *Hampi-LIVE*, a virtual tourist wanders the site (Fig. 9), occasionally corrals visitors to a specific location inside the AVIE, and videotapes them (Fig. 10). This video is then played back to the visitors in real-time. Conjoining the real and the virtual in this way provokes a hybrid dialogue based on the notion

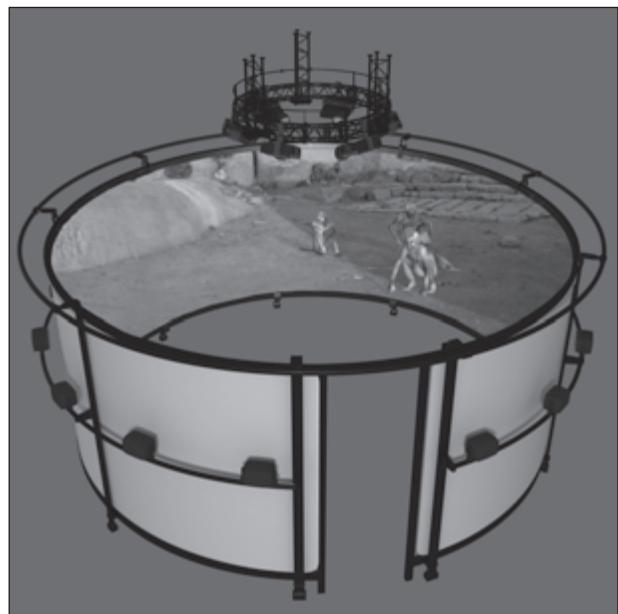


Figure 10. *Hampi-LIVE* in AVIE © Kenderdine & Shaw 2006/2011 (*iCinema*, UNSW).

of the 'touristic gaze' (Urry 2001). The mixed reality and augmented nature of the experience is two-fold. Firstly, the visitors to *Hampi-LIVE* are made explicitly aware of the performance of a 'touristic gaze' – in this case through the virtual tourist and her video recording device – as they themselves are also surveying the same scene. Secondly, participants become objects in this scene as the virtual tourist turns her 'gaze' upon them and draws them into the visual record. Thus, they are rendered both visitors to the virtual site and objects within it.

Spaces of Mnajdra

The prehistoric Mnajdra temples of South East Malta are one of the oldest megalithic structures in the world (3600 BC – 2500 BC). The temples were captured by high-resolution panoramas that were assembled into a virtual environment and projected onto the walls of the AVIE. The work is part evidence for a doctoral thesis by Bernadette Flynn and a continuing research project that investigates somatic knowledge in virtual environments (Flynn 2011). Engagement in the physical space of AVIE and in the situation of the digital frame calls forth different and simultaneous registers of bodily habitation. Users integrate the varied possibilities of physical movement, digital affect and interaction with screen performers through their own interaction strategies and conceptual framings. Personalised choreographies emerge, expressive of attitudes of intensity and deliberation, along with moments of spontaneity. Through performative enactment, as described in the mapping processes, the augmented environment of *Spaces of Mnajdra* is made comprehensible. The orientation of the doorways, prevailing axes and glimpses into intermediate chambers are critical devices for framing the relationship between inside and outside and to a lesser extent outside to inside. Users' habitual and emergent bodily movements and differing body postures animate these spatial orientations. Infolding between the virtual and the sensate, the circular spaces, doorways and passageways appear and disappear as users move from one panorama to the next. In AVIE, the trefoil and cinquefoil arrangements of semi-circular or horseshoe-shaped rooms and adjacent intramural chambers are restaged into the circular surround screen highlighting the spatial principles of circularity and receptivity, but diminishing other bodily affects, for instance, the experience of steps, elevations and differing floor heights. (Fig. 11)

In relation to the orientation of doorways



Figure 11. *Spaces of Mnajdra* © Bernadette Flynn.

and the staging of experience, it is worth recapitulating on some of the spatial strategies identified at the Mnajdra temple as indicative of ritual activity: “*Attention focusing devices, the presence of the transcendent and its symbolic form, the special aspects of a liminal zone, and evidence of participation and offering (sacrifice, libation, etc.)*” (Malone 2007, 23). The importance of the liminal, transitional and repeatable at the Mnajdra site as indicative of ritual significance has been previously advanced.

Cyberarchaeology

The aforementioned installations contribute to a re-definition of traditional forms of ‘virtual heritage’ (based on reconstruction and simulation) as examples of cyberarchaeology (Forte 2010) approaches to tangible and intangible heritage. Cyberarchaeology represents a research path of simulation and communication, whose ecological cybernetic relations organism-environment and the informative-communicative feedback constitute the core, but they have to be still fully investigated. Recent debates about cyberarchaeology (Forte 2010) have been focused on the relevance of specific factors of 3D embodiment, such as feedback and active behaviours in the interpretation and communication process. The basic principle is that the interpretation is a multiple, multivocal

and reversible interactive process whereas the final goal is not anymore the reconstruction of the past but its simulation. The simulation generates unpredictable informational processes during the cybernetic performance of the digital stakeholders, frequently represented by avatars or virtual humans.

The core of the process is not into the model, data or environment but in the mutual relations produced by interaction/embodiment/enaction (Maturana and Varela 1980). The enactive cognitivism discusses the dichotomy between intern and extern: cognition is an action “embodied” (Varela et al. 1991). In terms of enaction, the cognition depends on perceptual-motor experience and these capacities belong to biological-genetic but also cultural contexts. Thus the acquisition of data from the environment would be identified in the circularity between action and experience and between action and knowledge (Varela et al. 1991). The perceivable information in the environment comes from a perceptual motor interaction. In conclusion, even the cyber interaction or behaviour in a virtual environment can be totally reconsidered as an exchange of information organism-environment.

Rhizomes

Interwoven in the ideas of cyberarchaeology are those of cybermapping as a manifestation of the rhizome. Rhizome is a philosophical concept developed by Gilles Deleuze and Félix Guattari in their *Capitalism and Schizophrenia* (1972–1980) project. It is what Deleuze calls an ‘image of thought’, based on the botanical rhizome that apprehends *multiplicities*. *Rhizome of the Western Han* uses the term to describe theory and research that allows for multiple, non-hierarchical entry and exit points in data representation and interpretation. A rhizome, as opposed to linear methodologies “*ceaselessly establishes connections between*

semiotic chains, organizations of power, and circumstances relative to the arts, sciences, and social struggles” (Deleuze and Guattari 1987, 8). Rather than narrative history and culture, the rhizome presents history and culture as a map or wide array of attractions and influences with no specific origin or genesis, for a “*rhizome has no beginning or end; it is always in the middle, between things, interbeing, intermezzo*” (Deleuze and Guattari 1987, 27).

Rhizome of the Western Han

Introduction

The project “The Virtual Museum of the Western Han Dynasty” (of which the Rhizome of the Western Han was a subsequent project) started in 2008 with collaboration between the Xi’an Jiaotong University and the University of California, Merced, School of Social Sciences, Humanities and Arts. Later this collaboration was extended to the Xi’an Municipal Cultural Relics Conservation and Archaeological Research Institute (China), CNR-ITABC, Italian National Research Council (Italy). Scope of the project is the creation of different virtual museums (in China and in California) based on the 3D documentation and reconstruction of the most representative cultural relics in the Shanxi Province (for a detailed description of the project, refer to Galeazzi et al. 2010; Forte et al. 2010). One of the most important archaeological examples in Xi’an is represented by the mural paintings of the monumental tombs of the Western Han Dynasty. Despite their cultural and historical importance, they are at risk of being lost because of the critical conditions of plasters and colours. The reader is suggested to access the relevant project materials and video online. See *Reconstructing China: the Virtual Western Han Dynasty and Western Han Mural Tomb*, Xi’an, China listed in the bibliography. The new exhibition, *Western Han Dynasty: Archaeology@Reality*

Exhibit, opened on April 15 2011 at the Center for Information Technology Research in the Interest of Society, University of California, Berkeley (CITRIS).

Data acquisition & description

The acquisition of the two tombs (M1 and M27) integrated in *Rhizome of the Western Han* was made using a Riegl LMS Z390i. This kind of technology permits the acquisition of point clouds with an accuracy of 6mm for a range between 1-400m. The high geometry resolution of the final model depends on the point cloud density and the detail of the representation. The most representative Western Han Dynasty artefacts were also scanned in the 2009 fieldwork trip (more than fifty objects). Some of these were grave gods from M1. The Next Engine, a 3D desktop laser scanner, was used for making 3D relieves. This is a triangulation laser scanner, which permits a 3D scanning in high definition (HD technologies). It was possible to obtain an accuracy of 0.002 inches (about 50 microns) packing points finer than the accuracy spectrum.

Technical implementation and interaction

Rhizome of the Western Han was developed on top of the iCinema SDK for the AVIE system (<http://icinema.unsw.edu.au>). The iCinema SDK is an extension of the Graphics Authoring System Virtools allowing the programmer to handle special types of hardware and visualization systems (projection cluster, cylindrical domes, caves and so forth). All the engine modules were written in C++ while the main engine core relies on the Virtools Scripting Language and Building Blocks composition that are part of the Virtools Authoring System. Currently there are no other solutions than Virtools for the multi-channel stereo edge blending required for the AVIE system.

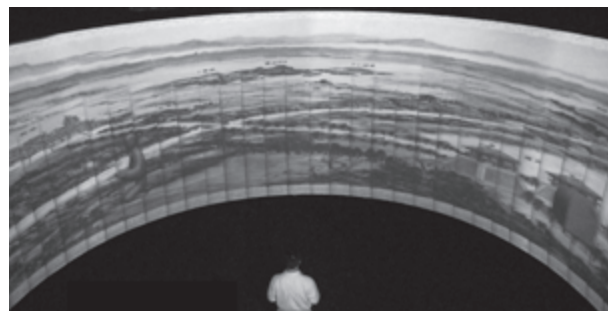


Figure 12. Menu Browser *Rhizome of the Western Han* prototype © Applied Laboratory for Interactive Visualization and Embodiment, CityU, Hong Kong.

The application engine has been developed in order to be completely dynamic and not dependent on the application data, which means that additional laser scan models from other location can be imported into the system once they are optimized. Every environment, information, models and behaviours are specified and loaded from a configuration file. When the application starts, an introductory 3D level surrounds the user (Menu Browser) (Fig. 12). This scenario allows the user to select between the 3D archaeological reconstructions from the laser scan data through intuitive iconic representations. This Menu Browser is dynamically created according to the total amount of models available for the application (in the *Rhizome of the Western Han* it is possible to select between two different 3D tomb reconstructions and an 3D objects browser, that is, there are 3 options in the menu).

The engine is able to generate two type of scenario that exhibits different behaviours and user experiences. The first type of environment (from now on Architectonic Model Viewer: AMV) allows the user to be immersed inside a 3D virtual reconstruction, in this case, of a tomb (Figs 13, 14 and 15). The user enters the model at 1:1 scale and then is able to navigate inside the model, scale it to different sizes and switch between different levels of details and different interpretations of the same environment. The application is also able to generate floating dynamic virtual paths that guide the user during

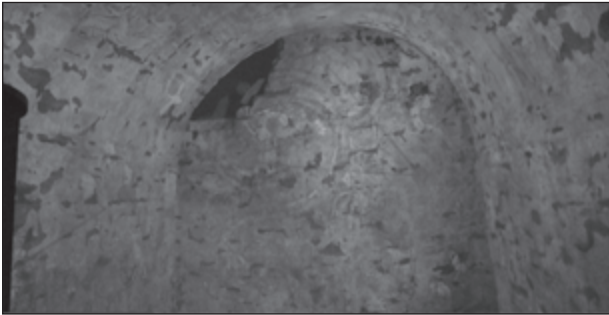


Figure 13. Activated spatial points Rhizome of the Western Han prototype © Applied Laboratory for Interactive Visualization and Embodiment, CityU, Hong Kong.

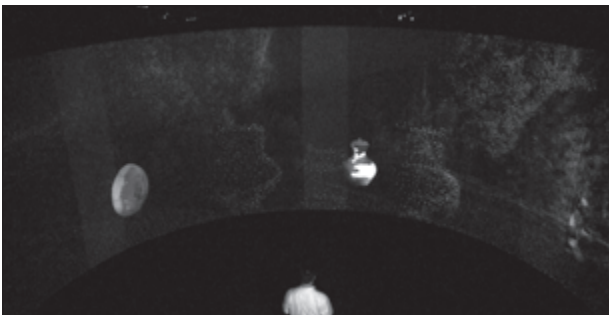


Figure 14. Object Browser Rhizome of the Western Han prototype © Applied Laboratory for Interactive Visualization and Embodiment, CityU, Hong Kong.



Figure 15. Active stereo glasses inside Rhizome of the Western Han prototype © Applied Laboratory for Interactive Visualization and Embodiment, CityU, Hong Kong.

the scene interpretation. Those paths are also associated with hot spots where the user can access to high-resolution images for in-depth examinations of wall texturing for example.

The second type of environment (from now

on the Object Viewer: OV) displays multiple virtual reconstructions of archaeological artefacts that result from laser scanning. These objects circulate around the user and at any time, the user may manipulate and magnify each single object independently. The object browser experience is also improved thanks to the visualization of a facultative 'cloud of points' in which the objects float. This scan data was taken from a museum garden setting (Fig. 16), the same place at which the objects are permanently housed (Fig. 17). *Rhizome of the Western Han* uses only six objects models in this prototype.

All the original models and images, from the archaeological survey, were post-processed in order to be adapted to the real-time graphic engine in AVIE. The resolution of every 3D mesh was originally around one million polygons and was reduced to 300K (but could be a lot higher). The initial detail of every model has been visually maintained thanks to the generation of the surfaces normal maps and remapping them accordingly. The high-resolution texture images that respond to the users interest and 'float' towards the viewer when selected were reduced to 4000 pixels each, for ease of loading.

Cybermap of the Western Han

The first cybermap realized in an archaeological context was in 2001, as part of the Scrovegni Chapel Virtual Reality Project (Forte et al. 2002). The M27 & M1 *Rhizome of the Western Han*, the cybermaps are 3D graphic representation of the relations between all the paintings realized in the main tomb chambers. Through the cybermap it is possible to show all the semantic relations of the scenes portrayed within the tombs. A cybermap is a network of interactive information able to generate three-dimensional connections.

The mural paintings of the tombs contain a complex interpretation code explaining the



Figure 16. Point cloud, Rhizome of the Western Han prototype © UC Merced.

relations between life and death during the Western Han dynasty. In M27 the eastern and western walls of the tomb are covered with vivid scenes of life among the elite, mostly unknown from other tomb murals. A hunting party gallops across the eastern wall, the horses bursting towards and away from the viewer, their riders aiming arrows at scampering game. Two women ride at a more leisurely pace towards the rear, exchanging knowing looks. On the western wall, a group of women seated on a long couch, surrounded by a high screen, enjoys a musical performance. A large zither is visible in front of one of the musicians, who also appear to be women. An obscured figure emerges from the left side of the screen. Is it a visitor? A music lover who wants to hear the concert? The combination of scenes painted in the tomb presents the broad range of images and iconography that a wealthy Western Han subject could combine to adorn his or her eternal resting place. The scenes described are connected to four main themes: *Daily life, Ascension to heaven, Five phases, Yin and Yang* (Figs 17 and 18). The semantics association of the iconography in tomb M27 (excavated in Xi'an in 2004 and documented by laser scanning) has been described in detail by Galeazzi et al. (2010), following excellent research by Paola Di Franco and will not be re-described here (also see Forte et al. 2010a, Forte et al. 2010b).

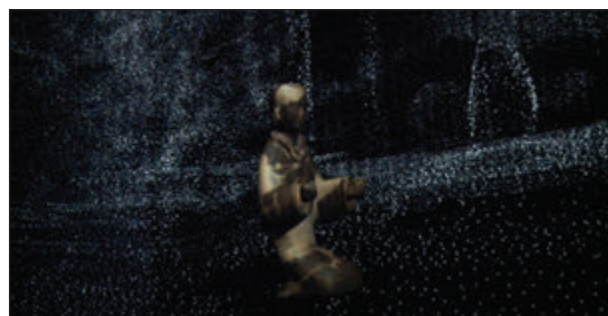
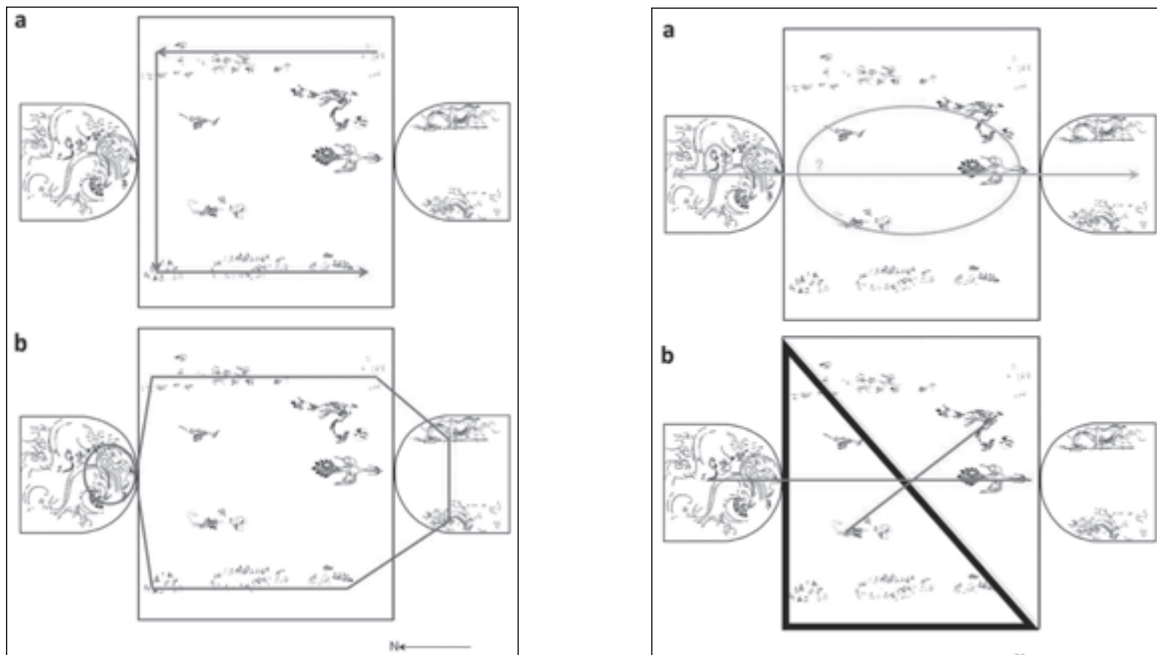


Figure 17. Object Browser 2 Rhizome of the Western Han prototype © Applied Laboratory for Interactive Visualization and Embodiment, CityU, Hong Kong.

This paper suggests that a simple description of the subjects in the iconography and the 3D virtual reconstruction of the tomb are insufficient for approaching a correct cultural interpretation. The use of cyber maps emphasizes the interpretation of the spatial, religious and symbolic connections of the different subjects and images decorating the vault and the walls of the tomb. Through this simulation, the potential semantic re-composition of the tomb creates new metaphors of learning and communication (Galeazzi et al. 2010) (Fig. 19).

In the Bamboo Garden (M1) tomb the work of iconographic mapping is still in progress and it is focused on the analysis of the spatial organization of the characters painted in the walls of the main chamber and in the representation of the sky in the vault of the



Figures 18 and 19. Themes. Left: a. Daily life; b. Ascension to heaven. Right: a. Five Phases; b. Yin and Yang © Galeazzi et al. 2010.



Figure 20. Levels of perception of the tomb M27 © Galeazzi et al. 2010.



Figure 21. Yuen figure. © Forte et al. 2010.

room. All the painted characters address the key element of the chamber, a screen painted on the East wall and representing the gate to the afterlife (Yuen Figure; Fig. 20). The ceiling is painted with the Sun, the Moon and constellations, in relation with the cardinal points of the tomb.

Future

The prototype provides a framework for the integration of subsequent laser scan datasets and the layering of content (GIS data, more object data and other contextual materials to complete the cultural atlas) into the cybermap. Important features that need to be developed are relative scales for all the 3D funerary objects and their relationships inside the tombs themselves. More tombs can be added to build up a representative landscape of different types, different iconography and locations.

Conclusions

Throughout the arts and sciences, new media technologies are allowing practitioners the

opportunity for cultural innovation and knowledge transformation. Media archaeologist Siegfried Zielinski celebrates those who, “inside the laboratories of current media praxis, understand the invitation to experiment and to continue working on the impossibility of the perfect interface” (Zielinski 2006, 259). The research at ALiVE focused on producing new modalities of interaction and interpretation for cultural data. New projects upcoming include the development of a rich interactive work in AVIE for the World Heritage Site at Dunhuang, Magao Caves in collaboration with the Dunhuang Academy and the Friends of Dunhuang Hong Kong. This work will initially interpret the many-layered significance of the rich walls paintings of CAVE 220.

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