2
Embodiment, Entanglement, and Immersion in Digital Cultural Heritage

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> [T]he museum is a theater of anamorphic and autoscopic dramaturgy; a place in which it is not so easy to tell which is the spider and which the web, which the machinery and which the operator. It is a place at the center of our world, our modernity, in the image of which those worlds continue to proliferate … (Preziosi, 2007:82)

Museum visitors gaze through lenses that have been refined over many centuries. Finding "presence" (or literally "being there")[1] in virtual environments is the result of traversing the histories of technologic immersion; generations of 'orama, sensoriums, and all manner of optical devices. It is to delight in automata, to believe in magic and the phantasmagoric, and to be transported by special effects (Kenderdine and Hart, 2003). Discussion of these histories of optical devices could include everything from cave paintings, scroll paintings, interior frescoes, and church interiors through to magic lanterns, mondo nuovo, various phantasmagorias, all manner of seventeenth- to twentieth-century "toys," *cabinets des curieux*, *Wunderkammern*, the Great Exhibitions, glass houses, and winter gardens. These early museographic forms were all part of the architectonic spaces whose images and relationships excited the private/public curiosity and that opened into new worlds of knowledge (Bruno, 2002:133).

The visual cultural theorist Jonathan Crary, in his analysis of nineteenth-century ocular devices and modernity, observed that "techniques of the observer" involve an array of perceptual and spatial expansions. In *Suspensions of Perception: Attention, Spectacle, and Modern Culture* (2001) he noted that certain elements made artificial ways of seeing more successful than others. Rather than accepting the dominant history of an evolutionary narrative culminating in cinema, he shows a history of politics of the conformation of the body (that is, the sublimation of the body to the demands of the viewing apparatus). For him, the optical devices that survived were the ones that combined two

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attributes: firstly, they were sufficiently phantasmagoric, meaning they possessed the capacity to create illusion and to conceal the process of production, and, secondly, those devices were the ones that had the ability to create a visual experience that presupposed the body to be immobile and passive. Yet, museum visitors today expect learning that stands up as an experience (Macdonald, 2007), and expect a physical experience enlisting all the senses (Hooper-Greenhill, 2006). The emergence of immersive and interactive visualization environments (IIVE) represents the greatest challenge to the "passive" body since the invention of the rollercoaster. These immersive architectures and their associated visual, sonic, and algorithmic techniques offer compelling means for mapping and remediating the tangible and intangible heritage encompassing embodiment, immersion, performance, and interactive narrative – in a new wave of cultural heritage visualization.

The purpose of this chapter is to examine immersive virtual environments and how they support embodiment for cultural heritage interpretation in museums – with broad implications for digital humanities research. IIVE provide innovative ways to interpret archaeological sites and materials for scholars and the public. The dynamics provided by the physical and digital parameters of IIVE present fresh ways of being and performing in space. An understanding of the embodied experience gives us a framework of analysis that can also contribute to an increasingly accurate evaluation of these experiences. The use of immersive systems is part of a growing trend to mobilize the viewer — stimulating embodied cognition through multimodal, kinesthetic, and somatic hypermedia design. Embodiment theory is an optic for exploring these issues, and the following analysis helps us extend the previous understandings of the immersive museum (Bruno, 2002; Griffiths, 2008) and the analysis of cultural heritage (Kenderdine, 2007a, 2007b, 2013a; Bonini, 2008; Forte and Bonini, 2008; Flynn, 2013).

A close reading of embodiment also helps us re-envision the applications we might want to build at the pivot of human–computer interface (HCI). As the humanities increasingly embrace digital tools, visualization, and interaction as the primary modes of communication, synergetic understandings of embodiment are increasingly relevant. New interface design progressively emphasizes embodiment, for example, through gesture control armband Myo, with the potential for the world to become an augmented information space with Google Glass, and by the personalization of virtual reality through Oculus VR.[2] Emerging technologies that encourage kinesthetic embodiment are simultaneously accompanied by shifts in critical theory that emphasize *performance*, *distributed* experience, and the *materiality* of the digital. These further break down dualisms of action | reaction and virtual | real.

Reframing Visualization

Visualization is the at the heart of some of the most pressing and persistent problems in society today. Visualization simultaneously offers pathways to new levels of cognition for researchers in the arts and sciences (Stafford, 2011), essential for research into new modalities of visualizing data in a world producing and consuming it at unprecedented rates (Keim *et al.*, 2006). Recent visualization research, however, remains largely constrained to 2D small-screen-based analysis, limiting interactive techniques to

"clicking," "dragging," and "rotating" (Lee *et al.*, 2010; Speer *et al.*, 2010:9). Furthermore, the number of pixels available to the user remains a critical limiting factor in human cognition of data visualizations (Kasik *et al.*, 2009). An increasing trend towards research requiring "unlimited" screen resolution has resulted in the recent growth of gigapixel displays (e.g., HIPerSpace at Calit2). Virtual reality systems for large-scale datasets are increasingly focused on effectively representing their many levels of complexity, including next-generation immersive virtual reality systems such as StarCAVE (UC San Diego; DeFanti *et al.*, 2009), the Allosphere at UC Santa Barbara, the Advanced Visualization and Interaction Environment (AVIE) at UNSW's iCinema Research Centre, and Cave2 from the University of Illinois.[3]

Immersive Applications in Cultural Heritage Visualization

A broad range of work undertaken is used to contextualize this chapter. This research acts as a proposition for the reformulation of digital narrative and digital aesthetics through virtual embodiment – bringing cultural heritage experiences into the public domain, specifically in museums. This applied research falls into two primary areas: the reformulation of digital cultural archives, including museological collections and cultural atlases; and the re-presentation of tangible and intangible heritage. Four pioneering works will be described to illustrate the former. The latter will be explored through the *Pure Land* case studies.

Reformulation of Digital Cultural Archives

One research area that can be framed by IIVE is the reuse and re-articulation of digital archives (so-called "cultural data sculpting": see Kenderdine and Hart, 2011; Kenderdine and McKenzie, 2013). The rapid growth in participant culture embodied by Web 2.0 has seen creative production overtake basic access as the primary motive for interaction with databases, archives, and search engines by public users. Intuitive exploration of diverse bodies of data allows users to find new meanings rather than simply access the information. The structural model that has emerged from the Internet, however, exemplifies a database paradigm where accessibility and engagement is constrained to point and click techniques where each link is the node of interactivity. The possibility for more expressive potential through interactivity, and alternative modalities for exploring and representing data, can be described in a few salient examples.

The Living Web (2002) by Christa Sommerer and Laurent Mignonneau, a CAVE-based interactive and immersive installation, was a pioneering attempt to explore the potential of the Internet as interactive and immersive data and information medium. In this installation, users immerse themselves physically, and in three dimensions, into image and sound information streamed live from the Internet. Microphones pick up the users' conversations and use them to generate and download corresponding image and sound files from the Web. Users interact with this data and explore its content in more detail. *The Living Web* presents a novel system for

intuitive, immersive, and entertaining information creation and retrieval. The work not only permits multilayered interaction; it is also *a new scientific instrument for visual analysis*, with the option of comparing up to 1000 images in a scientific discussion (Sommerer *et al.*, 2002).

The interactive installation *CloudBrowsing* (2008–2009) was one of the first works to be developed and shown in ZKM's PanoramaLab, and it takes another approach to harnessing Internet data in the form of a spatial narrative (Lintermann *et al.*, 2008a). In the current version of the project the user browses the free online encyclopedia *Wikipedia* inside the panoramic screen. The cylindrical surface of the 360-degree screen becomes a large-scale browser surrounding the user, who can thus experience a panorama of his or her movements in the virtual information space. A filter mechanism ensures that only open content is displayed in the installation.

The project lets users experience Internet-based information retrieval in a new way. As the developer Bernd Lintermann describes in a video clip:

> Whereas our computer monitor only provides a restricted frame, a small window through which we experience the multilayered information landscape of the Net only partially and in a rather linear mode, the installation turns browsing the Web into a spatial experience: search queries and results are not displayed as text-based lists of links, but as a dynamic collage of sounds and images. (Lintermann *et al.*, 2008b)

CloudBrowsing exemplifies the use of visual searching, in which users traverse data primarily through visual association and not through the pages and hyperlinks of *Wikipedia*; it privileges the visual over the textual. *CloudBrowsing* immerses the user in metadata-related arrays of images around particular semantic trajectories in an endless set of permutations.

ECLOUD WW1 (2012) by Sarah Kenderdine and Jeffrey Shaw was designed for a custom designed 9-metre wide by 3.5-metre high interactive 3D projection environment and developed by the Applied Laboratory for Interactive Visualization and Embodiment (ALIVE), City University of Hong Kong, in partnership with Europeana's *1914–1918*, a crowdsourced web-based archive (Kenderdine and McKenzie, 2013).[4] The installation activates over 70,000 images of war memorabilia ascribed to 2500 individual stories collected from across Europe. The installation instantaneously aggregates the digital imagery and associative metadata of this dataset through a large-scale interactive viewing experience. The platform, as an example of embodied museography, provides a powerful experiential tool for participants to engage in an everchanging coalescence of war ephemera and the social memories attached to these objects. It also offers curators and exhibition designers innovative methodologies for the display and interpretation of metadata through the use of cultural analytics to devise user-generated database narratives.

In situ and in-the-round, *mARChive* (2014) is the new interface to Museum Victoria's collections, resulting from an Australian Research Council Linkage grant with iCinema Research Centre University of New South Wales and the museum (Morris, 2014). The project aims to investigate visual searching and emergent narratives by integrating an immense archive of museum collection data into a 360-degree 3D space, allowing for interactive access to a data cloud of 100,000 records with images. Apart from the

advances in information visualization it offers, *mARChive* addresses one of the most fundamental challenges of access facing museums: only a fraction of their collections are on display. At Museum Victoria, for example, it is only 0.8%. The challenge of displaying and making sense of 100,000+ objects simultaneously from 17 different thematic areas from diverse collections including indigenous material, natural sciences data, and social history and technology presents both theoretical and practical challenges (Kenderdine and Hart, 2014).

mARChive is staged in the Advanced Visualisation and Interaction Environment (AVIE), one the nine immersive platforms that are basis for novel visualizations by the author.[5] AVIE, developed by iCinema, is the world's first omnidirectional (360-degree) 3D panoramic screen (360 degrees horizontal × 50 degrees vertical), 10 meters in diameter by 4.5 meters high. *mARChive* takes on these core challenges of information visualization inside AVIE, responding to the need for embodied interaction, knowledge-based interfaces, collaboration, cognition, and perception (as identified in Pike *et al.*, 2009). This display system is representative of the powerful qualities that distinguish *mARChive* from the panoramas of the nineteenth century: omnistereo imagery, spatial audio, real-time image generation, and interactivity (McGinity, 2014). The history of digital panoramic immersion and its affordances for embodiment are well described in a review of panoramic history and key works in new media art (McGinity *et al.*, 2007).

Panoramic Immersion

> In virtual reality, the panoramic view is joined by sensorimotor exploration of an image space that gives the impression of a "living" environment. (Grau, 2003:7)

As noted, the panorama has been at the core of the visualization paradigms described in this chapter as a conjunction of virtual reality technologies. Extrapolating from the 360-degree immersive panorama has been a basis for developing these new ways of representation, embodiment, inhabitation, navigation and narration. The mass public screen entertainment of the panorama is the subject of a number of extensive analytical histories,[6] and this led Stephen Oettermann to claim the panorama as "the first true mass medium … " (Oettermann, 1997:7).

In current media practices, the re-emergence of the panoramic scheme as "the new image vogue" (Parente and Velho, 2008:79) is based on the desire to design virtual spaces and places that can be inhabited by the viewer — maximizing a sense of immersion and ultimately "presence." In digital heritage this is expressed as displays of either past environments made from archaeological and historical data (digital recreations), or remote real-world locations (panoramic enclosures for archaeological site visualization and documentation purposes, for example). The panorama reveals itself as a navigable space, persistent throughout media history, which is charged with sociocultural implications (Kenderdine, 2007c). Considering the re-emergence of the panoramic scheme in contemporary virtual reality reinforces the primary notion under discussion in this chapter – that is, the affordances of IIVE in relation to the embodied experience.

In a discussion of contemporary panoramic form, it is important to introduce works by media artists and engineers that also exploit panoramic imaginary. The large-scale

installation artists Michael Naimark (USA), Luc Courchesne (Canada), Masaki Fujihata (Japan), and Jeffrey Shaw (Australia) have all been working within the oeuvre of extended narratives and augmented devices for immersive panoramic images since the mid-1980s, and their works are useful examples in the context of this chapter. Seminal works that invoke the panorama include, for example: *Moving Movie* (1977), *Displacement* (1984), and *Be Now Here* (1995) by Michael Naimark; *Morel's Panorama* (2003) by Masaki Fujihata; *Place – A User's Manual* (1995), *Place 'Ruhr* (2000), and the immersive platforms *EVE* (1993–2004) and *Panoramic Navigator* (1997) by Jeffrey Shaw; *Landscape One* (1997) and *Panoscope* (2001) by Luc Courchesne.

These works are of interest because they all re-enact cinematographic devices by the use of video sequences. They also combine immersive architecture with the panoramas and thereby conjoin the interactive language of the new digital interfaces with the movement of the cinema image. These artworks have laid foundations for many future possibilities of immersive and interactive cinema.

Michael Naimark, for example, traveled to heritage sites around the world to record his panoramic views for *Be Now Here* (1994). Using a 35 mm 3D stereographic camera mounted on a motor-driven tripod, he was able to capture 360-degree motion scenes at locations such as Angkor in Cambodia, Dubrovnik in Croatia, Timbuktu in Mali, and Jerusalem in Israel. His immersive display consisted of 3D video projected onto a 360-degree screen, combined with a spatial soundscape and an anthropological approach to both virtual travel and site documentation (Grau, 2003:240–2). *Be Now Here* is for a small number of viewers who stand on a platform that rotates 360 degrees every two minutes to give the illusion of panning across the images. The viewers are required to walk to keep their position respective to the fixed projection — an effective form of kinesthetic connection. The Be Now Here project website describes how this effect is "similar to the feeling when the train next to yours pulls out of the station."[7]

Jeffrey Shaw developed the idea of augmented and environmental cinema, anticipated by the painted panorama, as early as 1967 with his use of spherical projection in *Corpocinema*, which challenged the defined limits of the flat screen. This approach was further developed in 1974 with the *Diadrama*, which comprised three adjacent screens and three pairs of synchronized slide projectors, constituting a field of view of 270 degrees. Shaw's subsequent experimentations have been more or less immersive, engaging the visitor's whole body and giving priority to the gaze. Either through a projected visualization window or integrated in a system of vision, the spectator is always invited to accomplish a specific activity and to actualize the scene through a specially designed interface.[8]

Jeffrey Shaw's work, as the theorist and designer Lev Manovich describes, "evokes the navigation methods of panorama, cinema, video and virtual reality. He 'layers' them side by side" (Manovich, 2001:282). Here Manovich refers to installations such as *Place* (1995) and *Place Ruhr* (2000) that surround the visitor (who stands on a rotating platform) within a 360-degree panoramic screen. The idea of navigating panoramic constellations in *Place Ruhr* (2000) is echoed in the cultural heritage work *PLACE-Hampi* (2006). Shaw's works reframe the traditional panorama within the modalities of virtual reality. The interface allows the visitor to navigate between the various locations — each of which is depicted in panoramic cylinders that have been distributed throughout the landscape map. Once inside the individual panoramic

cylinders, the user confronts a scene augmented by incidental animated effects. These works contribute to the "representation and documentation of social and economic histories of the places depicted" (Grau, 2003:240–2).

The use of the panorama in virtual, immersive environments provides a lexicon for navigable space that is "not only a topology, geometry and logic of static space" but is also transformed by "new ways in which space can function in computer culture" (Manovich, 2001:280). The notion of navigating virtual spaces is key to the success of hybrid cinematic forms such as those described in this chapter.

Embodiment in Cultural Heritage Visualization

A series of museum-based works have been created by the author since 2000, interpreting significant cultural precincts using a variety of IIVE, including the UNESCO World Heritage sites of Olympia, Greece; Angkor, Cambodia; the monuments at Vijayanagara (Hampi) and the Fort of the Hooded Cobra in Nagaur, Rajasthan, India; Dunhuang, China; and numerous sites throughout Turkey. These works are: *Virtual Olympia* (2000), *Sacred Angkor* (2004), *PLACE-Hampi* (2006), *Eye of Nagaur* (2008), *Hampi LIVE* (2009), *PLACE-Turkey* (2010), and the *Pure Land* projects (2012) which are described here.[9]

Embodiment theory is used in this chapter to examine two world-touring installations that integrate a single archaeological dataset into two distinct interfaces, with unique outcomes. These installations arise out of the digitization work (laser scanning and ultra-high-resolution photography) undertaken at the Mogao Grottoes by the Dunhuang Academy. *Pure Land: Inside the Mogao Grottoes at Dunhuang* (2012, virtual reality)[10] and *Pure Land Augmented Reality Edition* (2012, augmented virtuality)[11] have been seen by over 300,000 people in five countries and are the subject of extensive critical acclaim (e.g., Kennicott, 2012) and commentary (Kenderdine, 2013b). This chapter extends that earlier work by examining these two installations explicitly from the perspective of embodied experience, using a framework of analysis by the philosopher Mark Johnson (2007). Johnson's thesis provides a meta-level analysis for understanding the entanglement of embodied experience as *biological*, *ecological*, *phenomenological*, *social*, and *cultural* (Johnson, 2007: 275–8). In these two installations, immersive interactive visualization architectures combine in distinctly different ways, to provide a context for multisensory mediation of a World Heritage site.

The modalities of embodiment in the *Pure Land* projects can be described as forms of prosthetic vision, acoustic immersion, kinesthetic activation, telepresence, augmentation, inhabitation, revealing, flying, dwelling, traveling, and walking. In these installations the sensory world of participant visitors is tuned for encounter, and emergent meaning becomes possible. Such sensory experiences are being placed at the forefront of cultural analysis — overturning linguistic and textual analysis, supporting both phenomenological and experiential inquiry. Museum specialist Linda Young, in her review of *Handbook of Material Culture* (Tilley *et al.*, 2006) 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)

Embodiment Theories

Embodiment theories attempt to understand the mind as a set of physical processes derived from the brain and body of a human, that ultimately serve his or her action in the physical world. Embodiment is multisensory and results from effects of visual, auditory, tactile, olfactory, and gustatory cues. Embodiment is entanglement through, and with, context and environment. Embodiment is immersive, resulting in emergent response to being in the world. And while these statements may seem obvious to us "embodied beings," as philosopher Mark Johnson describes: "Coming to grips with your embodiment is one of the most profound philosophical tasks you will ever face" (Johnson, 2007:1).

A discussion on theories of embodiment includes several broad fields of inquiry and analysis. The first area concerns the *phenomenological*, in which individuals are aware of their bodies in their thoughts and actions in relation to the world around them. The writings of phenomenologist Maurice Merleau-Ponty in *The Phenomenology of Perception* (1962) and American pragmatist John Dewey in *Art as Experience* (1934) are highly influential for subsequent theoretical development in embodiment and embodied cognition.

The wellspring of scholarship dealing with *cognitive* aspects of embodiment includes understanding the neural processes of message transmission and learning, which enables individuals to think and act. In second-generation cognitive science, empirical studies of embodied cognition are active in psychology and the neurosciences, including enactivism (as first proposed by Varela *et al.*, 1991). Enactivism provides alternatives to cognitivism, computationalism, and Cartesian dualism. For perceptual sensation to constitute experience – that is, for it to have genuine representational content – the perceiver must possess and make use of his or her sensorimotor knowledge.[12] An enactivist approach to learning, for example, understands human experience and knowledge formation as dynamically unfolding interactions with the environment (Stewart *et al.*, 2010; Noë, 2012; Hutto and Myin, 2013). The creation of experiential, progressive, and dynamic processes for students moves beyond traditional forms of procedural learning. Such approaches are multidisciplinary in nature and aligned with advanced studies in neuroscience, philosophy, robotics, artificial intelligence, as well as human–computer interaction and embodied cognition (Minsky, 1986; Bateson, 1987; Clark, 2010).

The embrace of embodiment theory also continues to drive a proliferation of research in aesthetics, linguistics and anthropology, and in specializations of philosophy including pragmatism, phenomenology, and ecology (Johnson, 2007:264; Shusterman, 2012). In recent times, we see embodiment theories reverberating in every humanities endeavor, for example: architecture (e.g., Pallasmaa, 2011, 2012), cinema (e.g., Sobchack, 2004; Bruno, 2002), post-processural archaeology (e.g., Pearson and Shanks, 2001; Tilley, 2004, 2008; Olsen *et al.*, 2012), anthropology (e.g., Howes, 2006; Mascia-Lees, 2011), cultural geography (e.g., Tuan 2001; Casey, 1998), performance (see Salter, 2012; Giannachi *et al.*, 2012), art history (see Parry, 2011; Crowther, 2009;

Pinney, 2004[13]), new media art (e.g., Duguet *et al.*, 1997; Shaw and Weibel, 2003; Grau, 2003), and digital cultural heritage (Kenderdine, 2007a, 2007b, 2007c; Flynn, 2013; Forte and Bonini, 2008), to name only a few.

The Machine–Body Ensemble

> We are in the midst of a transformation, from a world of screens and devices to a world of immersive experiences. (Krzanich, 2014)

The *Pure Land* projects build upon a history of various modes of "virtual reality" for large-screen displays, which emphasize the sensorial and immersive through panoramic immersion, stereoscopy, and augmentation (see Kenderdine and Hart, 2003, for an analysis of stereoscopy, the body and immersion, and Kenderdine, 2007a, for an extensive discussion of the panorama and new media).

Pure Land: Inside the Mogao Grottoes (*Pure Land*), shown in Figure 2.1, is staged in the AVIE. Inside this 10-meter-diameter, 4-meter-high theater, up to 30 visitors are able to freely perambulate a true-to-life-scale virtual Cave 220 from Dunhuang. A handheld interface provides interaction with the digitally rendered cave — allowing the user to reveal key elements in the mural paintings on its walls. Exploiting the high-resolution photography and laser scanning data recorded by the Dunhuang Academy, *Pure Land* reframes and reconstitutes the extraordinary wealth of paintings found in the caves at Dunhuang. Inside its panoramic enclosure, visitors engage in a surrogate experience of being inside this cave temple and seeing its magnificent Buddhist wall paintings. As well as offering a powerful space of embodied representation, *Pure Land* exploits various digital image-processing techniques such as 2D, 3D animation, and 3D cinematography to further develop its experiential and interpretative capabilities.

Figure 2.1 *Pure Land: Inside the Mogao Grottoes.* Image © Applied Laboratory for Interactive Visualization and Embodiment, CityU, Hong Kong.

Figure 2.2 *Pure Land: Augmented Reality Edition.* Image © Applied Laboratory for Interactive Visualization and Embodiment, CityU, Hong Kong.

Pure Land: Augmented Reality Edition (*Pure Land AR*), shown in Figure 2.2, uses mobile media technology to create a complementary augmented-reality rendition of the same data from Cave 220. This could be better described as an augmented "virtuality" (Milgram *et al.*, 1994) Walking around inside the exhibition space holding a tablet screen in their hands, users are able to view the architecture of the cave and to explore its sculptures and wall paintings as they appear on mobile "windows" – a kinesthetic revealing of the painted architectonic space of the virtual cave at one-to-one scale. Other viewers simultaneously follow these users as they interactively reveal the cave. In this installation the walls of the exhibition room (which share the same scale as the real cave) are covered with one-to-one scale prints of Cave 220's "wireframe" polygonal mesh – which provides users with visual cues as to what to explore. In doing so, the tablet screen shifts from being considered as an object in and of itself, to functioning as a mobile framing device for the staging of a "virtual" rendering of the real cave that relies on an intricate spatial tracking system.

Embodiment in The *Pure Land*

> The body carries time into the experience of place and landscape. Any moment of lived experience is thus orientated by and towards the past, a fusion of the two. Past and present fold upon each other. The past influences the present and the present re-articulates that past. (Tilley, 2004:12)

In *The Meaning of the Body*, philosopher Mark Johnson outlines an "embodiment theory" based on how the body and mind operate together in one organic process. Following John Dewey's somatic naturalism, Johnson argues that all our abstract conceptualization and reasoning, all our thought and language – all our symbolic expression and interaction – are tied intimately to our embodiment and to the pervasive aesthetic characteristics of all experience. Building on work done with George Lakoff (1999), Johnson demonstrates that human beings are metaphorical creatures and metaphor is essential for abstract conceptualization and reasoning, and that, through the nature of embodied experience, truth is not absolute. Johnson challenges us to "stop thinking of the human body as a thing" (2007:275), and argues that meaning and mind are embodied at a number of levels, simultaneously: as a *biological organism* (the body in the world as flesh); an *ecological body* (environmental context of the body in the world); a *phenomenological body* (our body as we live and experience it, the tactile-kinesthetic body); a *social body* (subjective relations); and a *cultural body* (i.e., cultural artifacts, institutions, practices that constitute "culture"). Each aspect of an embodied self cannot be removed from the others, with the implication that a study of embodiment needs to be multidisciplinary and must be subject to multiple methods of analysis.

Following Mark Johnson, it is possible to conceive a fivefold framework for the embodied nature of the *Pure Land* projects.

1. **The biological organism** (the body in the world as flesh) has different constraints in relation to the technologies employed. Every user-agent comes to the *Pure Land* projects with inherent physical capacities.
   Archaeologist Christopher Tilley demonstrates the manner in which the past can be understood and interpreted via a sensual human scale as opposed to an abstract, analytical gaze. In this context it is useful to quote his discussion of the interpretation of rock art:

   > Iconographic approaches are usually primarily cognitive in nature. … 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)

   The physical nature of the *Pure Land AR* interface, for example, requires dexterous manipulation to reveal the cave: strong arms to lift the tablet aloft, strong neck to gaze at the ceiling, and strong knees and legs to crouch in front of the elaborate paintings down at ankle level (where an animation of an inscription that dates the construction of the cave is embedded, waiting to be discovered).

   Twisting and turning of the interface demands an embodied engagement by the user-agent, which is the becoming of the *phenomenological* body.
2. **The phenomenological body** (our body as we live and experience it; the tactile-kinesthetic body) provides a different way of thinking about the past in the present. The interactive features of *Pure Land* allow the virtual cave to be transformed from a mimetic representation to a navigable space, rich with layered

interpretation and fully illuminated – impossible if one were there in person. The magnifying glass, for example, acts like a prosthetic device – enabling the viewers to examine the paintings at ten times the scale. 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), which is exactly the way in which the cave is brought to life. The "things" of Idhe's visual hermeneutics are viewed through the instrumental magnification of prosthetics, such as telescopes and microscopes, thus allowing perception to go where it has not gone before.

The interactive nature of *Pure Land* and *Pure Land AR* produces emergent narrative. As Jeffrey Shaw describes it, this has a particular phenomenological consequence:

> By creating virtual extensions to the image space that the viewer must explore in order to discover its narrative subjects, the navigable artwork allows the visitor to assume the role of both cameraperson and editor. (Shaw, 2003:23)

Pure Land AR is not a passive televisual environment, but an interactive performance, exactly mapping the real space of Cave 220 with the digital model. The conjunction of the actual wireframe image on the exhibition walls, and the life-like cave rendering seen on those walls via the tablet window, operates at the borderline of the indexically real and the phantasmally virtual – between re-embodiment and dis-embodiment.

Pure Land AR thus weaves a set of subtle paradoxes into its web of virtualization and actualization, and these paradoxes feed the kinesthetic excitement that is clearly evident in all visitors' astonished enjoyment of this installation. It thus aligns with the technologies of telepresence that virtually transport the viewer between the present location and another place – in this case, from the exhibition space to Dunhuang.

We see how the *phenomenological* body extends to become the *ecological* body.

3. **The ecological body** (or environmental contexts) of *Pure Land* and *Pure Land AR* are distinct, resulting in different affects in the way the work is embodied and meaning is created. They are both installations existing in standalone architectures with minimal interpretative support (except for brochures). *Pure Land* is an omnidirectional data space, rendering the virtual cave inside a spatial soundscape, and *Pure Land AR* takes place in a fully lit space. In both cases the virtual cave is rendered at 1 : 1 scale. The additional contextual settings include art biennales (Shanghai 2012), museums (Washington 2012), university exhibition venues (various through 2012 and 2103), book fairs (Hong Kong 2012), short-term exhibitions (Marseille 2013), and technology expos (Hong Kong 2013). Each venue brings different cultural audiences, prior knowledge and expectations. It should also be noted that Cave 220 is permanently closed to the public, so the digital cave is the only access for the majority of people.

The full omnidirectional potential of panoramic enclosure is fully realized in *Pure Land*, where the user is surrounded by the stereographic image space. Omnidirectional attention dispels the ego-centered view, since there is always something going on inside the same space but outside the user-agent's direct field

of view. One can invoke the notions of allocentric and egocentric cognition and spatial perspectives, where the allocentric are those pertaining to a perceived, fixed external framework (a reality that exists all-around and is distinct from oneself) and the egocentric which contains your relationship with a given object or frame. A cognitive map of an omnidirectional, immersive space allows for allo- and ego-centric interpretations simultaneously (Blesser and Salter, 2006:39–40).[14] Simultaneously, all spectators are able to turn and gaze at any point in the room, irrespective of the agent-user interactions in the application (which trigger augmentations such as the magnifying glass, 2D, and 3D animations).

The mural paintings on the walls of the cave itself could be described as part of this context, and depict early Tang renderings of Buddhist sutras. The north wall portrays the Bhaisajyaguru's Eastern Paradise Sutra. The east wall illustrates the Vimalakirti Sutra, and the south wall the Western Pure Land Sutra. *Pure Land* concentrates its visualization on the Eastern Pure Land paradise of the Medicine Buddha from the north wall, which is dominated by the seven forms or emanations that Bhaisajyaguru can assume as a healer. The Buddha-forms stand in a row on lotus platforms with a pool below and 24 musicians and four dancers alongside (Figure 2.3). The narrative of the painting relates to the 12 great vows of the Buddha and the provision of food, drink, clothing, medicine, and spiritual aids.

We see how the *ecological* body extends to include prior knowledge by visitors who may be able to decode these images, thus becoming the *cultural body*.

Figure 2.3 *Pure Land: Inside the Mogao Grottoes.* Image © Applied Laboratory for Interactive Visualization and Embodiment, CityU, Hong Kong.

4. **The cultural body** (i.e., cultural artifacts, institutions, practices that constitute cultural life). Every installation happens in a different cultural context: Buddhist practitioners, academics, and lay people each bring their own cultural body. Some recognize the spatial and iconographic significance of the murals, while others experience something that is less familiar. As with many locations of spiritual significance (e.g., places of worship, burial sites), the spatial and iconographic arrangement is crucial to the meaning of the narrative as well as to correctly reading iconography (Kenderdine, 2013a). The correctness of the environmental context allows a devotee the transcendent experience he or she may seek in this environment, while for scholars the accuracy of color reconstructions, animations, and 3D modeling are of profound importance. It is interesting to note that the *Pure Land* projects give scholars better access to the site than if they were there in person. The ability to travel upwards to roof level (that is, to fly upwards), and to magnify the murals, provides enhanced opportunities for study.

   The *cultural* body is sensitizing and hermeneutic and spirals into the *phenomenological* body.

5. **The social body** (subjective relations). *Pure Land* demonstrates the dynamics of a single-user, multi-spectator interface that is important to the notion of museums as places of socialization. In *Pure Land*, the majority are spectators as part of a three-way relationship (user–system, user–spectators, and spectators' view of the emerging interactions). In *Pure Land AR*, the two mobile tablets allow two users and, typically, groups of 3–10 people to follow the tablets around. This method has proven to be very successful in reinforcing the social qualities of the interpretative experience. A group of people will always surround the user, and will follow, direct, gesture, prompt, and photograph the user's view of the world. This dynamic is integral to the interpretation, and to the performance of the work. The view that everyone should have his or her own tablet interface would deny the dynamic of this interchange and only advantage more isolated journeys of discovery (Kenderdine *et al.*, 2009).

   Between the user and the system, the concept of embodiment is of primary concern. Embodiment is a "participatory" status and a foundation for exploring interaction in context (Dourish, 2001). In terms of the trichotomy of the system–user–spectators, embodiment implies a reciprocal relationship with the context – encompassing users, interactive systems, spectators, co-users, physical surroundings, and the meanings ascribed to these entities (Dalsgaard and Koefoed-Hansen, 2008:5; cf. Dourish, 2001).

   Researchers of computer–human interaction address the issue of how a spectator should experience a user's interaction with the computer (Reeves *et al.*, 2005:748). Borrowing from performance theory, the user is the inter-actor with the system, and the interaction between the user and the system is the performance. As Dalsgaard and Koefoed-Hansen express it:

> It is the ways in which the user perceives and experiences the act of interacting with the system under the potential scrutiny of spectators that greatly influences the interaction as a whole … it is precisely this awareness of the (potentiality of a) spectator that transforms the user into a performer. (Dalsgaard and Koefoed-Hansen, 2008:6)

The key to this relationship is the awareness of others, which provides the context for individual activity. The user not only acts in relation to the system but also is propelled by the knowledge that his or her perception of the system is a performance for others. Dalsgaard and Koefoed-Hansen (2008:31) call this "performing perception."

In the social, the body is interleaved with the *ecological*, *phenomenological*, and *cultural* body.

Evaluating the Embodied Experience

The evolution of visitor research in museums since the 1900s reflects an array of diverse evaluation typologies, pedagogies, collections, and curatorial trends. The museums' emphasis on the quality of their collections and scholarly frameworks has evolved to include visitors framed by these qualities. The next generations of embodied experiences described in this chapter, however, require new tools for analysis and evaluation. The subjective, affective, and embodied causalities of visitors' experiences are difficult to record — requiring visual, interactive, and engaging communication (Martinec and van Leeuwen, 2009). As this chapter has discussed, cognition is embodied when it is dependent upon features of the physical body — that is, when aspects of the person's body beyond the brain play a significant causal or physically constitutive role in processing. However, attempts to derive emotional state by gauging bodily responses (heartbeats and/or facial recognition) have proved unreliable (e.g., Kaliouby and Robinson, 2005). The gap in the task of evaluation has become the focus for a new research tool (Kocsis and Kenderdine, 2015). *I Sho U* is designed around interaction, introspection and narrative engagement and is used to determine visitor feelings and response.[15] It is based on the assumptions designers make in developing behavioral and emotional affordances. Through the design, interaction, and visualization scheme of the questions asked in *I Sho U*, visitors participate in instantaneous, collective, and participatory methods focused on their emotional, embodied, and cognitive states.

I Sho U can be compiled by museum evaluators online and deployed over the Internet, and downloaded to tablets. These tablets are distributed to visitors by docents at the museum. The average time for data gathering per person is five minutes, enabling hundreds of surveys per hour (a vast increase compared to traditional survey methods such as exit surveys or observation). *I Sho U* aggregates user responses online in real time, with cumulative and comparative interpretation. The tool undertakes audio mining and image analytics from the users' inputs.

The app encourages visitor agency through technological interface and creative visualization, and utilizes design-led integrative thinking, action, and creative data collection that are led by the visitor. Using this method positions the visitor as integral to the evolution of the design and construction of IIVEs and future museum exhibitions. *I Sho U* encapsulates the fundamental role of visitor evaluation and evolving social research to impact and improve the design, delivery, and dissemination of the museum — actual and virtual. The development of these tools is essential to begin to describe the embodied experience, from the perspective of the user.

Conclusion

The history of experimental interfaces for cultural heritage materials dates back to the 1990s in a series of works by influential media artists. In 2015, the powerful nature of these experiences is now recognized by industry and will no doubt become the basis for further developments in screen(less) technologies and immersive environments. Understanding the fundamental nature of embodied experience will put humanities scholars, and museum curators and designers, at the forefront of articulating and defining meaning in an increasingly ubiquitous screen culture. Within this context the purpose of this chapter has been to take a close reading of two immersive experiences to draw out the parameters of the embodied experience. The meaning that users and visitors to the *Pure Land* projects create as a result of their experience is contingent on the interplay of these five embodiments. By breaking down the *Pure Land* experience, it becomes clear how one *body* affects the others, and how no single aspect alone can be claimed to be the experience itself. If we can articulate these interrelationships clearly, then the kinds of social and physical environments we create will have a profound influence on our minds and our capacity for thought and reason. With proliferating datasets, the need for novel and humanistic solutions to visualization challenges must not be underestimated.

Notes

1 Presence research is an established body of inquiry for virtual environments, e.g., the International Society for Presence Research (ISPR), available online at http://www.temple.edu/ispr (accessed June 30, 2009); Presence and Interaction in Mixed-Reality Environments (Presence II), available online at http://cordis.europa.eu/ist/fet/pr.htm (accessed June 30, 2009).

2 Myo: https://www.thalmic.com/en/myo/; Google Glass: http://www.google.com/glass/start/; Oculus Rift: http://www.oculusvr.com/ (accessed November 20, 2014).

3 See HIPerSpace at Calit2 http://vis.ucsd.edu/mediawiki/index.php/Research_Projects:_HIPerSpace; StarCAVE at UC San Diego; Allosphere at UC Santa Barbara http://www.allosphere.ucsb.edu/; AVIE, iCinema UNSW at http://www.icinema.unsw.edu.au/technologies/avie; Cave2, U Illinois at http://www.evl.uic.edu/cave2; Applied Laboratory for Interactive Visualization and Embodiment, CityU Hong Kong, at http://alive.scm.cityu.edu.hk/visualization-systems/.

4 ECLOUD WW1, available online http://alive.scm.cityu.edu.hk/projects/alive/ecloud-2012 (accessed November 20, 2014).

5 AVIE, iCinema UNSW: http://www.icinema.unsw.edu.au/technologies/avie.

6 See Oettermann (1997), Comment (2000), Altick (1978), Avery (1995). Huhtamo (2004) makes an extensive review addressing a perceived lack of historical information published before his survey on the so-called "moving panoramas" and extends this analysis in Huhtamo (2013).

7 *Be Now Here*, Michael Naimark, available online at http://www.naimark.net/projects/benowhere.html (accessed June 30, 2009).

8 For an archive of many of the works by Jeffrey Shaw see www.jeffrey-shaw.net (accessed November 20, 2014).

9 Many of these projects have been archived on the ALiVE website. See ALiVE & Related Projects http://alive.scm.cityu.edu.hk/ (accessed November 20, 2014).

10 *Pure Land: Inside the Mogao Grottoes at Dunhuang* http://alive.scm.cityu.edu.hk/projects/alive/pure-land-inside-the-mogao-grottoes-at-dunhuang-2012/ (accessed November 20, 2014).

11 *Pure Land Augmented Reality Edition.* http://alive.scm.cityu.edu.hk/projects/alive/pure-land-ii-2012/ (accessed November 20, 2014).

12 See Noë (2004). Also see the European Commission, Network of Excellence on Enactive Interfaces, available online at http://www.interdisciplines.org/enaction (accessed June 30,

2009) and the Enactive Networks, available online at http://www.enactivenetwork.org (accessed June 30, 2009).

13 Corpothetics: a term coined by anthropologist and visual theorist Christopher Pinney (2004), meaning "corporeal embodied aesthetics" – that is, the processes of image-making that consciously invoke a bodily response in the viewer. In India, darshan is considered an example of *corpothetics*.

14 As sound theorists Blesser and Salter point out, different cultures may associate different aspects of their culture as either "ego" or "allo." The cognitive maps will vary across cultural groups; in one culture, language may be spatialized as egocentric (that is, things are described in relation to the viewer, which is good for encoding relative locations), or in the case of the Mayans, the allocentric framework means they have better sense of absolute locations and therefore navigation in wide open spaces (2006: 39–40).

15 *I Sho U* at Visitor Experience Studies, available online at http://ishou.com.au/ (accessed September 10, 2015).

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