

**NANYANG
TECHNOLOGICAL
UNIVERSITY**
SINGAPORE

**ANIMATED INSTALLATIONS FOR IMMERSIVE SPACES:
DEVELOPING A DESIGN PROCESS
TO ENHANCE THE EXPERIENCES
OF CULTURAL HERITAGE IN CHINA,
USING AN EXHIBIT DESIGN
FOR THE WESTERN XIA IMPERIAL TOMBS AS A CASE
HISTORY**

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2018

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The key research question originated from my working experience, since 2010, when I began working as a theme park designer. I was interested in how to enhance the experiences of cultural heritage in China, using animated installations for immersive spaces. The more I got into the industry design processes, the more I was planning to improve my knowledge of design processes in a graduate education programme. When I first knew about Singapore Nanyang Technological University School of Art Design and Media [ADM], I realized that it could be the place to fulfil my quest for knowledge in the field of animated installations for immersive spaces. Excitingly, ADM accepted my application. Thus, I have to thank ADM and NTU firstly for it made everything possible.

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Abstract

不闻不若闻之，闻之不若见之，见之不若知之，知之不若行之 / Not having heard something is not as good as having heard it; having heard it is not as good as having seen it; having seen it is not as good as knowing it; knowing it is not as good as putting it into practice (Xun Kuang c. 310–c. 235 BC, translation by John Knoblock, 1999, p. 197).

We, as we read, must become Greeks, Romans, Turks, priest and king, martyr and executioner; must fasten these images to some reality in our secret experience, or we shall learn nothing rightly (Emerson, 1993, p. 2).

This thesis is a study of developing a design process to enhance the experiences of cultural heritage in China, using the Western Xia Imperial Tombs Museum and Archaeological Site as a case history, in which the focus is on creating effective animated installations with content from China's culture past and present. The goal is to design stories using animated installations that are built on scholarly historical research and that lead audiences to gain an immersive learning experience.

The research focuses on three basic levels: animated installations, space perception, and key case studies on Chinese cultural heritage including the Western Xia Imperial Tombs museum design.

Starting from the definitions and concepts provided by scholarly literature, the thesis uses case studies of immersive experiences including Pure Land at Hong Kong (2012), the Theme Park of Oriental Imperial Valley at Xi'an (2013), the Panorama of Daming Palace at Xi'an (2014), the Interactive immersive space of Helv Relic Museum at Wuxi (2014), and Pirates of the

Caribbean at Shanghai Disneyland (2016) to investigate how cultural heritage has been used in immersive spaces in the People's Republic of China (PRC) from the end of the Cultural Revolution in 1978 to the opening of Disneyland in Shanghai in 2016.

The research investigates a theoretical approach that aims to discover and create a design process. The design process is focused on digital immersive spaces expressed through animated installations that are applicable to China and aim at displaying cultural heritage, and likely has other applications for presenting cultural heritage.

The vision is that animated installations can become a highly communicative and effective medium if their potential is fully harnessed in conjunction to a scholarly approach to contents and narratives. This could satisfy the popular demand of visitors and at the same time create a deeper understanding about the knowledge, protection, and reuse of cultural heritage (see Fig. 1).

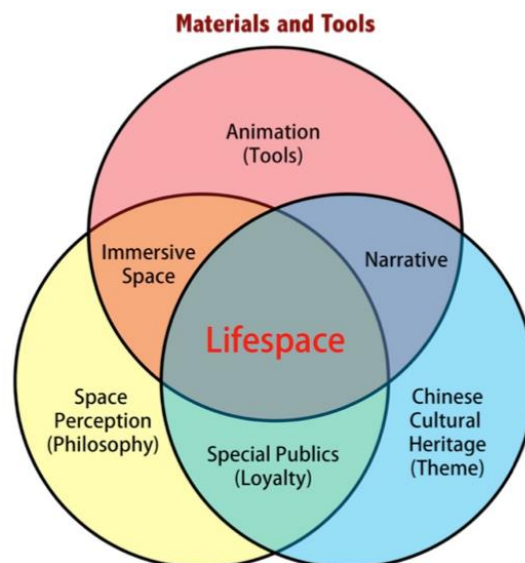


Figure 1 The Venn diagram represents this dissertation's process of gathering information from the outer content areas and drawing it toward the central research to find a design process that considers and incorporates the three domains of Philosophy, Themes and Tools. As these are combined, this research will draw out specific insights represented by the middle overlaps, Narrative, Immersive Space and Special Publics, which will result in a solid, dynamic and deeply supported methodology for creating effective animated installations for immersive spaces in China (Image by Luo ShenShen, 2016.)

The vision for this thesis is that an adequate knowledge of cultural heritage can help provide users with a more intuitive and effective experience, whose motivational intention is to develop and acquire what Scott Lukas defines as a *lifespace*: “A designed space that ‘stays with’ the guest for the entirety of that guest’s life. It is a space that when visited ‘follows the guest home’” (Lukas, 2013, p. 261). “In the sense of a ‘lifespace’, we will begin to see that experience with the space will occur not only during the physical visit of the guests to that space but in the ‘spaces’ that are entailed in the before and after of the guest’s visits, thus suggesting new experiments with time and temporality in these spaces on the horizon” (Lukas, 2016, p. 294). It is recognised that this is a hugely ambitious goal and at the same time does set aspirations high to accomplish creating “lifespaces” of cultural heritage. As for the theme of Chinese cultural heritage, this research concerns the Chinese narrative tradition¹ and China’s cultural heritage policy (1978–Present)².

The research uses several theories and hypotheses to assist in its development including Susanna Millar’s research about space and perception, Rick Altman’s theory about image narrative, Andrew Henry Plaks’ work on the Chinese narrative tradition, Mihaly Csikszentmihalyi’s flow theory, Russell Staiff’s work on interpreting heritage, and Scott Lukas’ work on immersive worlds.

1 See Andrew Henry Plaks (1977, 1995).

2 See Stevan Harrell (2013), Sicheng Liang (1963) and The State Council the People’s Republic of China (2014).

Following John Page's statement that "Systematic design is a three-stage process, demanding analysis³, synthesis⁴ and evaluation⁵" (Page, 1963, p. 205), in order to work with this three-stage process this thesis focuses on animated installations and immersive spaces as key elements.

To the concept design process for animated installations so far used by the industry in China, this thesis adds a critical approach to cultural heritage seen "as the treasure of human experience" for a new science of heritage" (Nanetti & Simpson, 2015, p. 88).

The whole design process includes three parts: (1) scene and space, (2) symbol and narrative, and (3) challenge and interaction—all of which are highly integrated in a practical project. The conclusion is in the form and content of a design process that can be applied in the theme park or museum fields.

The ambition of this research is to bring together several areas of study—Chinese heritage, landscape design, history, literature, modern technology and mass tourism—into a practical design process that provides effective ways to represent the past for useful meaning in the present and future. Using this new process, designers can analyse the content of a story, the scene design, the location of screens and projectors, the light, and the design and making of physical art works, to comprehensively approach the creation of immersive spaces to enhance the experiences of cultural heritage.

³ Analysis: "The collection and classification of all relevant information relating to the design problem on hand" (Luckman, 1969, p. 129).

⁴ Synthesis: "The formulation of potential solutions to parts of the problem which are feasible when judged against the information contained in the Analysis stage" (ibid).

⁵ Evaluation: "The attempt to judge by use of some criterion or criteria which of the feasible solutions is the one most satisfactorily answering the problem" (ibid).

Keywords

Animated installation, immersive space, space perception, Chinese cultural heritage, museum, theme park, design process

1. Introduction and Methodology

1.1. Introduction

In the themed environment, space is constituted as a textual device employed to tell the theme's backstory, or narrative underpinning. A story is told, in other words, not merely through its symbolic representation, but through its manifestation as a spatial environment (Lonsway, 2013, p. 76).

Through interpretation, understanding; through understanding, appreciation; through appreciation, protection (Freeman, 1977, p. 28).

The thesis author, in his experience in the theme park design industry in China from 2010 to 2014, realised that animation, which includes both traditional animation and computer-generated special effects, is an extremely versatile mode of storytelling, and with the rise of installation art and animation art, it has also been applied to video installations and animated spaces. In his professional experience as a designer in China, the author mainly worked on heritage-based projects, i.e., projects that used heritage materials as the major source for contents (Panorama of Daming Palace in 2015 and The Theme Park of Oriental Imperial Valley in 2013; see here Chapter 6) and realised that heritage can very effectively serve to design the narratives of media production. As an example, in imperial China, the traditional gardens can be considered as a film narrative with its own themes and plotting. Traditional Chinese literati deliberately designed these perceptive scenes in gardens. In these “traditional private gardens” (Qian, 1982, p. 14) also called “the gardens of the literati” (Keswick, 2003, p. 84), the designers, like film directors, have hidden the clues of a story in each

trail that visitors walk by and in the charming scenery behind the woods. At the same time, the visitor's identity is maintained when entering the world, which the designer created with pleasant smells and varied colours. It is all based on one concept: how to navigate this immersive artificial space.

Thus cultural heritage became a key focus for this PhD dissertation. Among the many and different definitions of cultural heritage, the author adopted the one proposed by his Supervisor, Andrea Nanetti, who suggested to approach "heritage as the treasure of human experience" for a new science of heritage (Nanetti & Simpson, 2015, p. 88). To introduce the *2nd Singapore Heritage Science Conference*, Nanetti wrote: "Heritage Science focuses on accessing, interpreting, conserving and managing cultural heritage. It takes into account knowledge and values acquired in all relevant disciplines, from arts and humanities (philosophy, ethics, (art)history, economics, sociology and anthropology) to fundamental sciences (chemistry, physics, mathematics and biology), as well as media studies, computer sciences and engineering. With so many heritage experts who document the human experiences of past generations and make this treasure available in the present digital era, we stand to add not only cultural and social wealth to local communities all over the world, but also monetary value to their creative industries." Here the creative industry includes "architecture, arts and antique markets, crafts, design (industrial, communication and fashion), publishing, film, video, and photography, radio and television, software, computer games and electronic publishing, advertising, music and the visual and performing arts" (Nanetti & Cheong, 2015, p. 6).

Russel Staiff discusses cultural heritage as “signs, symbols, stories, and rituals: he writes: “Much of cultural heritage, at the physical level, is just bricks, mortar, cement, steel, paint (and so on) or a series of dance steps or chopped vegetables and meat sitting on a plate with an array of coloured spices waiting to be cooked or a song cycle waiting to be sung or music made by plucking or striking or blowing. This is the stuff of everyday life and what transforms them into ‘heritage’ is a series of discursive moves by which the objects or sounds or performances become inseparable from their representation as something special, something not just ordinary, something deemed vital not only to the past/present but to the past/future, something deemed significant, drenched in values worthy of protection by individuals, families, communities or the state (citing Smith 2006; Harrison 2013)”.

This research is directed towards cultural heritage in China after 1978. Before 1978, “China's isolation from the international economy ... [and] a quarter century of socialist planning left China's economy riddled with multiple inefficiencies [...] and a system near the brink of a serious food crisis” (Brandt and Rawski, 2008, p. 6) that led close to China's social and economic collapse. In 1978, economic reforms began after Deng Xiaoping took power. The reforms included agricultural, industry, services reforms, open trade, and foreign investments (Brandt and Rawski, 2008, pp. 8-23). Since the beginning of this “reform and opening-up” policy, the cultural field in general experienced great development, and cultural heritage in particular received much attention. In China, as of the end of 2017, there are 52 UNESCO world heritage sites including the Suzhou Gardens.

The majority of tourism in China is linked to heritage sites and museums (China Tourism Academy, 2017). According to the 2017 China Tourism Academy report, in 2016 there were 4.44 billion domestic tourist trips in China that generated a revenue of 3.94 trillion RMB, with an increase of 11% and 15.2%, respectively, in comparison to the previous years. The number of foreign tourists' trips reached 138 million in 2016 with a revenue of 120 billion US dollars in foreign currencies, with increases of 3.5% and 5.6%, respectively, from the previous years (China Tourism Academy, 2017). In this context, joint-ventures with foreign companies such as Disney World, Universal Studios, and Six Flags introduced theme parks into the Chinese market to serve both domestic and inbound tourism and made use of China's national cultural heritage and symbols (Feng, 2013, pp. 5-8).

In China, theme parks constantly made use of animated installations to engage the visitors with immersive experiences. Museums have been more conservative. Perhaps because of concerns in terms of scholarly rigour, they have been reluctant to introduce animated installations (Li, 2004, p. 31).

In Chinese theme parks, there are an increasing number of construction projects that use digitization or animated installations to create immersive experiences. However, Chinese museums and theme parks have often ignored the theme and content when entering the digital world; they only centre on technology. All of this indicates there is an urgent to establish an operable immersive space design system based on Chinese cultural heritage and represented by animated installations.

With the development of virtual reality (VR) and augmented reality (AR) technologies, museums have increasingly recognised that animation and

immersive devices can greatly enhance the visitors' experiences of cultural heritage, helping visitors to understand their heritage from multiple perspectives (Remondino et al., 2018; Kateros et al., 2015; Bruno et al., 2016; Baraldi et al., 2015, Duguleana et al., 2016). Both the theme park industry and the museum industry have been engaged in the creation immersive environments to enhance visitors' experiences (Li, 2004, pp. 31-35).

Some independent research fields have been created around these animated installations because they can improve the people's experience of cultural heritage. In recent years, Sarah Kenderdine, Jeffrey Shaw, Vibeke Sorensen, and others have used animated installations to digitally restore and rebuild cultural remains. This not only effectively preserves symbols of cultural heritage, but also creates commercial and popular value.

In 2014, Professor Ben Shedd introduced the author to the book *The Immersive World Handbook: Designing Theme Parks and Consumer Spaces* by anthropologist Scott A. Lukas. The book introduced new ideas of immersive design with much to think about. In the same year, the author started this PhD research work at Nanyang Technological University (NTU) in Singapore. With education in design and work in academic research, the author has developed and tested guidelines for the definition of creative processes with regard to how to reuse tangible and intangible symbols of culture heritage in the design of animated installations for immersive spaces in China, with the aim to create cultural heritage-based content and experience delivery systems.

In this research, there are two questions to consider: First, how does one create immersive spaces using animated installations? Second, how does

one select appropriate animated installations to enhance the experiences of cultural heritage in China?

For the first question, this research is based on Susanna Millar's research into space and perception, Rick Altman's theory about image narratives, Mihaly Csikszentmihalyi's flow theory, Oliver Grau's theory of illusion and immersion in virtual worlds, Randall Packer and Ken Jordan's studies on the history of virtual reality, Jonathan Ling and Jonathan Catling's work in cognitive psychology and Scott Lukas's works on immersive worlds. Animated installations are key to this research.

Prof Subra Suresh, the President of NTU Singapore, frequently highlights the biggest challenge before policy makers will be to minimise the possible disruptions caused by fast changing new technology and maximise its benefits, as the world enters the new era of fourth industrial revolution.

In this context, designers should take care to minimise any potentially negative effects of immersive experiences, including discomfort (e.g., virtual reality sickness⁶) and confusion between the virtual and real worlds caused by presence or immersion (i.e., addiction). An excellent design can achieve the transition of presence between the virtual world and reality.

For the second question, this research is based on Russell Staiff's ideas about heritage iconography, Werner Wolf's theory of aesthetic illusion, Andrew Henry Plaks' essays on Chinese narrative tradition and Scott Lukas' writings about creating authenticity.

⁶ Base on Joseph J. LaViola Jr., "This type of sickness, cybersickness, is distinct from motion sickness in that the user is often stationary but has a compelling sense of self motion through moving visual imagery. Unfortunately, there are many factors that can cause cybersickness and there is no foolproof method for eliminating the problem" (LaViola, 2000, p. 47).

Russell Staiff has defined “heritage iconography” (Staiff, 2014, p. 84) as the constructed meanings of places/objects/landscapes and the decoding of these (or otherwise) by visitors; representations and performances to do with specific sites, and their ‘reception’ by tourists” (Staiff et al., 2013, p14). When audiences see real cultural heritage, and learn added knowledge from imagery and presentations, they begin to define the heritages and see their relevance.

The point is to highlight Staiff’s theory of heritage iconography and analyse its application in an existing cultural heritage experience project.

According to Tony Caputo in *Visual Storytelling: The Art and Technique*, “In fact, any narrative without visual representation, no matter how compelling, leaves the door wide open for as many independent interpretations as there are readers. Adding illustrations to a narrative text, so that all readers have the same pictures to look at, closes the interpretive door to some extent” (Caputo et al., 2003, p. 26). Nowadays, efforts are aimed at the goal of freeing human perceptual limitations and inspiring human memory or imagination through animated installations in an immersive space; immersion is not an end but a means. The design method here is the creation of a spatial atmosphere that guides the audience’s continued exploration and discovery. This thesis does not discuss the cause of such desire in detail or any psychological issue related to curiosity. The thesis is focused on what circumstances or environments arouse people's curiosity and desire to explore; whether animated installations can create this kind of environment; and whether a thematic environment created by animated installations can be applied in the design of enhance the experiences of cultural heritage.

The formation of the design process starts from a basic definition of design as "the creation of a plan or convention for the construction of an object or a system" (New Oxford American Dictionary). This study is divided into three parts.

- 1) The first step is to "unfold the design process" (Goldschmidt, 2014) through reverse engineering and the study of relevant immersive spaces that make use of cultural heritage in the design of their animated installations. The intention is to expand the research from academia to the culture industry.
- 2) According to Scott Lukas, in order to modify the design process based on the feedback from the practical project:
 - *Every element of the designed space should relate back to the big idea of the space and the story that you are trying to tell;*
 - *To create an authentic design space, each element should relate in a consistent manner to the other elements.*
 - *Think of how each design element will be experienced by the guest.*
 - *Focus on form and function together and think about how each relates to the big idea of the space (Lukas, 2013, p. 112).*
- 3) Develop a design process based on animated installations and apply the design process in a cultural experience project.

Through theoretical research and analysis of case histories, the author developed a new design process of animated installations for immersive spaces. This new design process was tested in the research project that developed the concept design for the Western Xia Imperial Tombs Museum

and Archaeological Site in Yinchuan, China as the practical component of this thesis.

For this practical project the author focused on animated installations and other creative solutions that could be developed to create a comprehensive and culturally aware experience at the Western Xia Imperial Tombs Complex as documented by the artefacts excavated in the Western Xia Tombs archaeological site. This design is based on the references of vast cultural relics, architectural image data on Western Xia, and the documentary film *Mysterious Tangut* realised by the Beijing Top Production Co. Ltd. (BTP). It took four months to develop and design the animated installation in order to make it possible for people to experience the cultural heritage of the region. Under the condition of reusing the Western Xia cultural heritage symbols and historical stories, the design team worked to utilize new display technology and immersive experience theory to visually show the cultural heritage through a dynamic narrative. With respect to this project, the team led by the author compiled the background research and analysis, symbol research and discovery, arrangement of narrative structure, visual effect and experience, and technical support to visualise the cultural heritage, of which symbols to use and why and the arrangement of narrative structure were top priorities. On this basis, we extracted the important cultural symbols of Western Xia based on the six complete story plots that were determined to summarise the rise and fall of Western Xia.

In the specific space design, we followed the design rules of immersive space and creatively used a "dark ride"⁷ to solve the challenge of viewing angles and motion. Then, the proposed design process of this thesis was used to dynamically integrate the story and images of this site's cultural heritage into the new animated installation.

In the digitized transformation of the underground tunnel of Western Xia Imperial Tombs, the team applied many technologies, including a giant screen, dome, a moving vehicle, and a Pepper's Ghost illusion system⁸ exhibit technique. Together with the stage design and live shows, the team developed different spaces to bring the visitors into the Tangut's more than 354-year history to experience significant historical events. The author led the NTU design team using previous experience combined with the design methods developed for this thesis, and in the end, this concept design (including the blueprint design, the script writing, the animation demonstration and the 1:50 model) resulted in a plan for an animated installation of cultural heritage far beyond previous practical projects. It also tested and modified the design process as it relates to cultural heritage-driven animated installations for immersive spaces and it will assist others with designing future cultural heritage sites. The project is currently under construction and is expected to be completed in the next few years.

⁷ "The indoor attractions typically feature a ride vehicle that follows a serpentine track through a series of narrated scenes populated by animatronic figures (MacDonald, 2015).

⁸ The Pepper's Ghost is a special effect technique named after Professor John Henry Pepper, who invented it with the British engineer Henry Dircks in 1862 (University of Westminster, n.d.; Costa, 2016). This illusion system consists of a piece of glass angled between the audience and the stage, in a way in which the audience perceives the reflections of images and authors as being on stage (Greenslade, 2011, p. 338).

The thesis is structured in eight Chapters (including this introductory chapter and the Conclusion) followed by a bibliography. Chapter 2 presents animated installations for immersive spaces, and explains how they can pioneer new solutions to display and communicate cultural heritage. Then, after having discussed the visual narration and traditional Chinese narrative structure in Chapter 3, interactive user experiences in Chapter 4, cultural heritage and heritage iconography in Chapter 5, they all become the premise to open the stage for Chapter 6 that proposes a new design process of animated installations for immersive spaces in China. In Chapter 7, the author presents the concept design project of the Museum of Western Xia Imperial Tombs as a case history and the practical component of this thesis. A Conclusion Chapter 8 completes this Thesis.

1.2. Methodology

1.2.1. Reverse Engineering

Reverse engineering (RE) is a process of measuring, analyzing, and testing to reconstruct the mirror image of an object or retrieve a past event. It is a technology of reinvention, a road map leading to reconstruction and reproduction (Wang, 2010, p. 1).

The term of Reverse Engineering is derived from analysis of hardware—“Reverse engineering is regularly applied to improve your own products, as well as to analyze a competitor’s products or those of an adversary in a military or national-security situation” (Chikofsky & Cross, 1990, p. 13). Robert J. Abella, James M. Daschbach and Roger J. McNichols described

Reverse Engineering as “the basic concept of producing a part based on an original or physical model without the use of an engineering drawing (1994, p. 381)”. The Wright brothers’ airplane is one of the most noticeable examples, what was designed partially based on their observations, and imitations of flying birds (Wang, 2010, p.5).

Software engineer Eldad Eilam writes in his thesis, “reverse engineering is the process of extracting the knowledge blueprints from anything man-made” (Eilam, 2005, p. 3).

Reverse engineering appears not only in the engineering field, such as mechanical engineering, electronic components and computer programs, but also in literature (e.g., literature creation). In Thomas Ballhausen and Katharina Sroger’s *Asking the Girls Out? Reverse Engineering and the (Re)writing of Austrian film History*, Ballhausen discusses how to use reverse engineering research in Austrian film history (Ballhausen, 2014, p. 160). First, Ballhausen collected nearly 1,000 Austrian movies as original data, and he writes, “The subsequent rejection of a model of a linear progression of history and historiography necessitates a productive discussion of the making of and reflection on history and historiography, which can be described coherently as a practice of ‘reverse engineering for the humanities’” (Ballhausen, 2014, p. 161). He built a data model in a computer and inputted the movie scripts and story plots, generalised the story model for all types of stories, summarised the different movies of specific time periods and developed a theory for the model structure that can be used to describe Austrian movies from 1969 to 1999. Recently, the popular American television series *House of Cards* has generalised the plots which

audiences deeply love using a similar reverse engineering theory (Carr, 2013). After the plots were input into the computer, the computer program could prepare and produce the story scripts.

The research methodology that the author is proposing for this dissertation takes advantage of reverse engineering to deconstruct both his own and other professionals' immersive design projects. The key interest is how cultural heritage has been used for animated installations in the theme park and museum industries. This research involves engineering and technical research as well as the contents of and research on the narratives to distil and analyse how cultural heritage has been taken into consideration in the overall design process.

1.2.2. Practice-led Research

Practice-led Research is concerned with the nature of practice and leads to new knowledge that has operational significance for that practice. ... the results of practice-led research may be fully described in text form without the inclusion of creative work. ... focus of the research is to advance knowledge about practice, or to advance knowledge within practice. Such research includes practice as an integral part of its method and often falls within the general area of action research... If the research leads primarily to new understandings about practice, it is practice-led (Candy, 2006, p. 1).

The term "practice-led research" has become extensively used. It is applied to the new understanding of known practices, especially in the humanities and the arts. "There are differences in the conceptual and applied uses of the term between those fields where it is most often found: design, health, creative arts, and education" (Candy, 2006, p. 3).

In *Practice-Led Research, Research-Led Practice in the Creative Arts*, Hazel Smith and Roger Dean draw an eight-step “cyclic web” (see Fig. 2) to represent the relationship between theory and practice. They write, “In our view for an artwork itself to be a form of research, it needs to contain knowledge which is new and that can be transferred to other contexts, with little further explanation, elaboration or codification, even if this transferral involves a degree of transformation” (Smith & Dean, 2009, p. 20).

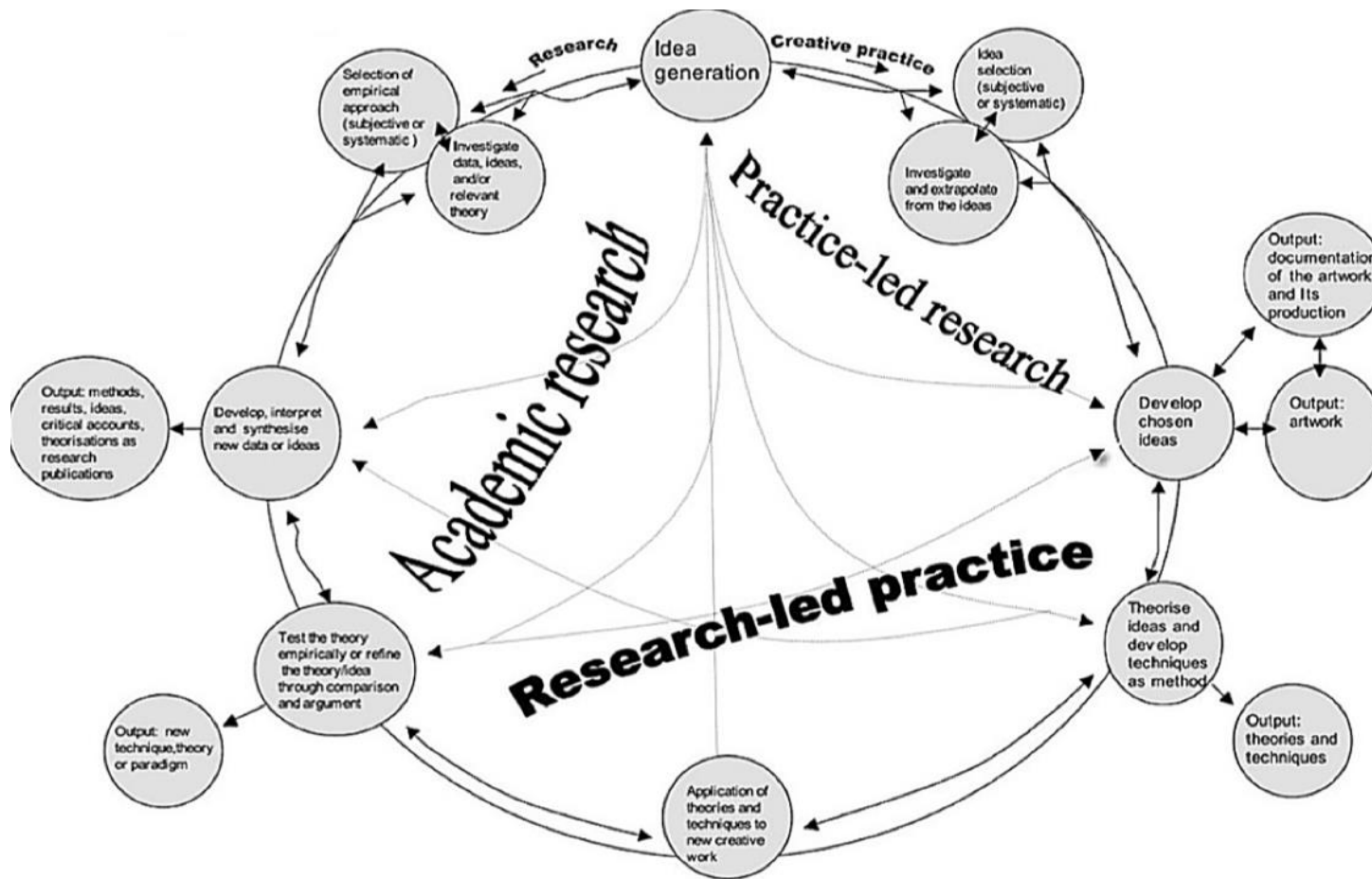


Figure 2 Practice-led research (Smith & Dean, 2009, p. 20).

From these specific methods, the author summarises the design system and process of the corresponding digital cultural heritage based on the original design works and verify as well as evaluate the validity of the prototype based on the practice achievements of the experience design. For the current international and domestic cases in this field, the author will analyse their similarities and technical and art processing characteristics; also propose suggestions and methods suitable for the studied subject by comprehensively considering the advantages of different cases.

Starting from the practical case (a concept design for an underground tunnel linking the Western Xia Imperial Tombs museum to the archaeological site) and combining a concept design, animation images and model making, this thesis establishes a design concept with the users' experience as a medium—that is, using an animated installation to enhance the experiences of cultural heritage. Based on this, it systematically demonstrates the design method and process of immersive spaces with animated installations.

1.2.3. Storytelling

In a movie or a drama, the first step to think about is storytelling. Both tangible and intangible cultural heritages can reflect the events behind them. Similarly, when designing an immersive space, narrative is still the element that the designer shall consider first. No matter from the perspective of cultural heritage presentation or immersive space design, we must consider how to tell the story in a favourable method.

In Robert McKee's *Story: Substance, Structure, Style, and the Principles of Screenwriting*, he proposes his classic archplot, miniplot, antiplot theory

(McKee, 1997, p. 46) (see. Fig. 3). McKee states “Archplot delivers a closed ending—all questions raised by the story are answered; all emotions evoked are satisfied” (McKee, 1997, p. 47); Miniplot is “a story climax that leaves a question or two unanswered and some emotion unfulfilled is an OPEN ENDING” (McKee, 1997, p. 48).

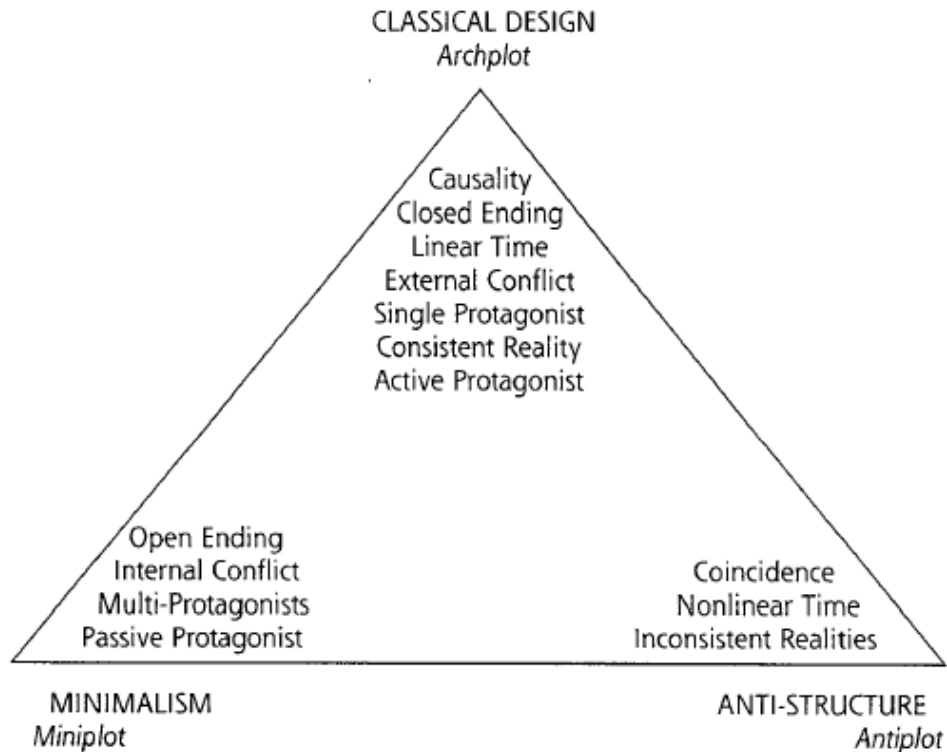


Figure 3 Robert McKee's theory of archplot, miniplot, antiplot. Image from *Story: Substance, Structure, Style, and the Principles of Screenwriting* (McKee, 1997, p. 46)

The audience is involved in the story in an immersive space centring on experience and interactive narrative, so there is more opportunity for the miniplot to be an open ending.

In this thesis, the author first reviews how to follow story design principles to develop research or creation based on previous works. Then, the author further analyses his own practical design works. The whole project is designed around representative events so that the story-led design process of the immersive space can be developed.

2. Animated Installations for Immersive Spaces

Animated installations for immersive spaces are the key design component that this dissertation is proposing to use to enhance the experiences of cultural heritage in theme park and museum spaces. In order to have a full awareness of their potential, this chapter introduces one by one each component according to their historical development in the creative industry. The understanding of animated installations is crucial to position the decision to use immersive spaces for the enhancement of experiences of cultural heritage. By combining animation and physical space, a concept of animated installation has been developed.

2.1. Animated Installations

The animation installation inevitably attempts to define space as a unique territory; a small world particular to an artist but an environment seeking out empathy and common bonds (Hardstaff & Wells, 2008, p. 68).

Participants entered into the space itself rather than view it from afar. The elements in the art environment filled the participant's peripheral vision creating the sensation of physical presence. Visual elements in the environment offered depth clues and moved accordingly (Mitchell, 2010, p. 102).

Animated installations are based on space and involve two-dimensional images. Since this research goal is to develop design rules applicable to 3D space, animated installation becomes the material medium and scope of the research. Thus, based on above definition, the scope of this research is limited to devices for art with 3D properties of space expressed through

animation or image as well as related sensory experiences. An animated installation, with animation as the leading performance and method of the narrative, combined with the field and environmental concept of installation art and other sensory experiences creates an immersive experience.

2.1.1. Animation

Animation is defined as “a way of making a movie by using a series of drawings, computer graphics, or photographs of objects (such as puppets or models) that are slightly different from one another and that when viewed quickly one after another create the appearance of movement” (Merriam Webster Dictionary). Animation is a method to express or show stories and ideas. Nowadays, animation has penetrated our lives deeper with the continuous development of display technology. “Animation is pervasive in video games, advertising, music videos, and is increasingly featured in forms of hybrid and blended media. Not only does cinematic vision now extend beyond the movie theatre but moving-image culture extends across a large landscape of technologies, media influences, and social relationships” (Buchan, 2011, p. 34). Furthermore, animation has played a significant role in the publicity and protection of cultural heritage. The so-called “virtual heritage” composed of 3D models, real-time calculations and interactive media has made a significant contribution to the study and restoration of cultural heritage monuments and architecture (Anderson et al. 2009; Zhou et al. 2012, pp. 5-11).

According to Giannalberto Bendazzi, as technology has matured gradually from silence to sound, black and white to colour and single screen to

multiple screens, animation has gone through six periods of development (Bendazzi, 1994).

2.1.1.1. The First Period (Before 1908)

Giannalberto Bendazzi argues this is period takes place before the screening



Figure 4 It is an earthen goblet discovered at the site of Shahr-i Sokhta (Burnt City) in Iran's south-eastern province of Sistan and Balouchestan (founded around 3200 BC) (Tasnim New Agency, 2016). The five images show the process of a goat eating leaves. It is now preserved in National Museum of Iran. Michał Sałaban (2010). Iranian vase with pseudo-animation. Retrieved September 30, 2017, from https://commons.wikimedia.org/wiki/User:Emesik#/media/File:Animation_vase_2.jpg.

of Émile Cohl's *Fantasmagorie*. "There is no 'animation' as such there, but the film still incorporates many features that look like what nowadays we would consider to be animation" (Bendazzi, 1994, p. 2). The pattern of the earthen goblet of the Burnt City (see Fig. 4), Ding Huan's "variety of

zoetrope”⁹ and the understanding of persistence of vision all explore how to show activities.

In 1798, Etienne-Gaspard Robertson first presented phantasmagoria—a performance that combines illusion images with stage installations (Castle, 1995, p. 143).

2.1.1.2. The Second Period (1908–1928)

This period is mainly characterised by silent animation. According to Bendazzi, a great number of pioneer artists from Europe and North America (e.g., *The Beautiful Lukanida* [1912] by Ladislav Starevich, *Little Nemo* [1911] by Winsor McCay and *El Apóstol* [1917] by Quirino Cristiani) emerged during this period, and animation seemed to become a new experimental art form. This period ended on “18 November 1928, the day of the public screening of Walt Disney’s first ‘talkie’, the short film *Steamboat Willie*” (Bendazzi, 1994, p. 61) (see Fig. 5).

⁹ In the first century BC Han dynasty (206 BC-220 AD), the Chinese craftsman Huan Ding / 丁緩 invented a animated device. According to *The Western Capital Miscellany* / *西京杂记* by Hong Ge / 葛洪 and Xin Liu / 刘歆. “又做九层博山香炉，镂为奇禽怪兽，穷诸灵异，皆自然运动”(yòu zuò jiǔ céng bó shān xiāng lú, lòu wéi qí qín guài shòu, qióng zhū líng yì, jiē zì rán yùn dòng / Ding used amazing techniques made a nine layers incense burner, which is carved with all kinds of animals on it, and can rotate automatically) (Ge & Liu, 2012, p. 43). Also “the historian Joseph Needham briefly describes several devices he classes as ‘a variety of zoetrope, which may well have originated in China’”(Needham, 1962, pp. 123-124). Until to Northern Song dynasty, *Remarks Made by Drunk Man* / *醉翁谈录* by Yingzhi Jin / 金盈之 (about 1126), recorded the a kind of rotatable decorative lamp used hot gas of candle, named trotting horse lamp / 走马灯, it is similar device with zoetrope (Zhang, 2015, p. 310).

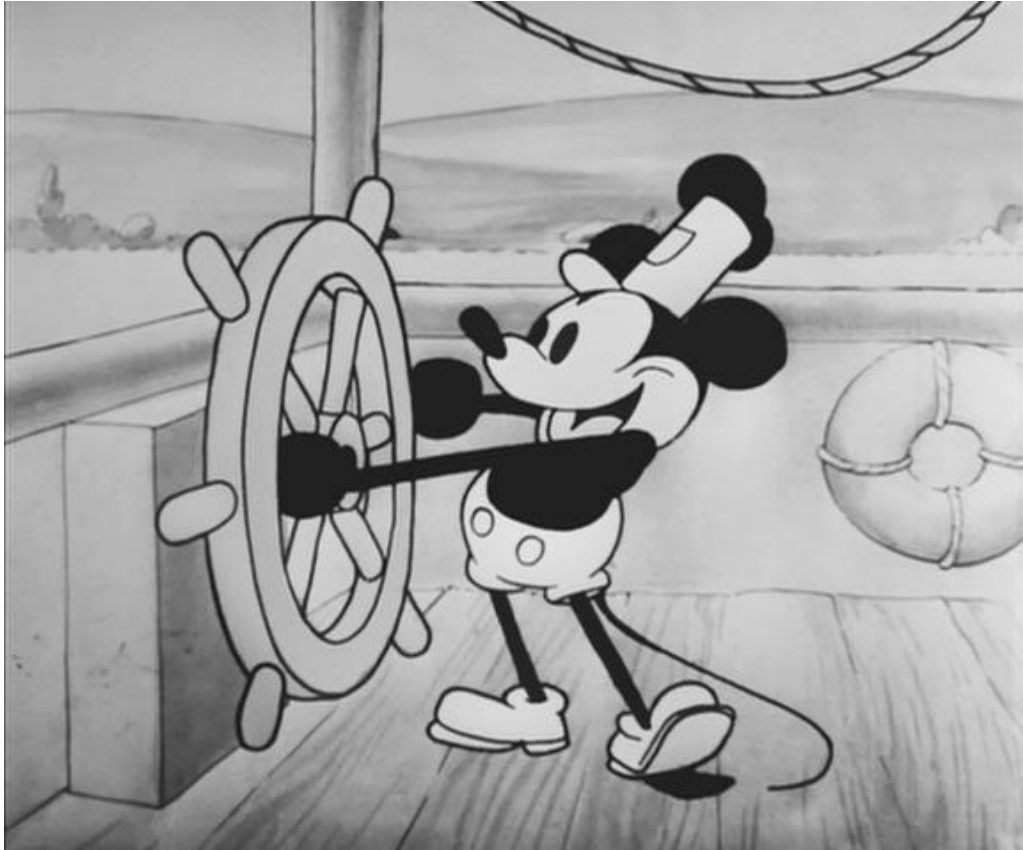


Figure 5 Disney, W., & Iwerks, U. (Directors). (1928). *Steamboat Willie*. In R. O. Disney & W. Disney (Producer). United States, Walt Disney Studios: Celebrity Productions. Image retrieved April 24, 2016, from <https://vignette.wikia.nocookie.net/disney/images/4/4e/Steamboat-willie.jpg/revision/latest?cb=20160408005013>. *Steamboat Willie* is a symbol of the beginning of the animation industry.

2.1.1.3. The Third Period (1928-1951)

Bendazzi calls this period “The Golden Age”. The Disney style dominated the world. At the same time, other countries entered the animation industry. In 1941, the Wan brothers finished Asia’s first animated feature film, *Princess Iron Fan* (see Fig. 6), in Shanghai (Du, 2017, p. 141). However, we can see the imitation of Disney and Fleischer Studio’s animation style combined with Chinese characteristics (Shi & Pan, 2016, p. 109).



Figure 6 Wan, G., & Wan, L. (Directors). (1941). *Princess Iron Fan*. In G. Wan & L. Wan (Producer). China: Cinema Epoch. Image by Neil Emmett (2015). Book Review: Chinese Animation: A History and Filmography. *Cartoon Brew*. Retrieved April 28, 2016, from <https://www.cartoonbrew.com/books/book-review-chinese-animation-a-history-and-filmography-110558.html>.

2.1.1.4. The Fourth Period (1951–1960)

Bendazzi argues this period mainly embodied the decline of Disney and the rise of United Productions of America (UPA).¹⁰ The period started with the UPA short *Gerald McBoing Boing* (1951) (Bendazzi, 1994, p. 130). A new animation style gradually formed that was different from Disney's animation. It was a highly creative period in all fields—abstract, concrete, puppet animation, clay animation, model animation, hand-drawn animation, etc. It is worth noting that some experimental animation, such as Jordan Belson's *Allures* (1961), Harry Smith's *Heaven and Earth Magic* (1957-1962) and Norman McLaren's works (see Fig. 7), are particularly excellent (Moritz, 1997; Richard, 1982).

¹⁰ "In 1943, Stephen Bosustow, David Hilberman, and Zachary 'Zack' Schwartz, three former employees of Disney, formed Industrial Film and Poster Service. One year later, the United Auto Workers hired them to make a film... On 1 May 1944, the company's name was changed to United Film Productions and, on 31 December 1945, to United Productions of America (UPA)." (Bendazzi, 1994, p. 130).



Figure 7 McLaren, N. (Director / Writer). (1968). *Pas de deux*. Canada: National Film Board of Canada. Image retrieved April 23, 2016, from, https://www.nfb.ca/film/pas_de_deux_en/.

2.1.1.5. The Fifth Period (1960–1991)

With the onset of the Cold War, the world was divided into two camps: the socialist Soviet Union and the capitalist United States. At the same time, the two camps used television as their main ideological propaganda tool and produced great animation works, such as Yuri Norstein's *Hedgehog in the Fog* (1975) and Robert Zemeckis' *Who Framed Roger Rabbit* (1988). With the rise of third world countries, Bendazzi also calls this period "The Three Markets" (2016, p. 97).

It is worth noting that with the invention of computer graphics technology, animation production became more uniform; "although it is varied and subjected to strong changes within the market" (Bendazzi, 1994, p. 97). In the 1960s, Bell Telephone Laboratories and Lawrence Livermore National Laboratory developed early digital computer animation (Masson, 1999, pp. 390-394; Sito, 2013, p. 26). In 1972, Edwin Catmull and Fred Parke created

an early computer-generated image, *A Computer Animated Hand* (see Fig. 8) at the University of Utah. Later, snippets of the film were used in the 1976 film *Future World* (Means, 2011; Sito, 2013, p.154).

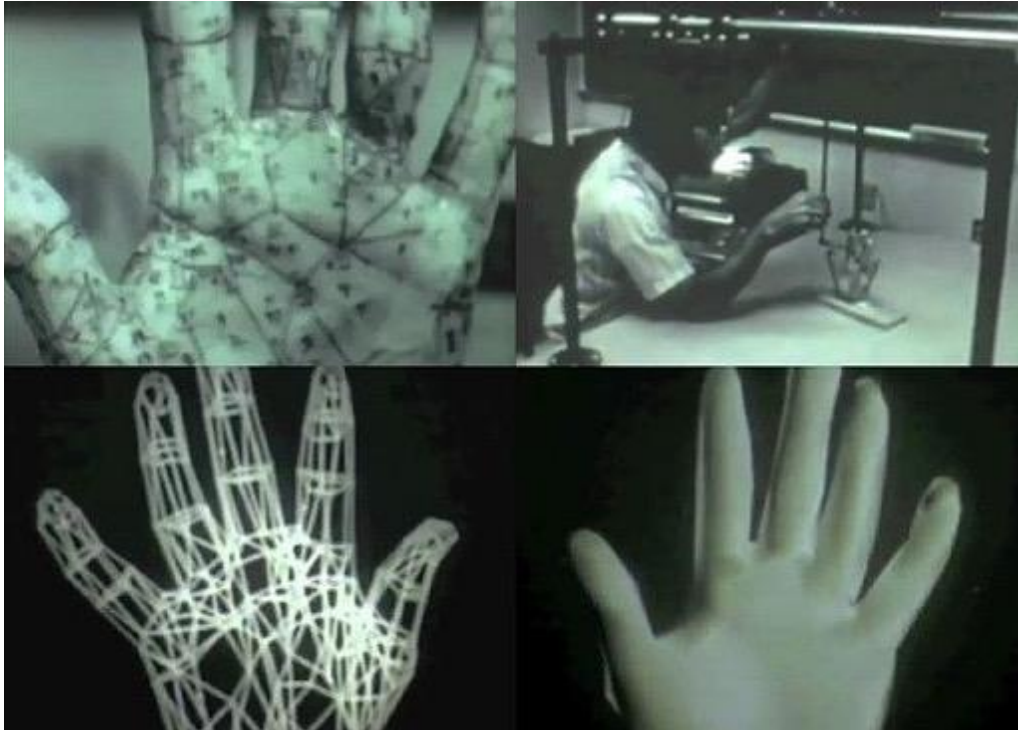


Figure 8 Catmull, E., & Parke, F. (Directors). (1972). *A Computer Animated Hand*. In E. Catmull & F. Parke (Producers). USA: University of Utah. Steemit. (2016). *A Computer Animated Hand*. Retrieved April 30, 2017, from, <https://steemit.com/animation/@stino-san/-a-computer-animated-hand>.

2.1.1.6. The Sixth Period (1991–Present)

According to Bendazzi, after the Cold War and with the rise of economic globalization, the extension of animation has become more and more broad. As animators develop new animation technologies and procedures, computer-generated animation has become the mainstream, and the animation industry started the global technology division (Bendazzi, 1994, p. 435-439). This is a rich period, but it has not settled yet. With the development of animation technology and exhibition media, animation is becoming increasingly module-based and more accessible. As a result, animation has entered various aspects of daily life. Animation tools are also

being improved with enhanced operability. Animation is no longer limited as a form of art. Large-scale industrial animation production has made animation an industrial form. However, industrial production expedites the instrumentalist process of animation. According to official statistics in China, the value of the Chinese animation industry surpassed 130 billion RMB in 2016 and has maintained a yearly growth rate of 10% (www.chyxx.com, 2016).

2.1.2. Installation Art

This questing process constitutes a discourse which investigates the relationships between the artist and audience. Installation is therefore defined by this process, something that has led artists to work with materials and methodologies not traditionally associated with the visual arts (Oliveira et al., 2003, p. 14).

...installation as phenomenon: instead of seeing installation as a self-sufficient aesthetic object, one must look at its relations to other phenomena and circumstances outside itself- external circumstances, if you will (Petersen, 2015, p. 37).

In general, the idea of installation art that audiences are part of is not only what artists are making, but also what the audiences and others are creating. In Richard Wagner's *Art and Religion* (1849), *The Artwork of the Future* (1849) and *Opera and Drama* (1852), he uses Karl Friedrich Eusebius Trahdorff's¹¹ concept of *Gesamtkunstwerk*, translated as "total or universal work of art" (Bergande, 2014, p. 131). This seems to be the earliest

¹¹ According to Simon Shaw-Miller, Karl Friedrich Eusebius Trahdorff first used the concept "Gesamtkunstwerk" in *Aesthetics; or, Theory of Belief and Art* in 1827 (Shaw-Miller, 2014, p. 45). Also, Alfred R. Neumann identified that the term first used by Karl Friedrich Eusebius Trahdorff (Neumann, 1956, pp. 191-193).

conceptual link to the installation art. Wagner wanted to create works that combined all forms of art, using it in the performance of stage (Packer & Jorden 2002, p. xx). As Simon Shaw-Miller commented, “The Wagnerian *Gesamtkunstwerk* aims not to represent a sensory field, but to be a sensory field” (Shaw-Miller, 2014, p. 45).

The rise of installation art has a tight connection to cubism. According to Faye Ran, cubism established a new appreciation for artwork, “Cubism’s break with fixed perspective suggests an Einsteinian merger of space and time. Cubism adds time to pictorial space by virtue of the fact that objects are represented in temporal multiplicity, not as they would be seen at any given or fixed moment. The whole idea of a closed structure by the process of collage, in which the dynamic structure of all pictorial elements was to be viewed simultaneously” (Ran, 2009, p. 62).

In the 1930s, Kurt Schwitters’ *Merzbau Hanover* was a landmark work (see Fig. 9) that “was a unique early example of what today would be considered installation, a large sculptural and architectonic assemblage made of wood, cardboard, metal scraps, furniture and other found objects, urban treasure and flotsam of all sorts” (Ran, 2009, p. 74). Schwitters tried to use an entire physical environment and “one that was in constant flux” (Thomas, 2012) to create an immersive space and implement Wagner’s *Gesamtkunstwerk* (Myers, 2009, pp. 100-107). However, this work was destroyed during World War II but was reconstructed at Sprengel Museum Hannover in 1983.



Figure 9 Schwitters, K. (1933) Merzbau. [Installation]. © VG Bild-Kunst, Bonn 2017. Photo by Wilhelm Redemann, 1933. Retrieved February 18, 2017, from Sprengel Museum Hannover website: http://www.sprengel-museum.com/painting_and_sculpture/spaces/index.htm?bild_id=71919653

“Before the term ‘installation art’ became part of the vernacular of contemporary art, there was the term ‘Environment’, which was used by Allan Kaprow in 1958 to describe his room-size multimedia works” (Reiss,

1999, p. xi). Kaprow's environment works focused on the idea of active viewer participation.

Following minimalist aesthetics, installation art is seen as a resistance to minimalist sculpture (Fried, 1995, pp. 116-147). As exhibitions of large-scale minimalist sculpture, these installations become a way to let the audience to participate in the exhibition space; the artwork and audience seem to perform together on the same stage (see Fig. 10).



Figure 10 Morris, R. (1964). *Untitled*. (Painted plywood). From *Robert Morris: The Mind/Body Problem* (p. 171), by Thomas Krens, and Rosalind Krauss, 1994. New York: Guggenheim Museum Publications.

At the same time, with advances in technology and the emergence of Portapak video cameras,¹² some artists combine video technology with

¹² "In 1967, Sony introduced the first Portapak, the Sony DV-2400 Video Rover. The first 'portable' video system, this two-piece set consisted of a large B&W camera and a separate record-only helical ½" VCR unit" (Shapiro, 2014).

installation and performance. Nam June Paik, Bruce Nauman, Dan Graham, Bill Viola and Gary Hill began to use video and the human body in installation art (London, 1995, pp. 423-426).

“In the late 1980s some artists began to specialize in constructing installations with the result that a specific genre—‘Installation Art’—came into being” (Walker, 1992, p. 357). Julie Reiss notes when “installation” first appeared in *The Oxford Dictionary of Art* (1988)¹³ (Reiss, 1999, p. xii). This change not only reflected improvements to the definition of installation art but also changes in the form of exhibition. “For many reasons, exhibiting Installation art became commonplace for major art institutions by the beginning of the 1990s” (Reiss, 1999, p. 136).

In 1991, the Museum of Modern Art arranged an exhibition titled *Dislocations*. “Between 1969 and 1991 there were projects that could be described as Environments or installations” (Reiss, 1999, p. 138). It now appears that this exhibition is not only a summary of installation art, but also a type of declaration of the future. At the same time, the definition of installation art has become fuzzy once again. It is hard to use the term to define separate categories.¹⁴ “In its most diluted form, the installation concept is also used when referring to artworks that are not easily

¹³ In 1988, in the first version, defines installation as “a term which came into vogue during the 1970s for an assemblage or environment constructed in the gallery specifically for a particular exhibition” (Chilvers & Osborne, 1988, p. 253).

¹⁴ Third version of *The Oxford Dictionary of Art* in 2004, defines installation as “a term that can be applied very generally to the disposition of objects in an exhibition (the hanging of paintings, the arrangement of sculptures, and so on), but which also has the more specific meaning of a one-off work (often a large-scale assemblage) conceived for and usually more or less filling a specific interior (generally that of a gallery)” (Chilvers, 2004, p. 358).

categorisable and which, due their mixed nature, cannot be placed in other 'purer' categories" (Petersen, 2015, p. 34).

Installation art has a few key characteristics (Petersen, 2015, p. 37), but in postmodern art forms "visuals no longer have to be the seat of meaning in such art. Light, fog, smell, texture and space can be the avenue for dialogue, with the body of the audience being the essential component" (Coleman, 2007). For installation art, it is important to create an environment or mood for the viewer and to guide the bystander into the field or situation. Then, the viewer completes the interaction with the installation. "Objects may fall directly in the viewer's path or become evident only through exploration of a space; the meaning evolves from the interaction between the two" (Reiss, 1999, p. xiii). Art critic Ina Blom uses the terms "immersive mode" (Blom, 2001) and "ambient" (Blom, 2002) to describe Nicolas De Oliveira's comment, "in which the subjective awareness ... appears to merge with the artwork, so as to create the sensation of a new more powerful experience of totality" (Oliveira et al., 2004, p. 49). This "space" is "the relativity of an accidental, discontinuous and heterogeneous space" (Virilio, 1991, p. 35) and "enables the packaging of total environments—the total engagement of the senses" (Koolhaas et al., 2001, p. 164). When Anne Ring Petersen discusses the characteristics of installation art, she recommends using the term "'ambient' to capture the way installations structure space" (Petersen, 2015, p. 42). She explains, "in an art context, the word refers to that which surrounds the figure of a person" (Petersen, 2015, p. 42).

Both "immersive mode" and "ambient" are used to describe the nature and purpose of installation art. Petersen discusses several features of

installation art including spatiality, theatricality, temporality, narrative and interactivity (Petersen, 2015, pp. 162-317). The spatiality of installation art is obvious; what is important is that the spatiality of installation art is actually a reconstruction of the space. Theatricality refers to the purposeful changing of a space into a dramatic space so as to create a perceptive experience of dramatic conflicts. The narrative and temporality are mutually connected. As numerous of installation art works have become an “event” (Petersen, 2015, p. 372), it takes time for the audience to interpret such events or images. The content of the event or image demonstrates the narrative structure of the art. Interactivity refers more to the installation art that appeared after video installation, as “video installation can emphasise that ‘space’ is a dynamic and changeable phenomenon” (Petersen, 2015, p. 317). Such a dynamic structure is expressed as a kind of performance in which the artists or audiences will participate. The performance they put on and the existing objects constitute the complete installation art experience. Like animation, businesses have often used installation art. To commercialize the concept of installation art, Walt Disney first carried on the practice. Disney’s *imagineering*¹⁵ used a similar philosophy to installation art when designing the artificial spaces for Disneyland in California in 1955 (Petersen, 2015, p. 423).

In 1963, Disney imagineers decided to use “Audio-Animatronics”¹⁶

¹⁵ “Walt Disney Imagineering is the unique, creative force behind Walt Disney Parks and Resorts that dreams up, designs and builds all Disney theme parks, resorts, attractions, cruise ships, real estate developments, and regional entertainment venues worldwide.” (Walt Disney Imagineerings, n.b.).

¹⁶ “Audio-Animatronics” is a form of robotics animation created by Walt Disney Imagineering” (Goswick, n.d.).

technology in the Enchanted Tiki Room in 1967 and in Pirates of the Caribbean attraction (Goswick, n.d.). These were the early appearance of installation art in the entertainment industry. Audio-animatronics is actually a dynamic robot technology in that it can move and make noise. Imagineers at Disney are constantly improving this technology. In Na'vi River Journey on Pandora, the new attraction at Disney's Animal Kingdom in Orlando, audio-animatronics technology has been used to create an impressive alien world (see Fig. 11). Scott Lukas explains, "Audio-Animatronics are used to establish characters like Jack Sparrow; technology, stage design, and other elements create setting; and as the guests move from one scene to the next, the sense of editing occurs as spatial transitions are used" (Lukas, 2013, p. 42).



Figure 11 Audio- Animatronics technology has created a shaman at The Na'vi River Journey in Disney's Animal Kingdom in Orlando. Martens, T. (2017). A visit to Disney's Pandora — what we learned. Photo by Jay L. Clendenin, 2017. Retrieved February 11, 2018, from <http://www.latimes.com/entertainment/herocomplex/la-et-hc-disney-pandora-avatar-20170502-htmlstory.html>

In all, the installation art has turned into a stage on which its actors are invited to perform. These actors may be sculptures or paintings; music; the bodies of artists; or even robots, videos or animation. The purpose is to

create an immersive artificial world. “The goal of both theme parks and installations is invoke a world other than reality, a world in which audiences can enter with their entire body, not just via the imagination (as with a painting or a Disney film)” (Petersen, 2015, p. 426).

2.1.3. Animated Installations as a Stage

Like image-oriented performance theatre, video installation can emphasise that “space” is a dynamic and changeable phenomenon (Petersen, 2015, p. 317).

Animated installation is an artistic expression of animations and 3D stages “that often are site-specific and designed to transform the perception” (EERA, n.d.) of an interior space. As mentioned above, for animated installation, animation is a tool of transmission and display; the installation functions as a stage for animation to perform on.

Petersen comments that video installation involves two-dimensional images, “It is a feature of all video installations that the visitor must activate both the reflective gaze at the images as well as the body’s sensory-motoric navigation in space, and that these two forms of reception become inextricably intertwined with each other” (Petersen, 2015, p. 340).

Trying to combine image and installation, a Belgian inventor, physicist and student of optics named Etienne-Gaspard Robertson presented what he called the first phantasmagoria—a ghost illusion—show at the *Pavilion de l’Echiquier* in Paris in 1798 (Castle, 1995, p. 143) (see Fig. 12). Robertson used black images to create the illusion of free-floating ghosts. He also set up multiple projectors in different places, creating an environment

surrounded by ghosts. In order to add to the horror, Robertson and his assistants created voices for the show (Barber, 1989, pp. 73-86).

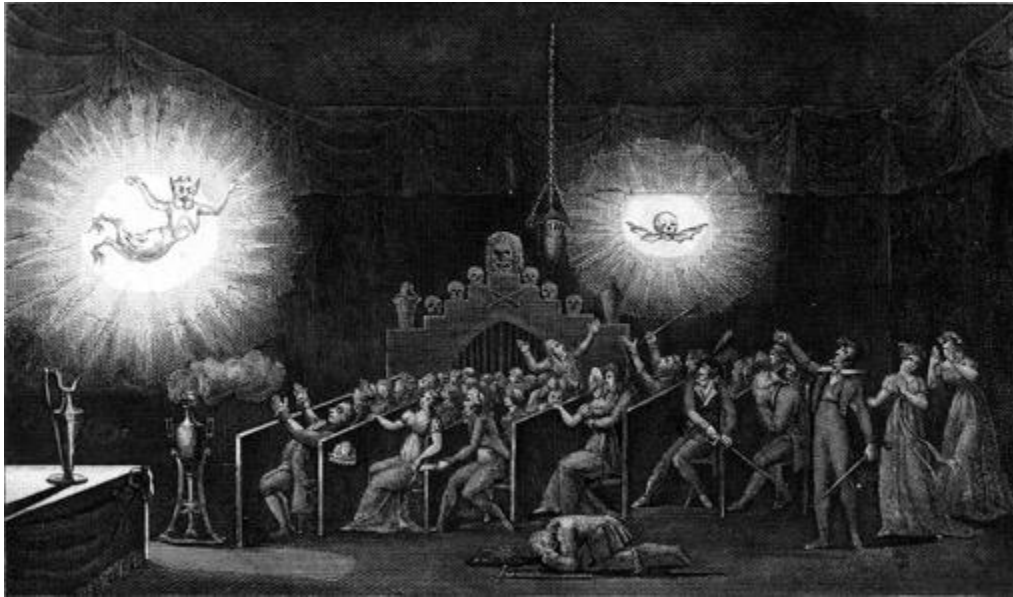


Figure 12 Robertson, E. G. (1831). *Mémoires récréatifs, scientifiques et anecdotiques du physicien-aéronaute* (Vol. 1). Paris: Chez l'auteur et à la Librairie de Wurtz. Retrieved January 20, 2018, from <https://archive.org/stream/mmoiresrcreatifs01robe#page/n7/mode/1up>

Animation tools are constantly changing. “While computer scientists and artists have sought to create virtual spaces using the computer, traditional artists were abandoning the sterile white walls and rectangular pedestals of the gallery in favour of an activation of the space between the walls” (Mitchell, 2010, p. 101). In 1958, a collaborative work between Edgard Varèse, Le Corbusier and Iannis Xenakis was exhibited at the Brussels World Fair (Bredel, 1984, p. 178) (see Fig. 13). “This seminal work (*Poème Électronique*) was the first fully immersive environment that combined electronic music, projections, and architecture for the purpose of creating a total work of art” (Mitchell, 2010, p. 101). Jak Boumans writes, “In this bold architectural pavilion Philips presented its first large multiple media performance. At the World Exposition of 1958 Philips wanted to symbolise progress and innovation: light, sound, electronics and computing. [...] The

visitors got to see a slide show with images projected all around 360 degrees, supported by electronic music coming from 400 speakers. The multiple media show named *Poème Electronique*, lasted 480 seconds and demonstrated the history of mankind in sound and vision with images from nature, masks and old cultures, armoury, children, matures seniors, cities, birth, life and death” (Boumans, 2013). Sven Sterken also comments, “Based principally on illusion, the immersive experience the audience lived in the Philips Pavilion does not actually largely differ from the way virtual reality is evoked today” (Sterken, 2001, p. 266).

As mentioned above, the overall design realised the Wagnerian Gesamtkunstwerk in the modern era (Lombardo et al., 2009, p. 31).



Figure 13 Corbusier, L. (1958). *Poème électronique and Philips Pavilion*. Photo by Wouter Hagens. Retrieved February 10, 2018, from <http://scalar.usc.edu/works/pandemonium/le-corbusiers-philips-pavilion-at-expo-1958>

With the development of computer technology, installation art and animation and interactivity have combined. In 1988, Jeffrey Shaw finished

The Legible City (see Fig 14). Tourists could ride on the bike and travel in the virtual building. “As the individual becomes completely absorbed in his or her experience, he or she becomes immersed in a newly created form of time and space” (Ran, 2009, p. 203). This is an early work in which the animated installation interacted with the viewer-participant.



Figure 14 Shaw, J. (1988). *The Legible City*. [installation]. Retrieved April 11, 2016 from ZKM Centre for Art and Media Karlsruhe website <http://zkm.de/en/artwork/the-legible-city>

In recent years, animation installations have become more and more interactive. In particular, the interactivity of animation installations as we understand it is appealing to different groups. TeamLab is a well-known Japanese new media design company. From 2016 to 2017, they held an itinerant exhibition around the world (TeamLab, n.d.). The most outstanding characteristic of TeamLab’s work is its diversified interactive elements, which when triggered by human action change the animation image and content in real time (see Fig. 15).



Figure 15 TeamLab. (2016). *Story of the Time, When Gods were Everywhere*. Singapore: ArtScience Museum. Photo by Luo ShenShen, March 21, 2016. In this interactive installation, “depicting a digitally projected world, visitors of all ages can create their own environment by touching the hieroglyphic characters (the Oracle Bones Script). When visitors touch the characters, the story begins” (ArtScience Museum unveils landmark exhibition: FUTURE WORLD: Where Art Meets Science”, n.d.).

In the entertainment industry, and the theme park industry in particular, installation animation is used even more widely. Scenic spots in Disneyland or Universal Studios with installation animations are too numerous to mention individually. These projects are appealing to tourists (see Fig. 16, 17).



Figure 16 Disney's most popular attraction: *Buzz Lightyear Astro Blasters*. Visitors shooting the enemies on the screens. Photo by Luo ShenShen. June 22, 2016.



Figure 17 In Universal Studio Orlando's *Hogwarts Express*, an animated installation depicting a scenery outside the window. Photo by Luo ShenShen. July 5, 2016.

Such explosive growth is a result of instrumental animation, which makes it easier to combine animation with other forms of art.

When discussing sculpture or other spatial arts, there is an obvious boundary between the art's subject and audience, with the subject surrounded by the audience. For installation art, there is a relatively open space. The audience is within the subject and is involved in its creation. The audience and objects in the installation create and recreate the spatial experience. When it comes to art, the purpose of installation is to change the audience's spatial perception and provide them with a completely different experience by creating the environment and space. The video installation, as a kind of installation art, also requires a material carrier for space construction. At present, most video installation art is realised by projection. Single- or multi-screen images are expressed with projection media, such as a wall or a projector screen. Such physical materials and images jointly constitute the space of video installation art.

2.2. Immersive Spaces

By changing space, by leaving the space of one's usual sensibilities, one enters into communication with a space that is psychically innovating...For we do not change place, we change our Nature (Bachelard, 1966, pp. 203-210).

An immersive world is a place in which anyone can get wrapped up. Whatever your background in life, whatever your political or religious views, and whatever you enjoy doing in your spare time, an immersive world will take you in such that you won't want to leave (Lukas, 2013, p. 4).

We once again turn our attention to the development of the technology of immersive spaces in order to see how we arrived at the decisions taken for our theme parks and museums.

Today the term “immersive space” covers numerous areas including virtual reality, computer games, digital film, large projections and surround screens as well as physical spaces. All such works and articles have a restrictive condition for the definition of immersive space: artificiality. In addition, the vast majority are created digitally and have some physical design.

Based on this definition, immersiveness is a characteristic of the computer-generated virtual world. Some scholars argue that immersiveness is one of the main components of a virtual world (Sherman & Craig, 2003, pp. 7-9).

Oliver Grau cited the illustration “Spherical Field of Vision” by Karen Wonders (see Fig. 18). In the figure, the observer is at the centre of a spherical space, and when the observer freely changes his or her angle and viewpoint he or she always observes the entire surrounding environment. In another words, the observer can observe his or her surroundings despite the time and location. This is the method of observation used in the real world and is the prerequisite for the creation of a virtual world. For the creation of a virtual immersive space, the most important object for “completely alternative reality” (Grau, 2004, p. 13) is to create an image that is rendered and updated from time to time. Meanwhile, the observer is given “the option of fusing with the image medium” (Grau, 2003, p. 13) to influence his or her sensory impressions and awareness.

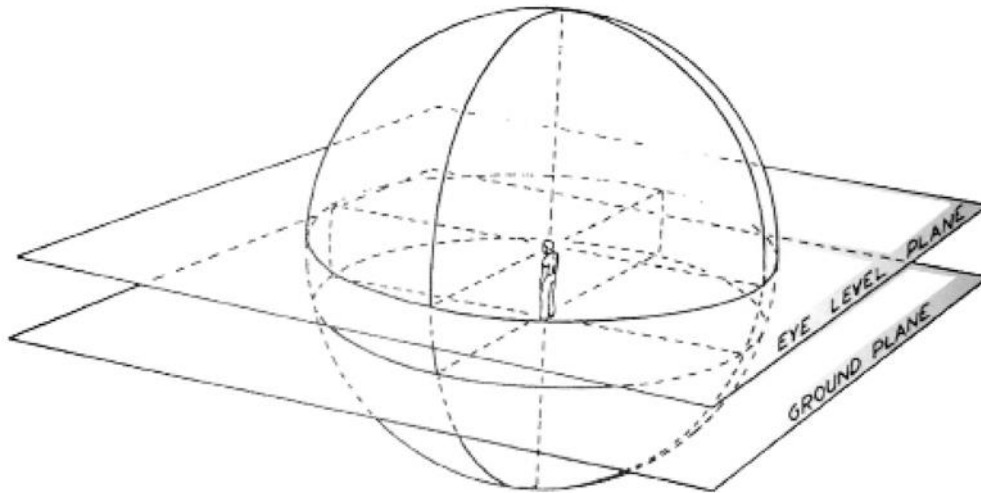


Figure 18 "Spherical Field of Vision." Drawing by John Boone. (Wonders, 1993, p. 207).

According to Randy Pausch, there are four points to note. First, an immersive world should be an experiential world, whether it is physical or virtual. Only if it allows the observer to be immersed can it be called an immersive space. Second, whether it is a virtual or real world, a hermetic environment is a prerequisite for creating an immersive space. Only in a relatively enclosed environment can the necessary information be conveyed to the audience without being subject to external interference. Third, to create a virtual immersive environment, image updating, and rendering must happen in real time; otherwise, the observer's immersive experience will be greatly hindered by rendering delays (Pausch et al., 1996, p. 201). This is why manufacturers are constantly increasing the refresh rate of the display and the image processing speed to avoid lag and stutter and to improve people's experiences. Eventually, to allow the observer to become immersed, sensory and mental factors are indispensable. This is related to people's memory and association.

2.2.1. A Brief Historical Background

Spatial coding is defined explicitly here as activity of integrating inputs from diverse sources as potential reference cues that specify the location (“where”), distance (“how far”) or direction (“what turnings”) in perception and action that a task demands (Millar, 2008, p. 3).

When we talk about space, we often ask, “Is space actually an entity, a relationship between our senses and physical objects, or an abstract concept? Can we define, create, and manipulate space to create aesthetic experiences?” (Mitchell, 2010, p. 102).

Immersive space can mean numerous things (Grau, 2004; Smelik, 1999; Bieger, 2013; Werner, 2007; Krueger, 1983). This follows Lukas’s definition of immersive space and focuses these ideas within the range of artificial space on personal senses such as vision, hearing, scent, taste and touch (considering thermoreception, temperature), equilibrium and the kinaesthetic sense, as well (Lukas, 2013, p. 198) triggered through some kind of mechanism. Therefore, the precondition of an immersive experience should be the appropriate artificial space to stimulate the senses organs. The space is unreality, so it should let a person forget about normal space and time and create different psychological feelings. The focus is on human feeling in immersive environments and their corresponding “non-encumbered” and “encumbered”¹⁷ design principles.

¹⁷ Bonnie Mitchell explain “when discussing immersive worlds, human typically divide the experience into two categories: encumbered and non-encumbered”. Head-mounted display systems is kind of encumbered world, the CAVE systems is kind of non-encumbered world (Mitchell, 2010, p. 100).

When we look up the definition of the word immersive,¹⁸ its noun *immersion* comes from late 15th century Latin *immergere* 'dip into', completely submerged by water (New Oxford American Dictionary). The term now extends to a computer-generated image. The early Chinese definition of immersion is similar to that in the West. The Chinese term is 沉浸 (*chén jìn*). Xushen's 说文解字 (*Shuo wen chieh tzu*)¹⁹ defines 沉 (*chén*) as “陵上澆水也” (*líng shàng hào shuǐ yě*; water on the earth after the heavy rain) and defines 浸 (*jìn*) as “水” (*shuǐ*; water) or “没” (*mò*; sink). Chuang Tzu said, “大浸稽天而不溺” (*dà jìn jí tiān ér bú nì*; the greatest floods, reaching to the sky, could not drown him) (Chuang tzu, n.d.).

Han Yu's (769-824) 进学解 (*Jin Xue Jie*) reads, “沉浸醲郁，含英咀华” (*chén jīn nóng yù, hán yīng jǔ huá*; immersed in a classic book like sweet wine and chewing the marrow out to taste it) (Han, 1936, Vol. 12, p. 140). This is the early appearance of the term "immersion" in reference to a mental state in ancient Chinese texts.

At this point, as Janet Murray writes, “immersion is a metaphorical term derived from the physical experience of being submerged in water... in a participatory medium, immersion implies learning to swim, to do the things that the new environment makes possible...the enjoyment of immersion as a participatory activity” (Murray, 1997, p. 99).

18 Immersive: (of a computer display or system) generating a three-dimensional image which appears to surround the user. New Oxford American Dictionary.

19 “The *Shuo wen chieh tzu*, know usually as the *Suo wen*, is the first comprehensive dictionary of Chinese characters that was ever compiled” (Boltz, 1993, p. 429)

There is an evocation of immersive experience in the earliest known form of human expression. People have long tried to build virtual environments for worship and other spiritual needs. Examples are found from the Cro-Magnons who left cave paintings of large animals in the great Lascaux Cave over 36,000 years ago (see Fig. 19), the Pompeii fresco depicting the Villa of the Mysteries (see Fig. 20), in the Dunhuang Grottoes on the Silk Road (see Fig. 21) and coloured drawings of Juan Qin Zhai from the reign of Emperor Qianlong of the Qing Dynasty (see Fig. 22). Humans consistently use technologies and ideas to build an inspiring virtual space within a relatively closed space. Oliver Grau describes this as the “illusionistic landscape room” (Grau, 2003, p. 58).



Figure 19 Brimberg, Sisse. (n.d.). *Lascaux cave wall*. [photograph] Retrieved January 5, 2018 from <https://www.scriptmag.com/features/what-is-a-story-an-introduction>



Figure 20 Weibel, Barbara. (2014). *Villa dei Misteri* (60 B.C). Room 5, Pompeii, Soprintendenza Archeologica di Roma. [Wall painting]. Retrieved January 15, 2018, from <http://holeinthedonut.com/2014/06/16/photo-frescoes-in-the-villa-dei-misteri-pompeii-italy/>



Figure 21 Mogao Grottoes No. 285, Dunhuang. (Xi Wei Dynasty, 538AD). Retrieved January 15, 2018, from Dunhuang Academy web <http://public.dha.ac.cn/content.aspx?id=694968101394>



Figure 22 Juanqin-zhai: Yanguangzhao with coloured drawings on paper, which covered the wall in the imperial palace, Beijing, China 1772. (Forbidden City Museum, 1995, p. 241).

From the above examples, we see numerous similarities between both Eastern and Western historical cognition. An immersive space requires some conditions. The author's view is that an immersive space is an independent, hermetically artificial space that is designed to trigger the human senses and inspire memories through some kind of mechanism. For the experiencer, this is a dynamic process, which is a gradual transition from sensory experience to a narrative experience. The expression of such an immersive space is a virtual environment or space created by humans using tools and technologies. Human beings will have immersive experiences in the virtual world in the same way that we have them in the real world.

We may safely draw the intuitive judgment that before the cinematic era, the immersive space was characterised by the normal objects' visual scales and 360-degree images.

2.2.2. Immersive Spaces Research and Display (18th–21st Centuries)

Virtual immersive spaces must be classed as extreme variants of image media that, on account of their totality, offer a completely alternative reality (Grau, 2004, p. 13).

From the Pompeii room mural and the “illusionistic landscape room” (Grau, 2004, p. 58) until the mid-18th century, artists created a new style of art: panorama. Based on Erkki Huhtamo (2013), Panoramas, and their associated forms: Diorama (p. 139), Georama (p. 189), Cyclorama (p. 6), Cosmorama (p. 77), Kineorama (p. 121), Poecilorama (p. 107), Physiorama (p. 163), and Udorama (p. 130), were part of the 19th century of “speaking in rama,” as stated in Balzac’s *Le Père Goriot* (Kenderdine, 2007, p. 305). Scottish painter Robert Barker coined the word panorama²⁰ in 1787 through images depicting cityscapes (Oettermann, 1997, p. 5; Huhtamo, 2013, p. 4; PANORAMA XXL web, n.d.). Barker’s main achievement was solving numerous complex perspective challenges in large-scale images. Later, Barker moved his panoramas and built a panorama building, “the world’s first purpose-built rotunda opened in Leicester Square on May 14, 1793” (Grau, 2004, p. 58). It has been hailed as “the first true mass medium” (Oettermann, 1997, p. 7). This rotunda remained open until 1864 and

²⁰ Robert Barker had first given it a French title: *La Nature à Coup d’Oeil* / Nature at a glance (Boyle, 2013), because of the political trends in 18th century, French became the language of “modern tyrants” and “Hellenism was coming into favour” (Huhtamo, 2013, p. 4), Barker coined a new term: panorama in the late eighteenth century from two Greek roots, *pan* (all) and *horama* (view)” (Oettermann, 1997, p. 6).

exhibited a total of 126 different panoramas (Grau, 2004, p. 83) (see Fig. 23). The panorama is deemed as a method for tourists to escape reality. Panorama means creating a virtual image across as much of the horizon as possible in a closed environment. The panorama is based on an illusion principle, and it attempts to make the audience feel they have been sent into the scene represented by the image. To realise this goal, the audience is asked to walk past a dark corridor and up ambiguously directed stairs to get to the central platform of the hall. The visitors look around on this platform, and they are unable to see the hidden bottom of the picture. A huge curtain stops the visitors from seeing the roof of the building (Fay, 1847, p. 3). Stephen Oettermann states, "In the panorama, real image spaces are created in which the observer moves around" (Oettermann, 1997, p. 41). The best method is to draw an interconnected large image inside a drum building. This form is so attractive that in the 18th and 19th centuries, panorama artists spent most of their time travelling to various countries to create exotic panoramas. As for the content, in the 19th century, the theme of war became popular in panoramas followed by exoticism and heritage cities (Huhtamo, 2013, pp. 112-120; PANORAMA XXL web, n.d.).

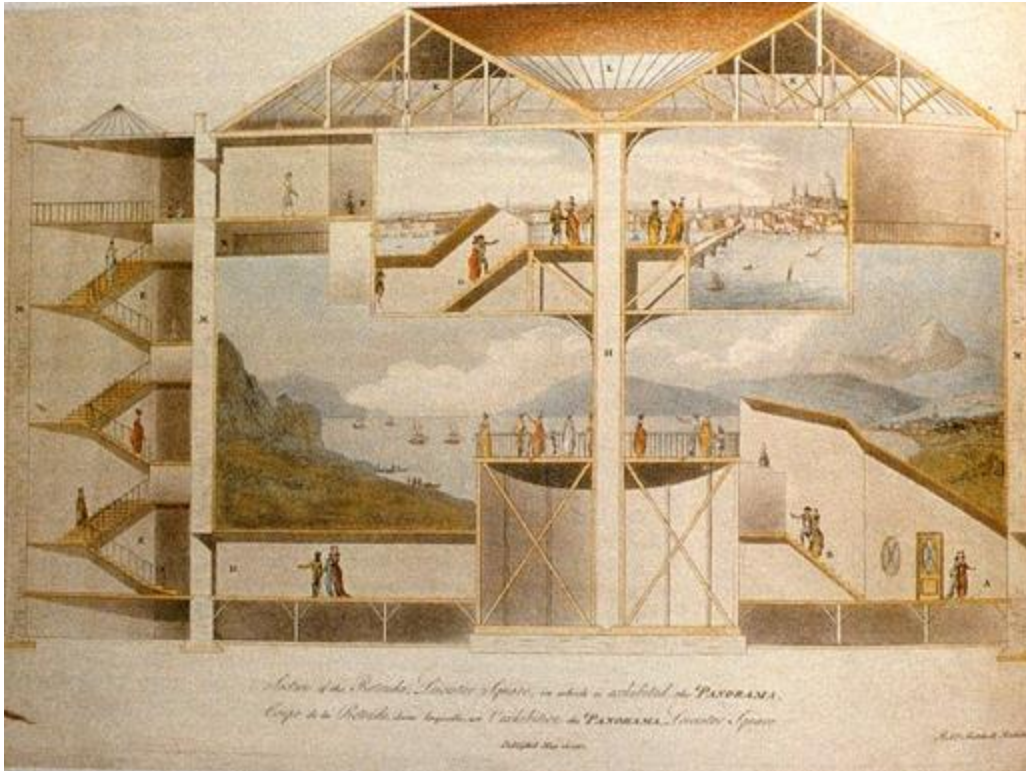


Figure 23 Mitchell, Robert. (1901). *Robert Barker's Panorama Rotunda at Leicester Square*. [aquatint]. (Oettermann, 1997, p, 104).

As mentioned before, scholars consider that Wagner's attempt to create a stage-oriented drama blending all art forms in 19th century was inspired by panorama art. Wagner's *Gesamtkunstwerk* can be interpreted as creating an immersive space in the physical world (Zarobell, 2010, p. 20; Petit, 1983, p. 245). "Wagner's description of the *Gesamtkunstwerk* is one of the attempts in modern art to establish a practical, theoretical system for the comprehensive integration of the art" (Packer & Jordan 2002, p. xx) and "Richard Wagner's *Gesamtkunstwerk* was driven by a vision of theatre in which the audience loses itself in the veracity of the drama, creating an immersive experience" (Packer & Jordan, 2002, p. xxiii). Wagner's art concept is a criticism of the traditional opera performance at the time. In his view, drama and opera were an integral whole. Secondly, such art experiences should combine all the sensory experiences of the audience

watching a harmonious performance to ultimately awaken the audience and lead them into a deeper level of appreciation and experience (Wolfman, 2013). This method indicates an experience of virtual reality. The audience may immerse themselves in the stage of the virtual world.

In the beginning of the 20th century, panorama became more popular. A well-known impressionist, Claude Monet, started creating panorama paintings in his later life. From 1915 to 1917, Monet created numerous single 12m x 2m water lily panorama paintings (Grau, 2004, p. 141) (see Fig. 24). Monet tried to express the water lilies in the water of his garden and the surrounding environment in the panorama, creating “the illusion of a single continuous canvas” (Sagner-Duchting, 1985, p. 55).

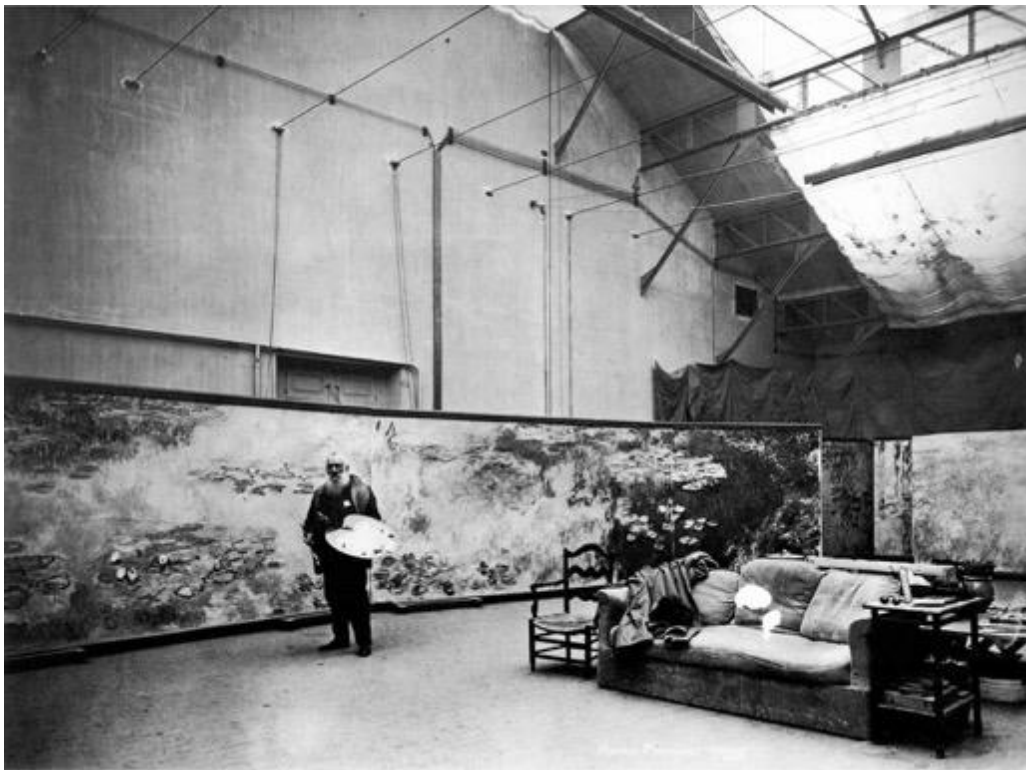


Figure 24 Monet and his panorama painting of water lilies, Giverny (King, 2016, p. 433).

Barker, Wagner, and Monet were all trying to create a maximized sensory experience. With the sensory experience, the observer’s mind is pulled away

from the real environment in which the body is located to the virtual world the artist has created.

2.2.2.1. Projection Systems (*Cinematic Panorama, Dome Theatre, Pepper's Ghost Illusion, CAVE and Projection Mapping*)

With the advent of film, the demand for active images and stereoscopic vision became stronger. At the end of the 19th century, some people wanted to use film technology in panoramas to arouse people's passion for panorama again. In 1895, a rotating equipment Stereopticon, which comprised 16 projectors, was successfully registered by Charles A. Chase in Chicago, Illinois. This new technology was called the Stereopticon Panorama Machine (1895) and was first presented at the 1900 World Exhibition in Paris (Grau, 2004, p. 147; Huhtamo, 2013, p. 317; Kiessling, 2017, pp. 2-3) (see Fig. 25). The creator, Raoul Grimoin-Sanson, used ten 70mm film projectors to show a connected 360-degree image around the viewing platform (Friedberg, 1993, p. 84). The visitors looked around, standing on the high platform similar to a huge balloon basket with a balloon, and the images in the surrounding environment (Ø 30m) were actually projections from the ten projectors (Kiessling, 2017, p. 3).

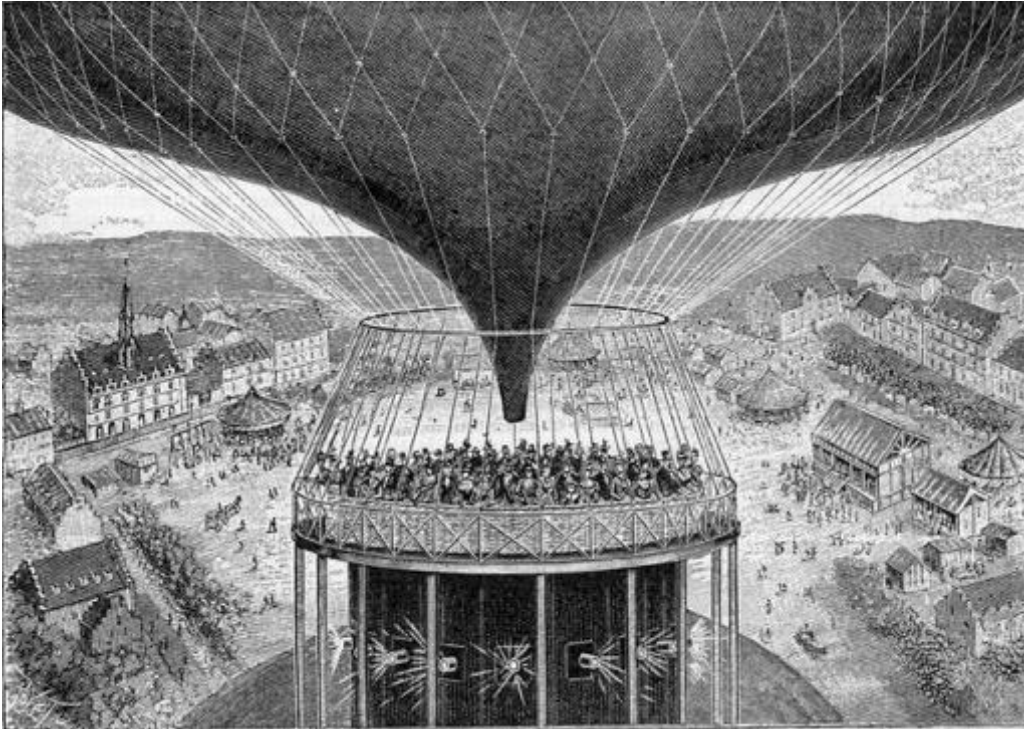


Figure 25 The Cineorama at the 1900 World Exhibition in Paris. Grimoin-Sanson, Raoul. (1897). *Nouvel appareil permettant de photographier et de projeter sur un écran circulaire des vues animées panoramiques en couleur par le Cinécosmorama Sanson. patent nr. 272.517 (FR).* (Kiessling, 2017, p.3).

This presentation laid the foundation for the future digital immersive space.

This method of exhibition is still used today with newer technology. In Rouen, France, a project named Panorama XXL attracts millions of visitors every year (see Fig. 26). In this panorama theatre, visitors still stand on a high platform in the middle to enjoy the High Definition (HD) images of the Rouen cityscape in the Gothic period, the Roman cityscape in the classical period or the mysterious Amazon jungle (PANORAMA XXL web).



Figure 26 Rouen Gothic in The Panorama XXL. Retrieved June 6, 2017, from PANORAMA XXL website, <http://www.panoramaxxl.com/en/expositions/rouen/>

With the technological progress and emergence of HD projectors, panorama completely abandoned the tradition of painting. To form a large, arc-like screen, it adopted a software-based solution, which includes geometry calibration and edge blending and combines photography and virtual reality technology (e.g., *Sacred Angkor* (2004), *PLACE-Hampi* (2006), *Eye of Nagaur* (2008), and *Pure Land* (2012)) (Shaw, 1993, pp. 60-61; Hansen, 2004, pp.43-45; Kenderdine, 2013, pp. 199-218) (see Fig. 27).



Figure 27 Kenderdine, S., & Shaw, J. (2012). *Pure Land*. Hong Kong, China: City University of Hong Kong and Dunhuang Academy. Image Retrieved July 7, 2017, from <http://www.asia.si.edu/events/pure-land.asp>.

“Dome” is an architecture term that resembles the hollow upper half of a sphere. It has been around for thousands of years. Like panoramas, early humans painted in domed spaces, trying to build a maximized immersion

experience. However, the panorama is a cylindrical space while the dome is the upper half of a sphere, or it can even be the lower half (e.g., the Saudi Pavilion at the Shanghai Expo 2010). In three-dimensional geometry, it is called 2π steradians.²¹ As with the development of panorama, the projector was used in domes instead of painting and film (Kiessling, 2017, pp. 6-7). In the 1920s, the Zeiss Company first used domes as projection screens (Shaw et al., 1998; Kiessling, 2017, p. 5) (see Fig. 28). Zeiss's most impressive dome screen construction project—a reinforced concrete planetarium that is 27 metres in diameter and can hold 1,440 patrons—was completed in the newly founded Soviet Union in 1929. This was a mark of victory the socialist Soviet Union demonstrated to its Western opponents (Firebrace, 2018).



Figure 28 Public show of the first projection planetarium on the roof of the ZEISS factory in Jena (1924). Image courtesy of ZEISS. Retrieved 7th February 2017 from ZEISS website, <https://www.zeiss.com/planetariums/int/media/images/history.html>.

²¹ Steradian: “the SI unit of solid angle, equal to the angle at the centre of a sphere subtended by a part of the surface equal in area to the square of the radius” (Oxford Dictionary of English). “From the center of a sphere, the solid angle subtended by the sphere is 4π sr: The surface of a sphere is 4π times the radius squared” Vincent et al., 2016, 56).

In 1963, Pacific Theatres Inc. opened a new design for theatres to present widescreen Cinerama films. Since the 1970s and 1980s, film industry has tried to enhance immersive experiences in the cinema. In 1973, the first IMAX Dome Theatre opened in Reuben H. Fleet Space Theatre and Science Centre in San Diego. The dome system, first called OMNIMAX, “wraps 180° horizontally, 100° above the horizon and 22° below the horizon for a viewer at the center of the dome” (IMAX, n.d.), with an average diameter of 23 m, a tilt angle of 25 degrees and 300+ seats (Duncan, 2006, p. 89; Kiessling, 2017, p. 8; Disse, n.d.). In 1983, Nelson Max in *SIGGRAPH '84 Call for Omnimax Films* showed the image of the new dome theatre and described its design and display system at the OMNIMAX theatre of the Science Museum of Minnesota (see Fig. 29).

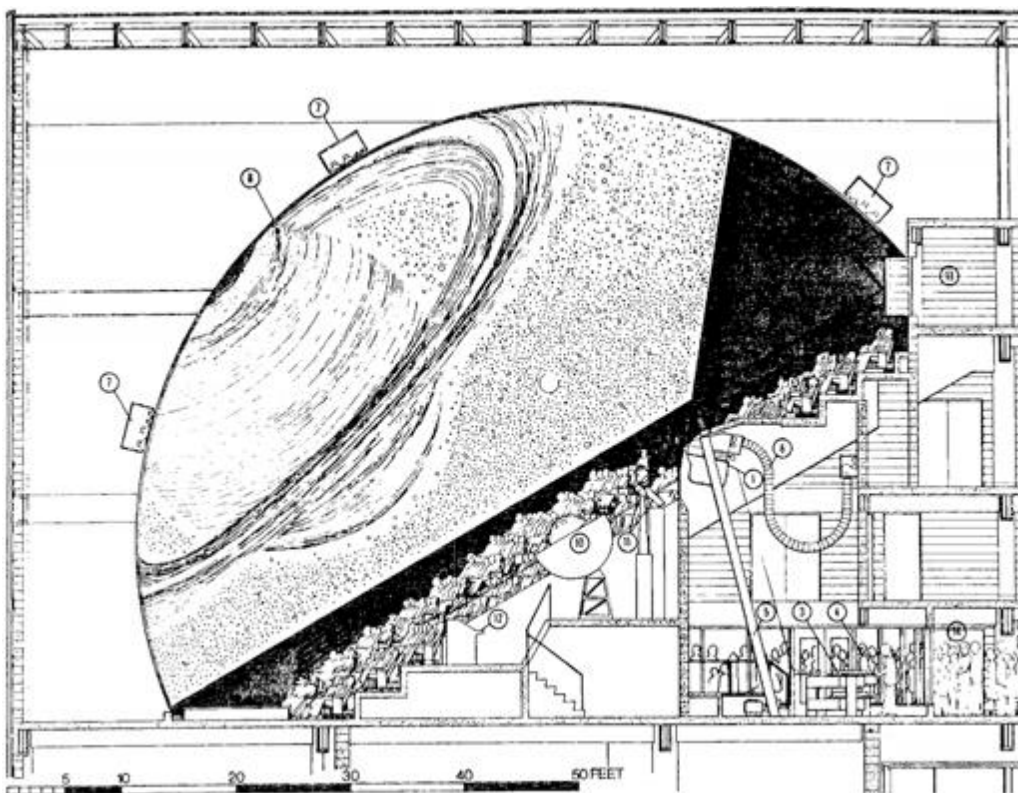


Figure 29 Omnimax Theater, 1984. (Max, 1983, p. 74).

From then on after two decades, the various concepts of new domes emerged as digital technology became available: fulldome, halfdome, IMAXDome [formerly OMNIMAX] and horizontal or tilted domes. James J. Gibson commented, “With a Cinema screen, the virtual window may sample as much as 160° of the ambient array, instead of the mere 20° or 30° of the usual movie theatre, and the illusion of locomotion may then be compelling, uncomfortably so” (Gibson, 1986, p. 184).

Today, numerous dome theatres and dome movies around the world are used in areas such as education and entertainment (Jacobs, 2004; Hauerslev, 2006). "'Tour of the Universe' in Toronto and 'Star Tours' at Disneyland are among the first entertainment applications of simulation technology and virtual display environment” (Packer & Jordan 2002, p. 260). In recent years, with the popularity of three-dimensional stereoscopic film technology, dome theatres are used for immersive experiences in theme parks and museums (see Fig. 30, 31).



Figure 30 A digital dome theater in Papalote Children’s Museum, Mexico City. Image retrieved June 7, 2017, from <https://panasonic.net/cns/projector/casestudies/028.html>

Such dome screens are combined with other somatosensory devices, such as movable chairs, devices that simulate airflow and devices that emit odours. Such devices are integrated into the visual experience provided by the dome screen to give visitors a more immersive experience.



Figure 31 Soarin' Around the World (Soaring Over the Horizon) at Disney California Adventure, Epcot and Shanghai Disneyland. This attraction uses an OMNIMAX screen. Bricker, Tom. (n.d.). Soarin' Around the World Review. Retrieved June 7, 2017, from Disneytouristblog website, <http://www.disneytouristblog.com/soarin-around-world-review/>

A different projection method called the Pepper's ghost illusion was invented by Professor John Henry Pepper and English engineer Henry Dircks in 1862 (University of Westminster, n.d.; Costa, 2016). This installation was first presented in 1862 at the Royal Polytechnic Institution in London (Castle, 1995, p. 151; Huhtamo, 2013, p. 288). This is an illusion using a piece of glass with its angle placed between the audience and the stage. The stage is used to reflect the light from an actor below the stage toward the audience. The illusion that audience can see through the transparent glass and an illusion of the actor's image hovering on stage in a

real background. (Pepper, 1996; Greenslade, 2011, p. 338; Castle, 1995, p. 151). (see Fig. 32). Pepper's ghost is often confused with the concept of holograms. In fact, most holograms seen on TV or stage are variations of Pepper's ghost (Williams, 2015). This form of exhibition is particularly applicable to the exhibition of indistinct objects, with the objects suddenly appearing or disappearing. This makes the space mysterious and fantastic.

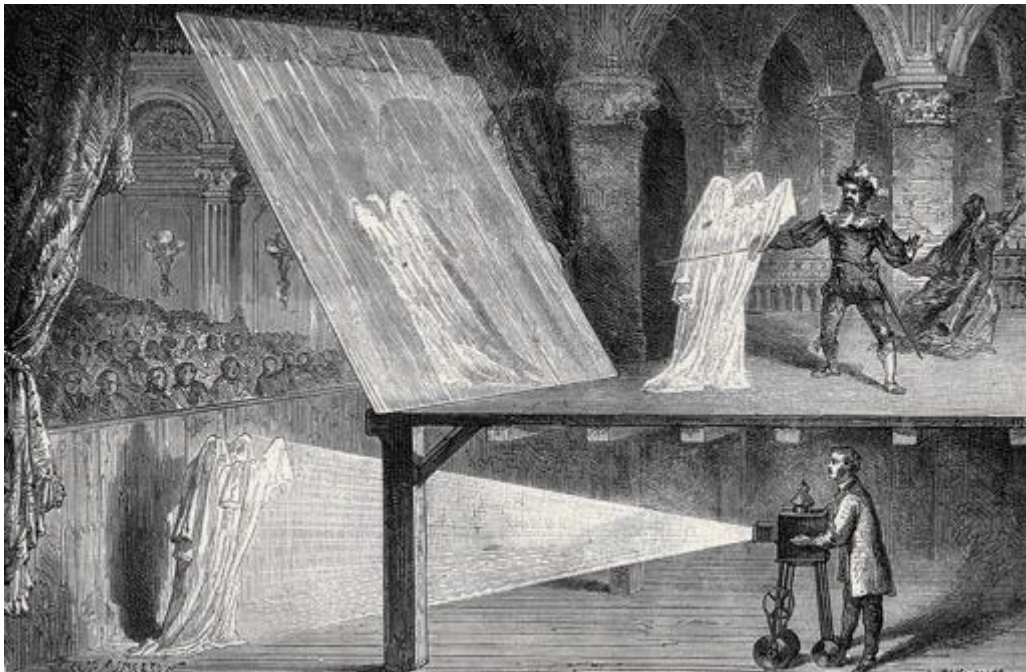


Figure 32 The Pepper's ghost illusion on the stage. Tissandier, Gaston. (n.d.). Popular Scientific Recreations. London: Ward, Lock, and Co., London. p. 138. This book was originally published in French in 1880. (Greenslade, 2011, p. 338).

Over the years, theme parks and other stage performances have increasingly used Pepper's ghost through 3D computer-generated imaging and projectors instead of actors a separate the light source (Hofer, 2011, p. 232-251). In 2007, a drama about Norman McLaren's life and animations appeared on the stage. The work was presented at the Canadian in 2007 in a lavish production, which later travelled the world (Lemieux Pilon 4d art, 2008). The piece is a tribute to four-time Academy Award-nominated filmmaker Norman McLaren, and uses a combination of film, dance, music,

theatre and Pepper's ghost (see Fig. 33) with McLaren's animations projected on the slanted glass mixed with a live performer.



Figure 33 Lemieux Pilon 4d art. (2008). Norman 2007. Retrieved June 27,2018, from Lemieux Pilon 4d art website, <http://4dart.com/en/creation/2007/norman/>

Another projection system was made during the 1970s, soon after media artist Daniel J. Sandin and engineer Thomas A. DeFanti joined the Electronic Visualization Laboratory at the University of Illinois, Chicago. They and Ph.D. student Carolina Cruz-Neira tried to combine computer graphics and video imaging (Cruz-Neira et al., 1992, pp. 64-72; Cruz-Neira et al., 1993, pp. 59-66). In 1991, they designed and built the first Cave Automatic Virtual Environment (CAVE) system, which used "computer-generated imagery and 3D audio with physical space-freeing the user from the confinement of the head-mounted display and dataglove" (Packer & Jordan, 2002, p. 287). The CAVE system is used in a relatively enclosed square space in which a follow-up mechanism is equipped to capture visitors' actions. The captured dynamic state is fed back to the image-processing system in real time. The

image-processing system, with the projector, projects the video onto the wall and ground of the space (Gutierrez et al., 2008, p. 135) (see Fig. 45).

This installation integrates the virtual world and real world. Packer writes, “Unlike other systems of virtual reality, the properties of CAVE are enhanced by the interplay between the real and the virtual [...] (CAVE) is viscerally aware of his or her physical presence ‘on stage’ amid the animated imagery and orchestrated sound” (Packer & Jordan, 2002, p. 287). At the same time, it is not suitable for multiplayer experiences, because “the screen images are shown from the perspective of only one person, the so-called lead viewer, who is being tracked” (Sandin et al., 2002, p. 291). The initial design concept of the CAVE system aimed to break away from the limit of the Head Mounted Display (HMD) system and minimize constraints on user motion. In addition, it offers a shared virtual and reality experience. At present, this technology is widely used in building, art and engineering design (Hazan, 2007, pp. 143-144).



Figure 34 Cave Automatic Virtual Environment applies in the game. Retrieved June 27, 2017, from <http://www.technobyte.org/2016/03/introduction-virtual-reality/>

Projection mapping, also called spatially augmented reality (Raskar et al., 1998, p. 1), projection-based augmented reality (Mine et al., 2012, p. 32) or projection-based spatial displays (Oliver & Raskar, 2005, p. 87), is a display technology that projects videos onto surfaces of various objects. Most scholars classify it under augmented reality (Azuma, 1997, p. 355-385; Bimber & Raskar, 2005; Zhou et al., 2008; Krevelen & Poelman, 2010, p. 1-20). This technology augments three-dimensional objects and spaces in the real world by projecting images onto different angled and shaped surfaces. The shape modelled projected images are software created and can be computer-generated, photographed, pre-recorded or in real time (Bimber et al., 2008, pp. 2219-2245; Hartley & Zisserman, 2004). Generally, projection mapping uses one or more projectors to project images onto one object or group of objects in the space. The differences between images and projection objects in terms of shape, colour, saturation and contrast are used

to create images with visual impact (see Fig. 35).



Figure 35 Architectural and environmental projection mapping at the National Gallery Singapore. Retrieved February 10, 2018, from <https://www.green-hippo.com/spectacular-projection-mapping-opening-national-gallery-singapore/>

According to Brett Jones, the first known instance of projection onto a non-flat surface occurred in 1969 at the opening of the Haunted Mansion ride in Disneyland (Jones, n.d.). According to Mark Mine's summary, projection mapping has the following merits: "1. compared with traditional illuminating methods, projection mapping is more capable of creating a dynamic, beautiful environment; 2. compared with AR equipment for one, it provides shared experience for multiple viewers; 3. as projection objects move less or have fixed motion trails, projection mapping has less image delay; 4. in consideration of the design, projectors are easy to conceal, making the overall environment more integrated" (Mine et al., 2012, p. 33; Svoboda et al., 2005, pp. 407-422; Szeliski, 2011, pp. 27-86; Majumder & Brown, 2007; Cham, 2003, pp. 513-520).

The biggest difference between projection mapping and flat screen

projection is that it must account for the Z-axis (depth) of images. Unlike flat screens, projection objects are mostly objects with curves (e.g., surface of cars) or different spatial layers (e.g., balconies and pillars behind or before building facade in building projection); therefore, correcting image distortions and visual issues of multi-screen displays become more important. Nowadays, the majority of popular projection mapping software has taken the 3D path in their evolution. In general, the targets of projection mapping are static objects; projection onto dynamic objects is occasionally problematic, which results from the image displacement caused by tracking system delays (Sakamaki & Hashimoto, 2013, p.39) and also the instability of existing algorithms in different image brightness levels (Sueishi et al., 2015, p. 98). These challenges will be solved as research progresses.

The application of projection mapping is becoming wider and is involved in medicine, education, design, entertainment, and acting. Recently, it has become particularly active in theme parks. Mark Mine comments, "Projection-based AR is a powerful tool for enhancing and energizing theme parks and other entertainment environments [...] Projection-based AR continues to be an important tool in Imagineering's tool chest, helping to make buildings come alive in theme park entertainment shows" (Mine et al., 2012, pp. 39-40).

2.2.2.2. Head Mounted Displays [HMD] and Hand-Held Displays

The aforementioned projection mapping, together with head-mounted and hand-held displays, falls in the category of augmented reality research (see Fig. 36). The latter two types of equipment display through liquid-crystal

display (LCD) or organic light-emitting diodes (OLED) rather than projected images, as projection mapping does (Bimber & Raskar, 2005, pp. 70-72) (see Fig. 36).

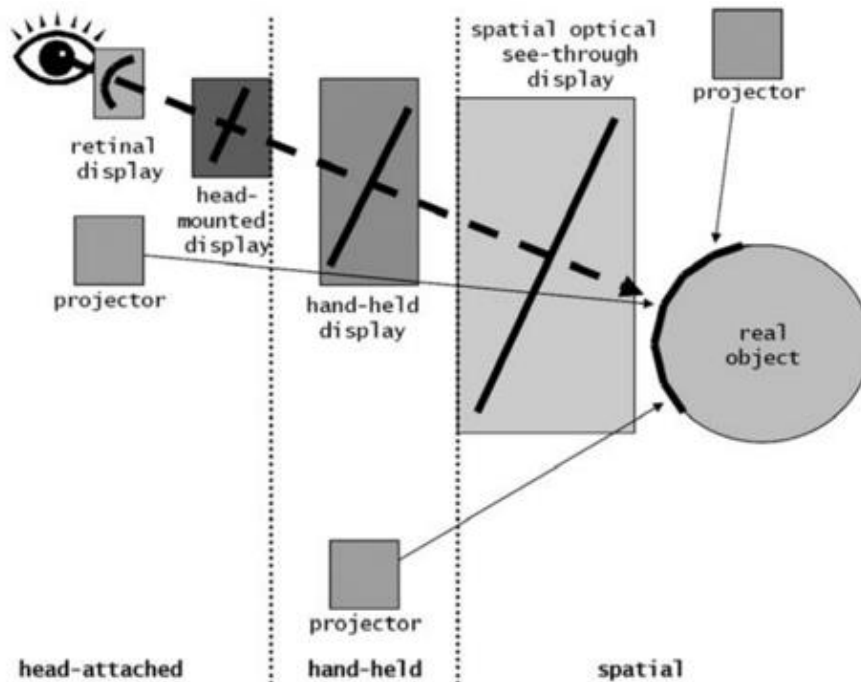


Figure 36 Image generation for augmented reality displays (Bimber & Raskar, 2005, p. 72)

HMD is short for head-mounted display or helmet-mounted display. This installation is the most popular virtual reality and augmented reality experience device at present. The reason it is head-mounted is to control the image placement in relation to where the viewer is looking or turning their head. Devices worn on the head can be very effective to simulate the virtual world.

The HMD design originated from a safety helmet used during the First World War. According William Sherman and Alan B. Craig, U.S. Patent 1,183,492 for a head-based periscope display was awarded to Albert B. Pratt in 1916 (Sherman & Craig, 2003, p. 24; Li et al., 2013) (see Fig. 37). This device used the specular refraction principle to observe the enemy from a trench, but it

was not widely used during the First World War.

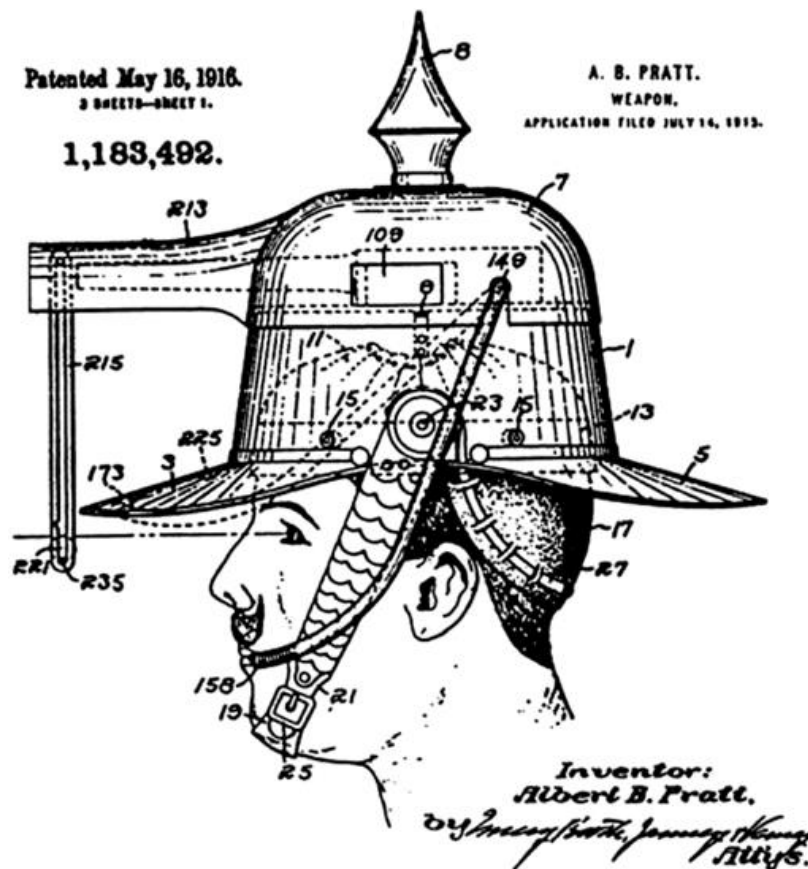


Figure 37 The first head mounted display was patented in 1916 (Image courtesy of United States Patent & Trademark Office) (Li et al., 2013). Retrieved February 20, 2018, from <https://www.spiedigitallibrary.org/journals/Optical-Engineering/volume-52/issue-11/110901/Review-and-analysis-of-avionic-helmet-mounted-displays/10.1117/1.OE.52.11.110901.full?SSO=1>

In 1850, William and Frederick Langenheim invented the “stereopticon”. It allowed people to use two flat images to obtain a stereovision through a set of optical lenses, one for each eye. It is similar to a 3D space (see Fig. 38). Stereographic photography is based on “a depth clue called stereopsis. Each eye receives slightly different views of an object” (Chan, 2014) from two similar photographs taken from slightly different angles. Through the human perception, these images combine into a single 3D image (Chan, 2014) much like seeing the real world with two eyes. This design has developed into the 3D glasses seen in cinemas today.



Figure 38 A stereographic glasses. Chan, Tiffany. (2014). *The Technical Challenges of Turning Stereophotography into 3D StereoGIFs*. Retrieved January 10, 2018, from <https://www.hastac.org/blogs/tiffany-chan/2014/10/20/technical-challenges-turning-stereophotography-3d-stereogifs>

In 1960, Morton Leonard Heilig created the “Stereoscopic television apparatus for individual use” (Heilig, 1960, p. 1). It is a device that combined two miniature TV screens with the principles of the stereoscope (Grau, 2004, p. 157).

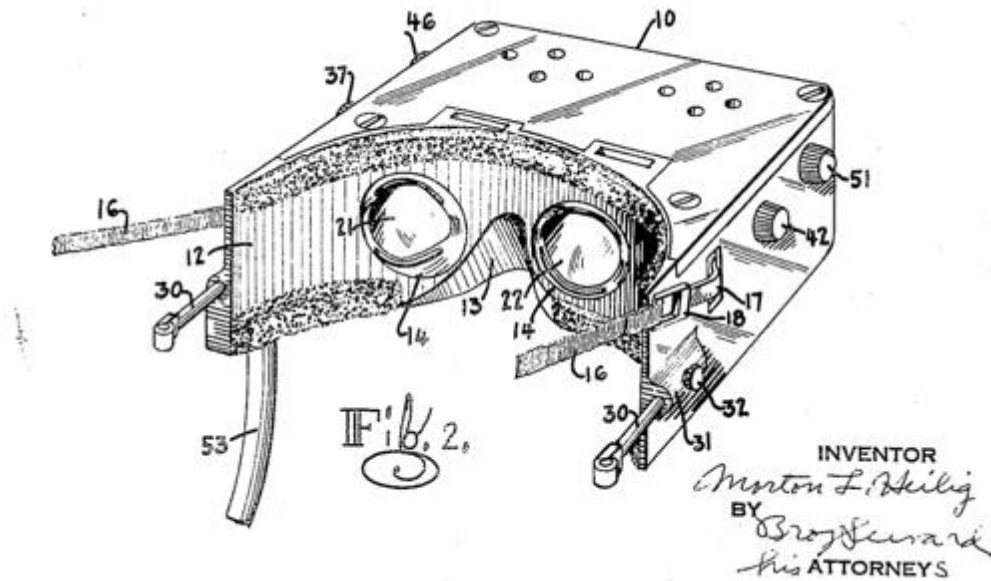


Figure 39 Stereoscopic television for individual use. (Heilig, 1960, p. 1). Retrieved July 10, 2017, from <https://patentimages.storage.googleapis.com/81/df/f1/f6cc2106f8c7ab/US2955156.pdf>

Later, Morton Leonard Heilig built a prototype of his device dubbed the Sensorama simulator in 1962, which combined and engaged multiple senses (i.e., sight, sound, smell, touch) (Heilig, 1962) (see Fig. 40). In this giant piece of equipment, users are given an opportunity to interact with the virtual world through a 3D screen, a stereo sound box and through touch. What should be noted is that in 1966, Sega launched an arcade game named *Periscope*, which simulated submarine shooting. The electromechanical interactive mode used here set a precedent for subsequent arcade games (Pettus et al., 2013, p. 6). The overall design concept of this Sega game is similar to the Sensorama simulator (see Fig. 41).



Figure 40 The prototype of Sensorama by Morton Leonard Heilig. Retrieved June 27, 2017, from <https://mediartinovation.com/2014/06/03/morton-heilig-sensorama-1957/>



Figure 41 An abandoned *Periscope* game. Retrieved June 27, 2017, from <https://www.flippers.com/images/SEGA-Periscope-found-exposed.JPG>

With the development of computer graphics technology, in 1968, Ivan Sutherland and his student Bob Sproull developed a primitive virtual environment computer system and augmented reality HMD system: *The Sword of Damocles* (Sutherland, 1968, p. 757-764). It provides an opportunity for interaction between individual users and the virtual world.

The user may see virtual graphics on the display that do not exist in the real world. “(Sutherland) was the first person to conceive and build an immersive VD (virtual displays) system” (Loomis & Blascovich, 1999, p. 557) (see Fig. 42).

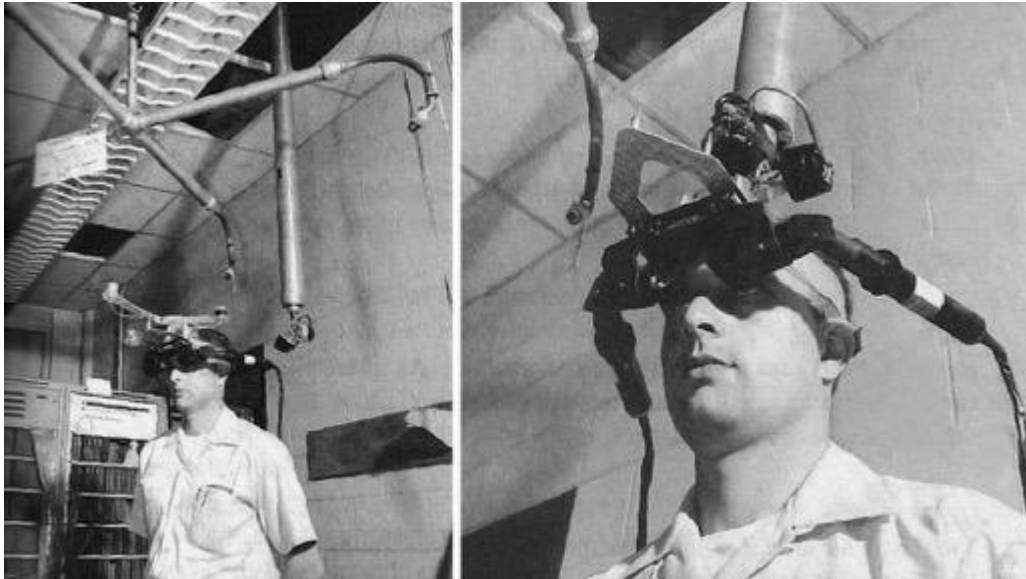


Figure 42 *The Sword of Damocles in use.* (Sutherland, 1968, p. 760).

In the 1990s, Char Davies’ team made *Osmose*, an epoch-defining masterpiece in the history of virtual reality. The HMD equipment at that time was very close to the equipment used today with lower image resolution. It can be regarded as a milestone in the development of HMDs, as in the world of *Osmose* users may interact with the virtual world through the HMD and the real-time motion capture system (Davies, 1998, pp. 144-155) (see Fig. 43). However, there has yet to be a major breakthrough in this immersive and interactive mode.



Figure 43 Davies, C. (1995). *Osmose*. Beckman, John. Ed. (1998). *The Virtual Dimension: Architecture, Representation, and Crash Culture*. Retrieved June 27, 2017, from http://www.immersence.com/publications/char/1998-CD-Virtual_Dimension.html

For commercial applications, Disney opened its first VR attraction, the story Aladdin using both HMD and projection-based visual displays in 1996 (Pausch et al., 1996, p. 193). In 2016, the hyper reality experience company VOID²² published a new hybrid-reality game, *Ghostbusters*, at Madame Tussaud's New York. This is a system for a four-person game. Besides an HMD, visitors are required to bring a backtop™ computer and wear a haptic vest to feel physical vibrations in their hands when they use the virtual weapons (Ghostbusters Day Contest, n.d.).

As the research of VR has boomed in recent years, the HMD equipment market has become very competitive for manufacturers, and the equipment is already synonymous with VR. Along with the development of materials and processing techniques, HMDs are becoming lighter, smaller and wireless with much higher image resolution and refresh rates needed for movement.

²² The VOID, the hyper-reality experience design company in Salt Lake City. Retrieved October 10, 2017, from <http://thevoid.com/#section-tech-slider>

Hand-held displays such as table PCs, smart phones or digital pads generate images within arm's reach and "combine processor, memory, display, and interactive technology into one single device, and aim at supporting a wireless and unconstrained mobile handling" (Bimber & Raskar, 2005, p. 79). Cameras integrate photographed images and augmented information and pass them to display equipment for users to interact with via the display. George W. Fitzmaurice called them "spatially aware" (Fitzmaurice, 1993, pp. 39-49).

In the wake of the wide application of Global Positioning System (GPS) techniques and improvements to image tracking, and because of portability and ease of use, hand-held displays' share of the virtual and augmented reality markets is swelling (traveling, shopping, communication, etc.). As more and more immersive experience scholars and designers have found that some apps can significantly expand the space and time of users' immersive experiences by means of increasingly powerful personal mobile terminals (Lukas, 2013, pp. 219-220; Atherton et al., 2013, pp. 6-10; Robinson et al., 2014). This phenomenon has emerged in some museums and theme parks. After an immersive experience, users can understand the history and culture related to a scene or region with the help of a specific app and can even further their experience via gaming (see Fig. 44). Scott A. Lukas commented, "Mobile media and augmented reality will continue to impact the design of themed and immersive spaces and designers should consider some of the basic ways that the space can be made more immersive and meaningful to the guest" (Lukas, 2013, p. 220).



Figure 44 Augmented reality game: Pokemon Go. Jansen, Mark. (2018). Escape reality with the best augmented reality apps for Android and iOS. Retrieved February 15, 2018, from <https://www.digitaltrends.com/mobile/best-augmented-reality-apps/>

2.2.2.3. Immersive Audio

The auditory sense determines people's spatial orientation and distance perception. The visual sense is especially responsible for giving a clue, while the auditory sense is responsible for verifying the authenticity of that clue. According to Tomlinson Holman, "around 1550, Flemish composer Adrian Willaert working in Venice used a chorus in left and right parts for antiphonal singing, matching the two organ chambers oriented to either side of the altar at St. Mark's Basilica" (Holman, 2007, p. 2).

For stereo reproduction, capturing and restoring sound are two important aspects. As the most vivid simulation technology, 3D surround audio can perfectly restore the sound field of the scene (Gutierrez et al., 2008, pp. 142-143; Kapralos & Mekuz, 2007, pp. 256-257).

Human ears have their own system to analyse and locate sound. The signal reaching our eardrums can be described by a filtering system, and what the "sound source + filter" (transfer function) gets is the signal before the sound reaches the eardrums. There is a difference between the sound source and such a signal. In addition, there is also a difference between the sounds heard by the left and right ears (Starch, 1905, p. 35). This may be a result of our evolution. The visual sense cannot help us to locate objects in the dark. However, we can locate objects in the dark based on the different sounds heard by our left and right ears. This filter is called the head-related transfer function (HRTF) (Algazi et al., 2001, p. 1110; Evans et al., 1998, 2400; Iida et al., 2007, p. 835). We can obtain the filter matrix if we have the filter banks of signals from all directions. Then, we can restore the sound signals coming from the space as a whole in recordings (Carlile, 1996, p. 1-11).

The HRTF is individual because everyone forms their own auditory perception in the growth process; different people have different head sizes, ear distances, ear contours and cochlea shapes (Gutierrez et al., 2008, p. 141). We have developed our own unique listening habits over time. Therefore, it can be said that the same sound is heard differently by different people.

This type of audio can also be called surround sound (Holman, 2007) (i.e., Dolby Atmos) or immersive audio (Kyriakakis, 1998). During the same period as the original stereo reproduction idea from Bell Labs in 1933, Alan Blumlein also developed numerous techniques at EMI in England (Holman, 2007, p. 3). In 1938, Walt Disney and Leopold Stokowski while "sitting in his living room in Toluca Lake some time later thought that during *The Flight of*

the Bumblebee, not only should the bumblebee be localizable across the screen, but also around the auditorium. Thus, surround sound was born” (Holman, 2007, p. 4).

Bell Labs’ Vocal Research Department made a mechanized artificial head named Oscar with two microphones in its ears. Oscar was placed in the exhibition room to record his surroundings. The solution provided by Bell Labs was called “binaural audio” (Lalwani, 2015). Simulating the head’s shape and ear distance, the sounds recorded are quite similar to those heard by humans. This effective "blunt method" restored the HRTF on the physical level. Based on this, Neumann, a German company specializing in microphones, continuously made breakthroughs from 1973 to 1992 in the field of binaural audio. It successfully produced better radio devices and placed microphones on the eardrums of artificial ears (Lalwani, 2015).

The widespread use of HMDs in VR industry has changed this technology. Specifically, the head-mounted VR devices still needs 3D audio to create real immersion, but we cannot turn our heads when using binaural audio (Gutierrez et al., 2008, pp. 148-150; Larsson et al., 2002, pp. 31-38). If there is a sound from behind when playing VR games, players' instinctive reaction is to turn around. However, if the sounds are still in “front” of players, the immersion is greatly reduced.

Surround audio, another technology used to recreate the real sound field, also cannot support head turning. Two well-known companies specializing in such technology are DTS and Dolby (Kyriakakis, 1998, p. 943). The operating principle is to use several physical loudspeakers to create a 360-degree sound field, and the sounds from different directions are emitted

through different loudspeakers (Kyriakakis, 1998, p. 942). For example, numerous loudspeakers are placed around the audience in a cinema with surround sound. If there is an explosion on the left side of the screen, the left loudspeaker will make a sound instead of the right one. Because the speaker's position is fixed, the audiences can only hear the most realistic simulated sounds in a fixed position, as well.

The key to solving this challenge is calculation. After obtaining the sounds through binaural audio, we shall restore the HRTF based on these calculations. Thus, a spatial audio whose sound field can change with head's location can be created. One example of this came from Princeton University's 3D3A Lab, which developed a technique called BACCH[®] 3D Sound or Pure Stereo 3D Audio (3D3A Lab, n.d.), a high-simulation sound system. Human beings typically rely on binaural hearing to get an accurate measurement of where sound sources are located. The study tries to use two speakers instead of multiple surround speakers. It takes advantage of the rotation of human binaural hearing to relocate the sound source by eliminating crosstalk. As we can imagine, this kind of equipment is very suitable for an enclosed virtual environment (3D3A Lab, n.d.). However, while this algorithm is effective, the experience is limited as the device needs to be centred in relation to the listener. If the audiences move out of the scene or leave the centre point, their immersion will immediately disappear. In the present global market, no company can provide a perfect method to solve this challenge because the application of 3D audio in head-mounted VR still has some technical challenges. (Gutierrez et al., 2008, p. 146).

2.2.2.4. Virtual Reality

The medium of 'immersive virtual space', or virtual reality—as it is generally known—has intriguing potential as an arena for constructing metaphors about our existential being-in-the-world and for exploring consciousness as it is experienced subjectively, as it is felt (Davies, 1998, p. 144).

The *Oxford English Dictionary* defines virtual as “not physically existing as such but made by software to appear to do so”. What is meant by “reality” is more complicated. The *Oxford English Dictionary* defines reality as “the state of things as they actually exist, as opposed to an idealistic or notional idea of them, or the state or quality of having existence or substance”. Based on the above definitions, the author posits that *virtual reality* is “the computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors”. In modern times, it seems that virtual reality, a term which is almost contradictory, has become an industry standard. Numerous digital industries are trying their best to integrate VR into their business concepts.

In 1950, Ray Bradbury first described the potential of such a simulated space in his book *The Veldt*. In this science fiction novella, the author shows a nursery in a future world, and the children live wherever they can imagine. This is the early description of the relationship between virtual and realistic space. In 1955, Morton Leonard Heilig developed a radical vision of the immersion idea to include taste, smell and touch (Heilig, 1992, p. 291). In *The Cinema of the Future*, he writes, “Each basic sense will dominate the

scene in roughly the same proportion we found them to have in man. That is, sight, 70%; sound, 20%; smell, 5%; touch, 4%; and taste, 1%” (Heilig, 1992, p. 292). Heilig “was the first to attempt to create what we call virtual reality” (Packer & Jordan, 2002, p. 240). Heilig quantified human perception and attempted to simulate the signals in the natural world and allow such signals to be perceived by human beings. Later, Ivan Sutherland wrote *The Ultimate Display* in 1965, “in which he made the first advance toward marrying the computer to the design, construction, navigation, and habitation of virtual worlds” (Packer & Jordan, 2002, p. 253). Because of this research, artists were inspired to mimic real technology, and the world’s first VR concept appeared as the Holodeck in the animated series of *Star Trek* in 1973 (Lukas, 2016, p. 120).

In the 1960s, Myron Krueger began to research interactive immersive environments (Mitchell, 2010). In 1982, Krueger coined the term “artificial reality” (Krueger, 1983; Gutierrez et al., 2008, p. 5) that was “used to describe his interactive immersive environments, based on video recognition techniques, that put a user in full, unencumbered contact with the digital world” (Krueger, 1983; 1991). In 1985, Scott Fisher made a significant advancement towards what he termed “telepresence”, or the “projection of the self into a remote location or virtual world” (Packer & Jordan, 2002, p. 258).

Jaron Lanier, founder of the Visual Programming Lab (VPL), created the terms “virtual reality”, “substitute reality”, “vicarious reality” and even “vicarious environment” in 1987 (Fuchs et al., 2011, p. 5; Gutierrez et al., 2008, p. 6). The complete concept of VR had first appeared in the world. In

1997, Char Davies used the term “immersive virtual space” in *Changing Space: Virtual Reality as an Arena of Embodied Being*, saying “such environments can provide a new kind of ‘place’ through which our minds may float among three-dimensionally extended yet virtual forms in a paradoxical combination of the ephemerally immaterial with what is perceived and bodily felt to be real” (Davies, 1998, p. 144).

Virtual reality and augmented reality are not only a kind of technology, but also an interactive medium (Craig, 2013, p. 2). William Sherman and Alan B. Craig describe that the virtual reality (VR) experience has four key elements: a virtual world, immersion, sensory feedback and interactivity (Sherman & Craig, 2003). According to Philippe Fuchs, virtual reality has five elements: a computer science base, behavioural interfaces, a virtual world, real-time interaction and pseudo-natural immersion (Fuchs et al., 2011, p. 8).

Sherman and Fuchs both clearly define the application scope of VR and the elements it should contain. Besides, sensory feedback means that the system must have the ability to identify people's behaviour and make changes accordingly, while the interactivity means such changes must be in real-time and sustainable.

VR is formed through real-time, three-dimensional image calculations based on computers. The artificial spaces people created before this (e.g., cave paintings or hand-painted panoramas) were not interactive and could only be called virtual worlds or virtual spaces. What the author wants to emphasise here is that the term VR movie used by some modern media is essentially incorrect, because real-time interaction is absent. Instead, such movies shall be called “*cinerama*” or “*circamara*” (Nilsen, 2011, p. 75).

Sherman and Craig have distinguished five kinds of VR displays: fish tank (monitor-based); projection (CAVE system, projection mapping and holographic 3D); head-based (occlusive HMD); non-occlusive head-based (“see through” augmented reality display); and handheld (mobile phone, pad) (Sherman & Craig, 2003, p. 140). Mario A. Gutierrez, Frederic Vexo and Daniel Thalmann have classified VR display: Head-Mounted Displays, Fish Tank VR, Handheld Displays, Large Projection Screens, and CAVE Systems (Gutierrez et al., 2008, pp. 130-135).

With the emergence of concept of augmented reality (AR),²³ in 1994, Paul Milgram and other researchers first introduced the concept of the reality-virtuality continuum (see Fig. 45). The following list is used to further distinguish the essential differences and similarities between the various display concepts that Milgram classify as mixed reality:

1. *Monitor-based (non-immersive) AR displays, upon which computer graphic (CG) images are overlaid.*
2. *Same as 1, but using immersive HMD-based displays, rather than WoW (window-on-the-world) monitors.*
3. *HMD-based AR systems, incorporating optical see-through (ST).*
4. *HMD-based AR systems, incorporating video ST.*
5. *Monitor-based AV systems, with CG world substratum, employing superimposed video reality.*

²³ Ronald T. Azuma, summarized that three characteristics in augmented reality: Combines real and virtual; Interactive in real time; Registered in 3D (Azuma, 1997, pp. 356).

6. Immersive or partially immersive (e.g., large screen display) AV systems, with CG substratum, employing superimposed video or texture mapped reality.

7. Partially immersive AV systems, which allow additional real-object interactions, such as 'reaching in' and 'grabbing' with one's own (real) hand (Milgram et al., 1994, p. 285).

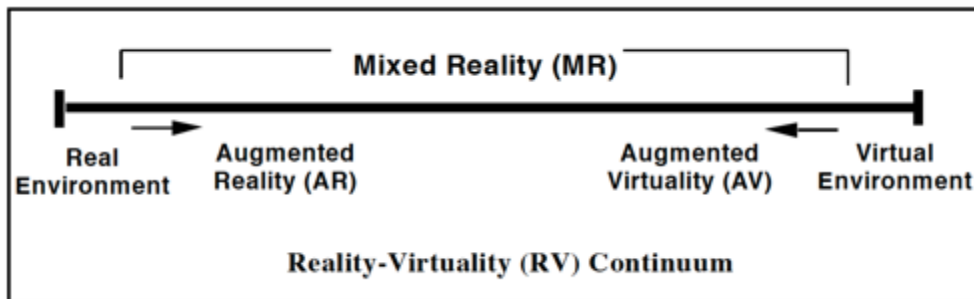


Figure 45 Simplified representation of an RV Continuum. (Milgram et.al, 1994, p. 283).

Whatever the definition of virtual, augmented or mixed reality, we shall consider them as virtual images generated by computers. In consideration of the medium and application scope, whether customers' experience can be integrated into the real world has become key to distinguishing different terms in the virtual world. Based on the above definitions, the research focuses on the projector and the HMD systems based on mixed reality.

2.2.3. Aesthetic Illusion as Part of Human Perception

Based on the definitions of Oliver Grau and Scott A. Lukas, in general, illusion occurs when humans or animals observe objects based on an empirical or inappropriate reference and eventually form an incorrect judgment and perception in a relatively closed environment. Before Jaron Lanier created the term virtual reality in 1987, illusion space, as a means of creating immersive space, was used for thousands of years.

2.2.3.1. Illusion of Perception

If we consider the history of illusion spaces... that it was intended they should arouse in the observers, through which the message was conveyed. In its concentration, the transmedia functional continuum of the hermetic illusion space appears to be anthropological constant (Grau, 2004, p. 340).

Illusion: Illusion can be a powerful tool that makes a space feel more authentic because it gives the guest a sense of being somewhere different and the possibility of experiencing (and perceiving) an entirely different space or world. Depth: This approach to authenticity can take the guest beyond their immediate experience and can establish a sense of being in another place (Lukas, 2013, p. 119).

During the second half of the 19th century, the psychology of perception and the works of Wilhelm Wundt and Hermann von Helmholtz considered that there was no difference between the perceived object and the image projected on the retina (Berntson & Cacioppo, 2009, p. 236-237). However, Adelbert Ames published his famous optical geometric illusion that demonstrated “a lack of correspondence between perception and reality” (Pujol, 2011, p. 42). To put it simply, the world is 3D, but the images are formed in each retina are 2D with slight differences. Our perception of the image is distorted and inverted by the lens of the two eyes (Fischler et al., 1987, p. 213-219) and combined in the brain.

In 1925, David Katz devoted more attention to touch rather than vision in *Der Aufbau der Tastwelt* (The World of Touch) (Millar, 2008, p. 11). In the 1950s, the German gestalt school was the first show that human cognition is not passively accepted, but rather actively intervenes in our perception of the world depending on the context and configuration of the perceived

elements (Toccafondi, 2002, pp. 199-211). Thus, “perception goes beyond the simple ‘stimulus - response’ scheme and consists of a dialogue between the environment—which generates conflictive stimuli—and the person—who actively explores, selects and processes them according to his/her needs and expectations” (Pujol, 2011, p. 42). Based on modern cognitive psychology and artificial intelligence, scholars argue that perception is the result of a series of convergent automatic processes. In sum, human vision is not a perfect reflection of the real world; it is a complex cognitive process that depends on our experiences, demands and expectation (Bruce et al., 2003). Laia Pujol argued, “Our brain transforms the information into meaningful knowledge about that scene” (Pujol, 2011, p. 43). There are numerous designs based on this perception process. For some themed space designs, the audience’s expectations lead to what they want to see through propaganda in the early stages and some spatial underlays. When the audience’s expectations are met, the project is successful.

Mihaly Csikszentmihalyi states that this cognitive method stems from the constraints of problem handling in the nervous system. He writes, “The nervous system has definite limits on how much information it can process at any given time. There are just so many ‘events’ that can appear in consciousness and be recognized and handled appropriately before they begin to crowd each other out [...] because each one of these activities exhausts most of our capacity for attention” (Csikszentmihalyi, 2013, p. 49). In another words, most people are able to handle a limited number of activities at one time. As a result, when we are too focused on one object, we forget about others, such as the time and space. It is not that we forget such

objects deliberately. Our brain and nervous system just do not have the capacity to process them all. In such a case, there is illusion (Langer, 1975, pp. 311-328; Csikszentmihalyi, 2014a, pp. 169-171; Csikszentmihalyi, 2014b, p. 169).

The principle of illusion is already used in art, either intentionally or unintentionally. Based on Alfred Neumeier and Oliver Grau's analyses, "illusion works on two levels. First, there is the classic function of illusion that is the playful and conscious submission to appearance, which is the aesthetic enjoyment of illusion" (Neumeier, 1964, p. 13). Second, "intensifying the suggestive image effects through appearance. this can temporarily overwhelm perception of the difference between the image space and reality" (Grau, 2004, p. 17). When humans realised the principle of illusion, they began to consciously create illusion in art, especially in the visual arts. Artists use perspective, light, contrast and colour to create illusions, the purpose of which is to portray a three-dimensional space in a two-dimensional plane or to project that three-dimensional space in people's consciousness.

Because our retinal image is two-dimensional, we have to add depth to create and experience the world through "a range of cues including size constancy, perspective and stereopsis" (Ling & Catling, 2012, p. 17). Our reliance on our visual sense of the reference object can be used to form a visual spatial illusion. One famous visual illusion is the Müller-Lyer illusion (Millar, 2008, pp. 143-158). This example tells us that what we see may not reflect reality, but rather the image created in our minds. The so-called arrowheads and tails could be regarded as perspective lines. Whether in the

physical or virtual space, the illusions of being near or far could be produced by designing the arrowheads and tails according to the mechanisms of visual illusion (See Fig. 46).

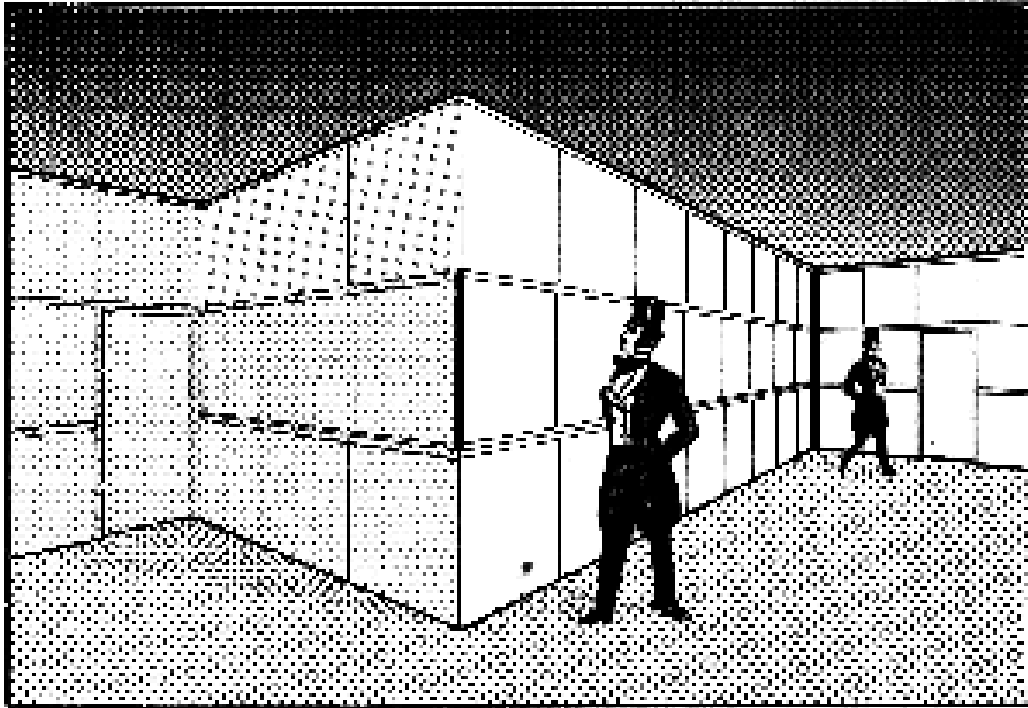


Figure 46 The bold vertical lines appear to be of different lengths. Petralia, Mile. (2013). *Die Müller-Lyer-Täuschung*. Lingelbachs Scheune. Retrieved September 8, 2017, from [http://www.die-scheune.info/die-muller-lyer-tauschung/#lightbox\[gallery-1YVz\]/1/](http://www.die-scheune.info/die-muller-lyer-tauschung/#lightbox[gallery-1YVz]/1/)

Susanna Millar also mentions “reference cues” (Millar, 2008, p. 2), which are “crucial for spatial tasks” (Millar, 2008, p. 190). This includes external cues and body-centred cues. Our definition of a space depends on reference cues from different sense organs. These reference cues influence the location, distance and direction of the space that people perceive. The eyes and neck are influenced by reference cues, which can produce visual illusions. All of these factors inspired designers to create space experiences using the sense organs. Susanna Millar argues, “Spatial perception and performance depends on a number of distributed cortical and subcortical areas, which have intricate and mostly reciprocal interconnections. It is noteworthy that

these areas receive inputs from multiple sensory sources” (Millar, 2008, p. 32). She emphasises that our visual system runs not only through eyes, but also through our balance system tied to the movement of the eyes and neck (Millar, 2008, pp. 32-36). In an experiment on blind children, Millar suggests people mainly define their location and movements through hearing and proprioception in absence of vision. We can imagine Gothic churches in the Middle Ages or rockery stones in Chinese gardens (See Fig. 47). They forced audiences to look up so as to change the audience's state of mind to achieve the purpose of changing their psychological space.

Philippe Fuchs determined that the spatial perception and evaluation of the surrounding world relies on the visual, vestibular and egocentric sensory



Figure 47 Lion Grove in Suzhou. Photo by Luo Shenshen, 2015. In a narrow space, visitors have to look up to see the whole stone. This creates the illusion of mountain climbing. “As you wander wherever your feet take you, you may doubt that there is any boundary to the place; as you raise your head to gaze around, deep motions will be stirred in you. The narrow paths should be long and winding; the lofty peaks should be glorious and venerable. The magnificent scenery on every side, the mountains and forests a hand’s breadth away- their subtle attraction all springs from one man’s imagination, and their elegance derives from a mere heap of earth” (Ji, 1998, p. 104)

perceptual systems (Fuchs et al., 2001, p. 68). In some cases, due to the different information provided by these perceptual systems, there may be perceptual illusion. As for space perception, visual and auditory contents are most easily understood, but the importance of muscle movement is a priority. Take the movement of a train as an example; without muscle movement, it would be difficult for our eyes to judge whether the train is moving. The biosciences demonstrate that space perception is the result of an interweaving of vision and touch, and even though vision may take the lead, the illusion of muscle movement will affect visual perception (Rock & Victor, 1964, pp. 595-596). From research in modern neurobiology and psychology, Millar concluded that our spatial perceptions are the results of interactions with multi-sense organs, not only vision, making a bold inference about the relationship of vision and muscle movements to space perception (Millar, 2008, pp. 27-46). Millar demonstrated through a number of experiments that the Müller-Lyer illusion could also be applied to touch, meaning that a misjudgement of length also occurs through touch. Thus, Millar emphasised that vision and touch must be combined when defining space perception (Millar, 2008, pp. 150-153). "Acuity in discriminating stimuli and the use of apparently irrelevant local touch cues for reference should probably be emphasised also in specifying the aspects of vision that combine with information from touch and movement and so add to inputs from touch alone in spatial tasks" (Millar, 2008, p. 180). The visual illusion also occurred in the sense of touch, because for spatial processing vision and touch have an overlapping relationship.

Millar was also curious about how people move in an unfamiliar, large-scale space that lacks orienting cues. She found people “veer from the straight-ahead more and more in a particular direction” (Millar, 2008, p. 182). The sense of direction comes from unexpected and unrelated sounds and posture cues. She argues, “New findings showed that external cues can be used for reference also with purely haptic sensory inputs, contrary to the notion that haptic inputs are necessarily tied to egocentric frames of reference and that allocentric coding is impossible without inputs from vision or other distal sensory cues” (Millar, 2008, p. 186). She demonstrates that spatial orientation and distance depend on integrating diverse sensory inputs as reference cues.

In fact, such muscle consciousness is called kinaesthesia,²⁴ which is often used by designers to create artificial spaces. In Edward Hall’s book *The Hidden Dimension*, he uses an example of Japanese gardens to illustrate how to expand space:

They were particularly ingenious in stretching visual space by exaggerating kinaesthetic involvement. Not only are their gardens designed to be viewed with the eyes, but more than the usual number of muscular sensations are built into the experience of walking through a Japanese garden. The visitor is periodically forced to watch his step as he picks his way along irregularly spaced stepping stones set in a pool. At each rock he must pause and look down to see where to step next. Even the neck muscles are deliberately brought into play (Hall, 1965, pp. 51-52).

This example demonstrates the relation between kinaesthesia and visual experience. It is just like the Chinese garden rockery and the Gothic churches

²⁴ Kinaesthesia: awareness of the position and movement of the parts of the body by means of sensory organs (proprioceptors) in the muscles and joints. Come from Greek *kinein* ‘to move’ + *aisthēsis* ‘sensation’ (Oxford Dictionary of English).

mentioned earlier. Despite the actual size of a space, the space which individuals experience could expand or reduce through the application of muscle perception. Touch and vision are interwoven and integral. In the field of classical Chinese gardens, there is a space creation method called 欲扬先抑 (*yù yáng xiān yì*; ascend slightly prior to decline intensively) (Yu, 2015, p. 90). Audiences' vision is limited when they walk through a section of narrow road in a space surrounded by trees; later, when they walk through an open environment where the space is expanded by a borrowed view and the vision is broad, audiences feel sincerely pleased and comfortable.

As mentioned above, the hyper reality experience VOID is an example of the interaction between touch and vision. They have tried to develop a training and entertainment system using the interaction of physical touch and a VR system. It is an excellent demonstration of Millar's theory. In the virtual world of *Ghostbusters*, the positions of the tourists depend entirely on the auditory and tactile stimuli from real objects and the virtual haptic device.

2.2.3.2. Aesthetic Illusion

Aesthetic illusion is a basically pleasurable mental state ... Aesthetic illusion consists primarily of a feeling, with variable intensity, of being imaginatively and emotionally immersed in a represented world and of experiencing this world in a way similar (but not identical) to real life ... however, this impression of immersion is counterbalanced by a latent rational distance resulting from a culturally acquired awareness of the difference between representation and reality (Wolf, 2009, p. 270).

Aesthetic illusion is a typical artefact that includes painting, sound, film, drama and other fields. In the virtual world, it is reflected mainly in computer-generated imagery (CGI). However, this is a vague and inexact definition. In *Immersion and Distance – Aesthetic Illusion in Literature and Other Media*, Werner Wolf argues, “aesthetic illusion is a basically pleasurable mental state frequently emerging during the reception of representations (text, artefacts or performances) which may be fictional or factual, narratives or descriptions, and can be transmitted by various media and genres” (Wolf, 2013, p.52).

Wolf notes that aesthetic illusion lies between total rational distance and complete immersion. He explains that “aesthetic illusion... as a rule excluded poles of total rational distance and complete (and pre-dominantly emotional) imaginative immersion in the represented or constructed world (the asymmetry consisting in maintaining a certain proximity to the pole of immersion)” (Wolf, 2013, p. 18). We can assume aesthetic illusion arises from perceptual illusion, or some reasonable perceptual illusions can trigger aesthetic illusion. In the end, people achieve complete immersion through aesthetic illusion.

However, aesthetic illusion is neither a delusion nor a hallucination. Aesthetic illusion is “to a certain extent... while being predominantly a state of imaginary immersion and re-centering—and thus the state of an experiencing or ‘participating ego’ always also involves our meta-awareness that we are witnessing a representation or a medial construct only” (Wolf, 2013, p. 16). According to Wolf, the aesthetic illusion is a process that is “an activation of the imagination” (Wolf, 2013, p. 7), and empathy for an artefact

with a mood or emotion is the major aim of illusionist works with reference to immersion (Wolf, 2013, p. 35). Aesthetic illusion is a process of complete immersion, during which people feel not only sensory but also mental immersion stimulated by the space through various means (see Fig. 48).



Figure 48 The process of complete immersion. Image by Luo ShenShen.

As for entities, the simulated wonders of the world erected at the gates of Las Vegas casinos and Disney theme parks are aesthetic illusions in the real world. Aesthetic illusion is formed based on the real world according to the Wolf, who infers that aesthetic illusion is closely related to popular culture and entertainment “as well as in framing contexts, e.g., cultural–historical, situational or generic ones” (Wolf, 2013, p. 52). At the same time, aesthetic illusion is based on cognitive psychology for the research (Miall, 1995, pp. 275-298) and interpretation of “heritage iconography” by Russell Staiff.

2.2.3.3. Chinese Garden: A Case Study of Aesthetic Illusion and Immersive Experience in Real Environment

Classical Chinese garden design, which seeks to recreate natural landscapes in miniature [...] the gardens reflect the profound metaphysical importance of natural beauty in Chinese culture in their meticulous design (UNESCO, n.d. b).

In Chinese, 关系 (*guān xi*; relationship) is the key word to understand the Chinese concept of space. Xiaodong Li and Kangshua Yeo, based on Derk Bodde’s (1991) concept of sense-perception, argue, “the tendency of the Chinese to dwell beyond what is directly perceived [...] necessary in

representing the perception of phenomena by implied correlation, exclusive of formal abstraction. Correlative thinking therefore can be postulated as an imperative extension of the Chinese cognitive process” (Li & Yeo, 2007, p. 135). In Chinese private gardens, the real scenes and their corresponding associations (such as the poetry that can be associated with seeing a specific view, or the scene and atmosphere that can be related to seeing an inscription) constitute a sophisticated space, with multiple systems of reference cues for each sensory entity. Li and Yeo state that every existing space reference is independent and that “space is also defined as the relation between entities and not as an abstract void in which Euclidean geometry acts as a definition of the rudimentary code of architecture” (Li & Yeo, 2007, p. 138).

As mentioned above, Millar illustrated that sound and movement are closely related in large-scale space and that touch is more important for defining smaller spaces. “In such cultural ‘ecosystems’, space is experienced, not primarily as a static ‘visual field’, but as a ‘lived-through’ environment: continuously changing, resonant with sound, ‘learned’ through the muscles of the body and all the sensory systems working together to register changes in temperature, light, moisture, friction, even smells” (Ran, 2009, p. 14).

In the Chinese garden example below, the designer uses arrangements of ground stones to stimulate the muscles of the foot to form a mental space or, through managing the positions, form the different voices of the wind (see Fig. 49). This is in agreement with Millar’s theory that different space locations could be created if people’s hearing and foot proprioception are disturbed in an unfamiliar environment.



Figure 49 The wind sound hole, Ge Garden. The air through the 24 holes simulates the sound of winter wind. Retrieved November 20, 2017, from http://1844.img.pp.sohu.com.cn/images/2013/4/13/14/12/u61545758_13ec5e4bb3fg2_b.jpg

The Chinese garden design is a typical comprehensive art combining landscape, sculpture, painting and architecture. The phrases 步移景异 (*bù yí jǐng yì*; A driving tour, relating to the deictic perspective) (Li & Yeo, 2007, p. 138) or 移步换景 (*yí bù huàn jǐng*; with every step, the view will change) (Bryant, 2016, p. 15) describe the Chinese aesthetic illusion in the Chinese garden space. Werner Wolf states “Aesthetic illusion cannot be triggered by natural phenomena, nor refer to artefacts that are either non-representational or do not create (or suggest) an imaginable world” (Wolf, 2013, p. 10). In a Chinese garden, the landscape and architecture become a kind of inspiration to the observer. Everything becomes a compelling correlation between what one sees and what one believes. “Buildings are designed to bring forth a particular response from the viewer through the atmosphere created by the construction process and materials used” (Li &

Yeo, 2007, p. 144). As mentioned above, aesthetic illusion is dependent on perceptual illusion. To experience a Chinese garden, the first requirement is motion; the experience process is dynamic and relative. The same object will convey different meanings depending on the observer's location, which is why the observers experience different inspirations. This is an exchange process between the temporal and spatial senses.

In the illusion mentioned above, Chinese garden designers often use offsets and adjustments to the optical illusion of space to let people experience the differences in perception. In the process of construction, designers use image and colour illusions to integrate the imagination and the reality that constitute the space. The image illusion can use features such as line length, area size, twists and turns; segmentation and contrast; colour illusions including hue contrasts; differences in colour temperature, size and distance; and so on.

Alexander Gosztonyi defines the experience of space as follows: "The virtuality of the movement must be emphasised; one can also 'enter' the space virtually, i.e., in thought or imagination, whereby the distances are not actually experienced but rather assumed" (Gosztonyi, 1976, p. 959).

When it comes to an illusory space or an immersive space, it must be enclosed. For the traditional design of classical Chinese gardens, fences or trees are used to form a relatively closed space. The interference of the external world is reduced, and the space does not appear closed. At the same time, it is an expression of the philosophical design concept of classical Chinese gardens.

Yuan Ye by Cheng Ji is one of the earliest works on landscape design theory

in China dating back to the 17th Century. *Yuan Ye* is the most desirable place for Chinese hermits and scholars, and its aesthetic can be summarised as 壶中天地 (*hú zhōng tiān dì*; the world in a pot) (Huang, 2002, p. 1) or 壶中日月 (*hú zhōng rì yuè*; sun, moon and stars in a pot) (Xu, 2013, p. 63). These represent a Taoist worldview (Huang, 2002, p. 4). It is actually the pinnacle state pursued unremittingly by designers of classical Chinese gardens.

Yuan Ye contains an important aesthetic concept: the dialectical relation between natural space and artificial space. In the beginning, the book says that landscaping “虽由人作，宛自天开” (*suī yóu rén zuò, wǎn zì tiān kāi*; though manmade, they will look like something naturally created) (Ji, 1988, p. 45. Translation by Alison Hardie). In many scholars’ research, this aesthetic concept carries on traditional Chinese aesthetic thought, which can be a key guideline for creating the spatial illusion of the traditional Chinese garden (Ji, 1998; Zhang, 1991; Ruitenbeek, 1996; Fung, 1999; Jin, 2017). Xuezhi Jin writes that the aesthetic thought in *Yuan Ye* reflects the process by which art creation extracts elements from nature and the final artificial space transcends the natural space (Jin, 2017, pp. 95-102). Then he quotes Jiayi Zhang (1993) to explain landscaping in classical Chinese gardens. In a limited space, simply imitating nature only results in a garden as fake as a model; only by extracting from and summarising nature can a successful garden be built (Jin, 2017, p. 97).

The space of a classical Chinese garden is in line with the previous discussion of immersive space within an enclosure. Designers separate gardens from the outside with enclosure walls while leaving as much space as possible for

visitors to see the sky and its reflection on the water so as to increase the multi-dimensional spatial depth and reserving space in appropriate places so that visitors can see distant landscapes outside the garden, a practice called “borrowing landscapes” / 借景 (*Jiè Jǐng*)²⁵. In this regard, a traditional Chinese garden is like a “bowl” where visitors can see things in the distance in order to be immersed in the garden’s spatial illusion without interference from redundant information (see Fig. 50).

²⁵ 借景 (*Jiè Jǐng*) infers the meaning that the *Yuan* has to be designed by the *zhǔ chí zhě* (主持者, the person who designs and builds gardens) in consideration of both the perspective of the people (range of vision, distances, and angles of view) and the natural elements of time (seasons) and space (location). Because of the different viewing angles, the observer will feel surprised and see the new landscape in the same place every time. “The discussion of this key term indicates its relevance to the question of ‘the immediate garden’ and its relationship to a ‘larger landscape’” (Fung, 1999, p. 36).



Figure 50 Space diagram of indoors, outdoors and the Chinese garden. Left photos retrieved July 3, 2017, from <https://www.stuckincustoms.com/2007/10/25/forgotten-churches-of-italy/>; <http://www.chinatrekking.com/routes/adventure-tour/haba-snow-mountain-circumambulation>; and <http://citylife.house.sina.com.cn/detail.php?gid=38235>. Drawing by Luo ShenShen.

Chinese garden design is a kind of aesthetic illusion of space, which relies on the conflict between human visual perception and kinaesthesia. These two mechanisms coexist and operate simultaneously, which inevitably results in experiences of conflict and pleasant surprise (see Fig. 51).



Figure 51 Visual size and actual size of the stone bridge of the Master of the Nets Garden. Retrieved July 3, 2017, from <http://www.yangqiu.cn/dfsjrcn/1037690.html>

In addition, in the design of a classical Chinese garden, the designer uses occlusion to deliberately create a sense of mystery and attract visitors, which results in a sense of wonder. The Lingering Garden, a famous classical Chinese garden, is used as an example here. The function of the doorway is to separate the yards of different spaces. Visitors may only see the environment of the opposite space through the round door. At the same time, the designer used completely different colours and building materials for the two yards. Whichever space the visitor is in, he or she is able to see a rather different scene in the adjacent yard, but only a part of the scene can be seen. This encourages visitors to continue sightseeing and unknowingly immerse themselves in the space (see Fig. 52).



Figure 52 Tang, Ge. (2007). You Yi Cun of Lingering Garden. [photograph]. Retrieved July 3, 2017, from https://commons.wikimedia.org/wiki/File:Youyicun_garden.jpg

Furthermore, there are three Chinese characters written above the doorway, which translate to “one more village”, a reference to Lu You’s *A Visit to Villages in Shanxi*, “山重水复疑无路，柳暗花明又一村” (*shān chóng shuǐ fù yí wú lù, liǔ àn huā míng yòu yī cūn*; after endless mountains and rivers that leave doubt whether there is a path out, suddenly one encounters the shade of a willow, bright flowers and a lovely village) (Hillary Clinton quoted the Chinese poem “*A Visit to Villages in Shanxi*” in English at the Shanghai 2010 World Expo). “One more village” represents another space or another wonder. Therefore, the inscriptions above the doorway allow Chinese visitors to think of Lu You’s words. This is a dual action of emotion and perception and operates as a perceptual “clue”. The visitors expect to see more based on the clue and enter the ideologically immersive state the designers have created through the aesthetic illusion.

2.2.4. The Degree of Immersive Experience in Virtual Environments

Immersion can be an intellectually stimulating process; however, in the present as in the past, in most cases immersion is mentally absorbing and a process, a change, a passage from one mental state to another (Grau, 2004, p. 13).

Total immersion is presence. (Brown & Cairns, 2004, p. 1299).

When we get to some immersive spaces, we feel ourselves blending in among them and almost become part of the space.

In 1994, Mel Slater, Martin Usoh and Anthony Steed studied the level of presence in immersive virtual environments (VEs) (Slater et al., 1994, 130-144). Later, Mel Slater and Sylvia Wilbur took this point a step further, proposing “that the immersive capability of a VE depends on the degree to which it is inclusive, extensive, surrounding, vivid and matching” (Slater & Wilbur, 1997, pp. 603-616).

Haylie L. Miller and Nicoleta L. Bugnariu explain the meaning of these elements, “Inclusive refers to whether a VE (virtual environment) eliminates signals indicating the existence of a physical world separate from the virtual world. Extensive refers to the number of sensory modalities accommodated. Surrounding refers to the visual presentation of the VE, including field of view and the degree to which the physical world is shut out. Vivid refers to the fidelity and resolution with which the VE simulates the desired environment. Matching refers to whether the viewpoint of the VE is modified to match the user's perspective through motion capture” (Miller &

Bugnariu, 2016, p. 247). For the degree of an immersive experience, each element is divided into three levels: low, moderate and high. In simple terms, the degrees of the five elements determine the final degree of the immersive experience. However, this description is subjective and lacks quantitative support.

William Sherman and Alan B. Craig used and developed this point, classifying four levels of immersive experience: none whatsoever, minor acceptance, engaged and full mental immersion (Sherman & Craig, 2003, p. 388). On the other hand, Gutierrez argues and classifies the levels as fully immersive (e.g., HMD), semi-immersive (e.g., large projection screens) or non-immersive (e.g., desktop-based VR) based on the form of technology (Gutierrez et al., 2008, pp. 2-3).

However, these classifications are based on display technology under a premise of unlimited increases to the intensity of human senses through such devices (Forte & Bonini, 2010, pp. 45-56).

Using cognitive theory, more and more scholars began to study the relationship between cognition and immersion.

Emily Brown and Paul Cairns discuss the structure of schemas in narratives and write that “these structural differences are what differentiate engagement from immersion and immersion from flow” (Brown & Cairns, 2004, p. 1297). J. Yellowless Douglas and Andrew Hargadon argue, “hovering on the continuum between immersion and engagement, flow draws on the characteristics of both simultaneously” (Douglas & Hargadon 2000, p. 158). In response, Csikszentmihalyi said flow is “the process of total

involvement with life” (Csikszentmihalyi, 2013, p. 14). Werner Wolf studied immersion and distance from the view of aesthetic illusion (Wolf, 2013).

For VR research, immersive experience is significant, especially “the extent to which a person’s cognitive and perceptual systems are tricked into believing they are somewhere other than their physical location” (Patrick et al., 2000, p. 2). In a context of games, Emily Brown and Paul Cairns discuss a “robust division of immersion into the three levels: engagement, engrossment and total immersion” (Brown & Cairns, 2004, p. 1297). They argue that attention is a key factor; gamers’ visual, auditory and mental attention determines the degree of immersion. At the same time, they emphasise that there is a strong connection between total immersion and flow (Brown & Cairns, 2004, p. 1297).

Another term is *presence*, a shortening of the original *telepresence*, the psychological experience of “being there” (Bailey et al., 2012, pp. 24-26) or “existing in” (Heeter, 1992, p. 262; Sheridan, 1992, pp. 120-125; Steuer, 1992, p. 73; Witmer & Singer, 1998, p. 885). Creating presence for the user in a virtual space is a key indicator. Thomas B. Sheridan defines two types of presence, “virtual” presence and presence in “teleoperations”. Presence is a feeling of being transported into an artificial space or a place created by a various computer system (Sheridan, 1992, p. 120). Bob G. Witmer and Michael J. Singer argue that presence is based on the interaction between sensory and environmental stimuli and the internal tendencies of the person (Witmer & Singer, 1997, pp. 885-888). Therefore, in the VE, presence depends on the user’s degree of attention as they displace themselves from the physical environment.

Based on the above descriptions of immersive space and intensity of feeling about the immersive experience, the author proposes the gradual assumption of immersive spaces. It is an immersive assumption based on the process of human perception: perception, memory and association, manipulation. All immersive space designs should be based on this process or create this process for experiencers.

The perception process is based on the human sensory organs. The information formed by external stimulating factors is sensed through these organs. When we are surprised by the visual wonders and impressive images in an artificial environment, we reach the first point of the immersive state, which is called perception immersion.

Perception immersion can be quickly entered and exited. This state is unstable and temporary. This is why we must enter the next immersive state of memory and association.

Such impressive perceptual experiences need to convey certain narrative information to the experiencer. To this end, information that arouses the inner resonance of users, such as familiar symbols or stories, is needed. This requires designers to carry out design based on the characteristics of different groups or cultures.

Eventually, the experiencers will desire to deliver feedback on the information they receive, which is the desire to manipulate. They will want to become part of the story or interact with their circumstance, and this is the culmination of the immersive experience and complete immersion.

What should be pointed out is that every state can result in immersive experience. However, the perception triggers memory and association,

which in turn triggers manipulation.

The impulse towards the unknown and the desire to express and explore the world through imagination and representation are fundamental. Immersive space is not an end, but a method; to increase the desire to explore is the purpose of VR design.

The motivation to learn or obtain new information or to execute certain operations arises from expected rewards. In this method, the motivation and reward concept are closely related to people's desire to explore (Costa, et al., 2014, p. 556). Curiosity is a motivational prerequisite for exploratory behaviour (Berlyne, 1960). When we enter a themed stadium, whether it is an inspiring themed park or a museum full of exhibits, we want to discover something different, to explore an unknown world.

According to the aforementioned Chinese garden design, Daniel Berlyne argues that this curiosity is externally stimulated (Berlyne, 1960). The curiosity drive is delivered by conflicts in external stimuli. This encompasses complexity, novelty and surprise. At last, a moderate level of arousal is most effectively influenced by the complexity and novelty of the arousing object. J. McVicker Hunt proposed the complexity hypothesis (Hunt, 1965) and Jeroma Kagan proposed the discrepancy hypothesis (Kagan, 1970, p. 298). In other words, as we grow old, we tend to care more about complex stimuli for a longer time. "Higher discrepancy elicits anxiety and avoidance behaviour. Lower discrepancy results in feelings of boredom" (Keller et al., 1994, p. 291).

A successful themed scene design should be based fully on visitors' desires so as to balance the location and theme of the exhibits or recreational

facilities. Whether it is the creation of secret areas in classical Chinese gardens or the vast universe represented on the IMAXDome screen, the designer creates specific clues in an area. Such specific clues combine to form sensory stimuli (such as odour or light) ambiguous narrative clues (such as symbols or poetry) or behaviour installations that interact with visitors (such as video games). When one design constantly satisfies visitors' curiosity and creates objects that inspire their curiosity, it is a successfully immersive theme design.

2.2.5. Artificial Spaces

(Artificial is) Produced by art rather than by nature; not genuine or natural; affected; not pertaining to the essence of the matter (Simon, 1996, p. 4).

When we seek to understand what "immersive space" is, we need to understand the definition of the category itself. Scholars from different fields have developed overviews and it is helpful to compare related areas by examining their work. It is important to note that different academic disciplines have different interpretations of the same entities. All of them are rich of meaning that can be used in the design of animated installations for immersive spaces. In order to take full advantage of this potential knowledge, the designer needs to understand that different academic disciplines use different academic languages and provide different contextualisation to the same entities. Thus the knowledge of many disciplinary fields can be useful to the designer as the designer is able to contextualise and compare them.

These tables provide a systematic overview of VR, AR, Immersive Space, and Illusion Space by area of specialty by Alexander Gosztonyi, Werner Wolf, Bob G. Witmer, Michael J. Singer, Oliver Grau, Mel Slater, Sylvia Wilbur, Scott Lukas, Philippe Fuchs, Guillaume Moreau, Pascal Guitton, Gutierrez Alonso, Frederic Vexo, Daniel Thalmann, Woodrow Barfield, Eric Danas, Pujol Laia, Randy Pausch, Jon Snoddy, Robert Taylor, Mark O. Riedl, R. Michael Young, Scott Watson and Eric Haseltine, including comparative sub-tables. (See below)

2.2.5.1. Definitions Across Disciplinary Boundaries

	<i>Real World (Natural Sciences)</i>	<i>Sensory Perception (Neuroscience)</i>	<i>Psychology</i>	<i>Computer Science</i>	<i>Interactive Media</i>	<i>Narratology</i>	<i>Sociology</i>	<i>Arts (Aesthetics)</i>
Immersive Space	The virtuality of the movement must be emphasized; one can also 'enter' the space virtually, i.e., in thought or imagination, whereby the distances are not actually experienced but rather assumed (Gosztonyi, 1976, p. 959)		<p>Immersion can be an intellectually stimulating process; however, in the present as in the past, in most cases immersion is mentally absorbing and a process, a change, a passage from one mental state to another (Grau, 2004, p. 13).</p> <p>Immersion as a psychological state characterised by the fact of perceiving oneself "in" an environment (virtual) that provides a continuous flow of information (Witmer & Singer, 1998, pp. 225-240).</p>	Immersion is a description of a technology and describes the extent to which the computer displays are capable of delivering an inclusive, extensive, surrounding and vivid illusion of reality to the senses of a human participant (Slater & Wilbur, 1997, p. 605).		A story is a key aspect of the immersive world. It's what gives the space context and meaning and it gives the guest a reason to be in that space (Lukas, 2013, p. 52).	An immersive world is a place in which anyone can get wrapped up. Whatever your background in life, whatever your political or religious views, and whatever you enjoy doing in your spare time, an immersive world will take you in such that you won't want to leave (Lukas, 2013, p. 4).	

<p>Illusion Space</p>		<p>Illusion: An instance of a wrong or misinterpreted perception of a sensory experience: stripes embellish the surface to create the illusion of various wood-grain textures. (Oxford Dictionary of English)</p>	<p>Illusion is a basically pleasurable mental state ... Aesthetic illusion consists primarily of a feeling, with variable intensity, of being imaginatively and emotionally immersed in a represented world and of experiencing this world in a way similar (but not identical) to real life. (Wolf, 2009, p. 270)</p>				<p>Illusion can be a powerful tool that makes a space feel more authentic because it gives the guest a sense of being somewhere different and the possibility of experiencing (and perceiving) an entirely different space or world. Depth: This approach to authenticity can take the guest beyond their immediate experience and can establish a sense of being in another place. (Lukas, 2013, p. 119)</p>	<p>Aesthetic illusion is a response to an artefact which results in a certain state of mind. (Wolf, 2009, p. 6)</p>
<p>Virtual Reality</p>	<p>Virtual reality also makes it possible to simulate the phenomena differently, a realism that “goes beyond” the reality. We thus obtain a simulation of the real world, which is “enhanced” by more adequate, though unreal, representations of physical phenomena or objects. (Fuchs</p>	<p>The purpose of virtual reality is to make possible a sensorimotor and cognitive activity for a person (or persons) in a digitally created artificial world, which can be imaginary, symbolic or a simulation of certain aspects of the real world. (Fuchs 1996)</p> <p>VR displays are the means by which participants are physically immersed in a</p>		<p>Virtual reality is a scientific and technical domain that uses computer science and behavioural interfaces to simulate in a virtual world the behaviour of 3D entities, which interact in real time with each other and with one or more users in pseudo-natural immersion via sensorimotor channels. (Fuchs et al., 2011, p. 8)</p>	<p>Virtual reality will help him to come out of the physical reality to virtually change time, place and (or) the type of interaction: interaction with an environment simulating the reality or interaction with an imaginary or symbolic world. (Fuchs, 1995)</p>	<p>Since the behaviors the user performs in the virtual world can affect the way in which a storyline unfolds, interactive narrative systems often use a branching story structure where non-interactive story presentations are interleaved with user decision points. (Riedl & Young, 2006)</p>	<p>The computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors. (Oxford Dictionary of English)</p>	

	et al., 2011, p. 6)	virtual world, replacing or augmenting their sensory input with computer-generated stimuli. Achieving mental immersion is not as simple as physical immersion, but it can be greatly aided by display of the virtual world to multiple senses (Sherman & Craig 2003, p. 202)					
Augmented Reality	A type of virtual reality in which synthetic stimuli are registered with and superimposed on real-world objects. (Sherman & Craig, 2003, p. 18)	Often used to make information otherwise imperceptible to human senses perceptible. (Sherman & Craig, 2003, p. 18)			Augmented reality is interactive, so it doesn't make sense to watch it or listen to it. We must engage with it in order to gain the experience that it provides. (Craig, 2013, p. 2)		Augmented reality is a medium in which information is added to the physical world in registration with the world. (Craig, 2013, p. 15)

2.2.5.2. Comparative Summary Table of Their Basic Components

	<i>Physical Infrastructures (architectural space, sculptures, etc.)</i>	<i>Computer Generated Imagery</i>	<i>Interactivity System</i>	<i>Wearable Devices</i>	<i>Social Interaction</i>
Immersive Space					

<p>Illusion Space</p>	<p>If we consider the history of illusion spaces, from the Villa dei Misteri to the high-tech illusion Osmose or genetic and telematics art, then the enormous expense and effort that went into them is explicable in terms of the effect, of suggestion, that it was intended they should arouse in the observers, through which the message was conveyed. In its concentration, the transmedia functional continuum of the hermetic illusion space appears to be anthropological constant. (Grau, 2004, p. 340)</p>				
<p>Virtual Reality</p>	<p>Virtual world 1. an imaginary space often manifested through a medium. 2. a description of a collection of objects in a space and the rules and relationships governing those objects. (Sherman & Craig 2003, p. 7)</p>			<p>Thus, the VR system needs hardware devices that monitor the user in order to provide the user</p>	
<p>Augmented Reality</p>	<p>Augmented reality can be considered a type of virtual reality. Rather than experiencing physical reality, one is placed in another reality that includes the physical along with the virtual. (Sherman & Craig, 2003, p. 18)</p>	<p>Virtual Reality in its most "classical" form requires real-time graphics, a stereoscopic display, used to produce the illusion of 3D, and a tracking system to acquire head and hands motion. (Gutierrez et al., 2008, p. 1)</p>	<p>The introduction of virtual reality techniques is thus in line with an "interactive" approach of the "perception-action" looping and of the "in real time" study of the sensorimotor transformation. (Mestre & Vercher, 2011, p. 83) Virtual reality is a medium composed of interactive computer simulations that sense the participant's position and actions and replace or augment the feedback to one or more senses, giving the feeling of being mentally immersed or present in the simulation (a virtual world). (Sherman & Craig, 2003, p. 13)</p>	<p>information necessary to make a display physically immersive. Inputs from the user also enable them to interact with the virtual world. (Sherman & Craig 2003, p. 75)</p>	

2.2.5.3. Comparative Summary Table of Their Basic Outcomes

	<i>Physical Immersion (sensory)</i>	<i>Mental Immersion</i>	<i>Education</i>	<i>Interactivity</i>	<i>Entertainment</i>	<i>Socialisation</i>
Immersive Space	<p>Immersion can be defined as all the objective characteristics of a virtual environment that aim towards providing a user with sensory stimulations and possibilities to carry out actions in this virtual environment. (Mestre & Vercher, 2011, p. 99)</p> <p>Physical immersion is accomplished by presenting a virtual world to users based on their location and orientation and providing synthetic stimuli to one or more of their senses in response to their position and actions. (Sherman & Craig, 2003, p. 382)</p>	<p>The optimal state of inner experience is one in which there is order in consciousness. This happens when psychic energy—or attention—is invested in realistic goals, and when skills match the opportunities for action. The pursuit of a goal brings order in awareness because a person must concentrate attention on the task at hand and momentarily forget everything else. (Csikszentmihalyi, 2013, pp. 24-25)</p> <p>Mental immersion is that the participant is engaged to the point of suspending disbelief in what they are experiencing. (Sherman & Craig, 2003, p. 384)</p>	<p>In a participatory medium, immersion implies learning to swim, to do the things that the new environment makes possible . . . the enjoyment of immersion as a participatory activity. (Murray, 1997, pp. 98-99)</p>		<p>In the game context, immersion is clearly considered to be very important. Game reviews mention immersion as related to the realism of the game world or to the atmospheric sounds. Immersion is also said to have depth. (Brown & Cairns, 2004, p. 1297)</p>	
Illusion Space						

<p>Virtual Reality</p>	<p>The purpose of virtual reality is to make possible a sensorimotor and cognitive activity for a person (or persons) in a digitally created artificial world. (Fuchs, 1996)</p> <p>Extent to which a person's cognitive and perceptual systems are tricked into believing they are somewhere other than their physical location. (Patrick et al., 2000, p. 478)</p> <p>Virtual reality a medium composed of interactive computer simulations that sense the participant's position and actions and replace or augment the feedback to one or more senses, giving the feeling of being mentally immersed or present in the simulation. (a virtual world) (Sherman & Craig 2003, p. 13)</p>		<p>Use of haptic display in VR is on the rise in applications that involve training or evaluation of manual tasks, such as medical operations or serviceability testing of mechanical equipment. (Sherman & Craig, 2003, p. 178)</p>	<p>In a manner similar to content creators of other media, the VR experience designer has complete control of the virtual world, at least during the design and implementation phases, and must determine all aspects of what is or is not in the world. They establish all of what can or cannot happen in the virtual world, who can or cannot participate, and what happens to the world at the end of the experience. (Sherman & Craig, 2003, p. 411)</p>		<p>The possibilities of virtual realities, it appears, are as limitless as the possibilities of reality. They can provide a human interface that disappears - a doorway to other worlds. (Fisher, 2001, p. 257)</p>
<p>Augmented Reality</p>	<p>Augmented reality mixes the physical world with computer-generated information. The user is able to interact and affect the remote environment by their actions. (Sherman & Craig, 2003, p. 22)</p>		<p>VR's greatest advantages is that it can contribute to the understanding of abstract ideas, like temporal or spatial concepts, by making them visually concrete, avoiding irrelevant details, and underlining specific aspects through sounds, graphics and movements. (Pujol, 2011, p. 47)</p>	<p>First, there are the opportunities that the observer has to modify the sensory information from the environment, according to his position in the environment. Second, there are the possibilities that the observer has to effectively modify the environment. (Mestre & Vercher, 2011, p. 95).</p>		

2.2.5.4. Comparative Summary Table of Human Senses Involvedt

	Vision	Hearing	Smell	Taste	Haptic			Vestibular (Equilibrium)
					Touch		Kinaesthesia (proprioception)	
					Thermoreception	Mechanoreception		
Immersive Space	If we want to achieve visual immersion, it is necessary to take into account the movements of the eyes and the head. An eye can turn in its orbit by approximately 15° horizontally and vertically, with a maximum speed of about 600°/s. The head can turn at a maximum speed of about 800°/s. This means that theoretically it is necessary to have a field of vision of 170° horizontally and 145° vertically on the images. (Fuchs et al., 2011, p. 68)							
Virtual Reality	In practice, the field of vision in the head-mounted displays is much smaller (in the top-of-the-range head-mounted displays, we can reach 120° horizontally). The impression of visual immersion is thus more or less strong with these devices. It is therefore necessary to study in depth what the sensorimotor I2 require at the visual level. The total field of vision with movement of the head and eyes is very wide (horizontally >200° temple side and 130° nose side while vertically it is 140° up and 170° down). (Fuchs et al., 2011, p. 68)	Many VR system architects are concerned with the underlying technology for localizing sound. In our experience, the careful selection/creation of ambient sounds and music (i.e. the content, is much more important than the specific details, or even the use of sound localization). (Pausch, 1996)	A virtual olfactory display as a collection of hardware, software, and chemicals that can be used to present olfactory information to the virtual environment participant. (Barfield & Danas, 1995, p. 109-121)		Tactile displays focus on the skin's ability to interpret stimuli. The categories of skin (dermal) stimuli are pressure, temperature, electricity, and pain. The two methods most commonly used to "attach" the user to the display are to affix actuators to a participant's hand or have the user grasp a wand, joystick, or		The perception of the vertical direction is very important to understand the spatial body schema and thus to be able to assess the world surrounding us. There are three systems for perceiving the vertical (visual, vestibular and egocentric). Depending on the individual, one of the three is predominant. However, it is possible to change this system through vicariousness. (Fuchs et al., 2011, p. 79)	
Augmented Reality	The technical idea that is virtual reality now makes it possible to represent space as dependent on					Haptic displays offer tactile and force stimuli to the user, generated by contact with the devices that emulate objects in the virtual world. Most commercially available haptic displays provide either tactile or force stimuli, but not both. Two separate systems can be combined in a single VR system. (Sherman & Craig, 2003, p. 198)	In some VR applications, the only required vestibular sensation is that the participants' perception of gravity is reduced or eliminated. This effect is	

	<p>the direction of the observer's gaze: the viewpoint is no longer pendent static or dynamically linear, as in the film, but theoretically includes an infinite number of possible perspectives. (Grau 2004, 16)</p>				<p>steering wheel device. (Sherman & Craig 2003, p. 187)</p>			<p>desirable for simulating low-gravity situations. Although it is not possible to entirely eliminate the sense of gravity, there are methods that can help. One technique, used for many years in training for space travel, is the use of an underwater environment. Obviously, this poses some serious problems for a medium like VR that relies heavily on electronic apparatus. Another method suitable to VR involves placing the user within tri-concentric rings that rotate on orthogonal axes or suspending the participant in the air. Another, simpler technique is to have the participant stand on a dense foam pad into which they slowly sink. (Sherman & Craig, 2003, p. 201)</p>
Illusion Space								

3. Storytelling

The Plot, then, is the first principle, and, as it were, the soul of a tragedy: Character holds the second place (Aristotle, trans. Butcher, 1902, p. 29).

In this chapter, the thesis will discuss the development of storytelling and visual narration and will then focus on the traditional Chinese narrative structure, which is the premise behind adding Chinese traditional narrative principles when developing the design process in the practical part.

Storytelling is a social and cultural behaviour (Chaitin, 2003). The storyteller shares his or her story through dictation or writing (McAdams, 1993, p. 27). Some scholars argue that early man used cliff paintings as a carrier of story recordings or used music and dance to record meaningful events before the invention of writing (Eder et. al., 2010). After writing was developed, storytelling was used more for entertainment (Birch, 1996, pp. 106-128), education and the instilment of values (Chaitin, 2003). E. M. Forster, in *Aspects of the Novel*, discusses the novel under six headings: story, people, plot, fantasy, prophecy and pattern or rhythm (Forster, 1927). Rene Wellek and Austin Warren, in *Theory of Literature*, break down the novel's elements into plot, characterisation, setting, worldview and point of view (Wellek & Warren, 1948). Robert Scholes states that narration is divided into four elements: plot, character, point of view and meaning (Scholes et. al., 2006).

3.1. Visual Storytelling

The effectiveness of any visual storytelling medium—comics, film, or interactive games—depends on the creative talents of the writers, artists, directors, and technical experts who have a common goal: they want to draw the audience into the story unfolding before their eyes and keep them there (Caputo, 2003, p. 26).

Visual Storytelling is a marketing strategy that communicates powerful ideas through a compelling story arc, with your customer at the heart of the story, and delivered through interactive and immersive visual media—in order to create profitable customer engagements (Ron, n.b.).

According to Werner Wolf, narrativity comprises three core areas: experientiality (perception of time), representationality (creation of a recognisable story-world) and the purpose of the imagery (Wolf, 2003, pp. 180-197). The graphic information-processing speed of our brain is 60,000 times faster than our word-processing speed (Parsons, 2016); in addition, 90% of external information is transmitted to our brain through the visual sense, and 93% of human communication is reliant on vision (Pant, 2015). Caputo notes that when the audience obtains an experience through watching a film, cartoon or game, it is called visual storytelling (Caputo et al., 2003, p. 29). Visual storytelling is a new term. However, the use of visual images to tell stories dates back to the initial phases of human civilisation. For all issues related to visual storytelling/narrative, they all come down to two basic questions: “First, what is a written image, hence, how can it be

read? Second, how can (graphic) images narrate?" (Herman et al., 2005, p. 629). In the medieval period, the definition of narrative painting is clear, "the narrative image is made up of a combination of elements and relationship that present a fact and tell a story. It is read like an account of fact, like a story. Located in space and in time, the development of the action has a particular direction" (Garnier, 1982, p. 40).

Pieter Bruegel was a painter in the Middle Ages who was highly capable of narration. Rick Altman evaluates Bruegel's *Children's Games* as "undermining perspective principles to ensure perpetual recirculation of viewer attention... Influenced by the perspective system of centred diagonals, viewers are inevitably guided toward the central area, which, by its prestige, has the power to hold the gaze permanently. Constantly propelling us away from the centre ... Once outside, we inexorably return, each time describing a new path through the city maze, each time attending to a new set of characters" (Altman, 2008, p. 212) (see Fig. 53).

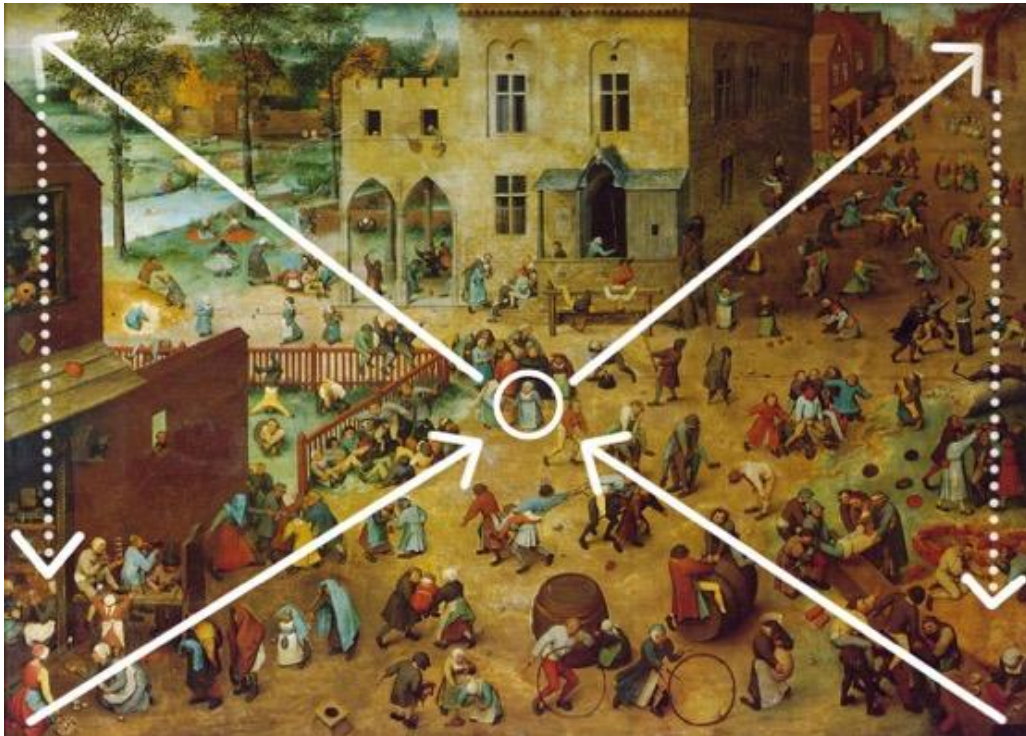


Figure 53 Altman, Rick. (2008). *Children's Games. A Theory of Narrative*. Based on Bruegel, P. (1560). *Children's Games*. Vienna, Austria: Kunsthistorisches Museum. Can we imagine, how to organise the picture if every character were animated and how to organise this story sequence?

Put simply, Rick Altman argues that Bruegel designed an infinitely recurrent visual tour to encourage the audience to look at the painting from different angles. This is the method to read traditional painting narration. Traditional paintings describe all events that occur in the same space (or different spaces) and at the same time. If we want to exhibit events that occur at different times and in different spaces, we need another approach, such as the Bible story fresco in churches or frescoes about the stories of *Sakyamuni* on the walls of Chinese Buddhist temples.

Visual storytelling, as described in this argument, focuses more on storytelling using modern visual media, such as comics, photographs,

illustrations, video and interactive games, with the addition of other elements such as music and sounds (Caputo et al., 2003, pp. 49-57). Visual storytelling is widely used in film / animation; it is the function of the “film” narration to deal with one time in another, while (verbal) description’s function deal with another space in one time. Image deals with one space in another. The author argues that for visual storytelling in new media, interactive elements are usually added (which are described later). This allows the new media to represent different times and spaces within the same space, such as a computer game. Alexandra Green comments, “visual narratives have been analysed either as an illustration of a text or as self-sufficient, the former marking the work of art too derivative and latter requiring a loose definition of ‘narrative’” (Green, 2013, p. 65).

As for Herman’s second question—how can we create the visual storytelling for people to read? —Tony C. Caputo states that “Clarity + Realism + Dynamism + Continuity = Total Immersion of visual storytelling” (Caputo et al., 2003, p. 64).

Clarity can be reworded as “whether readers, viewers, or players [are] able to follow the visual story” (Caputo et al., 2003, p. 65). The significance of interpreting the concept is that a clear scene should be built up at the beginning. This is a widely used concept in film narrative. For example, many Hitchcock films use a full-length shot to establish the background of the story, with the camera moving in space to introduce key objects of the

film. After that, an obvious representation of figures moving or events occurring is needed. Even for branch storytelling, as seen in a video game, the context of every event should be clear. At last, the author uses “the 180 Degree Rule”²⁶ and “set up and payoff”,²⁷ two frequently used film terms, to further demonstrate how to establish an obvious visual narrative. To sum up, clarity refers to a clear stage and a relatively simple story clue.

Realism is not the same as photorealism. Realism relates “to the perception by the audience that what is happening is real within the context of the story and graphic style” (Caputo, 2003, p. 72). In simple terms, objects that do not exist in reality must be associated with real life and the real world. The author takes *Jurassic Park* as an example. In the film, the computer-generated dinosaurs run in a real environment, and the actors interact with the computer-generated dinosaurs as if they are real in a real environment. The audience, who sees the dinosaurs in the real background, tend to believe that the dinosaurs are real. The author has noticed the application of such realism in historical documentaries. As mentioned above, the attention we pay to cultural heritage sites is actually paid to the symbolic objects, and the symbolic objects in the film give a reason for the audience to believe they

26 “The 180-degree rule deals with any framed spatial (right-to-left or left-to-right) relationship between a character and another character or object. It is used to maintain consistent screen direction between the characters, or a character and an object, within the established space” (Proferes, 2008, p. 4).

27 “Setup and payoff is a technique used in storytelling, particular in humor, in which a seemingly irrelevant detail or statement is ‘set up’ early in the story, and has an importance that becomes very clear later (i.e., ‘pays off’) later.” (FANDOM n.b.).

are real. Through trust in such cultural symbols, the audience believes the story told in the film.

In visual storytelling, dynamism is a behavioural trend and “what can be done to achieve dynamism depends on the output medium” (Caputo, 2003, p. 75). Dynamism is represented as lines within a frame in cartoons. However, in a film or interactive game, it is represented in “moving trails” with visual effects. In numerous of modern recreational facilities, we find that the dynamic trail in the film frame is increasingly reliant on special effects and that visitors or audiences will move with the film frame. This is due to the design of the equipment, in particular the chairs. This is potentially dangerous because if the movement of chairs completely matches the film frame, visitors will be completely immersed, but this will be a disastrous viewing experience.

Caputo argues that the significance of continuity lies in the continuity of frames and scenes. Frames with discontinued scenes, figures or objects should be avoided. For example, the application of a detailed hint repeatedly appearing in the frame will help enhance the continuity of visual storytelling (Caputo et al., 2003, p. 151).

For such approaches, the ultimate goal is to allow the audience to become immersed in and enjoy the process of visual storytelling. As mentioned above, immersion resulting from such visual storytelling belongs to the second level of the immersive state—memory and association.

3.2. Interactive Storytelling

Beyond the Center for Digital Storytelling, the concept of digital storytelling encompasses a number of other practices and forms of expression. These include the interactive narrative forms from hypertext, Web-based narratives combining image-sound-animation-video, the virtual cinema of narrative games or game like conceptual pieces, and other practices of using digital media tools (video, motion graphics, animation, etc.) to explore both nonfiction and fictional narratives (McLellan, 2007, p. 70).

In interactive games the player, who is both viewer and navigator, not only sees the graphics (the 'eye') but participates (the 'I') in shaping the way the story unfolds (Caputo, 2003, p. 43).

Interactive storytelling (IS) is a term with an incomplete definition. There are numerous similar terms with ambiguous definitions including interactive drama, interactive narrative, interactive storytelling or digital storytelling. Such terms often reflect the presentation skills used by different research groups in different research periods. According to Maria Arinbjarnar, “interactive narrative is often used for systems which currently generate a high-level plot outline” (Arinbjarnar et al., 2009, p. 15). Arinbjarnar argues “interactive drama” applies to the entire process of the developed system. Many researchers argue interactive storytelling is a new storytelling approach that is an interactive technique based on science, social contact and collaboration “to offer content adapted to new behaviors in a rapidly changing cultural ecosystem” (Hoguet, 2014). Digital storytelling, which is similar to interactive storytelling, is more of a general

term. Wendy Ann Mansilla states “[it] is a new form storytelling that combines various media content and technology such as images, music, voice, video and virtual worlds or real time data” (Mansilla et al., 2014, p. 3). Furthermore, Hartmut Koenitz summed five important challenges of digital narrative: Need a New Narratology for IDN (interactive digital narrative), Interoperability is Key, Sustainability is Essential, IDN Needs to Be Author-Focused, and The User Experience is Crucial (Koenitz, 2014, pp. 134-138). In recent years, more and more scholars have started to care about IS. For example, since 2003, the conference of *Technologies for Interactive Digital Storytelling and Entertainment* has been held annually. In 2008, the *Conference on Technologies for Interactive Digital Storytelling* and the *Entertainment and International Conference on Virtual Storytelling* were combined into the *International Conference on Interactive Digital Storytelling* (ICIDS), which has become a grand conference for programmers, computer researchers, developers and theoretical researchers. The topics relate to IS, and the discussion mostly focuses on narrative research, computer interaction and immersive technology (ICIDS, n.d.).

Being different to the traditional narrative method, interactive storytelling can provide readers/players with an opportunity to influence the story (Linaza et al., 2014, p. 110; Huseinovic & Turcinhodzic, 2013, pp. 65-72). Interactive storytelling shows a dynamic and nonlinear structure dependent on the audience’s independent choices. Many researchers argue that

interactive storytelling will become the major art form in the 21st century (Stern, 2008, pp. 1-5). Both simple, multi-line interactive storytelling and interactive storytelling prepared by artificial intelligence (Mateas & Stern, 2005) have great differences from the traditional narrative structure (Markouzis & Fessakis, 2015, p. 5). Interactivity is not unique to new media but is generally considered to be a central characteristic of it (McMillan, 2002, p. 163). Some scholars posit that the concept of interactive storytelling stemmed from Wagner's concept of drama. Though Wagner did not use this term, he was devoted to creating a drama form without "four walls", so as to allow the visitors to be a part of the stage and to offer a real-world experience (Wagner, 2002, p. 43; Dinehart, 2015). On one hand, the most famous example in the field of exhibitions is the *Star War Identities: The Exhibition*. Set in the *Star Wars* universe, visitors to this exhibition redefine their status in the world of *Star Wars* (Star War Identities: The Exhibition, n.d.). Such interactive storytelling does not attempt to change the original structure or events of the movie; instead, it tries to make all the visitors involved in the film and redefine their identity associated with it. On the other hand, *Sleep No More*, which has been the representative of immersive and interactive drama since 2011, has created a new dramatic form. The audience can move through different rooms, interact with the props and watch the actors perform at their own minds. It is still performed around the world (The McKittrick Hotel, n.d.).

In the computer era, the artificial intelligence sector started to use this term to study the human-computer interaction issues, especially in the video game sector. In fact, some scholars are thinking that computer games are the new form of the art Wagner pursued. In 1976, Will Crowther developed the first text-interactive adventure game, *Colossal Cave Adventure* (Barton, 2008, p. 13), for the PDP-10 Mainframe.²⁸ In a cave full of wealth, players need to make choices after being prompted so that they can get as enormous a fortune as possible to leave the cave. In 1986, Brenda Kay Laurel cited the concept of drama described in *Poetics* by Aristotle in her doctoral thesis titled *Toward the Design of a Computer-Based Interactive Fantasy System* and described a method to use interactive storytelling to build a virtual world in a computer (Laurel, 1986). Stephen E. Dinehart argues, “the craft of interactive narrative (storytelling) design focuses on creating meaningful participatory story experiences with interactive systems” (Dinehart, 2015). The users are able to experience the story in the virtual world while they view the “dataspace” (Dinehart, 2015). interactive storytelling design lies between ludology, narratology and game design, “turning the conjoining into functional synthetic experiences” (Dinehart, 2015). Andrew Glassner

²⁸ “The Digital Equipment Corporation PDP-10 (1964-1983) is one of the most influential computers in history in more ways than can be listed here. It was the foundation of the DECsystem-10 and the DECSYSTEM-20 and ran a variety of operating systems including TOPS-10, ITS, WAITS, TYMCOM-X, TENEX, and TOPS-20. It was the first widely used timesharing system. It was the basis of the ARPANET (now Internet)” (The Digital Equipment Corporation PDP-10, n.d.).

defines interactive storytelling as a two-way experience, where “the audience member actually affects the story itself” (Glassner, 2004, p. 14).

What should be pointed out is that the so-called IS is now mostly branching or multi-path narratives with pre-set results, which David Herman calls “a work of fiction or video / film where the audience or reader at specific points has to choose between branching alternatives in the text” (Herman et al., 2005, p. 323). This interactive narrative is more “user-to-user” (interpersonal) and “user-to-content” (user-to-documents) rather “user-to-system” (user-to-computer) (Szuprowicz, 1995; Jensen, 1998, pp. 185-204; McMillan, 2002, pp. 163-182; Bostan and Marsh, 2012, pp. 19-42). The interactivity of the first two levels respectively represents interpersonal interaction between two persons or between a person and the computer character and the interaction between a person and the computer documents. The two interactive levels correspond to the two representation methods of interactive narrative (Herman et al., 2005, p. 323). Single branch, with three or more possible choices, generally relies on one moral dilemma; the other is the labyrinth solution in the game, which generally requires some clue to find the correct path. However, the user-to-system level corresponds exactly to the last narrative representation method (Herman et al., 2005, p. 323): fragmented work. There is no correct or incorrect choice; the user is not allowed to build a narrative meaning that is the best for them. This is because for interaction on this level, the research focuses more on

human-computer interaction (HCI). The interaction does not only involve hardware and software; it also involves psychology, sociology, cognitive science, human factors, interface design etc. (Bostan et al., 2012, p. 23). As such, the narrative approach of this level is more reliant on the new-generation immersive devices (e.g., HMDs). The users are allowed to explore on their own in a virtual world “into a new reality [...] previously undreamed-of states of consciousness” (Csikszentmihalyi, 2013, p. 107).

In such a situation, a new question arises: how can we advance the story in a virtual panorama space? In traditional narrative media, the users can get the “moments” that advance the plot through a shot focus or deliberate description. In a virtual world, the audience has to explore with their own senses. The “moments” must be made into objects with special natures, which are commonly used in games (see Fig. 54). However, the challenge is that the virtual reality of the world is broken by those objects, and the audience / players would immediately realise the world is a game rather

than a real world.



Figure 54 In *Fallout 4*, the player needs to be close to the shiny object to start an interaction. Retrieved July 30, 2017, from <https://gaming.stackexchange.com/questions/244719/how-do-i-repair-a-damaged-object>

As such, it becomes an urgent challenge to offer a real experience in a virtual world while allowing the audience to understand the storytelling. The related research findings still focus on ideas related to perception, such as fast-moving objects or surround sound that draws the attention of the audience.

Aladdin was the first Disney VR experience game (see Fig. 55). “We have experimented with explicit techniques for controlling the guest’s position, such as having a character grab the carpet and drag the guest to a desired location. Another coarse grain technique is to close doors behind guests to keep them from backtracking. We have also experimented with implicit techniques such as a ‘water skiing tow rope’ metaphor, where an invisible

boat is controlling the eventual position and the guest is free to fly within a moving envelope” (Pausch et al., 1996, p. 201).



Figure 55 *Aladdin* the first Disney VR game. (Photo from Pausch et al., 1996, p. 193).

On the other hand, with the popularity of VR and AR technology, interactive narrative began applied into the design of the museum and historical research. (Spierling et al. 2017, pp. 49-62; Yuan & Ender, 2017, pp. 313-324) (see Fig. 56).



Figure 56 Visitors are using SPIRIT app. The goal is to find spirits that appear at specific historical places at the outdoor museum site of the Saalburg Roman Fort (Spierling et al. 2017, 51).

Computer games are the most representative medium for the interactive narrative. As computer games gain popularity, there is increasing research into computer game narratives. Generally, there are two types of computer game narratives: traditional explicit stories and player stories (Arthur et al. 2002, pp. 229-262; Lee, 2013).

Traditional explicit stories have complete plots, roles and conversations, which correspond to a pre-set theme. Player stories involve the individual experience of the player. There is clear connection between the emotion and events the player experiences in the game and the results of the player's operations. The resulting experience involves independent roles, plots, conversations and stories. Teun Dubbelman further explains, "these mental stories are not created in retrospect after the experience; they are not constructed in a moment of retelling, but are created real-time in the experiential moment itself" (Dubbelman, 2017, p. 40).

An outstanding interactive narrative will integrate all these together. Terence Lee comments on the future of the computer game narrative "We

should stop looking to cinema as inspiration for our narrative and start realising that non-traditional structures can be a stronger storytelling technique than the ones in the biggest scripted and cinematic games. Let's redefine game narrative to mean more than just plot and dialogue — what we really care about is the story that happens in the player's mind" (Lee, 2013).

Perhaps how we explore the narrative approach of VR should change. We may need to hide some objects and not try to show all of them. In real life, humans instinctually explore and realise the world. Therefore, the display and narrative methods of VR should encourage people to explore, rather than represent the real world as much as possible.

3.3. Changing of Narrator, *Narratee* and Point of

View

By narrative we mean all those literary works which are distinguished by two characteristics: the presence of a story and a story-teller (Scholes et al., 2006, p. 4).

According to David Herman and Wolf Schmid "The Narrator is the agent or, in less anthropomorphic terms, the agency or 'instance' that tells or transmits everything—the existents, states and events—in a narrative to narratee" (Herman et al., 2005, p. 388); "The term 'narratee', coined by Gerald Prince (1971) following the French term 'narrataire' (Barthes, 1966,

p. 10), designates the addressee of the narrator, the fictive entity to which the narrator directs his narration” (Schmid, 2009, p. 364).

For traditional media (e.g., painting, illustration or even film), the narrator and *narratee* on two opposite sides, with the narrator narrating and the *narratee* watching or listening; the *narratee* describes and understands the story in the visual sense as led by the images the narrator produces.

In other words, in text narration, the *narratee* is a third person; in film or TV narration, the *narratee* becomes a bystander and observes the events and roles as a second person. After the emergence of video games, the relation between narrator and *narratee* became vague. In a game, the narrator becomes a participant (Lee, 2013) and to some extent a narrator; or, we can even say that no narrator is needed. This is because that the player (audience) is interacting with the game and may change the content and result of the game. The shift in identity allows the audience to become an experiencer rather than a bystander.

Herman discuss that in cinema, “Point of view refers to the representation of what a character sees, as in a point of view shot” (Herman, 2005, p. 440), but in literature, “the physical, psychological, and ideological position in terms of which narrated situations and events are presented, the perspective through which they are filtered- and few have been associated with as rich a terminology” (Herman, 2005, p. 442). Generally, the “point-of-view” (POV) can include the first-person, second-person and third-person

perspectives (Rasley, 2008, pp. 66-185). This classification is mostly based on traditional text or image narration. In *Three Types of Point of View in Video Game*, Altug Isigan expounded the categories and functions of POV to accommodate the development of digital media narration (computer games in particular) at present (Isigan, 2013).

Isigan cites Seymour Chatman's theory (1980) at the beginning of the article and divides POV into perceptual POV, ideological POV and POV of interest (Isigan, 2013; Porteous et al., 2010). Isigan argues that with a full understanding of the significance of such a classification, the narrative designer would be able to freely combine and change the POV and manipulate players' emotions so as to provide better immersive experience. Isigan further posits that the perceptual POV focused on the meaning of what we see to us. The POV is the classification of different traditional perspectives, as the author has mentioned above. This is the visual perception of objects and can be deemed as perspective. Realistic painters in all ages have been trying to create reliable spaces. Isigan notes that in a computer game, the artists and designers attempt to make the audiences forget the distance between their eyes and the screen to create a visual, real, natural world. The consequence is that the players believe that what they see on the screen is real, which may act upon other senses, such as the tactile sense.

To Isigan, the ideological POV not only involves viewpoint but also worldview. It correlates to ideas, beliefs and feelings. For example, in some movies, there are voiceovers and comments. In the computer games, the players may see the comments from the game itself after performing certain operations. Isigan states that these are all in the ideological POV. At the same time, the designers may provide ideologies different from those of the audience, which may result in conflict or exaggerated psychological activity so as to manipulate the players' mental state.

POV of interest and ideological POV are inseparable. Isigan writes that "Interest, is therefore not about perception or ideology, but rather about an awareness in regard to the consequences of events" (Isigan, 2013). For example, when a player (audience) becomes aware of the negative results of his/her choice, he/she may choose to face the results due to ideological persistence, or he/she must face a dilemma. In such a case, the player's emotions will change with encounters, or the POV of interest may conflict with the ideological POV of the game character. Isigan also takes *Kassandra*, a figure from Homer's *Iliad*, as an example. She saw the result of the Trojan War but could do nothing about it. In a film or a game, the player usually knows the result, while the character does not. Hitchcock called this approach to creating suspense and attracting the audience "MacGuffin"²⁹.

²⁹ "MacGuffin" is the term we use to cover all that sort of thing: to steal plans or documents, or discover a secret, it doesn't matter what it is. And the logicians are wrong in trying to figure out the truth of a MacGuffin, since it's beside the point. The only thing that really matters is that in the picture the plans, documents, or secrets

In all, Isigan notes that under the three POVs, the narrative designer is able to create an interesting narrative structure and provide the players with even more interesting immersive experiences.

3.4. A Showcase: Google Spotlight Stories

Google's Spotlight Stories project was released in the Google Play Store and App Store in July 2015 and gave users a VR experience of moving around while watching a video. As the angle shifts with the movement of the mobile phone, users can freely change the viewing angle of the image in real time and enjoy 360-degree panoramic images on their mobile phone screen—of course, the term "360 degrees" cannot be found in the introduction and media reports. More accurately, it should be referred to as 4π steradian—"no dead angle" in spatial perception.

There are several projects available in the App Store. The author focuses on *Duet* (2014), *Special Delivery* (2015), and *Buggy Night* (2014), which are mobile terminals based on 4π steradian Cinerama. These works not only provide users with interesting experiences but are also a special "variation" in film narrative. The author will try to analyse and compare these three 4π steradian Cinerama works with traditional cinema, such as movie theatres, TV series and online videos, in terms of the narration and storytelling, the immersion-featured VR and augmented reality and typical video games in

must seem to be of vital importance to the characters. To me, the narrator, they're of no importance whatever" (Truffaut, 1985, p. 138).

terms of the interaction mechanism, in order to clearly describe the narrative aesthetics of 4π steradian Cinerama at the mobile terminal.

3.4.1. The Separation of Frame View and Panoramic Views

In a traditional film, the viewer's vision is limited to what is presented on the screen. On a giant screen in the cinema, a television screen, a computer monitor or a smartphone, the video always has predetermined a frame in which the film offers all visual material for the spectators. Moreover, we can still understand the world "outside of the frame", knowing that the moving image within the square's periphery can go beyond it. To an extent, the audience can choose its perceptual POV.

It is seen everywhere. For example, when we see the cat in *Tom and Jerry* scoot away and disappear from the left side of the frame, we would insist that he is going to the right of the frame, possibly far out of the view (see Fig. 57). Our judgment of the cat comes from the visual gestalt, which we can use to assume what happens out of the frame according to what is displayed within the frame.



Figure 57 Tom is chasing Jerry. Hanna, W., & Barbera, J. (Directors). (1940-1958). *Tom and Jerry*. In R. Ising, F. Quimby, & W. Hanna (Producer). United States: Metro-Goldwyn-Mayer. Retrieved October 2, 2016, from <http://www.cartoonpics.net/r-tom-jerry-9-tom-and-jerry-run-cover-695.htm>

During the production of images, animators do not need to draw the gestures of the cat after it leaves our view. Traditional films are often visual rhetoric with omission; what happens out of view can only be inferred. It is the essential basis for the visual narrative of traditional films, which leave room for imagination.

In *Spotlight Stories*, however, the case is completely different. The pictures for a single view are very different from the panorama provided by the video, which are respectively named “frame view” and “panoramic view”. The frame view varies every time it is watched, as it is only a minute part of the latter view. Some information might be neglected in a single view, but the objects out of the frame that are missed are intrinsic to the movie. Spectators can see more by adjusting the angle the next time, which means that curious spectators will watch the movie over and over again.

Duet sets up intertwined visual plots for the boy and the girl. They meet many times throughout the film. For example, they met when they are kids and then run away from each other. The two children grow up while running and meet again under a tree. One cannot know both story lines from a single view and must watch the movie several times (see Fig. 58).



Figure 58 Keane, G. (Director). (2014). *Duet*. In G. Keane (Producer). USA: Google's Spotlight Stories. Retrieved October 2, 2016, from <http://www.cartoonbrew.com/shorts/watch-glen-keanes-new-google-short-duet-100828.html>

A film theorist and critic against the montage, Andre Bazin states that the film is the “asymptote of reality” (Bazin, 1971, p. 82); accordingly, film creation should follow the aesthetic principles of recording and representing reality. Bazin, in his resistance to montage, proposes the theory of long takes/depths of field, emphasising the flexible *mise-en-scène*—longer and more detailed shots are faithful to the spatial and temporal continuity of reality. He prefers what he referred to as “true

continuity" (Bazin, 1971, p. 28) through *mise-en-scène* (placing on the stage) over experiments in editing and visual effects. He points out that montage often imposes ideas on the audience, but the long take/depth of field can restore ambiguity and polysemy and inspire the audience to think.

Bazin's theory of realistic cinema still has far-reaching effects on the later generations for film creation, and although Bazin's theory is based on the precise recording of the real scene in front of the camera and the preservation of authenticity, mainstream animations have basically adopted the visual-audio languages of real-scene films, hence nourished by Bazin's theory. For real shots or animation, many are obsessed with or at least admire the so-called "one take", which reflects the influence of the "long take school" of film.

The playing mechanism of *Spotlight Stories*' sets a predetermined, fixed view, which will generate a natural long take. There is no film editing involved in the whole process. Thus, montage is eliminated not by the director's artistic choice, but through the inherent characteristics of the images used. Additionally, by giving the audience control of moving objects/narrative elements in the scene, the polysemy of real life is better displayed, and the audience is inspired to think and even actively participate in it. It can be said that the mechanisms of the *Spotlight Stories* conform to Bazin's core idea.

3.4.2. The Interactive View in a Panoramic Movie

In *The Aesthetics and Psychology of the Cinema*, Jean Mitry draws an analogy between traditional film and windows and mirrors (Mitry, 2000, p. 74). Traditional film is closely relevant to the frame. Whether we are located on the left or right side of the screen, what are presented in front of us are only the frame and the images within it. However, windows and mirrors are different. The images in mirrors or windows are more closely associated with the position of the observer because the objects are not the same when we stand on one of the mirror or the other.

Obviously, the mirror he talks about is stationary relative to the ground, but the position of the audience is not fixed. This is a natural choice for traditional film scholars. The phones or pads used to view Cinerama, however, are quite different; they are more like small mirrors that can be held or carried around. Here, the frame is no longer fixed, but rather is subject to change as the spectator wishes, which changes the images within the frame. It differentiates the panorama video in the phenomenological sense from the traditional video and from the window or dressing mirror; both the images within the frame and the position of the frame itself are changing.

At least until now, we could not have imagined that we would be in control of the screen to search for the wandering Santa Claus in *Special Delivery*.

Therefore, it can be said that the 4π steradian panoramic Cinerama is specially designed for mobile terminals (see Fig. 59).



Figure 59 Ruffle, T. (Director). (2015). *Special Delivery*. In Aardman Animations (Producer). USA: Google's Spotlight Stories. Retrieved October 2, 2016, from <http://www.cartoonbrew.com/interactive/aardmans-interactive-short-special-delivery-now-available-youtube-360-127391.html>

Special Delivery is a non-linear narrative in a way. "In the full interactive experience which uses the motion sensors of mobile devices, the story includes 10 subplots, three potential ways to see the ending, and 60+ moments where you can decide to follow the story in different ways" (Amidi, 2015).

The interactive experience led the author to unconsciously think about the Hitchcock's *Rear Window* (1954) (see Fig. 60). Spotlight Stories is hence endowed with the original visual pleasure of a film. It is independent of traditional film, and its immersive images aim to erase the frame. It is the peephole-moving image that stresses the existence of the mobile frame.



Figure 60 Hitchcock, A. (Director). (1954). *Rear Window*. In A. Hitchcock (Producer). United States: Paramount Pictures. Retrieved October 3, 2016, from <https://caragaleblog.wordpress.com/2015/01/19/resolutions-2015-rear-window/>

Of course, that the viewers can freely change the angle is also found in VR equipment such as Oculus Rift or Microsoft's augmented reality glasses HoloLens. However, they aim at visual immersion technologically. The audience needs to wear a dedicated VR helmet, by which the sense of reality is created. The frame and boundaries are erased, the visual range is suffusing with images and the eyes are replaced with the machine. That is why Oculus was introduced as "incredible visual fidelity and an immersive, wide field of view" (Oudolsky, 2016), and Oculus Rift's tag line was "Seeing is believing" (Oudolsky, 2016).

Any aesthetic form of the image cannot be "omnipotent" or absolutely "advanced". The 4π steradian view and mobile frame are able to provide new possibilities though inevitably imposing limitations on narrative. A new film language is developed based on traditional film, which is inseparable from the frame.

The 4π steradian viewing mechanism indicates the interactive nature of the film. It resembles video games or electronic games in that it is viewed on mobile terminals like phones and tablets. In fact, the video game is the product from a combination of animated images with interactive elements. Thus, ludology, or game studies, aims to turn the storytelling in video games into “task” sequences for players; this can be seen as a shift in game studies. We can list the possible forms of the task in various games on the market. Tasks can include searching for and accumulating articles, eliminating of enemies, pursuing an imaginary diva, mastering a piece of music, flying over a pipe or just walking from point A to point B; even in the online games, there can be multiple, continuously updated task sequences. Every game has an end—victory or defeated, accomplishment or failure, high or low score, etc..

Most games on the market involve players who, with interactive operations, try to complete tasks or events and ultimately end the game under certain conditions. Spotlight Stories are based on visual interaction instead of incident-based interaction. In *Duet* and *Special Delivery*, the user is the gazer without an identity, rather than a player involved in an incident.

The pause mechanism is typical in *Duet*. Glen Keane made the animation and the frame attractive to the audience with delicate, smooth and perfect movements. If we visually follow one of the roles in the film, the plot is told as scheduled and the narrative timeline is maintained. But, if we do not

follow the boy when he climbs up the tree and look somewhere else, then the development of the plot will not continue after the two young people look to each other with affection, and the mood of the music changes—the main story is suspended. It seems that the film waits patiently for the audience. In this case, *Duet* provides a visual guidance: a butterfly appears and then flies toward the place where the boy and the girl meet. If we ignore the butterfly, there will be more butterflies to lead the way. Once we move the frame to follow the butterfly, the boy and the girl will come back into our field of vision and the story will proceed. In a Cinerama where the fixed timeline is disrupted, visual interaction participates in the narrative.

Buggy Night is more special. The viewer must change the perspective to find the bugs. If the viewer does not locate the bugs, the story will not proceed. Each time a bug is discovered, there will be one less and the rest will run away. This process repeats until five bugs are found. In other words, the

audience must trigger the event five times to complete the viewing process (see Fig. 61).



Figure 61 Oftedal, M. (Director). (2014). *Buggy Night*. In M. Oftedal (Producer). USA: Google Spotlight Story. Retrieved October 3, 2016, from <http://www.andtwinsmake5.com/2014/03/a-360-degree-storytime-adventure-buggy.html>

In addition, if you look to the sky when looking for the bugs, you see that there is a hole on the highest tree, from which an owl sticks its head, and you hear a tranquil tune different from the previous secretive, humorous one. It also has an event similar to the pause mechanism. Thus, *Buggy Night* has tasks for the user, the main story as well as tentacled plots. The spectator is not only a gazer, but also an active subject, which makes the work more like a video game. However, the pause mechanism situates the film within traditional interaction and subverts the visual interaction Google claims.

In addition, in the other three films, the player's vision does not belong to anyone other than the player. It is not the vision of any character in the story;

for example, there are only the boy, the girl and the dog in *Duet*, without the "audience". However, *Buggy Night* is different. The player's vision is actually woven into the narrative, the player becomes a living object, hereafter referred to as "it", looking for the bugs in the forest. No one knows what it looks like, but it has a key role in the story. To some extent, the audience's POV of interest and the character's ideological POV conflict; the audience does not want the worm to be eaten by frogs, but the worm is inevitably eaten.

Therefore, Google's Spotlight Stories are not pure films, but are genetically video games. There is, in fact, no difference between them and a video game except that they have relatively independent stories while having the signs of a video game.

3.5. Chinese Narrative Thinking

(Chinese Narrative) From a literary point of view, a single moment of time, however vividly captured, would not constitute a narrative in itself; rather, it would be a reference, or an allusion, to the larger context of a story or sequence of events from which the illustrative moment was taken (Levy 2013, p. 28).

The Confucian mode of historical narration has been very important in Chinese historiography. It has deeply influenced various genres of narrating the past, including numerous local gazetteers which can be seen as the traditional Chinese genre of recording heritage" (Wu, 2014, pp. 852-853).

Andrew Henry Plaks, in *Towards a Critical Theory of Chinese Narrative*, compares the Chinese and Western views on the narrative, “The first problem that presents itself here is whether or not the transposition to Chinese literature of the Western term ‘narrative’ as a classifier for diverse literary materials provides a valid critical tool of analysis” (Plaks, 1977, p. 310).

Narrative³⁰ is called 叙事的 (*xù shì de*)³¹ or 叙述 (*xù shù*)³² in Chinese. So, semantically, narrative means “sequential say” in Chinese. The development of the Chinese class narrative is not the same the Western development of the “epic-romance-novel” (Plaks, 1977, p. 313). According to Plaks, Chinese narrative literature can be traced back to the *Book of Documents* (《尚书》; *shàng shū*)³³ and *Tso Chuan* / 左传 / *zuǒ zhuàn* (Egan, 1977, p. 323-352; Wang, 1977, 3-20).

Based on Xiuyan Fu’s *Chinese Narratology*, the Chinese narrative tradition began in the pre-Qin period.³⁴ In 尚书•金縢 (*Shàn shū jīn téng*)³⁵ and 诗经-

30 “Narrative: (noun) a spoken or written account of connected events; a story: a gripping narrative. (Adjective) In the form of or concerned with narration” (Oxford Dictionary of English).

31 “叙，次第也”(xù, cì dì yě) /sequence.. “事，职也” (shì, zhí yě) / official position. (See Xu Shen, *Shuowen Jiezi*); extension as a matter; thing; business. “的”(de) / of. 叙事的 is an adjective in Chinese (Xu Shen, *Shuowen Jiezi*).

32 叙 (ibid). “述，遁也” (shù, dùn yě) / Migration or escape; extension as writing a book or dictating an event. 叙述 is a verb in Chinese (Xu Shen, *Shuowen Jiezi*).

33 “The Book of Documents or classic of History, also known as the Shangshu, is one of the Five Classics of ancient Chinese literature. It is a collection of rhetorical prose attributed to figures of ancient China, and served as the foundation of Chinese political philosophy for over 2,000 years” (Confucius, 2016, p. 1).

34 Before AD 221.

35 *Jin Teng* is one of the articles of *Shangshu*.

卫风·氓 (*shī jīng wèi fēng máng*),³⁶ there are already coherent events and full stories. At the same time, authors portrayed series of characters with distinct personalities (Fu, 2015, p. 66).

“The Four Great Classical Novels of Chinese Literature”³⁷ actually touch on the psychology “gene” (Fu, 2015, p. 167) of the Chinese nation and reflect the Chinese preference for a narrative structure defined by the transformation of the social contract and individual contract. This idea of contracts comes from Robert Scholes’s *Structuralism in Literature: An Introduction*. Fu took the structuralist analysis method to “The Four Great Classical Novels of Chinese Literature” and summed up the two opposing categories: the hero’s aspiration for orthodox and unorthodox and the opposition between freedom and obligation (Fu, 2015, p. 164). Today, this story structure is still generally recognised by the Chinese people.

Accounting to Andrew Henry Plaks, if we focused on the narrative fiction, the most ancient Chinese novels are the Chinese supernatural tales in the six dynasties (六朝志怪; *liù cháo zhì guài*)³⁸ followed by the development of

36 *Shi Jing* is the oldest existing collection of Chinese poetry from the 11th to 7th centuries BC. Mang is the first poem in *Shi Jin* (Cranmer-Byng, 2015).

37 *Water Margin* (Shi, 2010), *Three Kingdoms* (Luo, 2008), *Journey to the West* (Wu, 2010) and *Dream of the Red Chamber* (Cao, 1974).

38 Chinese Supernatural Tales in the Six Dynasties refers to the ghost story novels in Six Dynasties (AD.222-589).

bianwen (变文; *biàn wén*)³⁹ and *chuan qi* in Tang (唐传奇; *táng chuán qí*).⁴⁰

During the Song and Yuan periods, the Chinese novel gradually developed into classical Chinese novels and vernacular novels (Plaks, 1995).

Plaks sticks to the point that classic Chinese novels originate from historical records of the pre-Qin period, while China attaches much importance to historical records and takes a derogatory attitude to fictional narrative. The author agrees with the point, because the earliest literary review work in China, *The Literary Mind and the Carving of Dragons* (文心雕龙; *wén xīn diāo lóng*), *The fourth volume* (史传; *shǐ zhuàn*), points out, “贵信史也” (*gùì xìn shǐ yě*; explicitly historical biographies need to put true history first) (Liu, 2008, p. 160); therefore, various elements of fictional narrative are hidden in books regarding historical records as intermediaries of true history. It is interesting that the method of pursuing new style out of the ordinary and clinging to the hearsay (弃同即异, 穿凿傍说; *qì tóng jì yì chuān záo bàng shuō*) (Liu, 2008, p. 160), which Liu Xie criticised becomes the persistent writing method of China’s historical novels in the Ming and Qing Dynasties. Fiction from the Ming and Qing Dynasties are still affected by China’s classic historical narrative; on one hand, they centre on real historical stories, and on the other, they select new-fangled statements to remove, which is the

³⁹“*Bianwen* is a technical term in vernacular and prosimetric narratives in Chinese literature of Tang dynasty, “a unique verse-introductory (or pre-verse) formula, an episodic narrative progression, homogeneity of language, an implicit or explicit relationship to illustrations, and prosimetric structure” (Mair, 1989, p. 15).

⁴⁰ The classical fiction Chinese short stories in Tang dynasty.

relation between historical narrative and fictional narrative in the Chinese narrative system, according to Plaks. The fundamental question is in the understanding of “historical” and “fictional”. Plaks suggests that the West focuses on “imitation” (Plaks, 1977, p. 314) that presumes all comes from fiction, which explains why the West’s “epic-romance-novel” (Plaks, 1977, p. 313) has single-track development. However, the ancient Chinese concentrate on “transmission” (Plaks, 1977, p. 312) to declare the truth. “In both the historical and the fictional branches of the Chinese tradition, the final justification for the enterprise of narrative may be said to lie in the transmission of known facts, a point perhaps not unrelated to the use of the character *chuan* / 传 (with its alternate reading) to refer to a broad range of narrative forms” (Plaks, 1977, p. 312). However, “truth” in China is subjective and relative and differs with the different times and events. This phenomenon continues today, such that compared to the West’s narrative development routine, China’s “myth-historiography-fiction”⁴¹ has a more multi-line development.

In addition, Plaks argues that Chinese narrative always points to the narrative method of “Non-narrative + Spatial” (Plaks, 1995, p. 48) and turns the original vivid myth into a spatial narration when talking about Chinese

41 Plaks was divided a list the narrative continuum from history to fiction in China: “Official Historiography; Chronicle Historiography; Unofficial Historiography; Fictionalized history; Quasi-historical; Supernatural hero-cycles; Exemplary, fantastic, or anecdotal fiction; Mimetic or ‘domestic’ fiction” (Plaks, 1977, p. 319).

narration structure. Plaks attributes the phenomenon to the Chinese 礼 (*lǐ*; ritual) which had been forming since the Shang dynasty to standardise rituals and connect myths and the seasons' changes with the alternation of yin and yang to form a kind of institutionalized pattern. Therefore, the Chinese narration concentrates on objects' relations, not the objects themselves. Plaks calls this "the overlapping of event" or "the interstitial space between events" (Plaks, 1977, pp. 314-316).

For traditional Chinese narration, each event is not the real entity, but is rather part of a greater spatial conception. For historical Chinese narration, it is more important to cover lots of ground, instead of chronology.

3.5.1. *Tso Chuan* / 左传⁴² as Chinese Narrative Archetype

The *Tso Chuan* is an ancient Chinese narrative history that is one of three main commentaries (the *Kung Yang* / 公羊, the *Ku Ling* / 穀梁, and the *Tso Chuan* / 左传) on the ancient Chinese chronicle The *Ch'un ch'iu* or *Spring and Autumn Annals*⁴³ by Zuo Qiuming (Fu, 1984; Iijima, 1941, p. 155-194; Kang,

⁴² 左传 (*zuǒ zhuàn*) / *The Tso Chuan* or *Tso Zhuan* or *Zuo Zhuan* or *Zuo Commentary*. 左 (*zuǒ*), generally refers to the author of the book, Zuo Qiuming; 传 (*zhuàn*) means 传记 (*zhuàn jì*)/Biography. According to Anne Cheng, the 左传 have originally two versions: "modern script" (今文 / *Jīn Wén*) version, "which was circulated during the Former Han Period (206 BC – AD 220) (Cheng, 1993, p. 69); and "ancient script" (古文 / *Gǔ Wén*) version, "being kept in the Han imperial archive" (r. 7–1 BC) and "it was brought to light by Liu Hsin (46 B.c.-A.D. 23)" (Cheng, 1993, p. 69).

⁴³ "The *Ch'un-ch'iu* (*Spring and Autumn Annals*) or *Spring and Autumn* is a chronicle of the reigns of twelve dukes of the state of Lu 魯 covering the period from 722 to 481 b.c. It contains, in barest outline, notations of the internal affairs of Lu, of diplomatic conferences, feudal wars, and Lu's other relations with neighboring states, and occasional records of eclipses, floods, earthquakes and prodigies of nature. The account is entirely impersonal,

2010; Karlgren, 1926, p. 365; Pi, 2011, p. 16-18; Duan, 1977; Watson, 1958; Cheng, 1993, pp. 67-76). Ronald C. Egan commented, "Like all good history, *Tso chuan* describes the relations between events, in addition to recording the events. Though there surely are limitations in *Tso chuan*'s description of the past, it does consistently give the reader a sense of the larger, causal context of particular events" (Egan, 1977, p. 323).

Plaks uses the theory of archetypal criticism⁴⁴ to explain myths. Archetypal criticism deems that there are series of significant archetypes either in the entire human knowledge system or in literature, history and philosophy subsystems. These recurring structural patterns promote the entire knowledge system of all nations. Thus, *Tso Chuan* can be considered a kind of archetype, because it is the archetype of Chinese historiography and traditional Chinese narration structure (Herman et al., 2005, pp. 62-63). Therefore, understanding the narrative method in *Tso Chuan* is important in researching classical Chinese narrative literature. "A closer look at this work will therefore not only enable us better to understand early Chinese narrative, but it will also shed light on the narrative tradition as a whole"

with no trace, at least to the untutored eye, of the personality or attitude of the recorder or recorders" (Watson, 1958, pp. 75-76).

⁴⁴ "Archetypal criticism argues that archetypes determine the form and function of literary works, that a text's meaning is shaped by cultural and psychological myths. Archetypes are the unknowable basic forms personified or concretized in recurring images, symbols, or patterns which may include motifs such as the quest or the heavenly ascent, recognizable character types such as the trickster or the hero, symbols such as the apple or snake, or images such as crucifixion (as in *King Kong*, or *Bride of Frankenstein*) --all laden with meaning already when employed in a particular work" (Delahoyde, n.d.).

(Wang, 1977, p. 3).

It is worth noting that *Tso Chuan* is the historical book of the Lu state from the Spring and Autumn Periods, and its writer, Zuo Qiuming, was a Lu historiographer who numbered the years according to the kings' reigns, so it is inevitable to review the history relying on Confucian morality. "The Tso is thus a handbook of moral cause and effect, a system of divination based not upon numbers or omens, but upon the more complex, but infinitely more trustworthy, moral patterns discernible in actual human history" (Watson, 1962, p. 47).

In *The Nature of Narrative*, Robert Scholes and Robert Kellogg argue narration is divided into plot, character, point of view and meaning. These four elements are used by John C. Y. Wang to deconstruct narration method of *Tso Chuan* (Wang, 1977). It is an effective method to use.

3.5.1.1. Plot: Time and Space

John C. Y. Wang argues the plot of *Tso Chuan* has not only timeliness but also spatiality. The plot of *Tso Chuan* is linear, but it narrates from the end to break the progressive linear motion of events; in terms of spatiality, the author adopts a combination of biography, journey and drama, which is a kind of deliberate design (Wang, 1977, pp. 5-7).

Tso Chuan lays emphasis on the narration of the integral origins and results of events, but describes the process briefly (Waston, 1962, pp. 40-45; Wang, 1992, pp. 74-75). The most prominent achievement of *Tso Chuan's* narration

is in its depiction of war, which fully reflects its narrative features. *Tso Chuan* vividly depicts hundreds of major and minor wars. Generally speaking, *Tso Chuan's* depiction of war is not limited to a narration of the engagement process, profoundly revealing the causes and consequences of war with less focus on the wars themselves, which is different from Greek epics' descriptions of war and modern war narratives. John C. Y. Wang explains that the phenomenon is like Chinese painting; if the painting would show the moon, painters would draw clouds and bring out the location of moon to let audience experience its beauty.⁴⁵

With its strong symbolic narration (Guo, 2008; Chang, 2013, pp. 79-121), *Tso Chuan* is from the period of the Spring and Autumn Annals, when Chinese culture gradually eradicated the primitive shaman (巫覡, *wū xī*) tradition. However, this tradition still had great influence, so the whole has numerous plots related to witchcraft, genies and predictions of the future. The story of Jin Jing Duke in Cheng Gong has a zigzagging plot formed by three related dreams. The Jin marquis dreams of the devil, which is so dramatic that he is thrilled; the descriptions of incurable diseases are vivid, and the shaman's interpretations of the dream are full of mysterious colour and are like mythical novels.

⁴⁵ Wang use Chin Shen Tan's comments: 烘云托月 (*hōng yún tuō yuè*) / Painting the clouds to bring into relief the moon (Wang, 1977. p. 8).

3.5.1.2. Character: Static Character

Wang divides the portrayal of characters into “development” and “static” (Scholes, 2006, p. 168). The characters in *Tso Chuan* are static; therefore, the characters’ personalities are seemingly fixed and do not change from the beginning to the end.

Tso Chuan depicts various characters, but its depictions are not presented in a series of biographies that narrate the life stories of characters and are not the same as those in later novels that shape characters in its own method. The chronicles, words and stories of characters are dispersed in throughout the events of the text without concentrating on a single character, and the full personality of a character is realised through his or her relation to the events of other characters.

Action and dialogue is the major method of character performance in the narration of *Tso Chuan*, while the subjective static depiction of appearance and mentality account for less. Characters’ personalities are formed through words and actions in significant historical events.

This is the consistent aesthetic orientation of Chinese narration. In numerous Chinese classic novels, most characters are depicted as static; authors pay attention to some basic character features but are not interested in the origins of these features. John C. Y. Wang only finds one developmental character in *Tso Chuan* in the depiction of Fu Chai, King of Wu (Wang, 1977, p. 9).

3.5.1.3. Point of View: Impersonal Narration

In Wang's opinion, the author of *Tso Chuan* narrates as a third-person reporter. In *Tso Chuan*, the author uses the third-person POV, which is not the omniscient but rather that of an insider involved in the development of events. The author of *Tso Chuan* adopts an un-emphatic narration to help readers understand the meanings of events without his own opinions, so that readers can understand the author's meaning from the narration itself. Ronald C. Egan calls the narration "impersonal" (Egan, 1977, p. 325). "It is this reluctance of the author to address the reader directly, or to cultivate a narrative persona, that makes the tone of *Tso Chuan* completely unlike that of ancient history in the West, in which the narrative persona of an empirical and painstaking investigator of the past is constantly at the reader's side, guiding and interpreting for him" (Egan, 1977, p. 324).

The depiction is good for readers to access the essence of the stories. John C. Y. Wang takes the well-known example of "Duke Chuang of Cheng and His Mother and Brother"⁴⁶ (Legge, 1893, pp. 5-6). It says that Duke Chuang consistently indulges his brother to revolt against their mother, but he kills his brother at the last moment and imprison his mother. The story is the basis of the most famous hypocritical human debate. Most think that Duke Chuang intentionally indulges his brother and mother to humiliate him, but others think that Duke Chuang is just a kind elder brother who loves his

⁴⁶ Duke Yin 1st year (722 BC).

family and must protect his authority at the last moment. It is hard to define the features of real historical characters. *Tso Chuan* does not draw any conclusion because it records the content in the third person, not from the omniscient POV later historians use to make historical records more like a novel (Wang, 1977, p. 12).

3.5.1.4. Meaning: Emphasising the Causal Relationship of Morality and Result

“I [Confucius] would rather reveal meanings in its depth and clarity through subtle descriptions of actual events rather than carry my thoughts in empty words” (Sima,1999. p. 3297).

Wang’s view is the same as other scholars’, and they suggest that causal narration of events is characterised by morality and mystification. The whole narration of *Tso Chuan* contains the elements of ritual, righteousness and morality, which the author considers significant.

The author of *Tso Chuan* uses Confucian thought to reveal the political landscape of each country in the Spring and Autumn period, adding a strong feeling of preaching without consciousness. Therefore, it is similar to Watson’s assessment of *Tso Chuan* as “a handbook of moral cause and effect, a system of divination based not upon numbers or omens, but upon the more complex, but infinitely more trustworthy, moral patterns discernible in actual human history” (Watson, 1962, p. 48).

However, for this kind of historical literature, *The Nature of Narrative* reads, “The convergence of the novel with the history, biography, and autobiography has resulted not so much from impatience with storyteller’s Fantasy as from a modern scepticism of knowing anything about human affairs in an entirely objective (non-fictional) way. Science seems to have demonstrated that Aristotle’s distinction between history and fiction was one of degree, not of kind. All knowing, and all telling are subject to the conventions of art. Because we apprehend reality through culturally determined types, we can report the most particular event only in the form of a representational fiction, assigning motives, causes, and effects according to our best lights rather than absolute truth” (Scholes et al., 2006, p. 151).

On the contrary, *Tso Chuan* concentrates on recording strategies and the application of schemes of war. When *Tso Chuan* narrates a war, it first emphasises the monarchic morality and view, and the depiction of war focuses on the application and flexibility of schemes, not the atmosphere of the battlefield.

3.5.2. Chinese Visual Storytelling

Julia K. Murray, in “What is ‘Chinese Narrative Illustration’?” defines Chinese narrative illustration as referring to a story, “where ‘story’ means the presentation of one or more events that occur in a sequence of time and bring about a change in the condition of a specific character” (Murray, 1998,

p. 608). In fact, Murray's discussion of Chinese narrative illustration proves Wang and Plaks' understanding of traditional Chinese narrative: the Chinese narrative tradition is one of both timeliness and spatiality. Chinese artists, or artists influenced by traditional Chinese narrative, try to use a "long shot" expression to show what happens to a character in different times and spaces.

3.5.2.1. Space and Time in Chinese Painting

In *Night Revels of Han Xiza* (see Fig. 62), Hongzhong Gu uses serial pictures to depict the process of revelry. The master of the banquet appears five times in the image. The whole image shows the night revel from beginning to end and all kinds of activities in different locations. On the other hand, interesting plots are hidden in the image, such as a maid talking and a spy hacking. According to the *Xuanhe Huapu* / *宣和画谱*⁴⁷, Southern Tang Emperor Li Yu sent Gu to infiltrate the residence of a Han who has been documenting Han lives. This also is an interpretation of Aristotle's *Poetics*, "Dramatic action, therefore, is not with a view to the representation of character: character comes in as subsidiary to the actions. Hence the

⁴⁷ "The *Xuanhe huapu* 宣和画谱 / Notes on painting from the Xuanhe reign is a treatise on painting written during the Xuanhe reign (1119 - 1125) of Emperor Huizong 宋徽宗 of the Song dynasty 宋 (960-1279)" (CHINAKNOWLEDGE, n.b.).

incidents and the plot are the end of a tragedy; and the end is the chief thing of all”.⁴⁸



Figure 62 Gu, H. (937-975). *Night Revels of Han Xiza*. The Palace Museum, Beijing. Retrieved March 5, 2018, from <http://www.mh50.com/minghua/129.html>

Another example comes from Kano Sansetsu’s *Song of Lasting Sorrow Picture- scrolls* (see Fig. 63). Sansetsu was a Japanese painter influenced by Chinese literati paintings. In “Emperor Minghuang mourns Yang Guifei”, according to Shane McCausland, on the right side, Emperor Minghuang is with Yang Guifei and simply sways along with the summer breeze. On the left side, Emperor Minghuang sits alone in the courtyard in autumn and thinks of Yang’s death. The two emperors gaze at each other to communicate through time and space. The overall image is similar to *Night Revels of Han Xiza* formed in an organic whole (McCausland, 2013, pp. 41-60).



Figure 63 The same character from right to left, from summer to autumn. Sansetsu, K. (1590-1651). *Emperor Minghuang mourns Yang Guifei*. Dublin, Trustees of the Chester Beatty Library (McCausland, 2013, p. 42).

Due to the right-to-left mode of deployment of traditional Chinese scroll painting, the audience’s gaze begins on the right side and ends on the left. The process of deployment changes the position of the audience’s visual

48 Aristotle, *ibid.*

focus, corresponding to the change of time and place in the image. This is characteristic of traditional Chinese visual narrative, which is known for timeliness and spatiality, and is at the same time full of metaphor.

3.5.2.2. *The Visual Path in Chinese Painting as the Narrative*

Space, as a medium in which material objects and our interactions with them exist, can “locate” a spatial narrative somewhere between us and our physical environment. These spatial stories are as much in our heads and bodies as they are in the physical environment surrounding us. It is this ‘mediate’ condition that has made spatial narratives so profoundly instrumental throughout history (Lonsway 2013, p. 48).

In the Dore J. Levy’s *Vignettism in the poetics and Visual Narrative Painting*, the Chinese visual narrative (painting) is highlighted as a symbolic model. Compared with Western painting, traditional Chinese painting emphasises the background story and implied meaning through the painting. Therefore, understanding the Chinese visual narrative depends on the reader's education level and background knowledge (Levy, 2013, pp. 27-40).

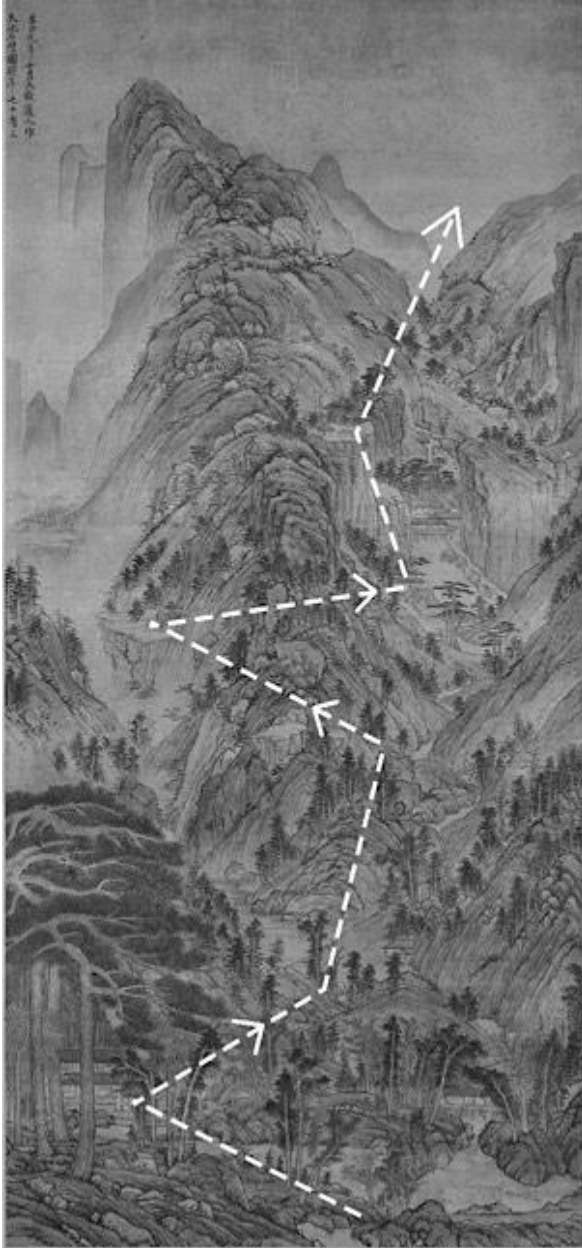


Figure 64 Dotted line by Shen-Shen Luo. Based on Huang, G. (1343). *Tian Chi Shi Bi Tu*. Beijing, The Palace Museum. Retrieved September 7, 2017, from http://www.npm.edu.tw/exh100/fuchun/images/07_1b.jpg

Immersive spaces can be seen as visual paths. They use the environment and atmosphere to tell the narrative. Following the narrative theory related to space and image in *A Theory of Narrative*, Altman called his theory of image narration a “Space of Multiplicity” (Altman, 2008, p. 191), which focuses more on the rules of identifying single images through the naked eye. The theory groups and intensifies images using a range of perspective lines and reference systems to catch the audience’s eyes on the

narrative theme, and during this process, parts of image display the plot and content of

the narration. No matter the audience's location, the point of sight will finally concentrate in the middle of the picture.

In fact, this kind of narrative space is very common in traditional Chinese painting. Chinese paintings are mostly vertical compositions hung on the wall with the bottom of the picture at eye level. Viewing the painting requires physical action to complete, the basis of “glance logic” (Bryson, 1983, p. 122) and paths of image and direction. Thus, there will be multiple shapes to attain the so-called state of narrative space. The audience always looks from the bottom up to see the painting. The formation of path is not to draw a road, but to use shape contrast cues that guide the audience's eyes upward. As in Gongwang Huang's *Tian Chi Shi Bi Tu* (see Fig. 64), the audience tries to identify a path from the bottom of the picture to the top of the mountain through the complexity of the scene. In the process, the path is blocked by dense woods or clouds. It makes the audience inadvertently see the more interesting information. Artists and audiences seem to form a bidirectional interaction relationship; the painter sets up a maze to confuse the audience, and the audience struggles to find a way out. As a result, the audience gradually understands the meaning in the painting.

This is a process that shapes visual paths and narratives. Gaze means seeing all the performances in the scene completely free from involvement. Thus, there are no rules for a pure gaze according to which the achievement of the view is judged. The end only means "the story is finished". The freedom of sight does not have any effect on the role-play or the progress of the story; we are merely passive bystanders. However, traditional Chinese paintings

make the audience more than a bystander. There are numerous interaction mechanisms that allow users to go beyond simple gazing.

On the other hand, the audience's subjective perception enters a state of illusion when looking up to reach the distant mountains.

4. Interactive User Experiences

According to the *Oxford English Dictionary*, interactive means “(of two people or things) influencing each other” or “allowing a two-way flow of information between a computer and a computer-user”. In both the human-human interaction and the human-computer interactions is the autonomic behaviour of humans. In the design of an immersive space, the experience of human-human or human-computer interaction will simultaneously influence users' feelings. This research focuses on the inducements creating interactions and the immersion state created by interactive action. Technological breakthroughs and psychology are important to this study because they allow the author to think more deeply about how to structure the design process.

4.1. Flow Theory

Flow is a state in which an individual is completely immersed in an activity without reflective self-consciousness but with a deep sense of control (Engeser & Schiepe-Tiska, 2012, p. 1).

Flow Theory is the major theory of psychologist Mihaly Csikszentmihalyi (1975), who argues there must be a stage to reach a “flow” status during people’s pursuit of happiness (Engeser & Schiepe-Tiska, 2012, p. 2). In short, flow theory, which involves ability, attitude, cognition, emotion, motivation and personality (Rogers, 2015), focuses on how to obtain a kind of “optimal experience” (Moneta & Csikszentmihalyi, 1996, p. 277). When people experience such feelings of enjoyment, they naturally enter the immersive experience—that is, “flow”. Such a “highly functional state” often appears in the process of creative activities, studies and sports (Csikszentmihalyi et al., 2005).

In Csikszentmihalyi’s view, people who are immersed forget about time and space, fully concentrating on one thing, such as the imaginative experience of novel plots, artistic creations and so on. When performing activities, people first need to project their “psychic energy” (Csikszentmihalyi, 2013, pp. 55-58) to the target. This is about attention, the energy that determines our memory, associations and other activities and plays an important role in improving our experiences. Csikszentmihalyi states that the emergence of such optimal experience must be accompanied by at least one of the following seven characteristics:

1. **Clear goals and feedback.** There is a clear and specific goal and quick feedback (Csikszentmihalyi, 2013, p. 78). Just like the process

of playing tennis, a player always knows when to return the ball and score (Csikszentmihalyi, 2013, p. 84).

2. A challenging activity that requires skill. Flow can be obtained through a restricted rule, and an optimal experience derives from a sense of control. People must recognise it is possible to accomplish the task when there is an opportunity (Csikszentmihalyi, 2013, p. 79).

3. The merging of action and awareness. With the determination of a clear goal, action and awareness can merge. In other words, our unconscious actions are repeated (Csikszentmihalyi, 2013, p. 83).

4. Concentration on the task at hand. The experience of flow can make us forget about life and focus on upcoming challenges (Csikszentmihalyi, 2013, p. 88).

5. The paradox of control. We are unable to control ourselves if we concentrate all our senses on one job. If we always act based on our skills, we are no longer able to focus on other things. One common manifestation is indifference to success or failure (Csikszentmihalyi, 2013, p. 89).

6. The loss of self-consciousness. If action and consciousness are combined, "a loss of ego" is generated. Meanwhile, abandoning self-awareness can help establish a clear self-concept in the flow, thus inviting us to challenge and improve ourselves (Csikszentmihalyi, 2013, p. 93).

7. **The transformation of time.** It will feel like that our perception of time is lost and time flies if the above situations occur (Csikszentmihalyi, 2013, p. 96).

In other words, Csikszentmihalyi argues that humans need high-level skills and the ability to cope with high-level challenges to reach flow status (see Fig. 65). As time goes by, we are likely to enter flow if the challenge matches our corresponding skills. Specifically, the challenger will feel anxious if the challenge is beyond his or her problem-solving skills. However, the challenger will feel bored if the challenge is far below his or her problem-solving skills. So, no optimal experience can be obtained under those two situations.

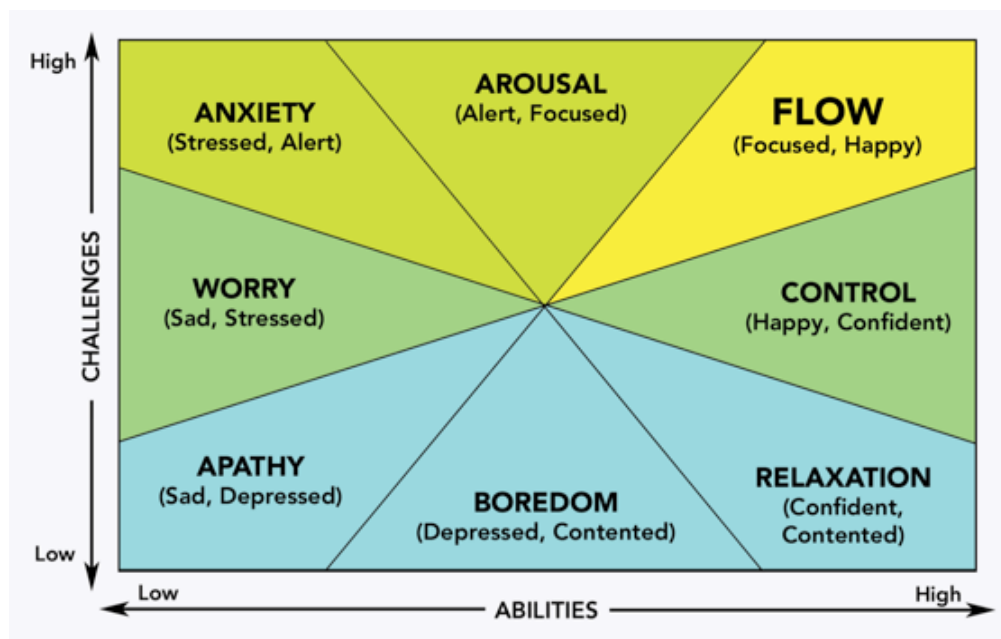


Figure 65 Ratio between challenges and skill (Csikszentmihalyi, 2014, p. 139). Retrieved 7th February 2017, from <http://www.globoforce.com/gfblog/2013/happiness-flow-and-how-to-be-a-better-leader/>

Moreover, flow theory is based on a personal, proactive challenge to the environment. The obtained optimal experiences originate from people's favourite activities and the situational conditions associated with them (Abuhamdeh, 2012, pp. 109-122). However, as a theory emphasising personal experience, it is strongly subjective, so self-report measures cannot be replaced by the analysis of human physiological parameters (Peifer, 2012, pp. 139-164). As a result, researchers try to use various means and perspectives to complete their studies, such as Jean A. Hamilton et al., (1984) and Daniel Goleman's (1995) studies from the perspective of neurophysiology and David Marr's (1982) synthetic theory of cognitive, behavioural and neurophysiological explanations.

Recently, researchers have paid more attention to the flow experience generated during human-computer interaction (e.g., Nacke & Lindley, 2009; Prinzel et al., 2000; Rani et al., 2005; Fairclough, 2009). Their goal is to determine the relationship between players' real-time physiological parameters and game tasks and then analyse whether the tasks in the game can make players feel excited or bored (Peifer, 2012, pp. 139-164). Annette Rogers argues there are five flow characteristics that can be found in gameplay:

1) clarity with explicit gaming context, rules, feedback, and goals,

2) centring with narrative providing storyline,

3) choice with multilevel play, numerous episodes, variety of characters and actions, and guilds

4) commitment via resets (do-overs) and new virtual identity

5) challenge via incremental task difficulty and reward system (Rogers, 2015).

The inspiration the author gets here is that the deep mental immersive experience is guided by flow theory, and such guidance can be applied to numerous aspects when designing an immersive space. For example, designers use the space's environment and relevant challenges to help the visitor have an optimal experience. The designer needs to set a challenge for tourists. At the same time, the designer needs to ensure that visitors have the ability to resolve this challenge. Not only that, but the theory also involves the emotional control of visitors. This view is that designers can design challenges to influence visitors' moods. In addition, the designer must consider intention, attention and positive feedback.

4.2. Factors of Interaction of Immersive Spaces

The application designer must consider the goal of the experience and whether or not a sense of mental immersion is necessary, along with how to achieve it when appropriate. In a manner similar to content creators of other media, the VR experience designer has complete control of the virtual world, at least during the design and implementation phases, and must determine all aspects of what is or is not in the world. They establish all of what can or cannot happen in the virtual world, who can or cannot participate, and

what happens to the world at the end of the experience
(Sherman & Craig, 2003, p. 411).

Base on *Oxford English Dictionary*, interaction is a “reciprocal action or influence”. Of course, the realisation of this process requires an information/energy exchange between two or more parties. a space in which this information interaction can be realised is likely to create a better immersive experience.

Based on flow theory, suitable challenges and relevant problem-solving skills are the basis for obtaining an optimal experience. In the real world, interactive actions mainly derive from the information shared among people. Therefore, the space in which information exchange can be realised is the key to creating an immersive experience in the real world. For instance, information and images are often used at the entrances of entertainment venues. As a crucial step to create an immersive experience, such information and images can provide people with topics to consume, during which time these visitors will better understand and engender the expectations of the entertainment venues (see Fig. 66).



Figure 66 The entrance of California Aviators in Disneyland California. Photo by Luo ShenShen, 22 June 2016.

For a virtual space, the key to the immersive experience lies in whether timely feedback can be obtained from the virtual environment actions are taken. Such timely feedback, which is the interactivity of human-computer interactions, can not only prolong the immersive state but also play a crucial role in promoting narrative development. Base on Sherman and Craig's argument, we must consider three factors of interaction in virtual space: manipulation, navigation and communication (Sherman & Craig, 2003, p. 286).

Manipulation, whose main targets are objects in space, can help us understand the new environment. Specifically, the application of manipulation in the real world is reflected in the force exerted on the object

(i.e., moving it). Its application in the virtual world is reflected in object selection and in "contact" with the virtual space (Sherman & Craig, 2003, p. 286), such as document selection in a computer interface or a character's behaviour in a game. Manipulation actions in the virtual world are mainly reflected in four methods: direct, physical, virtual and agent (Sherman & Craig, 2003, p. 332). In a word, manipulation, which is the beginning of interaction, is reflected in our psychological cognition towards the challenge. Navigation, which is our movement from one space to another, consists of two parts: travel and wayfinding (Sherman & Craig, 2003, p. 332). Wayfinding refers to our spatial cognition, and Cathleen Stasz refers to the four strategies of making a spatial cognition map: divide and conquer (Stasz, 1980, p. 11), global networks (Stasz, 1980, p. 13), progressive expansion (Stasz, 1980, p. 14) and narrative elaboration (Stasz, 1980, p. 17). The first three strategies prefer to use landmarks to guide visitors. Narrative elaboration prefers to use events, which involves "creating narratives or categories incorporating adjacent elements" (Stasz, 1980, p. 17) to guide the visitors to find their methods in the virtual world. However, no matter which strategy is selected, a goal must be set before selecting the method (e.g., finding the city's TV tower or exiting a maze). This goal, which is equivalent to the challenge mentioned above, must be clear and definite. "For any world in which regions of interest extend beyond the virtual reach of the participant, travel is the crucial element that accords them the ability to

explore the space” (Sherman & Craig, 2003, p. 343). In the virtual world, this navigation involves movement in the real world, which can be converted into a signal in the virtual world through certain methods. In short, navigation is more of an ability than a skill.

Communication is a kind of feedback and exchange of information. There is no difference between the virtual and real worlds. Sherman and Craig note communication is mainly reflected in the experience sharing (of the user in different spaces) in the virtual world.

4.3. Interactive Experience in Virtual Environments

As mentioned previously, in 1996 Randy Pausch published a detailed research report on *Aladdin*, Disney’s first interactive VR game (Pausch et al., p. 1996). This study was the first on the VR commercial gaming industry. In his research, Pausch surveyed 22, 479 experiencers, 48.5% of whom were female, of all ages. After the game experience, 21% of visitors liked the steering control in the game; however, 30% of visitors did not (Pausch et al., 1996, p. 195). Pausch concluded that guests suspend disbelief; VR appeals to everyone; VR must be personally experienced; fidelity matters; content matters; the illusion of presence is fragile, and Guests need a background story; guests need a goal; guests do not need to turn their heads much; input controls are difficult; and the story should be straightforward (Pausch et al., 1996, p. 201). The experience in the virtual world varies from person to person.

However, Jonathan Steuer argues that the experiences in the virtual world share some similarities with the real world. According to Steuer, interactivity in virtual environments is composed of three elements: speed, range and mapping (Steuer, 1992, p. 85). Speed refers to the feedback time in the virtual world; range refers to “the level of activity a user can conduct in the virtual world; and mapping is a function of the types of controllers used to interact with the mediated environment” (Steuer, 1992, p. 85). All of these factors can affect the user’s experience in the virtual world.

Speed, which is a very important feature of interactive media, means timely feedback (Shneiderman, 1992, p. 199). In the virtual world, feedback speed can directly influence the user's experience and feelings. Compared to a game with gorgeous images and operational delays, a game with low resolution and quick feedback can give a much better user experience.

Range in the interaction describes the scope of the actions that can be controlled in the virtual world. It also refers to the number of objects that users can influence in the virtual world, including image sizes, colours, sounds and even the narration. In general, users want an interactive VR experience that is similar to or even far beyond the real world.

Mapping is a method through which we can control the virtual world in the real world. It also means that the human actions are connected to actions within the mediated environment (Norman, 1986; 1992). For example, the task in the virtual will go forward or backward when the mouse moves, and

corresponding words will appear on the screen when tapping the keyboard. The smoother the mapping process, the better the user experience. That is why game companies continue to improve their game-pads to meet the increasing experience demands of users. Today, such virtual experiences not only focus on the tactile sense, but also centre on the combination of each sense organ.

Overall, the main features of VR interaction according to Steuer are still applicable to today's extensive VR products.

4.4. A Tangible VR: *The Leviathan Project*

The integration of a representation of the observer's own body in the image space, that is an avatar, is also a means whereby immersion can be enhanced (Grau, 2004, p. 344).



Figure 67 Luo ShenShen experiencing The Leviathan Project at the USC World Building Media Lab. Photo by Yan Jiang, June 23, 2016.



Figure 68 The World Building Media Lab. (2016). The Leviathan. USC School of Cinematic Arts. Retrieved 5th February 2017, from www.fabricantlab.com

In June 2016, the author visited the University of Southern California (USC) and communicated with Alex McDowell, one of the founders of The

Leviathan Project (see Fig. 67). McDowell is a designer working in narrative interactive media at USC. His work focused immersive design, which integrates digital technology and traditional design techniques. He has created a holistic design process called Immersive Design (McDowell, 2015). McDowell argues, “the immersive space can be anything. Full immersion certainly starts from the five senses. It is an immersive space when we enter the cave or climb up the mountains. The key lies in how to bring in the full experience. You can believe, to be simple, that my body is in one position, but my mind is in another” (McDowell, 2018).

USC’s The Leviathan Project, which is under development, is based on Scott Westerfeld's best-selling trilogy, *Leviathan*. Users are invited to embody a flying whale in the MR project and interact with different roles to get to know the story.

The author flew in the virtual world when wearing the HMD system. Through hand movements, the author could slide into the whale, which was like a huge aircraft. After landing, the author saw nine operating devices corresponding to that on the green desktop in the real world. The author moved the operating device in the real world to the relevant position according to the voice prompt of the cartoon image. Then, the corresponding operating device in the virtual world showed a colourful visual effect and took me further into the plot (see Fig. 68).

This device tries to combine the virtual world with the tactile sense in the real world, rather than only using sensors to solve the challenge of touch. In the Leviathan world, the audience can recreate DNA, World War I and or even their own future. McDowell considers this project an attempt to create a new experience that combines video games and movies.

This is undoubtedly an ambitious project, so the author will evaluate it using the three indexes that influence users' interactive experience: speed, range and mapping. It is doubtless that speed will be restricted by the hardware condition. Generally speaking, the feedback speed of this project is timely, but there was still an image delay during the debugging, which influenced my immersive experience. For the operable objects, the range can help visitors have a rich interaction with the virtual objects via their hand movements and the hand tracking system. The mapping is the most interesting part of the design. As mentioned above, visitors' heads and hands are the tools connecting the real and virtual worlds through the application of physical touch. Besides, what should be specially mentioned is that visitors can actually touch the "real objects" with their hands so that their experience can be greatly enhanced.

This project has combined full panoramic vision and interactive storytelling. The designer has found a way to develop movie-like storytelling using human-computer interaction. Being similar to video game storytelling, this method uses interactive elements to promote the story within a limited

story framework. However, the difference is that the Leviathan Project prefers a prompt system, which is similar to a narrative, to guide visitors. In game storytelling, the whole scene is usually completely open.

During our communication, McDowell repeatedly talked about innovations in VR storytelling and how VR technology has changed people's storytelling habits. He argues that in the VR world, which is characterised by a 360-degree perspective, effectively guiding visitors and driving the story forward are a major challenge. How do we formulate the rules for the virtual world? There is no need to consider the narrative theories in different cultures or their differences because people are experiencing significant changes in their worldviews and rules as they switch from indicative images to VR technology. VR technology has changed people's storytelling habits. McDowell notes that people should not develop VR simply because it is the era of VR. We need to apply, listen to and use the technology. It is a freedom. We are at a technological crossroads. New producers need to formulate new rules and draw a line. There might be new, post-human races in imagined worlds observed through VR glasses (McDowell, 2018).

4.5. Selecting Different Media for Hybrid Immersive Spaces

“Space” is an idea, a concept, a relatively high-order abstraction of something that location, position, a relatively high-order abstraction of something that location, position, proximity, and movement seem to us

(or to other cultures) to have in common, namely, some field in which they occur or arena in which objects are located and move, is to privilege one meaning of “space” over others (Ran, 2009, p. 7).

To create immersive experiences, different media devices have different advantages and disadvantages. Immersive spaces in the real and virtual worlds and in mixed reality also require various media, devices and presentation modes. However, it is difficult for the immersive space to separate the real and virtual worlds in modern times. In most cases, what we see in the immersive space is the technology in the real and virtual worlds. The author has developed the term “hybrid immersive space”, to describe virtual spaces that include sculptures, installations, videos, stage performances and other elements that aim to maximize the limits of immersive experience. So, the designers shall apply different technologies to make plans for different themes and content.

4.5.1. Space, Stage and Perception in Immersive Spaces

The immersive space mainly involves three factors in both the real and virtual worlds: space, stage and perception. Space is the surrounding environment; the stage is the centre of the performance and perception is audience's angle of view. As mentioned above, the immersive space is primarily a closed space in which every event can be regarded as a stage. The stage performance is based on storytelling. When walking through the stage, users or visitors can make observations from different viewing angles

according to changes in time and position. A perfect immersive space design shall control not only the position and event sequence on the stage but also the viewing angles and sequence for users or visitors (see Fig. 69).

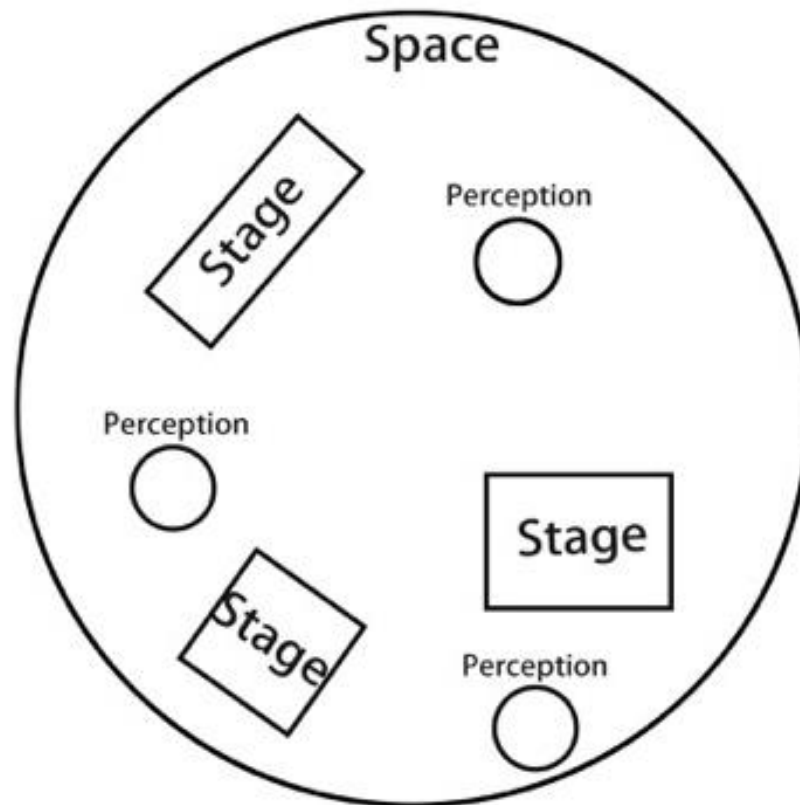


Figure 69 Space, stage and perception: The three major elements of immersive space. Image by Luo ShenShen.

This relatively closed system, which carries the stage and audience, must have a complete story, theme and narrative structure. The space serves as the actor and storyteller in this immersive system.

The stage here can be a flat image as well as a three-dimensional one. The reason it is responsible for the narrating or initiating narration is that the narration can be a complete or in parts/chapters. Just like an unfinished

book, a prompt of "to be continued" will be printed on the last page. There is also a similar prompt here to remind visitors to move to the next stage of the plot. Thus, interactivity appears to be particularly important.

Perception, which can directly influence the immersive experience, includes two parts. It first refers to the information-receiving process of the user's perception system. Users can receive information from the stage through their senses and then generate corresponding feedback. It also refers to the user's visual observation methods and viewing angles. There are two observation methods: viewing with naked eyes or with devices (e.g., 3D glasses, HMDs). While the user can get different visual effects from different viewing angles, such as limited vision, complete open vision and staring or glancing.

The creation of immersive space involves numerous factors, such as the light setting, stage design and mechanical device design. This research mainly focuses on using animated installations to create an immersive space, so it mainly discusses matters related to video design.

4.5.2. Frames and Projection Screens

Video images can be seen everywhere in modern society. All modern technologies, including the mobile phone screens, IMAX screens, electronic billboards and computer monitors, are like windows that show virtual spaces and images. Both "framing" and "screen" describe a type of boundary. It is a bit like realism in painting—a 3D space is described in a 2D space.

Today, using digital techniques, the limited screen display with borders has changed into the combined display mode or even the display mode that includes users. The audience's sensory threshold is becoming higher and higher because of these changes, thus forming the seamless panoramic display mode. This mode, which makes people become experiencers, has ultimately changed viewing relationship between people and images.

4.5.2.1. From Giant Screens to Domes

Cognitive information influences perceptual processes, but, at the same time, cognitive processes depend on perceptual information (Tacca, 2011).

A moving shot means the audience is moving, not the image on the screen. It is a cinematic world in which the audience can exist, and not just a screen on which they see images. (Shedd, 1999).

According to the above passage, more and more people enjoy deeper immersive experiences given the gradual increase of their perception threshold. Meanwhile, cinema screens have become larger, with giant IMAX⁴⁹-like screens around the world. Different from the common single screen, the giant screen emphasises "boundlessness". If we cannot see the screen's edges, we experience the illusion that we are in the movie world, and we do not have to concern ourselves with the influence exerted by the screen's edges on our immersive experience.

⁴⁹ Base on Lauren K. Duncan, Graeme Ferguson, Roman Kroitor, Robert Kerr and Bill Shaw created a system of high-resolution cameras, film formats-"IMAX: Large Format Films" in 1960s. The first IMAX film *Tiger Child* premiered at the 1970 international Expo in Osaka, Japan by Donald Brittain. (Duncan, 2006, p. 84).

Hollywood movies and feature films around the world have been developing storytelling techniques in framed movies for over 120 years and immersive technology has only existed since the 1950s⁵⁰. Ben Shedd, award-winning filmmaker (Peabody Award 1974 [Shared] *NOVA* and 1978 Academy Award for Documentary Short Subject *THE FLIGHT OF THE GOSSAMER CONDOR*) and Professor, Digital Filmmaking at the School of Art, Design and Media, Nanyang Technological University, Singapore, has directed and co-produced two IMAXDome / OMNIMAX 70mm films, *SEASONS* (1985) and *TROPICAL RAINFOREST* (1992). He has researched and written extensively about creating immersive dome cinema in his *Exploding The Frame: Seeking a new cinematic language* theory papers. (Shedd, 1989;1997; 1999).

Shedd posits that dome screens and giant screens are “frameless visual spaces” because the projected images surround viewers beyond their peripheral vision (Shedd, 1997), “and all imagery needs to be designed from the center out [...] With huge frameless images projected on the wrap-around dome screen, any camera movement in the images creates the imaginary sensation that the theater/seats/audience are moving/flying/tipping/tilting and all the camera action appears to happen on the audience’s side of the screen” (Shedd, 1997). Shedd reasons that even beyond the giant screen, the dome screen has expanded our immersive

⁵⁰ While, Director Abel Gance made triptic film *NAPOLEON* as a core early immersive film (Brownlow, 1983, pp. 132–138), wide screen technology began in the 1950s and giant screen IMAX technology in 1970.

experiences by surrounding us within moving images and sound, creating sensations of theater movement. Shedd posits “I believe that this sensation—this audience sense of movement—is at the core of developing a new cinematic language for frameless filmmaking. I have concluded that, for the sake of consistency, the sense of audience movement needs to be applied to everything seen and experienced in any gigantic screen film—not just flying shots. The movement sensation of the theater must be accounted for throughout a frameless film, in shots and from shot to shot... This idea represents a complete shift of approach in filmmaking, where the audience experience is the first order of focus, where all of the action occurs on the audience’s side of the screen.

“In accounting for the sensation of movement, the filmic experience has moved from passive, from being held in a frame, to active, to becoming the engulfing reality with the audience present within the filmic events. In frameless film the audience becomes the main character in the film.” (Shedd, 1989).

Michael Daut, an award-winning writer, producer and director of *Mousetrappe*. “created a digital full dome film for SIGGRAPH, 1999 in Los Angeles and also helped create the world's first digital dome transfer of a giant screen film, *Africa the Serengeti*, in 2007” (IMERSA, n.d.). He argues that the difference between IMAX and traditional smaller screens mainly lies in the presentation and editing modes. The challenge is how to move the

camera to show the sequence of events. In the case of dome screens, it is akin to a different language compared with small screens or giant flat screens. Dome theatre is like creating an environment, taking people to places where they do not have the chance to go. But there is no way to leave the environment, because they are in the middle of it. Immersive space brings visitors into the virtual world but does not necessarily touch a physical world (Daut, 2018).

In the design of the giant screen or dome screen, the coordination of sound and image is emphasised. In the immersive space, light, colour, sound and movement are very important (Daut, 2018).

Daut notes that light is vital to any kind of immersive space. The "light" referred to here is the lighting effect in the dark space. Undoubtedly, light changes are quite obvious in a dark environment, so this is an outstanding method to attract audiences' attention and trigger the plot. Changes in colour are the same. Contrasts in hue and saturation can attract audiences' visual attention. As mentioned above, sound, as an effective positioning system in the dark, has an incomparable importance in creating an immersive environment (Daut, 2018). This is why modern theatres are seeking the ultimate surround sound effect. For example, in the 2009 animated installation of Paolo Veronese's *Wedding at Cana* (1562-1563), Peter Greenaway had to disassemble and re-handle the original painting. Besides the application of multiple screens and surround sound, special

flowing light effects that “highlight specific characters in the scene and create dramatic effects with music and imagined conversations” (Hanson, 2010, p. 32) have been added to attract the audience’s attention (see Fig. 70).



Figure 70 Image showing Peter Greenaway's interpretation of Paolo Veronese's *Wedding at Cana* through light and movement. Greenaway, P. (2009). *The Wedding at Cana*. Venice: San Giorgio Maggiore. Image retrieved October 2, 2017, from <http://www.architecturenorway.no/questions/histories/lending-temporalities/>

The difference between the design of giant screen/dome design and the design of the traditional screen mainly lies in the images' movements. As Ben Shedd states: “There is greater image displacement on the gigantic screen, and ‘persistence of vision’ breaks down if the camera or object moves are too fast” (Shedd, 1989) causing audiences watching giant screen movies to see the individual flickering movie frames rather than the illusion of movement. Also, Michael Daut argues movement speed is the primary consideration (Daut, 2018). It is well known that we need time to identify an

image or understand a matter. As mentioned above, the speed of our neural processing is limited, so we will feel nervous or agitated if our perception system receives excessive information, or “information overload” (Toffler, 1970). In the IMAX or dome cinema, the screen size is usually several times that of the common screen, sometimes 5 building stories tall and 20+ meters across. So, if the object moves two metres on a traditional screen, the distance becomes four metres on a giant screen and may be even longer on a dome. Therefore, we can sometimes feel dizzy, and it is difficult for us to identify the image under the same movement speed. Traditional modes of filming or editing need rethinking. Daut also mentions that the giant screen (IMAX) and dome want visitors to be immersed, but the giant screen aims at the cinema or somewhere in between the dome and other spaces. The dome is a complete immersive space; it has changed the language of the film, like the giant screen changed the ordinary movie theatre. The dome completely surrounds you; without a fixed frame, you can watch the giant screen movie with the full dome, but there are differences in shooting. Therefore, if you cast it onto the full dome screen, you need more time to present various movements (Daut, 2018).

Another issue is image editing. Ben Shedd writes about giant screen editing in his paper *Exploding the Frame: Seeking a new cinematic language*: “Film making artifacts like depth-of-field details are not really visible in the editing room. While watching the film on an editing machine with a 20-inch screen,

the image will appear to have more apparent focus than when it is projected on a screen which is 80 feet across and 60 some feet tall. I project the 35mm workprint copy of the film as large as possible as often as possible. A particular phenomenon which I have found most interesting in frameless screen filmmaking is that cuts/edits from one image to another, rather than making a new image appear to the audience, can create a sense of an instant subtraction of the key object. On the editing table, the new incoming image may appear only an inch away from the outgoing image, but it can be 10 to 20 feet away when projected on a full size giant screen. It can appear that the thing that the audience is looking at just disappears when the incoming object is partway across the giant screen. This is the reverse of the way we expect new shots to affect the audience.” (Shedd, 1989). Also, Daut notes that if designers use fast cuts in immersive films, the audience will not have time to adapt, meaning that they cannot be totally immersed and there is no time for them to fully observe the environment. In traditional cinema, with fast cuts, even if the camera does not point to an object, the audience knows where the object is. But the dome, this is a different language—just like in a theatre, which would soon give audience a feeling of immersion as the spectators are involved in the action and considerable images surround the audience, but this very theatrical. The audience cannot skip from one scene to another (Daut, 2018). Building on Shedd and Daut’s discussions, the author notes that in traditional cinema, the audience enter scenes contained

within frames. However, the dome and giant screen is more basic space, because the audience is already on the inside the scene.

Fulldome Company has carried out several experiments based on the idea of combining HMDs, interactive systems and domes. The most recent example is *Earth Patrol*, an interactive shooting game from 2014 (see Fig. 71). The audience can interact with and shoot toward the dome image. According to official data, more than 100 people can be involved in the game at once (Fulldome UK, n.d.).



Figure 71 Russian company Fulldome.pro (n.d.). *Earth Patrol*. Retrieved September 7, 2017, from <http://www.fulldome.org.uk/events/earth-patrol/>

To use HMD and interactive technology in a dome, Daut notes that in this area, there is a large space for exploration, and the HMD is like the dome theatre, but its rules are dynamic. Visitors put something over their heads, and they go to another environment (Daut, 2018). Daut also argues few people can use an HMD for several hours at a time (Daut, 2018). To watch a dome movie in an HMD is not a best idea to him. It may be worthwhile for

the market and the experience if users can take the environment home and experience it. Perhaps for an HMD, panoramic vision may become easier because the user is in the middle of and seamlessly connected to the world. Dome designers have tried to use an interactive system numerous times, but the challenge is that independent feedback is needed from each visitor, which is difficult to complete. Daut argues the real interaction might include the viewer group choosing from several questions and making a selection based on them. There may be an HMD or VR theatre in the future. There is no limit in this area. The next step might address the fact that the market wants reasonable cost, replicable products and the audience wants the best experience (Daut, 2018).

4.5.2.2. Panoramic Screens

Visible landscapes are like icebergs: only a small proportion of their real substance lies above the surface (Roberts, 1987, p. 83).

Horizontally expanding the screen and forming an enclosed angle, the panoramic screen is suitable for grand and expansive scenes. Some panoramic screens are composed of several flat screens (see Fig. 72), while others are full, arc-shaped screens (see Fig. 27). These two kinds of panoramic screens can apply LEDs or multi-channel projected image fusion technology.

Panoramic screens also centre on the immersive experience. Different from the IMAX or dome, they can be placed inside buildings with low ceilings

because they have no requirement for the image height. This is why numerous circular screens are designed in to be thin, long and rectangular. Oliver Grau describes panoramic devices as ones taking “immense crowds into closed environments, with the world laid out in spectacle...one could project oneself imaginatively” (Grau, 2004, p. 8). It makes visitors feel that they are standing on the stage, and visitors’ perception is also on the stage. Specifically, visitors become a part of the stage, rather than only sitting in an auditorium.



Figure 72 TeamLab (2016). 100 Years Sea Animation Diorama. Singapore: ArtScience Museum. Photo by Luo ShenShen, March 21, 2016.

The level of immersion generated by the panoramic screen is somewhere between that of the dome and that of the common screen. Recent technological developments have made better combinations of HMD devices and domes. Since the 1980s, artists have tried to use VR technology and domes to make their artistic creations (e.g., Jeffrey Shaw’s *Place* [1995] and *Place Ruhr* [2000], Michael Naimark’s *Be Now Here* [1995]). In 2014, the

Laboratory for Interactive Visualization and Embodiment at the City University of Hong Kong made a new panoramic work, *Pure Land* (Kenderdine et al., 2014) (see Fig. 73). *Pure Land* has successfully applied scanned high-resolution images to restore the 220th grotto of Mo Kao Grotto at Dunhuang on a panoramic. Moreover, AR technology is used in the narration. *Pure Land* not only shows the limitations of panoramic screens, but also proposes a certain compromised solution.

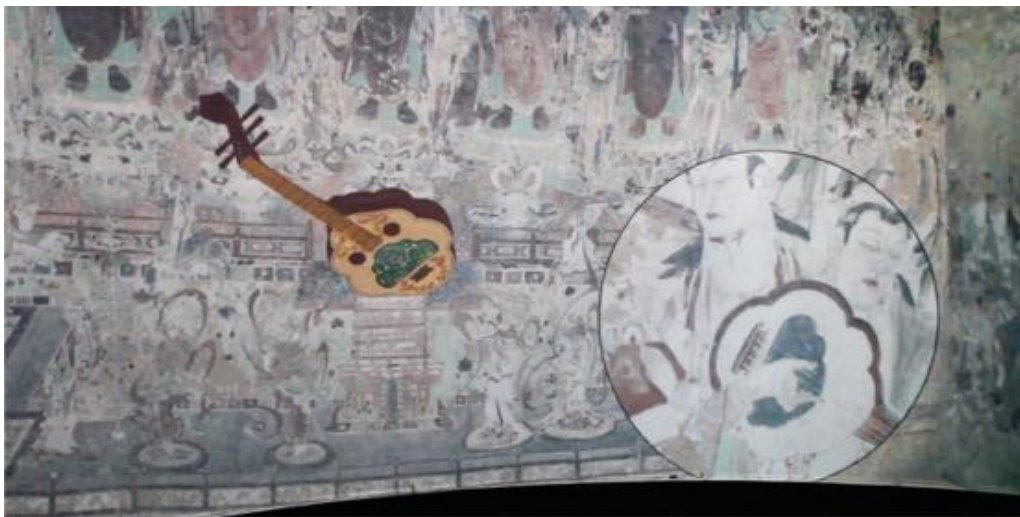


Figure 73 Magnifying glass and animated 3D model of a classical instrument in *Pure Land*. (Kenderdine et al., 2014, p. 8).

The advantage of the panoramic screen is scenery displays, including static images (e.g., *Pure Land*) and dynamic navigation (Kenderdine, 2007, p. 314). Kenderdine cites Erik Goetze's comment on panorama technology that “They typically just show a place; they don’t tell a story” (Kenderdine, 2007, p. 314).

The initial purpose of a panoramic screen is to present impressive exotic scenery. Different from the full-vision design of IMAX and domes, visitors

glance at the image at the centre of the panoramic screen. Visitors' generate adequate immersive experiences through their bodies' movements. As a result, the circular-screen is more suitable to present position in a long shot. However, the narrative expression is absent.

Pure Land uses the human-computer interaction to solve this challenge. Specifically, the user can turn the device in their hands towards a specific image, after which the computer will enlarge this image for interpretation. In fact, this is a split-screen narration based on the panoramic image and AR. This narrative mode is similar to the forms used in Pieter Bruegel's *Twelve Flemish Proverbs* (see Fig. 74) and Paul Driessen's split-screen narrative animation *The End of the World in Four Seasons* (1995) (see Fig. 75). These three works generate interactions among all their images while presenting a single image, thus creating a space in which the vision is coherent. According to Rick Altman (2008, 232), depending on technology and time, most of narrative systems apply a multiple-focus narrative.⁵¹ Among them, the single image uses a single-focus narrative System,⁵² and the interactive part applies to a dual-focus narrative system.⁵³

51 "When a text follows several different characters, I speak of 'multiple-focus narrative'. Many multiple-focus narratives involve multiple plots" (Altman, 2008, p. 241).

52 "Single-focus narrators operate entirely differently. Not only do they accord liberty of conscience to individual characters, but also, they consent to follow selected characters from incident to incident rather than measure each action by a preordained law" (Altman, 2008, p. 119); "Single-focus texts view the world as a limitless domain where enterprising individuals can discover and exploit new values. As such, single-focus narrative is particularly well suited to expanding societies and confident cultures" (Altman, 2008, p. 189).

53 "Dual-focus narratives begin by division into two antithetical groups or principles, both striving to govern the same space." (Altman, 2008, p. 119); "Dual-focus narrative is a chess game, a balanced confrontation



Figure 74 Bruegel, P. (1559). *Twelve Flemish Proverbs*. [oil painting]. Antwerp, Belgium: Musée Mayer van der Bergh. Retrieved January 20, 2018 from Blistar.net: <http://blistar.net/photos/photo43090.html>



Figure 75 Driessen, P. (Writer). (1995). *The End of the World in Four Seasons*. In M. Page & B. A. McLean (Producer). Canada: National Film Board of Canada. Retrieved January 20, 2018, from CARTOON BREW: <http://www.cartoonbrew.com/artist-of-the-day/paul-driessen-119686.html>

where the two sides move alternately according to a simple set of rules, each piece having a limited function meaningful only in terms of the larger fate of its side" (Altman, 2008, p. 57).

For *Pure Land*, the narrative mode of panoramic screen focuses more on storytelling. However, the interpretation and animation appeared to further reduce the immersive experience. The advantages and disadvantages of this split display on a panoramic screen are obvious, so the designer must find a balance point.

4.5.2.3. Multi-screens

Multi-screens require a combination of video images and physical spaces. As the window to the virtual world, the multi-screen has expanded the size of the real space. While the multi-screen assumes the task of storytelling, each split-screen is responsible for telling different chapters. Therefore, the designer shall plan a reasonable viewing route to present the complete story. Based on common and ancient presentation modes, the virtual space can be used to extend the real space, and the real space can be applied to guide the audience. Sonya S. Lee shows us the structure of the 32nd grotto of Mo Kao Grotto at Dunhuang (Lee, 2013, pp. 127-140) (see Fig. 76). This grotto, which mainly focuses on Buddha Nirvana, was established by the Li family in North-western China in 698 AD. When entering the dark grotto from the east entrance, visitors see the Buddha of Three Ages (the common presentation mode used in most temples or grottoes). There is a huge pillar in the grotto's centre. According to Buddhist tradition, visitors shall worship the Buddha around the pillar from its right side to its left. During worship, the visitors will see the *Vimalakirti* sermon on the north wall and the image

of *Fanhe* Buddha on the opposite pillar. Then, the huge sculpture of Buddha Nirvana will jump into their eyes while the south wall tells the story from the end. The designer has painted the events after the last sermon on the wall in the form of a picture-book. Finally, the visitors see the sermon image of *Amitabha* (symbolizing the future) and 50 other bodhisattvas (Lee, 2013, pp. 129-131) when walking back to the south side of the east wall. This grotto tells of *Sakyamuni's* nirvana and expresses the concept of Mahayana. Interestingly, there is controversy regarding the front statue's identity. Huang Jiang proposes in *Mo Gao Ku Di 332 Ku Zhu Shi Dong Xiang Mian He Zhang Li Fo Shi Mi Le Zao Xiang* that the statues of the Buddha of Three Ages violate the traditional sequence with *Dipankara* Buddha (Past) on the left, *Sakyamuni* Buddha (Present) in the middle and *Maitreya* Bodhisattva (Future) on the right. Instead, *Maitreya* Bodhisattva is in the middle, forming a corresponding relation with *Sakyamuni* on its back. Such difference is because Empress Wu Zetian claimed to be the reincarnation of *Maitreya* (Zhang & Gu, 2014).

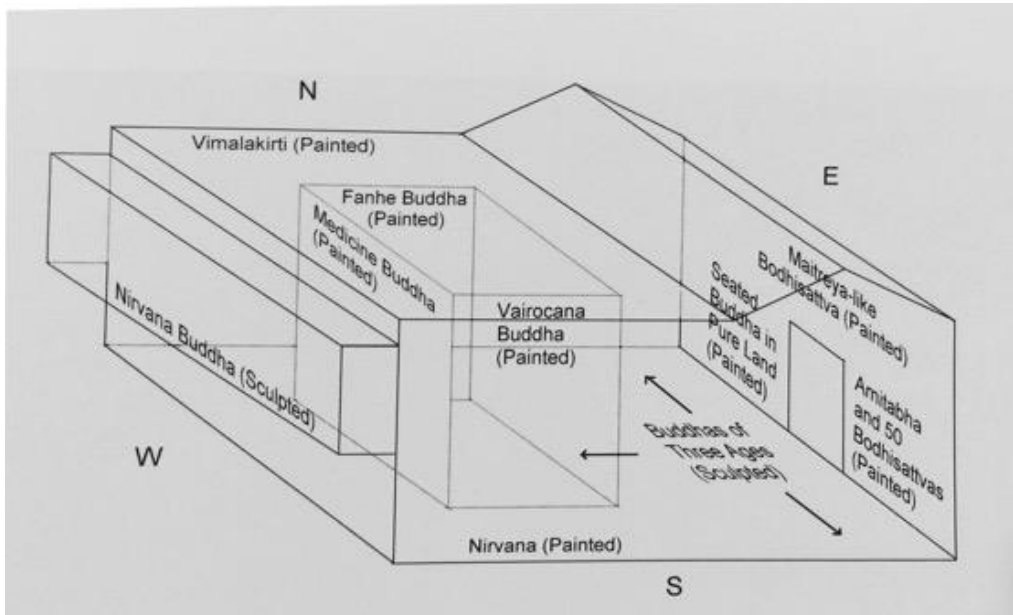


Figure 76 Location of pictorial motifs inside Cave 332, Mogao, Gansu, Dated 698 (Lee, 2013, p. 130).

In other words, the designer intends to strengthen this idea through the design.

It is feasible in painting, but it causes challenges in art forms based on time, such as video and animation, because identifying dynamic images takes time. Unless it is static image, it is difficult to find reference systems in the movement. We perceive that the 3D space is composed of six 2D images, so the formation of the visual path seems to be more complex than just shape hints and colour contrast. However, it is still feasible if the theory is applied to space, since in a device, vision could be led using different screens and images to narrate in a 3D space. In theme parks, this device is often called a “dark ride” (see Figs. 77 and 78).

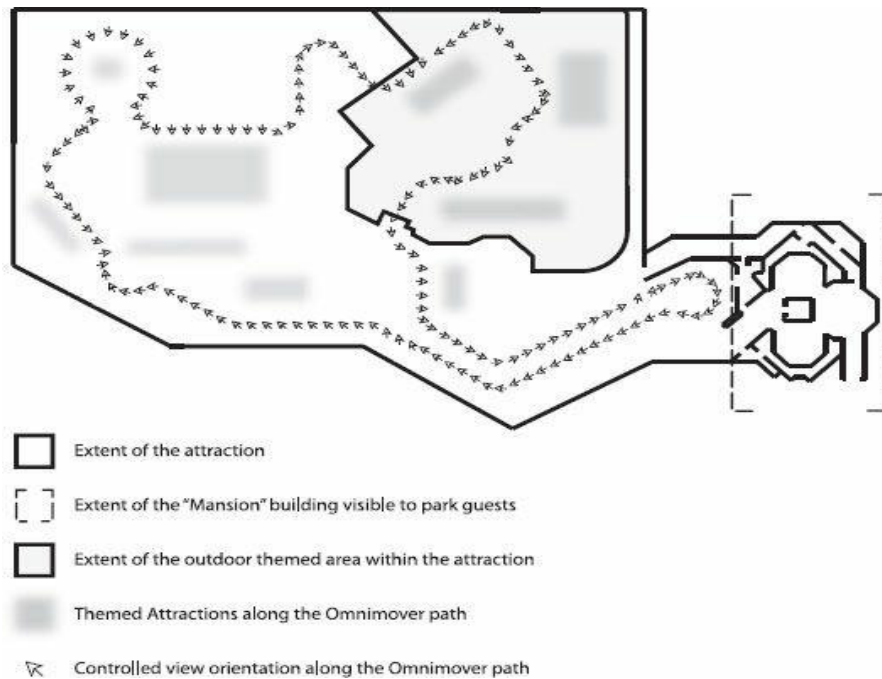


Figure 77 The cinematic path of the Haunted Mansion in Wait Disney World. "The diagram illustrates the spatial extension of the cinematic experience as a joint operation of architectural design and the engineering of the Omnimover. The visitor is carried along the path of arrows, faced in the directions indicated, framing specific moments of the storyboard. Drawn by Brian Lonsway, based on information from doombuggies.com (2007) and Lanier (2007)" (Lonsway, 2013, p. 137).

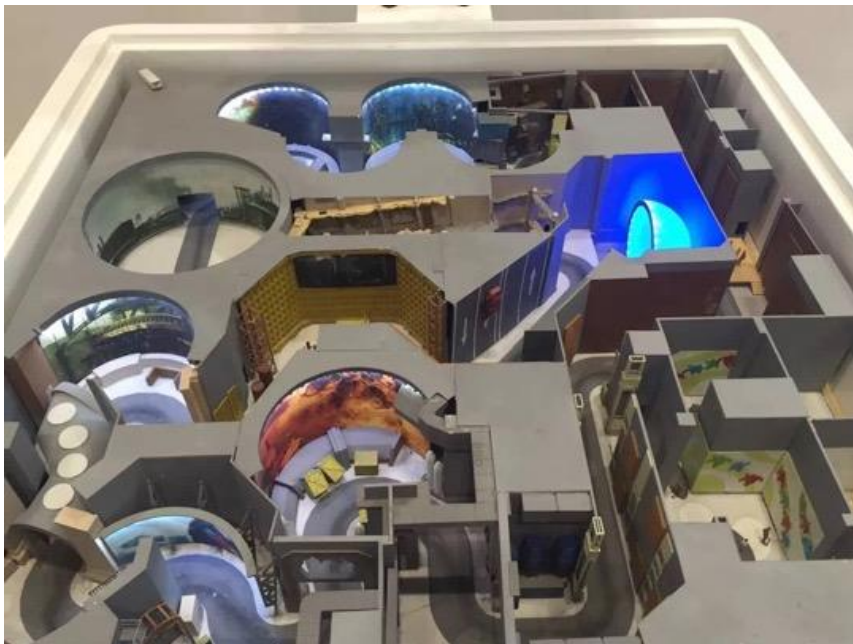


Figure 78 A model of a dark ride at Shenzhen Overseas Chinese Town Holding Company (OCT). Photo by Luo ShenShen, 2016.

When static images or text begin to animate, every object change. Conquering any challenge requires the designer to consider factors including the trajectory, change of colour, holism and whether there is conflict in the original information.

The multi-screen dark ride concept has solved the issue of viewing time. Sitting in the well-designed vehicle, the visitors can travel through screens (stages) according to the pre-designed time. However, such a design is not suitable for stories containing symbolic images or complex narrative structures. Because different people need different amounts of time to identify images, it can take more time to observe more complicated images. Perception and cognition are closely interrelated. According to David Marr, visual processing is composed of different stages (Marr, 1982, pp. 99-102; Tacca, 2011, p. 7). The visual process has three different stages: early, intermediate and late vision. "Roughly, at early stages of the visual system, processes like segregation of figure from background, border detection, and the detection of basic features (e.g., colour, orientation, motion components) occur. This information reaches intermediate stages, where it is combined into a temporary representation of an object. At later stages, the temporary object representation is matched with previous object shapes stored in long-term visual memory to achieve visual object identification and recognition" (Tacca, 2011, p. 7). The early visual process is automatic and independent of cognition, and the late visual process is more affected by our knowledge.

Another demand is to gather visitors together to achieve an immersive experience. Gustave Le Bon insisted, “that an individual immersed for some length of time in a crowd soon finds himself-either in consequence of magnetic influence given out by the crowd, or from some other cause of which we are ignorant-in a special state, which much resembles the state of fascination in which the hypnotized individual finds himself in the hands of the hypnotizer” (Bon, 2001, p. 77). To follow Le Bon’s view is to instil the mind with simple and clear thoughts, guide reasoning and display the images and contents that can stimulate the imagination.

The author argues the following rules are necessary when applying this kind of device to create an immersive space: a clear and reinforced theme, a clear narrative, and a magnificent visual spectacle.

As mentioned above, numerous immersive spaces are still created using the multi-screen, but these presentation modes are restricted by the above factors, which influence the final immersive experience.

Another factor influencing the immersive experience is the viewing angle. The visual angle discussed here is more about the mental activity caused by observation at different spatial positions. For example, people feel the universe is vast and we are tiny when looking up at the night sky, and many might feel a powerful protection instinct around small animals and children when seeing this kind of imagery. To apply this mental state in the immersive space, the giant screen is selected as the video device in most

cases and the video is projected either in the air or under our feet. All these designs aim to create a suitable angle for visual experience.

In order to represent flying, a large number of domes have been used in the *Harry Potter and the Forbidden Journey* exhibit, an entertainment facility described as a “motion-based attraction” (Cortelyou, et al., 2009) in California Universal Studios.

Sitting in the suspended mechanical seats in groups, visitors can travel through “a rotatable carousel having a plurality of domes” (Cortelyou, et al., 2009). During this process, guests’ eyes are always kept on a path at the dome’s centre, and “the plurality of domes with each of the plurality of guest supports” (Cortelyou, et al., 2009), their eyes always rest on the dome, thus solving the viewing angle challenge (see Fig. 79).

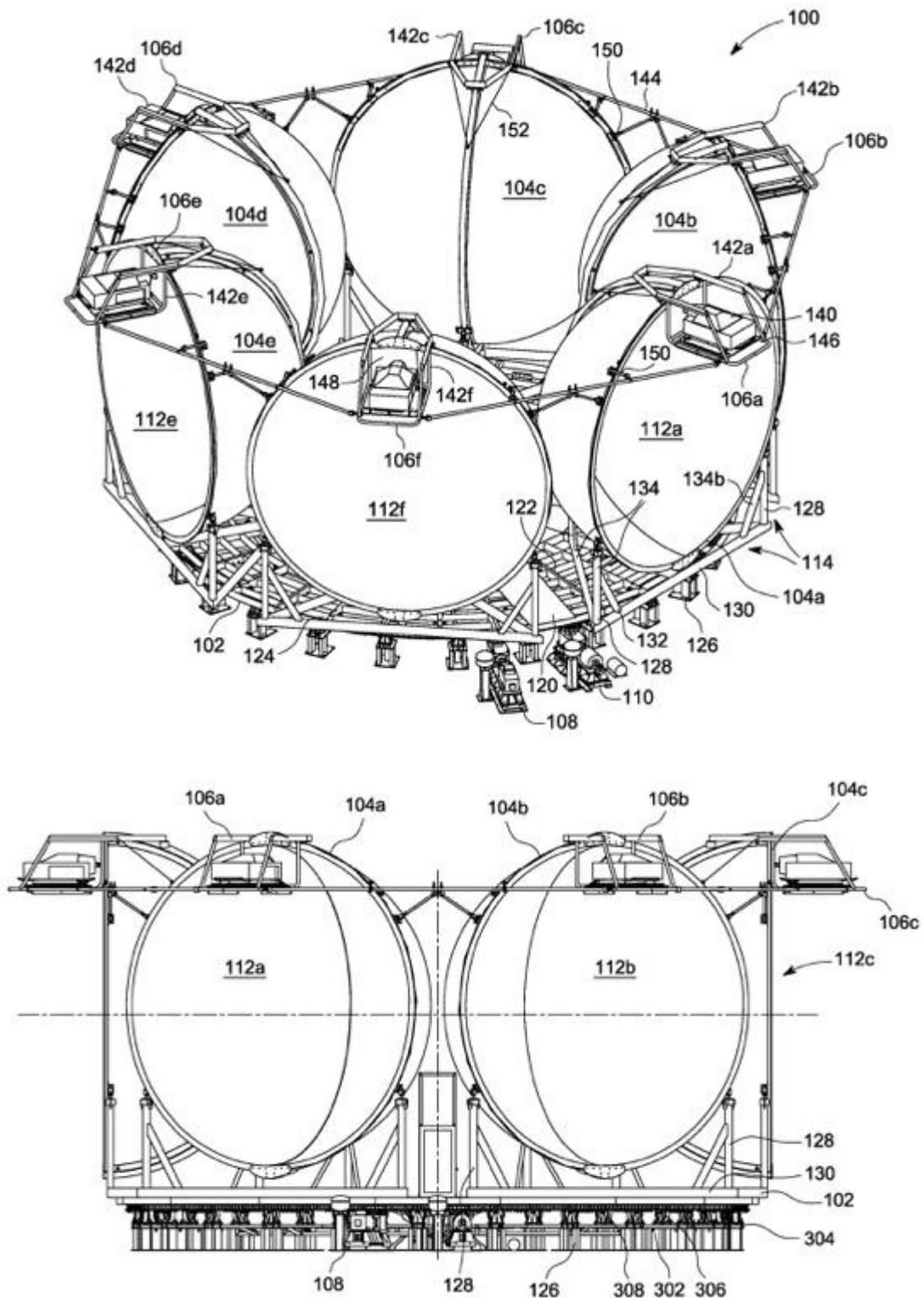


Figure 79 "Moving a plurality of guest supports along a path proximate the carousel" (Cortelyou, et al., 2009, p. 2). Retrieved January 15, 2018, image from: http://www.google.com/patents/US8137205?printsec=abstract&dq=motion+based+attraction&ei=Gw_5T96jA4-s8QSTyo2JBw#v=onepage&q=motion%20based%20attraction&f=false

In hybrid immersive spaces without a dome, the designer must pay attention to the viewing angle. For example, when designing the *Pirates of the Caribbean* in Shanghai Disneyland, the designer applied screens of different sizes to represent adventures on or under the Caribbean Sea. Meanwhile, the vehicle is equipped with horizontal axes that can be rotated. During the rotating process, the visitors' sight remains on the stages or screens (Summer, 2012) (see Fig. 80 and 81).

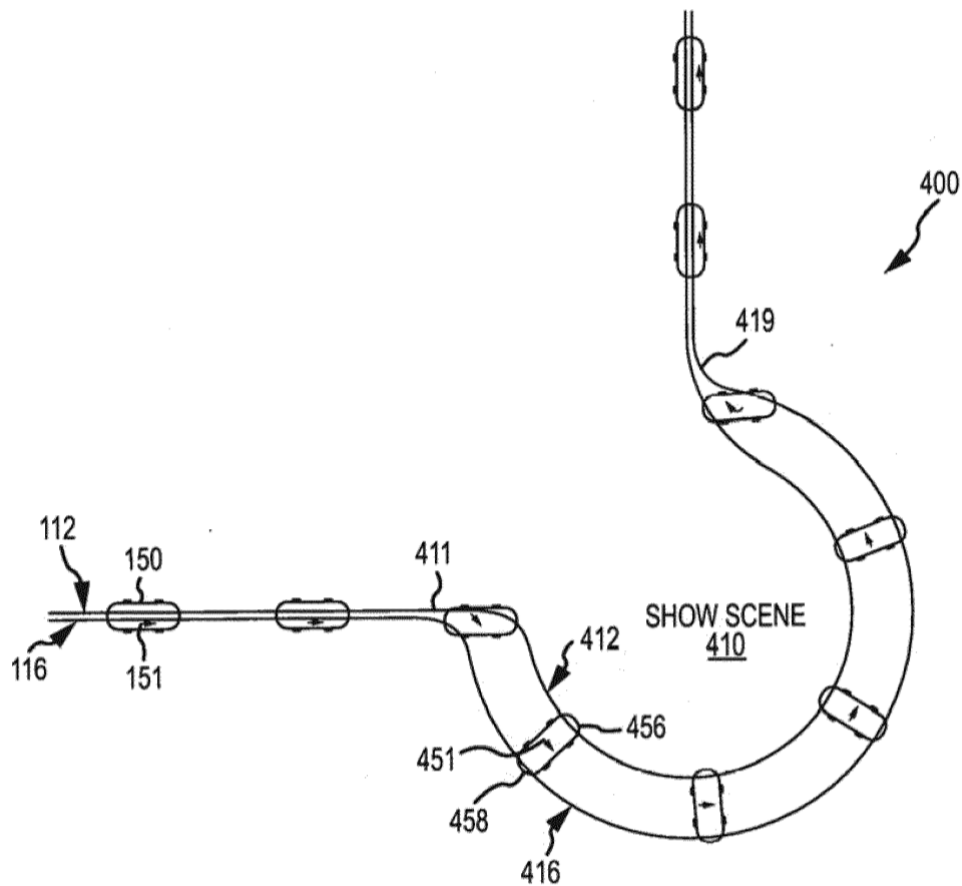


Figure 80 *Pirates of the Caribbean's* track and screen design at Shanghai Disneyland. (Summer, 2012, p. 5). Image retrieved January 15, 2018, from: <https://encrypted.google.com/patents/EP2505241A1?cl=pt-PT>

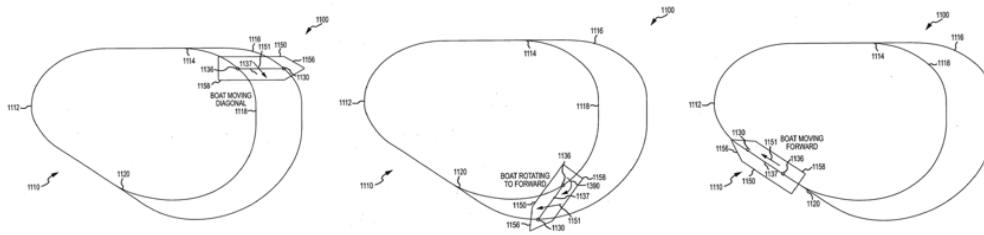


Figure 81 The design of two separate tracks guiding the vehicle towards the stage (Summer, 2012, pp. 12-18). Image retrieved January 15, 2018, from: <https://www.google.com/patents/EP2505241A1?cl=en>

This has inspirational significance to space design. Designers could, in the light of different locations and targeted groups, design some kind of space or apply space images to create different experiences for audiences.

4.5.3. Interactivity as a Key Property

Nowadays, more immersive spaces have combined HMDs, mobile devices, screens and real spaces. This is mainly because the interactivity is the bridge connecting the virtual and real worlds through the HMDs or mobile devices, thus improving user amusement and interest.

Interactivity is an important element in an immersive world. In 1995, Mark Mine presented the fundamental forms of interaction in a virtual world: movement, selection, manipulation and scaling (Mine, 1995, p. 2). Thus, he summed up three modes of interactive manipulation in a virtual world:

1. *Direct User Interaction. This includes the use of hand tracking, gesture recognition, pointing, gaze direction, etc.*
2. *Physical Controls. This includes buttons, sliders, dials, joysticks, steering wheels, etc.*

3. *Virtual Controls. Just about anything you can imagine can be implemented as a virtual control* (Mine, 1995, p. 2).

Direct user interaction is often based on camera/infrared sensor tracking of the heads or other body parts. Eye tracking is also frequently used nowadays. Meanwhile, multi-person interaction can be realised with the development of technology and the promotion of computer arithmetic (i.e., Wu Kingdom Helv Relic Museum). It should be pointed out that haptic feedback can be provided through physical control devices. Although this simple and effective method lacks flexibility, it is still used in interactive works suitable for children. Virtual controls are highly flexible (Mine, 1995, p. 13). These include the interactive modes of VR/AR devices. We will give two examples here. The first is *Polysensory Intermedia Exhibition* made by the University of Malaya Art Gallery in June 2015. This exhibition has used a plenty of AR mobile interactive devices so that visitors can obtain additional information from the AR devices while scanning their originals. The second is *Pure Land*, mentioned above, in which mobile terminals and HMDs are used to improve interactivity.

William Sherman and Alan B. Craig add a fourth category to this list: agent control, which refers to the user's command of an entity in the virtual world (Sherman & Craig, 2003, p. 287). This is the interactive mode most often used by video games. Moreover, agent control can also be used at the mobile terminal for interaction, such as on the water screen finished by TeamLab in

Las Vegas in 2016. This work allows visitors to control the virtual carp on the water screen through their mobile phones, thus realising the interaction. Now virtual and immersion equipment combine almost all kinds of interactivity modes.

What must be stressed is that mobile terminals, being popular and compact, have drastically extended users' immersive experience. Users can use downloaded apps anytime to experience AR. Meanwhile, they can learn the information relevant to the scenic area they have just visited via mobile terminals to upgrade an immersive sensory experience to a narrative experience.

However, no matter what devices are used, in an immersive space the visual occupies the most important position. Designers must consider some challenges at the beginning, referred to as "logistic properties" (Sherman & Craig, 2003, p. 122). These include user mobility, interfaces with tracking methods, environment requirements, associability with other sense displays, portability, throughput, encumbrance, safety and cost (Sherman & Craig, 2003, p. 116-140).

5. Cultural Heritage and Heritage Iconography

Cultural heritage is the legacy of physical artefacts and intangible attributes of a group or society that are inherited from past generations, maintained in the

present and bestowed for the benefit of future generations (UNESCO, n.d. a).

Culture represents the sum total of a people-the things that make them who they are. Culture is something that you can use to make your world more real, more immersive, and more interactive” (Lukas, 2013, p. 23).

This research uses the UNESCO definition and focus on the cultural significance of “heritage iconography” (Staiff, 2014, p. 84) in Chinese cultural heritage. The protection and reuse culture heritage in modern times has become a global concern, but with digital capabilities, the protection of heritage has changed from passive protection to active re-creation and reuse.

In Russell Staiff’s view, the image of heritage is communicated to audiences in modern media. “These representations, because they have a life of their own, help create a visual experience that in turn both instructs and informs the way visitors ‘see’ and interpret places” (Staiff, 2014, p. 84). When audiences see real cultural heritage, images in media and learn the relevant knowledge, heritages immediately come to their minds and they begin to define the heritages. Russell Staiff called this “heritage iconography”. This is the fixed mind-set of symbolization and following his analysis, the audience’s attention is not on the real heritage itself, but on its significance and content. In Staiff’s research, when audiences saw an image of the Eiffel Tower, they connected to the streets of Paris and their romantic atmosphere, whether the image appeared in Paris or in a casino in Las Vegas. This

example has been applied to numerous theme parks and leisure businesses. Later, with a vivid example of the Chinese film *Hero* (Zhang, 2002), Staiff illustrated how film techniques create a false ancient Chinese heritage that is different from the West's. The film's directors use many Chinese cultural symbols (i.e., the brick Great Wall, kung fu, Guqin, Chinese cold weapons) in this movie, but many of these places and objects did not exist 2000 years ago. Though the author argues Staiff does not understand the intention of the film, the author agrees with Staiff's conclusion. On the one hand, people may create so-called false heritages with modern technology. Cornelius Holtorf observes that "Heritage is often less valued for its literal than for its metaphorical content, that is, stories about the past that are much more so stories about the present. As a consequence, it matters little for the storytelling potential if a heritage site has been meticulously repaired, faithfully restored, or entirely reconstructed—as long as it gives a believable total impression" (Holtorf, 2014, p. 50). On the other hand, real heritage and culture could be intensified through image and design and provide audiences with memorable immersive experiences. Staiff writes, "I was instantly 'transported' into this world and the dramatic sequence occurred as I was visually connected to the semiotics of this historical moment—the costumes, the form of execution, the style of architecture, the modes of transport, the symbols of power and powerlessness, gender differences and poverty are all visually created" (Staiff, 2014, p. 91). Staiff also illustrates

relationships between culture heritage and narration. The so-called “real” history is defined from the perspective of modern history and archaeology research. The definition of “real” itself is doubtful. As for heritage, narration is not the only method to express it, but it is also the way to express our deepest desires, feelings, imaginations and emotions (Staiff, 2014, p. 113). Like the perceptual constraint of human beings mentioned above, we see what we want to see.

At the same time, aesthetic illusion is based on cognitive psychology research (Miall, 1995, pp. 273-298) and the interpretation of the heritage iconography. The advent of digital technologies and advances neurosciences have expanded the field and changed much of our understanding about how images work (Burnett, 2005). The analysis could be illustrated with numerous examples from films. Narration and heritage influence each other, “Ultimately, the desire to tell and hear stories about the places we are visiting is a deeply satisfying experience that emotionally and intellectually connects us to our perceptions of the past, to our understandings of our identities, to our cultural affiliations, to our fellow travellers and for me, above all else, to our imaginations and our desires; to the ineffable” (Staiff, 2014, p. 113). According to this passage, the stories about heritage are what we want to see in our unconscious mind and what our inner beings and ethnic cultures want to see in modern society.

In this study, the theoretical underpinnings of Staiff and Miall facilitate investigations into the visual transformation process of cultural heritage.

5.1. Virtual Heritage

“With so many heritage experts who document the human experiences of past generations and make this treasure available in the present digital era, we stand to add not only cultural and social wealth to local communities all over the world, but also monetary value to their creative industries” (Nanetti & Cheong, 2015).

The concept of the “virtual tour” first appeared in a museum in 1994.

Visitors could “walk-through a 3D reconstruction of Dudley Castle in

England as it was in 1550” (Abdelmonem et al., 2017, p. 30), using a three button controller (Boland & Johnson 1996, pp. 227-234) (see Fig. 82).



Figure 82 First virtual tour: Dudley Castle in England in 1550. Retrieved July 5, 2017, from <http://www.exrenda.net/dudley/greathall01.htm>

Virtual heritage relies on computer graphics interface, VR technology and more to reconstruct or recreate tangible or intangible life scenes in a virtual environment. Virtual heritage (VH) describes works that deal with VR and cultural heritage (Roussou, 2002, p. 93; Linaza et al., 2014, p. 110; Yuan & Ender, 2017, p. 315). Robert Stone and Takeo Ojika define what VH should be: “(It is) ... the use of computer-based interactive technologies to record, preserve, or recreate artifacts, sites and actors of historic, artistic, religious, and cultural significance and to deliver the results openly to a global

audience in such a way as to provide formative educational experiences through electronic manipulations of time and space” (Stone and Ojika 2000, p. 73).

Alonzo C. Addison (2000, p. 22) and Nazrita Ibrahim et al., (2011, p. 273) argue there are three domains of VH: documentation, representation, and dissemination. The first stage is to find information and to analyse and document authentic data from the cultural and architectural past. The second stage is representing a tangible heritage through an accurate visualisation via suitable media (Tan & Rahaman 2009, pp. 143-156). One of its major tasks is to disseminate history and cultural knowledge to others (Tost & Champion, 2007, pp. 245-256) by means of interactive digital media (Tan & Rahaman, 2009, pp. 143-156). For the production of virtual heritage projects, Daniel Thalmann, Barbara Maim and Jonathan Maim have presented six major real-time stages: Scaler, Simulator, Animator, Renderer, Path Planner, and Behavior Handler (2014, pp. 78-92).

Céline Loscos et al., (2004, pp. 271-279) as well as Greg Jones and Mark Christal (2002) have respective technologies that are forecasted to be in museums. Combining their opinions, the general theme is to use VR technology combined with the global network and VR technology could, in some places, replace the existing physical displays, and to a certain extent, visitors could touch the virtual objects with the help of the simulations.

Global network links provide a prerequisite for creating VR immersive spaces (see Fig. 83).



Figure 83 In the PURE-FORM project, visitors explore using the exoskeleton system and 3D glass to see 3D images and touch exhibits on the other side of the network (Loscos et al., 2004, p. 2).

Nazrita Ibrahim further explains that there are five important research areas when it comes to cultural learning in virtual heritage:

Navigation or wayfinding.

Interpretation of cultural heritage content in virtual environment.

Evaluation of virtual heritage project.

Cultural Presence in virtual environment.

Creation of meaningful content expressing cultural value in virtual environment (Ibrahim et al., 2011, p. 275).

Navigation or wayfinding is a classic challenge of VR. In both virtual games and museums, navigation is always a priority. The interpretation of VH from the view of architecture/archaeology and hermeneutics enhances users' understanding of cultural heritage (Rahaman & Tan, 2010, p. 93). Cultural presence in the virtual environment focuses on defining the elements that constitute cultural presence (including a series of interactions) (Ibrahim et al., 2011, p. 276). One example is *LIFEPLUS*, which gives visitors the possibility of a real-time interactive experience by animation. "Based on a captured/real-time video of a real scene, the project is oriented in enhancing these scenes by allowing the possibility to render realistic 3D simulations of virtual flora and fauna (humans, animals and plants) in real-time" (Papagiannakis et al., 2002, p. 1). This system relies on AR technology, earphones, mobile computing equipment and a tracking system. Through real-time positioning combined with real-time animation and sound generated by a computer image, "*LIFEPLUS* extends existing AR systems and provides key new technologies to render lively, real-time animations and simulations of ancient virtual life (3D human groups, animals and plants)" (Gutierrez et al., 2008, p. 180).

For the main issues of VH, Beng Kiang Tan and Hafizur Rahaman's criticism mostly focuses on either the process or the product but does not consider the user. This means there is a lack of meaningful cultural content

expressing in VH, and “most of the reconstruction projects do not permit later interpretation or update” (Tan & Rahaman, 2009, p. 147). On another hand, present VH environments lack thematic information (Mosaker, 2001, p. 17). Users walk aimlessly in the virtual environment and lack a kind of interactive purpose. When Lidunn Mosaker surveyed the *Hellenic Worlds* project, he found that “the users did not know about the details of the ancient” (Mosaker, 2001, p. 18) building, but were more interested with the human aspect of city life in the virtual world (Mosaker, 2001, p. 18).

Digital technology provides more options for the protection of cultural heritage, but at the same time, it brings visitors an immersive experience space. All of this indicates it is imperative to develop a new, more immersive and attractive VH model (see Fig. 84).

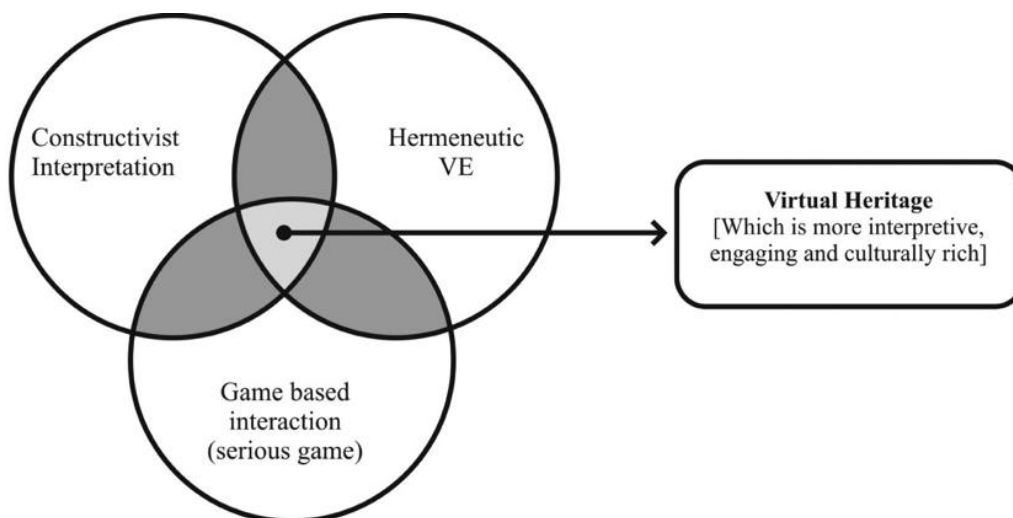


Figure 84 Tan and Rahaman propose a framework for a more interpretive VH environment (Tan & Rahaman, 2009, p. 154).

Associate Professor Andrea Nanetti, scholar of history and culture and Associate Chair of Research, School of Art, Design and Media, Nanyang

Technological University, discussed the relationship between digital technology and cultural heritage: "...we think of the application of data-driven narratives to cultural heritage as a conceptually very progressive way to approach our dynamic heritage. With modern ICT it is possible to show that the nature of cultural heritage is a living system, and very much complex. Here, data visualization can contribute a great deal, as it builds from research data representations that we can understand and study further. Today, digital tools (e.g., Google Daydream VR, Oculus Rift, or HTC Vive, and easy-to-handle 360° cameras), facilitate the capture of surround experiences with increasing levels of immersion and their sharing effortlessly" (Nanetti & Cheong, 2017, p. 348).

According to Tan, Rahanab and Nanetti, the author argues that the following principles can be used in new VH projects: new stories (narratives), new methods of expression (animated installations) and corresponding new technologies (immersive spaces and real-time global networks).

5.2. Protection and Development of Chinese Cultural Heritage

Heritage is a value-laden concept, related to processes of commoditization, and used in order to legitimize a national or communal consciousness (Zhu & Li, 2013, p. 51).

China's cultural and national heritage belongs not only to China but to the whole world and all of humanity (Aoshima, 2008, p. 7).

As of July 2017, China boasts 52 world heritage sites and is one of the two countries that have the most world heritage sites (UNESCO, 2017). On the other hand, the cultural heritage of China is closely related to the development of China's politics, tourism and economy. They are important content within the external image of China (Silverman & Blumenfield, 2013, p. 4). Stevan Harrell argues about politics and cultural heritage preservation in China:

"Like every other part of China's modernization, cultural heritage preservation is happening both 'with Chinese characteristics' and 'with universal characteristics.' This leads to a paradox: China needs to live up to international standards in heritage preservation as in other aspects of life, but meeting these standards is awkward, given the fact that the Chinese intellectual, architectural, and artistic traditions have never made much of a distinction between what is old, preserved, and authentic, and what is new, reconstructed, and copied" (Harrell, 2013, p. 287).

This may be true, because in traditional Chinese cultural heritage, the concept of preservation is a recent concept. The Chinese always renovate cultural relics, which seems to be the traditional Chinese culture. In traditional Chinese culture, a symbol of a culture (relic) means more important than the culture relic itself. For example, the Wofu Temple near

Xiangshan Park was built during the Tang Dynasty (618-907) and has been rebuilt several times. Since Emperor Yingzong, the emperors of four different dynasties expanded the temple. During the Ming Dynasty (1368-1644), the temple was rebuilt five times in Xuande (1426-1435), Zhengtong (1436-1449), Chenghua (1465-1487), Jiajing (1522-1566) and Wanli (1573-1620) respectively (National Architecture Institute of China, 2017). The Wofu Temple was almost complete at that time. During the reign of Emperor Qianlong of the Qing Dynasty, the temple was overhauled, and the West Temporary Imperial Palace and the Coloured Glaze Memorial Gate were built. By that time, the current pattern of the temple was formed. Wofu Temple is now a key cultural relic site in China.

Influenced by the cultural protection ideas of the West in 1963, Sicheng Liang proposed “整旧如旧” (restoration of the old as old) (Liang, 1963, pp. 3-8) to repair the cultural heritage sites and architecture in China. This idea particularly referred to the repairing of ancient buildings (Luo, 1998, p. 301). It cannot be denied that this policy has helped protect a number of cultural heritage sites in China. But at the same time, the restoration of the old as old “is not only aimed at the external effect of the restoration work but is also a technical methodology” (Qi, 1992, p. 125). These concepts accorded with the main international conservation theory. However, the restoration of the old as old is no longer part of conservation theory of today. Looking at cultural heritage preservation, Jinze Cui states that within the framework of world

heritage, people worship the “authenticity” (Venice Charter) of cultural relics as a kind of fetishism. At the same time, the worshipping of the West has an important influence on modern Chinese cultural heritage. Cui discusses three ambiguous concepts in Chinese cultural heritage protection: reconstruction, rebuilding and recreation (Cui, 2017, pp. 16-27). He argues after these ideas were introduced into China, some scholars confused them until now.

On the other hand, Chinese cultural heritage is influenced by factors such as living environment, socioeconomics and politics, which have become a kind of tourism product. Tzu-kai Liu comments, “In response to translocal and global commodification of ethnicity, the development of ethnic tourism in China’s impoverished minority regions has become a driving force in reshaping the relationships between culture / heritage and space / power” (Liu, 2013, p. 161). For the Chinese government, the use of cultural heritage to develop tourism is regarded as a national, political and educational issue. Heritage tourism in China is a powerful tool to spread Chinese culture, and it functions to emphasise patriotism and disseminate the Chinese ideology (Xu, 2007, pp. 48-51).

The Chinese government has invested 8.843 billion RMB in cultural heritage protection and 4.957 billion RMB in a free museum in 2014 (The State Council the People’s Republic of China, 2014), and this trend will likely continue. Cui notes that mistaken concepts and unscientific construction are

main reasons for the chaos seen in the protection of cultural heritage. In such a case, protecting cultural heritage sites and using them to develop tourism projects requires the development of a new digital technology or display mode.

The popularity of cultural heritage presentations using immersive animated installations has risen gradually. (Kenderdine, 2009; Kenderdine et al. 2014, pp. 141-158; Rahaman & Tan, 2009, pp 675-684; Forte et al., 2006; Forte, 2010; Bonini, 2008, pp. 113-125). At the same time, China's immersive exhibit design is taking off. However, some models lack the guidance of the design process, which is what this thesis aspires to consider.

6. Enhancing the Experiences of Cultural Heritage Using Animated Installations in Immersive Spaces in China after 1978

Since the announcement of economic reforms in 1978, China's economy has experienced rapid development. Since then, cultural heritage and its related cultural industries have been vigorously developed with the support of the Chinese government. In 2006, the Chinese government set the second Saturday of June as Chinese Cultural Heritage Day. At the same time, museums in China also experienced explosive growth. In the entertainment industry, some of the world's leading entertainment groups, such as Disney, Universal Studios and Six Flags, have entered the Chinese market. Meanwhile, Chinese domestic entertainment groups have also entered the market. These cultural and entertainment groups use many Chinese cultural symbols or elements to create theme parks suitable for the Chinese market. Because of the market expansion and audience needs, there is an increasing number of theme-based venues with animated videos. In the case of museums, people have become less interested in traditional exhibition forms of fixed exhibits with explanatory notes. Instead, they are inclined to visit an exhibition with experience and interaction. In the case of theme parks, people are more likely to accept entertainment devices with sense experiences because of their introduction in various overseas theme parks.

However, with such a large amount of construction, there is still no design process creating an immersive experience through animated installations using Chinese cultural heritage.

6.1. Designing a *Lifespace*

Special publics are defined as those unique or distinctive groups with which an organization needs to communicate (Hendrix et al., 2012, p. 312).

Before discussing the design of Chinese immersive cultural heritage, we introduce Scott Lukas and his book because the author has been greatly inspired by this book and communications with Lukas. Dr. Scott Lukas is a cultural anthropologist and an expert in designing themed spaces and a pioneer in immersive space research. His book *The Immersive World Handbook: Designing Theme Parks and Consumer Spaces* reviews the history of immersive space. The process of the historical analysis involves two centres. The first is to conduct historical research with the design style as the centre. It is necessary to compare the design style for the exterior scenes of immersive spaces in all periods and the interior layout of each project. The second is to conduct historical research with deconstruction and technical development at the centre. Lukas' book includes numerous useful interviews with designers and creators, particularly on the process of analysing how to transform content and the historical research methods required to uncover data. Historical research with the design style as the

centre involves cultural and film history, while historical research with deconstruction and technical development as the centre involves technology and architecture history.

In the book, Lukas represents the history of immersive space design, and presents his ideas on it. It is interpreted through numerous psychological theories including Plato's allegory of the cave, pointing out that we would regard what we see in the cave as reality.

Lukas compares the thematic spaces in different countries through international surveys conducted by institutions in the tourism and the other relevant fields. Included are also a number of published research reports. The author refers to the relevant literature, particularly the in-house journals of Walt Disney, and to research reports prepared by AECOM,⁵⁴ TEA⁵⁵ and IAAPA⁵⁶ for the comparisons.

Lukas' whole book focuses on how to design a theme-based *lifespace* for visitors/audiences (See Fig. 85). Lukas notes that the *lifespace* is not a real space, but ideas that can meet the needs of audiences through a variety of forms of media and experiences. To achieve this, different propagation modes are used, and an immersive design is required to realise the best information reception. During such a process, many areas are involved, including aesthetics, narratology, psychology and sociology. This

54 Global Reach, Local Knowledge, Innovation and Technical Excellence Technology Corporation.

55 The Themed Entertainment Association.

56 International Association of Amusement Parks and Attractions.

interpretation of Lukas's ideas is that immersive experience is necessary to achieve *lifespace* and derives from the design of immersive space and time.

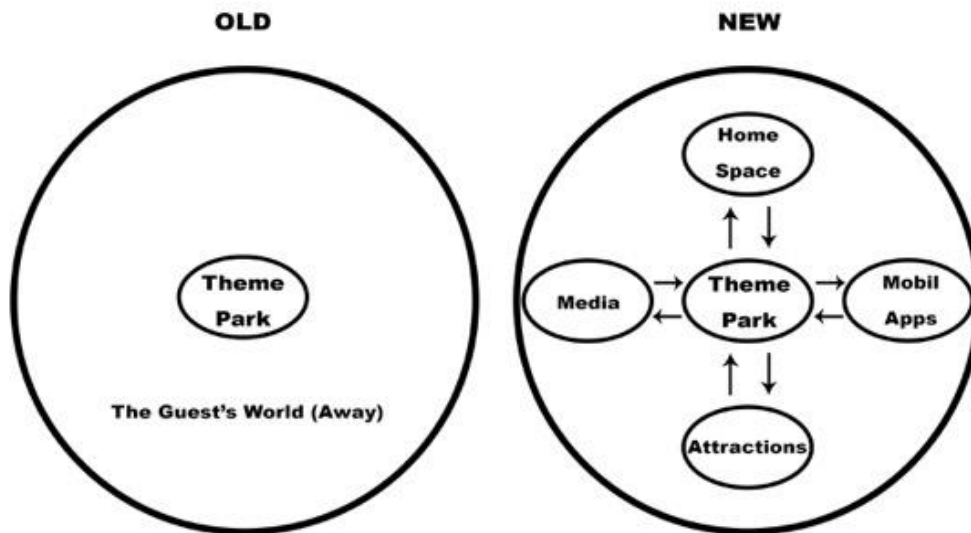


Figure 85 The contrast of old and new *lifespaces* in a theme park. Credit by Scott Lukas.

6.1.1. Theme

Creating an attractive story is a significant step to creating an immersive experience. “A story is a key aspect of the immersive world. It’s what gives the space context and meaning and it gives the guest a reason to be in that space” (Lukas, 2013, p. 52). While a clear theme is crucial for a story, its design is a powerful method for immersive experience creation (Lukas, 2013, p. 68). Lukas expresses the four forms of immersive space (see Fig. 86):

Place and Culture: As a common method for theme creation, it is based on particular cultural and symbolic places (Lukas, 2013, p. 69). All the designs aim to recreate and sometimes restore cultural sites. An example used in

Lukas' book is the Venetian Hotel in Las Vegas USA. When visitors enter this hotel, they see considerable performances and gondolas drawn from the city of Venice, old and new. Even the service staff speaks English in a Venetian accent.

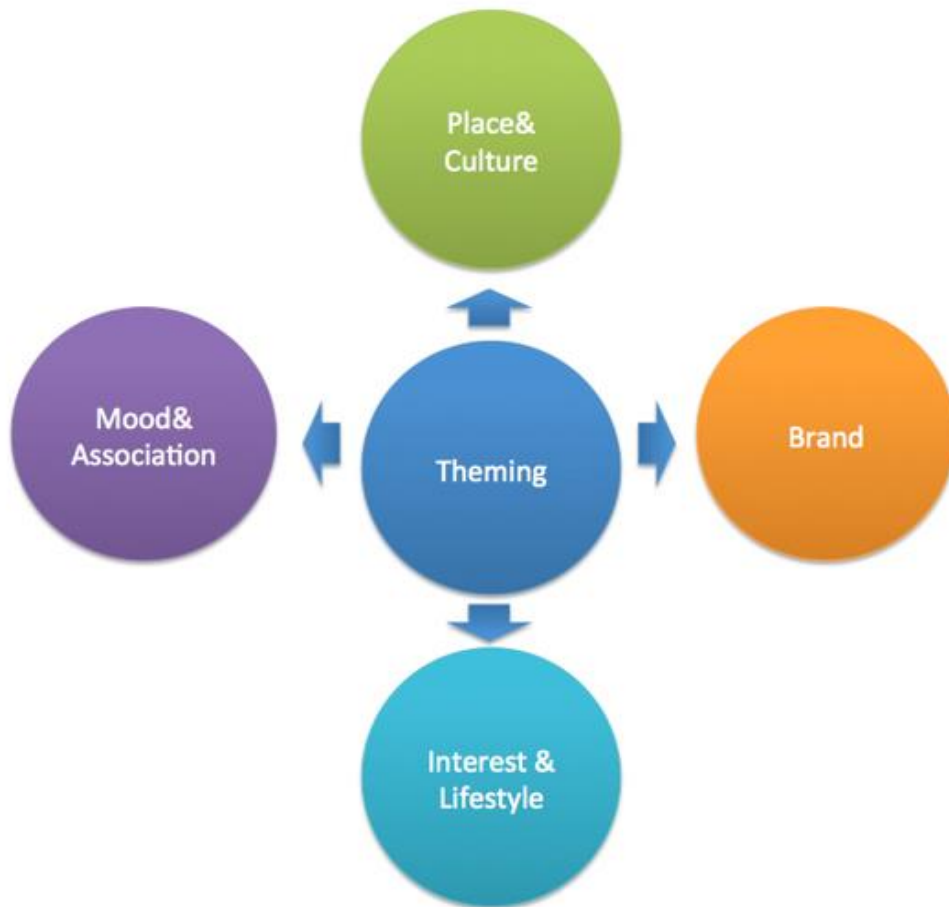


Figure 86 Types of theming (Lukas, 2013, p. 69).

Brand: This kind of theme is often used in commercial advertising (Lukas, 2013, p. 69). In particular, a specific brand is implanted into the space design, and every object in the space is connected with such brand.

Interest and Lifestyle: This kind of theme, which is often used in commercial places such as restaurants, emphasises creating a lifestyle or atmosphere (Lukas, 2013, p. 69).

Mood and Association: This means to create a theme that is non-existent in the real space (Lukas, 2013, p. 70).

Lukas states that a theme should be kept simple:

“I would say start simple, but then building complexity—the simplicity could begin at the level of key symbols...that could then be given more sensory, experiential, and cultural import. There would be an element of surprise as one discovers there is more complexity to be found underneath the simple symbols one first sees in the immersive space” (Lukas, 2018a). Lukas asks “When we decide to design, for example, a German theme park, how should we start? We may need an alehouse, the Brandenburg Gate, a castle and so on. We need symbols that visitors know. If we want a Parisian theme in Las Vegas, we would need the Eiffel Tower” (Lukas, 2018b). Many years ago, casinos, hotels and parks were not themed, but now Lukas sees that the theme park style is increasingly common. When we come to a place like a restaurant, we can see wood and stone, but we cannot see the story there. However, with the introduction of themes, visitors can feel a story. “Theming is especially popular because it uses symbols that most people know, it uses previous associations that we have had with themes, and it is a shorthand that allows a designer to accomplish a lot with a little” (Lukas, 2013, p. 69).

However, Lukas argues that the understanding and interpretation of a theme are different under different cultural backgrounds, like Disneyland in Shanghai. Therefore, the significant challenge of theme is attracting local tourists to enter into an immersive space from a different culture. In a Chinese garden, does the theme embody tradition and culture? Do we need to design a concrete or abstract symbol? We live amidst the global media. Themes can be used in theme parks or other immersive spaces, assuming that visitors already know them. However, theme parks should also provide visitors with new knowledge and new challenges. In museums, historical stories and exhibitions are combined, which is can be very effective, but theme parks have many restrictions.

As an example of a successful immersive space, Disneyland stresses creating spaces with sensory pleasures. Creating immersive spaces that can tell stories is the most important part of Imagineers' work. John Hench, a senior vice president of Walt Disney Imagineering, used the term "story environment" (Hench, 2003, p. 21) to explain how to create the space:

- 1. To provide an authentic image to tourists about historical sites and/or events.*
- 2. Using the queue to create expectations.*
- 3. Making a difference: "The distinguishing characteristics of forms that allow us to recognize what constitutes its identity. Both familiar and new forms can have emotional appeal".*

4. *Design an obvious landmark.*

5. *“Realer than real” in mood: “Each attraction must create a distinct mood if it is to give guests of the experience of an enhanced reality, the ‘realer than real’ thrill that is the signature of the Disney parks” (Hench, 2003, pp. 37-56).*

6.1.2. Authenticity

Creating authenticity is important for an immersive space. “Authenticity is all about bringing life to a space in such a way that the guest will see it as real, believable, and worthy of their time and attention. For a space to be authentic, it must involve a number of key qualities” (Lukas, 2013, p. 107). Lukas writes that the authenticity of an immersive space is based more on the details in the story or space design. An excellent immersive space design shall “focus on evoking emotions, memories, feelings, and sentiments that all people can enjoy regardless of their specific backgrounds” (Lukas, 2013, p. 38).

6.1.3. Visitors and Designers: Perception, Narrative and

Interactivity

Immersive space is designed to give the user a maximally immersive experience. Immersive experiences come from the gratification of perception, narrative and interaction and designers can create a successful immersive space by satisfying the user's perception, narrative and interaction needs.

These three elements are essential for the design of an immersive experience and immersive spaces themed around cultural heritages (see Fig. 87).

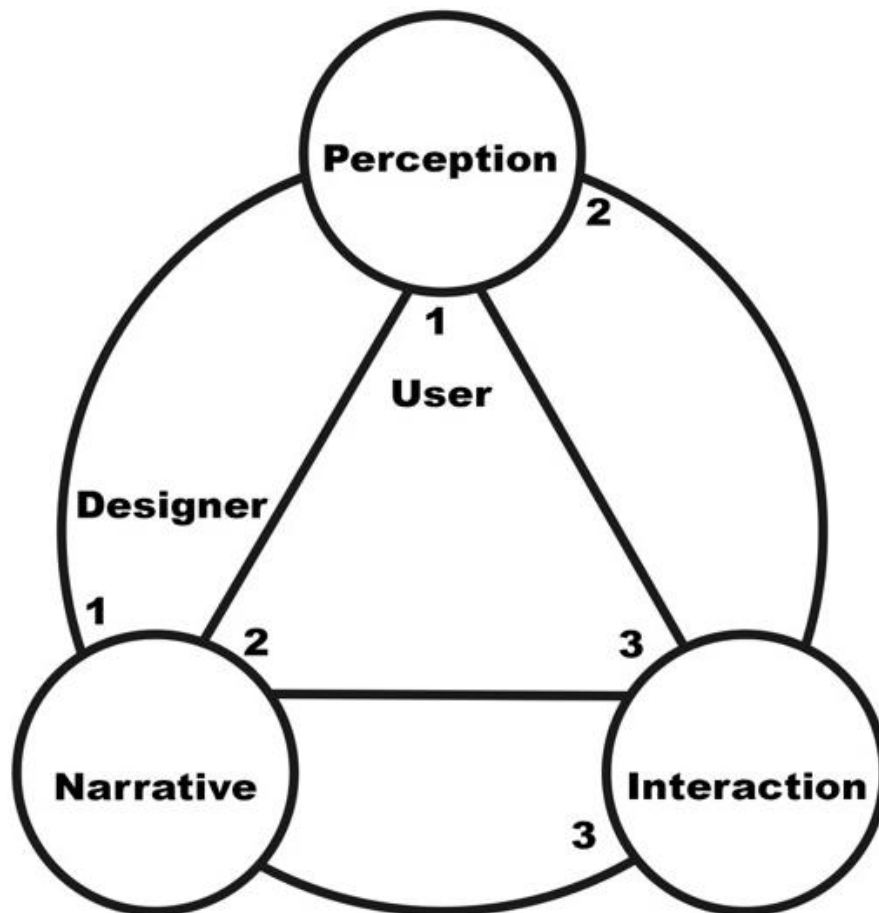


Figure 87 The relationship of perception, narrative and interaction. Image by Luo ShenShen.

The inner triangle represents the user, and the outer circle represents the designer. It must be emphasised that among these three elements, there is a continuous, sequential circulation.

In an immersive space themed around cultural heritage, the user's initial impression comes from perceptual experiences. This is consistent with the law of human acceptance of external information. An attractive first sensory

impression is crucial to users' immersive experience. Based on this, the user internally understands the narrative of the space. Moreover, the excellent narrative attracts users to focus on the meaning expressed by the cultural heritage, thus evoking their personal memories and emotions. After more attention is paid, users have a more active participation, so it is of high importance to provide a space in which interaction is available. It shall be noted that such interaction may be based on narrative or perception. After completing this process, users' immersive experiences are maximized. They then enter a new circulation of perceptual experience.

Immersive spaces themed on cultural heritage are different from other general immersive spaces, because cultural heritage has a strong narrative tendency as a cultural expression. After, both data collection and theme and storyboard writing need to be considered from the narrative and represented by storytelling. Then, the design enters the visualisation stage. Specifically, it is to present the spatial arrangement and theme—that is, in a perceptive mode. Next, the elements of interactive design are considered in the overall experience. In this process, the designer sometimes needs to return to the previous perception design several times. Finally, the designer needs to rethink and review whether the overall design and user experience is successfully expressing the story conveyed by the original cultural heritage. Often audience testing is part of this review. If necessary, this process repeats until the original goals are included.

6.2. Application Fields in China

A consideration of cultural heritage politics in China implicates tourism, economic development, government ideology, national and ethnic imaginaries, social sustainability, and intraregional, interregional and international relationships within the framework of China's fast-paced modernization in the context of globalization and China's assertive political maneuvering on the world stage" (Silverman & Blumenfield, 2013, p. 4).

China accepted and supported the UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage on December 12, 1985. As of 2017, China has 52 UNESCO world heritage sites, including 35 cultural heritage sites, 11 natural heritage sites, and four cultural and natural (mixed) sites, ranking second in the world (UNESCO, 2017). In the years since the Cultural Revolution, the Chinese are again accepting Western culture and thought. China has also gradually increased support for traditional culture and finding new methods to disseminate Chinese culture. The construction of theme parks and museums is strongly encouraged by the Chinese government. "The number of public museums in China is currently about 3,000, and currently about 80 percent of them are free...private museums in China, currently numbering about 500, will continue to grow as well. China's larger public museums have access to the most resources as they receive good government subsidies" (Rubin, 2015). However, issues have become evident in the context of development. "Problems generated by cultural tourism are well known. Mass visitation

exerts pressure on ancient walls, historic buildings, vernacular towns, and scenic spots as well as the physical environment supporting these. It can deform social relations, diminish community sustainability, transform the local economy, and generate political conflict” (Silverman & Blumenfield, 2013, p. 10). So, producing a kind of alternative, simulated environment / landscape is important for the protection of real cultural heritage sites.

As for tangible and intangible cultural heritage, this research is based on the UNESCO and ICOMOS Charter definitions, focusing on four examples in this dissertation:

1. *Daming Palace Panorama* (Xi’an, PRC)
2. *The Theme Park of ORIENTAL IMPERIAL VALLEY* (Xi’an, PRC)
3. *The Silk Road: Past, Present, and Future* (Guangzhou, PRC)
4. Interactive installations in Wu Kingdom Helv Relic Museum (Wuxi, PRC)

The Themed Entertainment Association/Economics Research Associates’ Attraction Attendance Report TEA/AECOM’s *Theme Index & Museum Index Report* is like a weather vane for capturing accurate resource data. Every year, they update the rankings of the most popular theme parks and museums in the world. This helped understand industry trends and guide the design of a popular thematic entertainment. The data sources “include statistics furnished directly by the operators, historical numbers, financial reports, the investment banking community and local tourism organisations

among others” (TEA/ERA, 2009, p.13). The report points out that 2017 was generally a strong year for theme parks and museums in China (TEA/ERA, 2017, p. 39; p. 64). It compares the three most significant theme park groups in Mainland China: Shenzhen Overseas Chinese Town Holding Company (OCT), Fantawild and Chimelong Group, all of which are in the world’s top 10 in 2017 (TEA/ERA, 2017, p. 9). The three most significant museums in Mainland China are the National Museum of China, the Shanghai Science & Technology Museum and the China Science Technology Museum, which are all in the world’s top 20 (TEA/ERA, 2017, pp. 18-19).

Fabienne Galangau Querat argues “we can outline the society as divided into two kinds of people: the scientists who hold the scientific knowledge and the anonymous crowd who do not necessarily hold educated opinions about science. One of the key challenges for museology is to explore new ways of filling that gap” (Querat, 2005, p. 178). Greenberg argues the significant challenge of the modern museum is that design is still focused on forms and objects rather than experiences (Greenberg, 2005, p. 356). Greenberg agreed with Peter Brook’s idea that “a museum space is primarily a performance space, and as such requires the same kind of thought and perception” (Greenberg, 2005, p. 357).

The rethinking the creative space is only half the story; the other half is the nature of performance itself (Greenberg, 2005, p. 358). Brook divides theatre into four categories: the conventional, the vulgar, the vital and the

holy (Brook, 1999). Greenberg argues that museums and visitor experiences must embrace all four and further explains the conventional and holy as an encyclopaedic museum and the vulgar as a theme park, but the “vital” as the “theatre of the spark” (Eyre & Wright, 2000, p. 360) demands a transforming visitor experience that combines imaginative interpretation and display with a resonant architectural setting. Stephen Greenberg argues, “these spaces will need creative directors to bring all the different elements together so as to orchestrate the experience” (Greenberg, 2005, p. 358).

6.2.1. Museums

Nowadays, cultural heritage (CH) exhibitions are becoming ever more interactive. Museums undertake the strategy of offering technological services to its visitors; furthermore, insiders are increasing their awareness about the need to provide visitors innovative solution of experiencing art. The spreading of advanced digital tools (e.g., mobile applications, addictive interaction systems and multimedia contents) made possible a new paradigm for art installations (Pierdicca et al., 2015, p. 38).

The word museum, via Latin from Greek *mouseion* “seat of the Muses”, is based on “muse” (Oxford Dictionary of English). Museum was revived to describe Lorenzo de' Medici's art collection in the 15th century (Lewis, n.d.). “The term ‘museum’ may mean either the institution or the establishment or the place generally designed to select, study and display the material and intangible evidence of man and his environment” (Desvallees & Mairesse, 2010, p. 56).

The contemporary museum still shoulders the tasks of display, transmission and education of the world's cultural heritages for the public. Contemporary museums have introduced digital devices to enhance the experiences of cultural heritage, such as *Virtually touch artifacts in a virtual museum* by Loscos et al. (2004), *EU-IST Lifeplus project* by Gutierrez & Vexo (2008), *Lascaux Cave Reconstruction* by Banguet (2016), and *Into the Wild: An Immersive Virtual Adventure* by Tan (2017). Each of these examples use mobile phones, giant screens, VR or AR equipment and so on. "This museal experience is based on a multilayered cognitive experience. It means that the visit calls upon the simultaneous use of many senses" (Querat, 2005, p. 178) and these devices enhance this kind of cognitive experience.

The history of modern museums in China starts with Nantong Museum,⁵⁷ the first public museum in China established by Zhang Qian in Jiangsu in 1905. In 1997, the CAD & CG lab became a pioneer to use digital technology and animation to restore and protect cultural heritage (Zhou et al., 2012, p. 7). They used mural photography and colour restoration techniques, developed Mogao Caves' virtual travel system, Dunhuang mural's copying aid and repairing system and computer-aided cave protection and repair systems (Pan & Lu, 2003, p. 310). Their work and research have not only made digital culture protection possible in China, but also have provided a system with which users can visit the grotto in virtual reality.

57 See Natong Museum website, retrieved October 1, 2017, from <http://www.ntmuseum.com/index.html>.

Recently, with the gradual popularization of immersive experiences in China, more Chinese museum exhibitions have started to use animated installations to create immersive spaces. In most cases, the museums use the dome, giant screen or head-mounted displays to guide visitors to enter a specific venue in which they will see the VR image and history. The museums also are creating websites through which their collections are displayed.

What the author wants to discuss is how museums can combine animated installations and related technologies with the material heritage and storytelling, thus creating a new exhibition form with the animated installation as the propagating carrier.

6.2.2. Theme Parks

The theme park as a cultural form has a long history in China. The Old Summer Palace ... may be viewed as a prototype of the modern theme park. It has been used as an excellent model not only for building an ideal garden but also for combining both entertainment and consumption in a built environment (Hai, 2007, p. 99).

The *Oxford English Dictionary* definition of a theme park is “an amusement park with a unifying setting or idea”. Coney Island in the United States was the first modern theme park and came into shape in the 1890s (Cross & Walton, 2005, p. 14). After World War II, modern theme parks ran differently than those prior to the war. In the 1950s, the USA Disneyland experience became part of a larger package, “the greatest theme park rides, the most memorable themed restaurants, and the most captivating

museums have one thing in common - they all create dreams that people can inhabit. People feel as if they can move through dreams that designers create for them” (Lukas, 2013, p. 29). Today, the modern theme park culture in the American style has spread from the United States to the entire world. Since modern media continuously emphasises and publicizes the symbolized world, most people believe the fixed visual images represent a particular culture and ethnicity.

Since the 1980s, a large number of amusement parks have been built along the southeast coast of China due to the opening-up policy. In November 1989, Splendid China Folk Village, the first theme park in China, was built in Shenzhen (Feng, 2013, p. 8). In June 2016, a Disneyland park was built in Shanghai. According to the current data, China now has more than 2,500 theme parks and the relevant invested capital has exceeded 300 billion RMB (Wang, 2016). According to New Mintel, the sales at Chinese theme parks were 39,543 million RMB in 2017, up by 27% compared with 2016, and sales are estimated to reach 89,239 million RMB in 2020 (Mintel Press Team, 2018). As the Chinese middle class is thriving, the Chinese theme park market will soon be the world’s biggest theme park market. International and domestic companies are scrambling for market shares in China (Zheng, 2016).

When Disneyland, Universal Studios and Six Flags exerted influence on China and as Chinese companies tried to use the Western format, the theme park industry in China has become a behemoth.

Driven by commercial interests, modern theme parks continually invest in the renewal of entertainment products to attract visitors. Using newer technologies, animated installations have been used in modern theme parks in the United States and China.

How can we define a successful theme park attraction? Lukas wrote to this author saying, “success is based on the degree to which guests experience different states, emotions, and senses (joy, sadness, excitement, etc.) while in the park. Also, perhaps whether they learned something” (Lukas, 2015). In Chinese theme parks, the author argues this new technology mainly involves three aspects. First, immersive technology has enhanced visitors' sense experiences. A large number of companies that specialize in VR technology have joined the theme park industry. Therefore, theme parks have started to use the HMD / dome systems, high-resolution videos and dynamic seats to make visitors concentrate on experiences (e.g., Pirates of the Caribbean in Shanghai Disneyland). Second, the changes in mobile and social technology have enabled theme parks to expand into the social field. Third, such changes are rooted in big data and computer database technology, so the experience for visitors can be made according to big data analysis. Finally, these experiences, which are classified as lifespace

experiences, help visitors establish a seamless connection between the theme park and the real world. This is similar to Henry Jenkins' thought of turning visitors into specific users. The complete immersive process is carried out and propagated by animated installations.

6.3. Reusing Cultural Heritage Symbols and Storytelling for Animated Installations in Immersive Spaces

In all of this we can appreciate the way culture, knowledge, our identities and the way these are embodied in the viewer / visitor are brought to bear in the ocular experience (Staiff, 2014, p. 74).

I think that, like works of art, heritage is not there just to provide knowledge in a direct way, rather it is about a whole series of interconnections and networks that encourage a multitude of responses and experiences, deepened reflections and heightened senses. Heritage is more than logical things and more than the logic of things (Nanetti & Cheong, 2017, p. 329).

What the author wants to make obvious is that our aesthetic experience has changed with continuing developments in science, technology, and presentation methods. Both museums and theme parks have begun to use the new technologies to attract visitors, which seems to have blurred the boundary between museum and theme park. Specifically, the theme park has begun to build its own museum, and the museum has started to use more technology to tell its stories and attract visitors. Their coincidence is

becoming more and more common. They simultaneously emphasise experience-based design and use similar methods. It should be noted, though, that their original design intentions and final goals are different; the museum is a place for education and learning, while the theme park is a place for entertainment. Therefore, the strictness of their background and theme creations are different during the design process. The displays of a theme park can be imagined or created without restrictions based on cultural heritage, while the foundation of a museum must firmly comply with academic research and data.

For immersive experiences, based on William R. Sherman and Alan B. Craig, there are two opposite views on realism. One states that “the experience must be realistic for it to be immersive” (Sherman & Craig, 2003, p. 383; Astheimer et al., 1994, p. 189). Like Laia Pujol says, “The CH (cultural heritage) field insists on presenting photorealistic, at most navigable, reconstructions as a window to the past” (Pujol, 2011, p. 47). The other states that “magical properties to exist as parts of immersive virtual experiences” (Sherman & Craig, 2003, p. 383; Slater & Usoh, 1993, p. 90).

In the field of cultural heritage protection, a high simulation-recovery animation image is ultimately in line with the Western cultural tradition of cognition. “And it has been established in the western world for purely historical reasons, related with the evolution of religious, architectural and philosophical-scientific concepts” (Pujol, 2011, p. 49). With the spread of the

media, this method is accepted more and more around the world. However, according to the research, when we encounter an unreal image (cartoon) in a virtual world, our heart rate, perspiration, breathing rates react as if it were a real object (Rothbaum et al., 1996, p. 477).

According to The London Charter (2009), “The choice of computer-based visualisation method (e.g., more or less photo-realistic, impressionistic or schematic; representation of hypotheses or of the available evidence; dynamic or static) or the decision to develop a new method, should be based on an evaluation of the likely success of each approach in addressing each aim”. Figure 88 shows us the CGI effect of *Legend of The Daming Palace* (Jin, 2010) made by Top Production Picture Co. This production company used a 3D model to restore the scene of Chang'an City in the Tang dynasty according to historical data. Therefore, it can be called a realistic restoration.



Figure 88 CGI of *Legend of The Daming Palace*. (Top Production Picture Co., 2014).



Figure 89 Luo, S. S. (2014). *Panorama of Daming Palace*. Xi'an, China: Top Production Picture Co.

Figure 89 shows the animation scene of *Panorama of Daming Palace* in Daming Palace Park; this production company created an non-realistic, animated immersive space with a combination of 2D and 3D models to be displayed on a 12 meter by 3 meter digital screen.

Daming Palace was the residence of the emperor at the time of the Tang Dynasty, and with a population of almost 100 000 people, it can be considered a small city in that period. Located on Longshou Plateau north of Xian City and eight times as large as the Louvre. Its construction started in AD 635 and burned down in AD 898. (Wechsler, 1979; Forte, 2013, pp. 499–507). This is a theme park about Tang dynasty culture. In 2012 to 2015, the author's team was involved in the project of design and fabrication. This animated installation presents a recuperative cityscape design made for the Daming Palace Museum in 2015. The design set of a single screen animated installations (12m X 3m) and other creative solutions to enhance the

experiences of cultural heritage and historical awareness of the Daming Palace museum complex as documented by the artefacts excavated in situ. The aim is to try to restore the history scene of living and entertainment in Tang Dynasty with seasons.

The important challenge involved here is that some real symbolic images (i.e., visual signs) are necessary in both authentic restorations and cartoon images. This is Russell Staiff's heritage iconography theory; the heritage presents visual images to visitors through modern media, which in return affects visitors' observations of the heritage.

This seems to be a paradox because the designer / creator strives to present a novel experience and story, while visitors are only willing to accept new information based on their existing understanding. In general, it is a challenge for the designer to effectively send information to visitors without overturning their established ideas. For example, both Figure 88 and Figure 89 are visual descriptions of a city scene in the Tang dynasty. Using credible historical data and archaeological literature, the team worked to restore the city's appearance through these two figures. The distinct visual signs in these two figures, which include wooden architecture and the traditional Chinese square layout, have satisfied visitors' imaginations of the Tang dynasty. Based on this, the designer strives to tell visitors that Tang architecture is often in simple colours and has broad roofs. Meanwhile, the

related costume information is also added to the design. Only through this method can the visitors effectively accept the information.

For narratives, it is similar to Staiff's questions about "how to represent the past in the present" (Staiff, 2014, p. 113). According to his explanation, the narrative related to heritage shall first reflect our deepest desires and feelings. Then, the main content of the narrative is not the heritage itself, but rather its stories told by the user or builder. The storytelling related to this heritage shall combine official and folk stories. Third, it is insufficient to use the simple linear storytelling to represent a complete cultural heritage. Finally, Staiff argues that storytelling related to a heritage aims to change people's attitudes (Staiff, 2014, pp. 113-115).

Hereinafter, the author specifically analyses how to use an existing cultural heritage to create representative symbols and how to represent a cultural heritage story based on the previously mentioned cases.

6.3.1. Reusing Culture Heritage Symbols (Embedding)

Symbols represent the key aspects of a culture- the essence of the culture distilled in a form (Lukas, 2013, p. 178).

Based on Russell Staiff's (2014) theory, the cultural heritage symbol involves two aspects. First, it is a specific object or place that represents a

particular period or region. Second, it is the specific figure or story that represents a particular period or region.

In 2012, the team received a commission to design a large theme park for the Xi'an municipal government. We were asked to use this famous historical city's story to tell the 1,000-year history of China. Since the beginning of this project, we have faced the challenge of theme and cultural symbol selection. After all, Xi'an has a history of 7,000 years. Since the Xizhou dynasty in the 11th century BC, Xi'an has experienced 13 eras, including the Qin, Xihan, Xin, Donghan, Xijin, Han Zhao dynasty, Former Qin, Later Qin, Xiwei, Northern Zhou, Sui and Tang dynasties. All 13 eras had Xi'an as their capital. Meanwhile, the most magnificent part of Chinese history is related to Xi'an, and there are endless stories about emperors, warriors, counsellors and heroes. The project is called *The Theme Park of ORIENTAL IMPERIAL VALLEY*.

We first surveyed the team to obtain each person's familiarity with the history and to know the history that everyone wanted to experience. It should be noted that the history here must be related to Xi'an. Then, we made a social survey asking 200 people on the street about the history related to Xi'an they wanted to experience. Based on these surveys, we find that the Qin, Xihan, Sui and Tang dynasties as well as their historical figures / events are the most recognisable. After narrowing the design range, our team read the related reference data to find the suitable theme and endow

it with entertainment. We selected 30 representative stories and figures from four regions for our design (see Fig. 90).



Figure 90 (Luo ShenShen, 2013). *The concept map of The Theme Park of ORIENTAL IMPERIAL VALLEY.* Top Production Picture Co. My team at Top Production Co. has designed four areas (Oriental Empire, The Stars of Civilization, The Silk Road and The World of Fantasy) and a total of 30 entertainment projects., including the game concept (theme), experience, scene design and time spent on each project.

Here, we take the design of *Quest for Mystery of Qin Shi Huang Mausoleum* as an example because it is the largest and the most well-known Chinese mausoleum. In 1987, the terracotta warriors and horses of Qin Shi Huang Mausoleum were officially listed as a world cultural heritage site. According to Qian Shima's (145 or 135 BC-86 BC) *Records of the Grand Historian* or *Records of the Scribe* (史记 / shǐ jì),⁵⁸ there was a river of mercury inside the

58 "The Shiji (Records of the Scribe) has been called China's national narrative. It is also one of two universal Chinese histories. This huge text, containing over half a million words when it was written about 100 BC, included all of Chinese history from earliest times" (Feldherr & Hardy ed., 2011, p. 465).

mausoleum, and this river can flow in the form of a mechanical analogy. This mausoleum not only has astronomic and geographic images, but also has rich treasures (Sima, 2004, p. 86). Furthermore, there is ample folklore about Qin Shi Huang Mausoleum. That is why we selected Qin Shi Huang Mausoleum as the cultural symbol of the Qin dynasty. It is worth mentioning that the theme of the mausoleum adventure is quite suitable for the theme park.

In this project, we first imparted a conceptual question to the audience: why was it possible to have various pyramid-shaped buildings on Earth as early as 3,000 years or 2,000 years ago? What significance does this convey? All pyramid-shaped buildings have been explored, but they have left considerable riddles. However, the only pyramid-shaped building that has not been explored is none other than Qin Shi Huang Mausoleum. So, we should tell tourists that the ultimate mystery lays here. As long as we can attract the tourists to go deeper and deeper into the design concept in their exploration, the project can give the hints through the technical approaches (e.g., "You are getting closer to the final answer, so keep looking for it!").

We have designed 10 different inner scenes to represent the adventure, throughout which the terracotta warriors are repeatedly used as a symbol because they are closely connected with Qin Shi Huang Mausoleum in both academia and pop culture. For example, movies have made the terracotta warriors become the major part of Qin Shi Huang Mausoleum, rather than

simple archaeological burial objects (i.e., *Fight and Love with a Terracotta Warrior* [1989], *The Myth* [2005], *The Mummy: Tomb of the Dragon Emperor* [2008]). Therefore, visitors can easily accept and appreciate the terracotta warriors as a visual sign and story from the cultural perspective (see Fig. 91, 92).



Figure 91 (Luo ShenShen, 2013). CG animation of *Quest for Mystery of Qin Shi Huang Mausoleum*. Beijing: Top Production Co.



Figure 92 (Luo ShenShen, 2013). Scene Design of *Quest for Mystery of Qin Shi Huang Mausoleum*. Beijing: Top Production Co.

6.3.2. Creating a Narrative Using Culture Heritage Systems

Spectacles make use of symbols and other elements to make a quick and possibly lasting connection with guests (Lukas, 2013, p. 184).

Another challenge after finding suitable cultural symbols is combining these cultural symbols together to create an attractive story.

Find Serica, another of our designs in the last theme park, tells the story of a merchant of ancient Rome who overcomes mountains of difficulties to go to China for trade. Under this background, we need to tell a complete story while using the image to create an immersive experience (see Fig. 93).



Figure 93 (Luo ShenShen, 2013). *Find Serica* conceptual design. Beijing: Top Production Co.

First, we shall show the countries the merchant passes through after setting out from the Mediterranean. The visitors to the theme park are more influenced by visual experiences, so the designer shall present visitors with the most famous events and countries related to the Silk Road in just a few minutes. According to our investigation, Chinese visitors believe that the main representative symbols of the west and of China are Julius Caesar (the emperor of the late Roman Republic) and Li Longji (the emperor of Tang dynasty, 713-756), respectively. However, we face an obvious issue. The nations along the Silk Road are diverse, and the Roman Empire had split into two parts in 395 AD. If the story takes place during the Tang dynasty (605-907), the mighty Roman Empire will have already been dismembered. The Tang dynasty and the Roman Empire are not contemporaneous.

In order to connect these two empires in different periods, we have applied an ambiguous time background. Specifically, we suppose that the story's

hero has travelled through time and space to fulfil his desire of finding a source of silk. Only through this method can we reasonably add the famous events and places related to the Silk Road. Finally, five representative scenes and cultural symbols are selected: The Roman Coliseum, Constantinople, Samarkand, Kucha's Buddhist murals and the Daming Palace in Chang'an City. Different geographies conditions, including the prairie, mountains and Gobi Desert, are added to each scene.

Visitors will follow the Roman businessman from Rome, across the Mediterranean to Constantinople and witness the "silk war" between Sassanid and Byzantine Empires. When he marches through the Middle East, he is attacked by bandits. Visitors continue to the east toward the transit city of Samarkand on the Silk Road and meet the silk cassock-wearing monk Xunzang. Finally, they continue through the Tian Shan Mountains and the Chinese desert to reach *Serica*. As an immersive experience, our design is a dark ride. The equipment will include 3D animation and stage scenery. These scenes must be coherently connected through a reasonable arrangement. If there is no way to connect the whole story, it will be displayed in several single windows. In architectural design, we selected the shape of Babel Babylon to effectively avoid video/audio interference among different scenes and to diversify the riding devices (see Fig. 94). All these designs aim to establish a communication and feedback system between the symbolic images and the visitors. "This is a symbolic form that quickly,

efficiently, and simply communicates (on its surface) the intended messages associated with the form” (Lukas, 2014, p. 396).

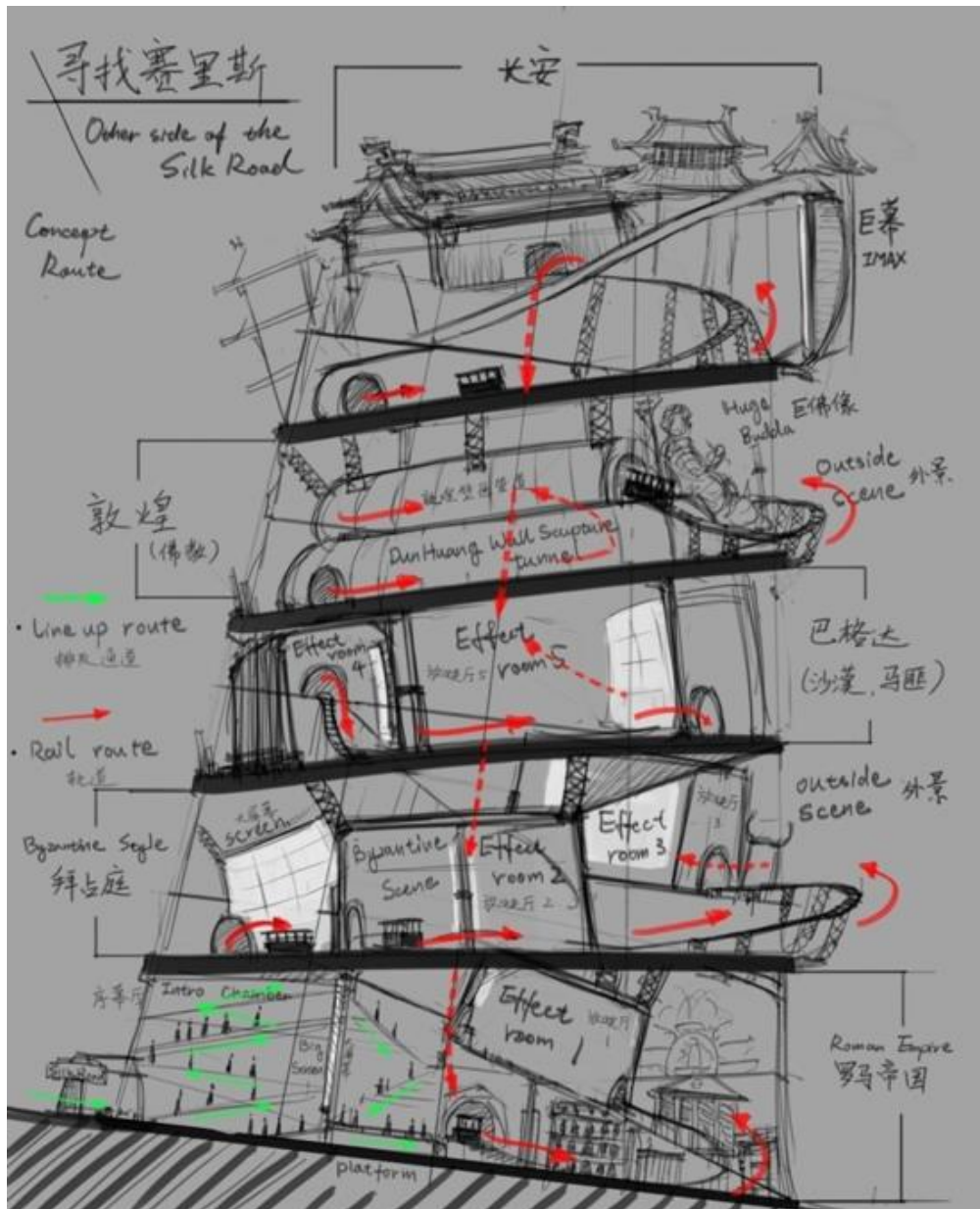


Figure 94 (Luo ShenShen, 2013). Find Serica: Section views of building interiors, scenes and route designs. Beijing: Top Production Co.

6.3.3. Accuracy and Storytelling

Transformation does not always lead to the disappearance of a heritage (a regime shift that is

frequently accompanied by the emergence of a new heritage), although this frequently happens. Sometimes transformation leads to the reuse, reimagining, and repositioning of heritage (Nanetti & Cheong, 2017, p. 345).

Neil A. Dodgson discusses how to reuse existing movie resources in cultural heritage research. He writes that the pursuit of authenticity in academia and the pursuit of story in film are contradictory, “The movie company is paying the bill, so the story-telling takes precedence. If historical accuracy makes for a worse story, historical accuracy will be discarded” (Dodgson, 2014, p. 100).

This contradiction is reflected in immersive space design. Authenticity is not often the first issue to be considered for theme parks, because of their focus on commercial interests. As a result, many cultural heritage applications in theme parks are regrettably superficial imitations. If the storyline is contrary to history, the historical authenticity will blur (or some changes will be made) in many cases.

Academic authenticity must be put first in museums and cultural heritage sites. It is hoped that theme parks can also find ways to incorporate cultural heritage themes with guidelines of accuracy.

No matter for the design of theme parks or museums, the story, theme and content are indispensable for attracting visitors. The constant challenge for the designer is to create an authentic, yet attractive, story.

6.4. Cultural Heritage Driven Animated Installations: Storytelling and Theme Design for Immersive Spaces

6.4.1. Interactive Storytelling

Storytelling is an ancient way of communication and information flow between people (Linaza et al., 2014, p. 104).

As mentioned previously, the interactive storytelling (IS) is a type of digital storytelling that combines text, video and interactive systems. While restricted by technology and capital, interactive storytelling is usually presented in a network—that is, the combination of text and video (e.g., the annual IFComp).⁵⁹ In 2017, Jingfang Hao, a Chinese network novelist, issued the first Chinese history interactive storytelling text by imitating IFComp and called it *Han Chu / 汉初* (Hao, 2017). This interactive storytelling text uses numerous historical allusions to early Xihan and nonlinear interactive storytelling. Specifically, this story has several clues, so that readers can make a choice at the major historical turning point to change the process and result, thus enhancing the immersive feeling.

⁵⁹ “The Annual Interactive Fiction Competition (IFComp) welcomes all kinds of text-driven digital stories and games, making them freely available in order to encourage the creation, play, and discussion of interactive fiction.” (IFComp, n.d).

In fact, *Han Chu* has made an excellent attempt at the text, especially because its narrative is attractive to readers. With numerous well-known historical allusions, the author made a second creation and provided readers with options. Therefore, the reader can feel that they are a part of history. However, it also has some obvious disadvantages. The oversimplified interactive storytelling structures may degrade the performance for the interactive text which is composed of numerous historical facts and readers are always asked to choose between two options. For the option, its amount is even less than that of *Colossal Cave Adventure* (a wordplay in 1976), so an obvious distinction between black and white is left to readers to decide. As well, the selected historical events are too famous, so the author's creation is limited to some extent. During the reading process, the choices readers make have a significant effect on both the historical descriptions and the final result. This indirectly reflects the complexity and difficulty of creating an interactive storytelling text.

In the field of cultural heritage, information and communication technologies (ICTs) have changed our social lives and leisure experiences. Scholars consider that IS is the basis for an in-depth study of ICTs (Markouzis & Fessakis 2015, p. 30).

Nowadays, more and more museums use ICTs in their designs (Sturabotti & Surace, 2016), so interactive storytelling is widely used in the field of cultural heritage. The website of the Hunan Provincial Museum uses

animation technology and IS so that visitors can appreciate not only the museum, but also the Daihou Mansion, which is restored based on unearthed relics and historical documents from the Mawangdui Han Dynasty Tomb. Guided by Xinzhui (the wife of Daihou), visitors can see the architecture and life scenes in the mansion. Visitors can also select their own viewing route through the mouse and screen, and the major cultural relic is designed with a detailed description.

No matter in the form of text or immersive image, the key to interactive storytelling lies in the extension of the story frame and branch content. The interactive storytelling story frame is different from the traditional linear frame. The former is a kind of nonlinear narrative, while the latter complies with a certain sequence from beginning to end. It shall be pointed out that the nonlinear narrative will encounter different "nodes" during development. Each node will be connected to several others, and their connections may be random or based on certain interactive rules (Linaza et al., 2014, p. 110). The designs of these nodes are the key to interactive storytelling design. In other words, each node represents a narrative branch, and the process of triggering these nodes entirely depends on the designer's aims. Therefore, the designer shall try to provide the nodes and rationalize the structure among them.

The interactive storytelling design should focus on visitors' identities. The designer shall give visitors the right to participate in the real historical event,

rather than simply changing the event. Based on this, it can be confirmed that the interactive storytelling design should begin before visitors enter the immersive space, so that they can better understand the background and select their identity.

6.4.2. Sensory Experiences

All key research points centre on the design process transformation. In the transformation, the essence lies in applying modern animated installation approaches to display the themes and story of a cultural heritage event or place to develop a practical design for an immersive space.

However, two issues are involved here: (1) how to transform cultural heritage symbols into animated installations and present them and (2) how to use these animated installations to create immersive spaces.

Regardless of the image content, adjustments must be made to obtain the best visual angle for different display devices, especially for immersive experience devices (e.g., dome, HMDs). Different from the traditional image experience, the immersive device will make visitors feel that the image is expanding from a limited space into an infinite space. Therefore, the positions of major objects or content on the screen are particularly important. After all, only if visitors receive sufficient visual information can the narrative develop. Since 2016, Andrea Nanetti and Luo ShenShen have been preparing for an animation project about the Silk Road. We want to use

the dome and animation to visually present the past, present and future of the Silk Road.

The first step we face is how to locate and use cultural heritage symbols. We need to build our design using cultural heritage symbols and stories as the foundation for our imagination. For example, the world map occupies an important position at the beginning and in the middle of the animation, so we first take the *Da Ming Hunyi Tu*⁶⁰ (see Fig. 95) as the original model. As a world map drawn during Ming dynasty (1368-1644), *Da Ming Hunyi Tu* shows us the territory ranging from Japan to Western Europe and from Mongolia to Java (Wang et al., 1994, p. 51-55). The author extracted the description of the mountains, rivers and seas from this map and then added these elements to a modern map (see Fig. 96).

⁶⁰ *The Da Ming Hunyi Tu (Amalgamated Map of the Great Ming)* is an extensive Chinese map. "One of these maps was the *Da Ming Hunyi Tu (Amalgamated map of the Great Ming)*, a 600-year-old depiction of China's known world" (Akin, 2016).



Figure 95 *Amalgamated Map of the Great Ming*. (1389). [painting]. painted on silk, 386 x 456 cm. Beijing: The First Historical Archives of China. (Liu, 2009, p. 37).



Figure 96 The map of Silk Road animation (Nanetti & Luo, 2016).

Furthermore, in order to better present ancient boats in the animation, we refer to numerous oil paintings of Chinese sailboats in the MOCA Yinchuan. All of these paintings are regarded as the models of ancient Chinese sailboats (see Fig. 97).



Figure 97 Left: Lamqua. (1860). *Chinese Boat Near Bocca Tigris*. [painting]. Oil on canvas. Yinchuan Museum of Contemporary Art, China. Right: Image for Silk Road Animation (Nanetti & Luo, 2016).

After completing these initial drawings, they will be presented on a particular display device. iDome, an immersive dome display system, is our first choice. Such system is suitable for a museum exhibition, because it is equipped with a glass-fibre hemisphere that is vertical to the ground with a diameter of roughly 3–5 m.

We have used iDome to test all the original images. An important technical matter is how fast is object's movement speed across the larger immersive screens. This is different from an image displayed on a small computer monitor. Specifically, the immersive screens are several times the size of a computer monitor, so the actual moving distance has been increased from projected frame to projected frame. As a result, the movement speed within the same timeframe from smaller screen to large immersive screen becomes

much faster. Therefore, we constantly adjusted the visual centre in the post-production to solve the challenge of image shift. Meanwhile, we slowed down the overall animation speed three-fold, basically solving the issue of visual dizziness. After that, we added in the dimensional sound and sound effects to further improve the immersive effect (see Fig. 98).

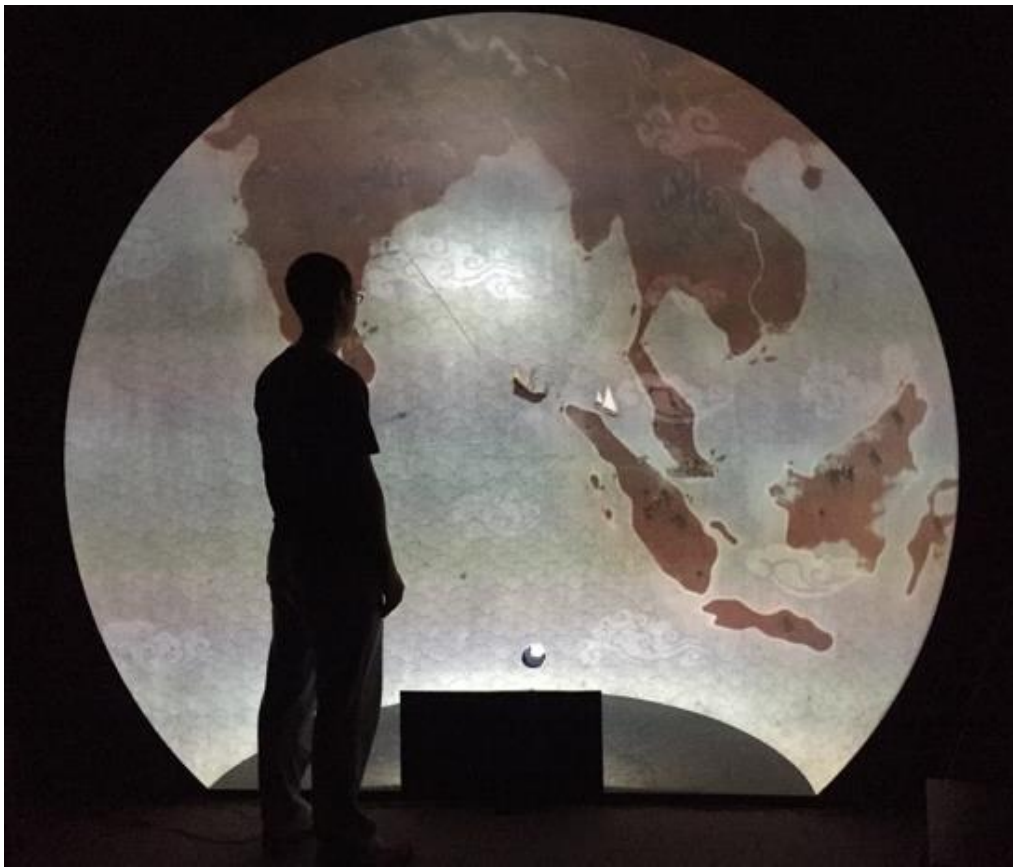


Figure 98 The author conducting imaging experiments at iDome lab. Photo by Yan Jiang, 2017.

For similar immersive experience projects, the designer shall first make different designs for different media and then continually adjust the original image based designs on a specific medium's display features as well as people's viewing habits. This is a dynamic process in real time, so even

experienced designers need to expect to make adjustments in overall design from seeing the media on the actual specific screen in real size.

6.4.3. Virtual Interaction

In addition to designing for usability, utility, satisfaction and communicative quality, sociability should be included (Smith, 2007, p. XIV). As modern phenomenology and neuroscience has shown, kinaesthetic sensations coupled with visual perception play an important role in perception (Petersen, 2015, p. 341). In addition, when people move, their experience appears more “real” (Hansen, 2006, p. 39).

In 2014, the world's largest interactive animated installation was established at Helv Relic Museum. The total area of this giant immersive device is 650 m², of which the interactive ground accounts for 400m². Its projection screen is 250 m², and it is surrounded by a mirror on three sides (ACCIONA, 2014).

Visitors can freely walk or sit down in this immersive animated installation. A single tracker can track each visitor at any time, so each visitor can interact with the image displayed on the ground in real time.

The 10-minute video shows the city of Helv in the 5th century BC, including its birth, rise and fall. This video uses a number of visual effects, so visitors feel that they enter a huge space when watching it. In such a space, they are shocked by amazing scenes, such as the stars in the night sky. Besides, the interactive induction device makes it possible for visitors to interact with

the images on the ground while watching the video. Sometimes, they will be stars in the sky, and sometimes they will be warriors on the battlefield. All of these elements constitute an exciting digital immersive space. Travelling through this interactive space, visitors can better combine their visual experiences, body kinematics and kinaesthetic sensations to have an impressive experience of cultural heritage.

According to Daniel Ellis Berlyne, our curiosity depends on the external stimulation. Berlyne also emphasises the importance of moderate stimulation (Berlyne, 1960). However, in this immersive device, visitors usually pay more attention to the interactive images on the ground, because they are quite attractive with perfect tracking and suitable changes. They completely ignore the video displayed on the projection screen. As a result, they know little about the video content. This problem permeates the whole process. What's more, the experience content does not exactly correspond with the video. It is more like an interactive game rather than a restored image based on archaeology and history (see Fig. 99).



Figure 99 Some tourists do not pay attention to the content of the film. Wu Kingdom Helv Relic Museum, Wuxi, China. iF Gold Design Award 2015, Red Dot Design Award 2014, New York Festival-Silver World Medal (ACCIONA 2014, 1).

It has to be emphasised that this is a museum project. Therefore, historical authenticity must be given priority. Due to the fictional history presented, visitors who are familiar with the history of Wu will not enter the full mental experience after enjoying the initial sensory immersion.

This indicates the challenge of balance. When we discuss whether an animated installation is successful from the perspective of sense, narrative structure and interactive experience, the balance and gradual improvement of the immersive experience must be considered. This is common in cultural heritage immersive experience projects, in which designers are often asked to balance fantastic visual effects, rigorous history and reasonable interactions.

Regardless, this device proves that digital animated installations, like other immersive spaces, can arouse curiosity, encourage exploration and provide an enjoyable educational experience. Meanwhile, it is obvious that such an

animated installation can give visitors a strong sensory experience. The overall experience of a cultural heritage project can be enhanced under reasonable sensory stimulation and story design.

6.4.4. Different Designs of Museums and Theme Parks

Museums and theme parks seem to be two different places. Theme parks are designed to be highly commercial places that market entertainment to children and families, whereas museums are places of academic research and rational thinking. Such a division confirms the meaning of each venue. Disney illusion engineer Allon Schoener argues, “We are not a museum and have never competed with them. The author feel that museums have a much different mission; they are dedicated to research, study, and the preservation of cultural properties. We are dedicated to storytelling” (Schoener, 1988).

As more museums have been built in recent years, they seem to go beyond great permanent collections and strong temporary exhibits and instead juxtapose peculiar building forms, small shopping environments and enjoyable food, making modern museums more like theme parks for adults (Rawsthorn, 2010).

Commercial considerations excluded, Lynda Kelly writes, “I suggest that it is the museum experience which links the three concepts. Museums have a strong learning focus, with the educational role being one way to deliver museum learning, and entertainment representing the enjoyment, leisure,

emotional and sensory aspects of a museum visit” (Kelly, 2014) (see Fig. 100). These “edutainment” experiences have gained more and more credit from society, which means museums are not limited to research and protection, as Allon Scholes said, but instead embark on education and culture dissemination by means of storytelling while fulfilling the two tasks described above.

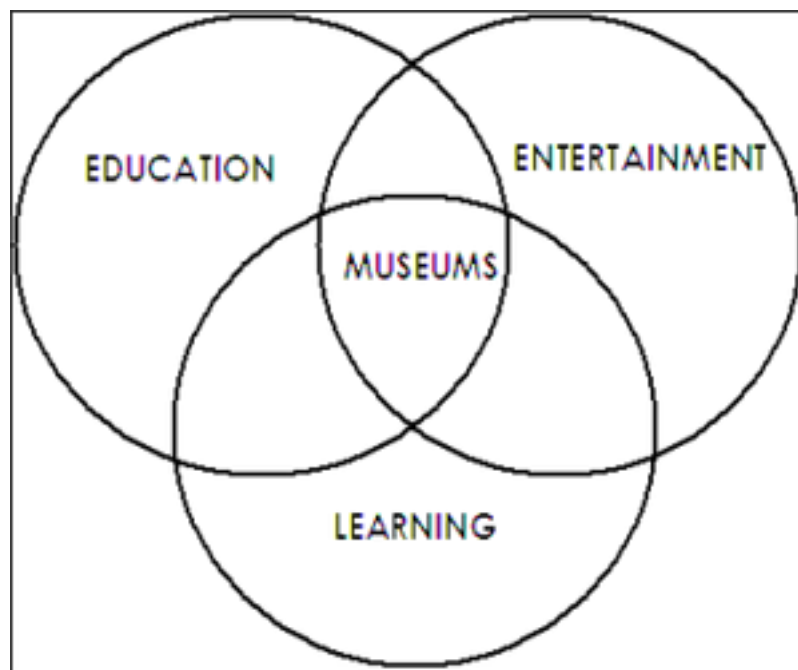


Figure 100 Museum is an aggregation of education, entertainment and learning (Kelly, 2014).

The boundary between museum and theme park seems to have blurred, and they are becoming increasingly similar. Both have to consider perception, narrative and interactivity in the design of immersive spaces, even though they vary in nature.

Generally speaking, theme parks often pay more attention to commerce and entertainment. For them, the theme is only an embellishment for arousing

users' memories. Therefore, they prioritize to perception design and recreational interactive design. As a result, the narrative design related to cultural heritage is given less attention, and may only exist in the overall design as a symbol. With this as a premise, theme parks structure and recombine symbols of cultural heritage to create highly dramatic stories.

In contrast, museums need to present and emphasise the significance of cultural heritages, so they have a great concern for historical narrative and accuracy. Leslie Bedford writes “storytelling is an ideal strategy for realizing the constructivist museum, an environment where visitors of all ages and backgrounds are encouraged to create their own meaning and find that place, the intersection between the familiar and the unknown where genuine learning occurs” (Bedford, 2001, pp. 27-34). That is why narrative design plays a lead role and perception and interactivity take a secondary position in museums. However, this does not mean that perception design and interactive design are not important when creating immersive spaces for museums. The narrative design is the centre around which the other two designs are built.

Through the comparison of these two design tendencies, the designer can better understand the priority and the direction of creative energy and investments when designing a theme park or museum.

6.5. A New Design Process of Animated Installations in Immersive Spaces to Enhance the Experiences of Cultural Heritage in China

Conceptual design involves producing the conceptual model for the product, and a conceptual model describes what the product should do, behave and look like (Rogers et al., 2011, p. 169).

6.5.1. Investigation of Design Processes

In 2007, Alex McDowell coined the phrase “immersive design” (Desowitz, 2008). He put forth the design process and creation methods for immersive spaces. This term, which is driven by narrative and story-space, is often used in new immersive designs (e.g., movie design, interactive design) (see Fig. 101). MacDowell said:

“When you design in a pre-visualization space or an immersive design space, you are no longer working in a linear film production process. It’s no longer pre-production, production and post-production. Those are really anachronistic terms now. We’re working in a non-linear workflow where we’re equally working on post-production as we’re working on production and shooting. At the same time, when we build a set now, when I design a set, I build it in 3D space. I’m sculpting space with software and you’re immersed in 3D space. It allows for an immersive collaboration” (Gallagher, 2010).

According to McDowell, we see that the immersive design process can be divided into the design process and the production process. This is inseparable from his former experience of being a movie director. When writing, the design process described on the right side of a page develops at the same time as the script on the left side of a page. The initial environment design involves script development and external visual design together. After finishing this initial design stage, the related work is distributed to each design department, so that cooperation and mutual correction can be ensured. Specifically, the non-linear design still has a lead from beginning to end in storyboards. In other words, from the core concept of the script, the pre-visualisation concept develops from the lead, followed by three major elements of immersive design: background research, story conceptual design and visualisation design. The three design factors (or departments) influence each other; the story concept can be pinpointed through research, and visualisation design can be started at the same time. The subsequent design is like a tree-shaped distributional structure in which the story and continuity start from the three main trunks.

McDowell has developed a useful chart called "*A non-linear process of immersive design in the new digital workflow paradigm*" to describe developing projects for immersive spaces (see Fig. 101).

Just as McDowell said, the design process of an immersive space is not linear. Instead, it is a divergent process originating from a theme or story concept.

This process is essentially dynamic with ideas and feedback flowing from both methods (McDowell, 2018).

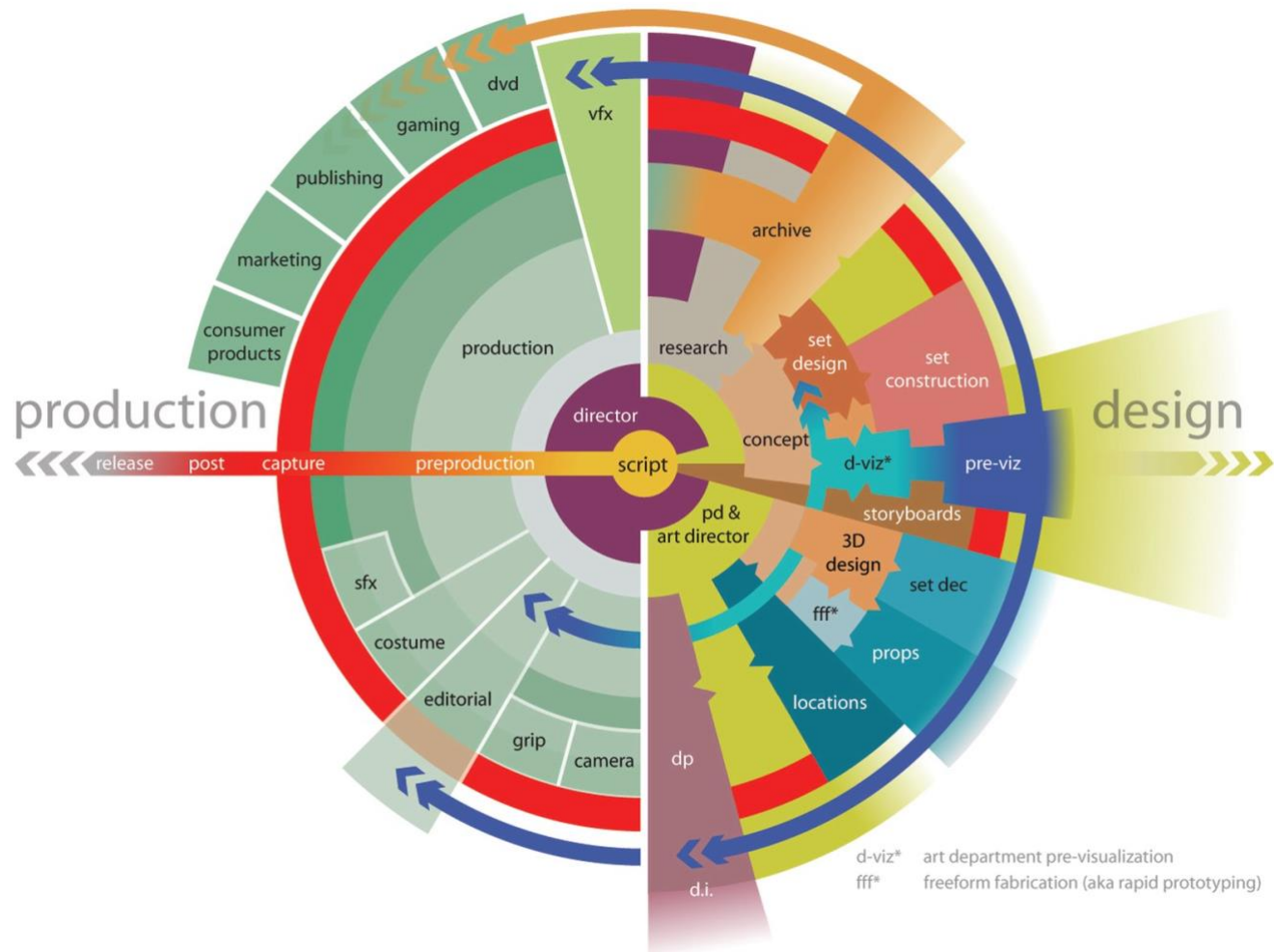


Figure 101 Alex McDowell. (2006). *A non-linear process of immersive design in the new digital workflow paradigm*. Retrieved January 10, 2018, from Animation World Network, <https://spring2013animationseminar.files.wordpress.com/2013/03/new-mandala.jpg>

On the other hand, Michael Daut notes that as a producer, he has a list of items that he must check and confirm. The object is a process of discovery. After writing the script, designers should use visual stories. If an image can replace 1,000 words, then a dome can replace 10,000 words. Designers should tell the story with the scene. First, designers produce an animation and check it. At first, there is just an idea to be storyboarded. Modifying the storyboard is easy. Modification is similarly required for the audio track, and designers need to make some audio to focus the audience's attention on the images. Designers should respect the audience so that the movie is not just one process followed by another. Designers need to keep their options open (Daut, 2018).

In general, Michael Daut comments that the immersive space (dome) design is a dynamic process in which the central challenge is the consistency between the designer's imagination and the visitor's experience. Each stage must be tested by visitors, as the design should be based on visitors' experience (Daut, 2018).

There are numerous papers that discuss how to use cultural heritage in design. However, most only centre on the process of digital and cultural heritage restoration (Lupo, 2007; Lupo et. al, 2011). In 2015, Zhigang Chen used the digital restoration of Mo Kao Grotto at Dunhuang as an example in his doctoral thesis and proposed a digital design and communication process for Chinese cultural heritage. He argues that such a process should comply with the following steps: content and technical research, feasibility analyses (including the cost, technology, value and content), investigation (including the site collection, expert consultation, data organisation and interviews with relevant persons), framing (content and technology), implementation of design (artistic presentation) and digitization (images, characters, music, videos, models), production and final release (Chen,

2015). This is the first time that a Chinese scholar has explained the digital design process for cultural heritage projects. However, with more attention paid to cultural communication, the authors do not emphasise the specific process of using digitization to create an immersive experience.

6.5.2. A Process of Conceptual Design

This dissertation proposes an overview in new conceptual design process taking the animated installation as the carrier and integrating Chinese cultural heritage into the immersive space design.

A. Concept Design Materials (proposed and possibly provided by the cultural institution that commissions the project)

1. Subject, including a. Title; b. Theme: Short description; c. Immersive space location and plan.
2. Data, including a. Cultural Heritage and Presentation with Consultants' advice; b. CAD mapping of immersive space location; c. Key academic consultants and references, including History, Art history, Anthropology, Cultural Heritage for development and content guidance.
3. Materials, including a. Archaeological sites, including Name, Bibliography, Image archives, Documentation and Documentary films; b. Museum collections, including Name, Bibliography, Image archives, Documentation and Documentary films; c. Documentary and narrative (primary) sources, including Name, Bibliography, Image archives, Documentation and Documentary films; d. Music and sound materials, including Name, Bibliography and discography, Sound archives

B. Concept Design Feedback (proposed by the designer)

1. Design philosophy; 2. Capture key design issues; 3. Research, Development and Capture key cultural heritage storytelling parameters and elements; 4. The stages of the design plan are: Pre-visualisation Proposal; Cultural Symbols Discovery and Extraction; Storytelling; Developing the Visitor's Path; During of the Visitor's' Experiences; and Setting the Elements in the Space.

C. Concept Design Elements (proposed by the designer)

1. Cultural Heritage parameters; 2. Animated installations flow, including Animation video, Resolution Choices (i.e., 2K, 4K, *and the future*), Mono (2D) or Stereoscopic (3D), Surround Sound. Display equipment choices including Mega flat screen, Dome theatre, Panorama theatre, Projection mapping, Pepper's ghost rooms, Holograms, CAVE system, Head mounted display (HMD) (AR or VR) or future displays post 2018.
2. Other installations as part of exhibition space, including possibly Gigantic sculptures, Ride systems (e.g., railcars), or Simulation systems (e.g., flight, navigation)
3. Overall stage design, including Lighting systems and Sound systems (directional/surround speaker systems)
4. Budget estimation (hard costs and soft costs)

D. Agreement on the "Immersive Space" Elements (Contract)

1. Number and kind of each chosen element; 2. Payment allocation

E. Pre-visualisation Proposal

1. Cultural symbol extraction and inclusion; 2. Story script and paragraphs; 3. User's path; 4. General narrative time; 5. Setting the elements in the space;
6. Approval of consultants

F. Feedback from Content Consultants and Discussion with the Cultural Institution that commissioned the project, and Endorsement of the Above

G. Storyboard (One per element)

1. Blueprint, including a. Layout of stage (CAD); b. Environment painting (stage and tourist); c. Angle of view of painting (tourists' view); d. The key frame of animation content (the screen)
2. Illustrated, including a. Stage description; b. The character aside; c. Animation content; d. Performance description; e. Interactivity of description; f. Lighting effect description; g. Scenery; h. Music or sound effect description; i. Key technology description; j. Expected time; k. Audience testing

H. Discussion with the Cultural Institution that commissioned the project, and Endorsement of the Above

I. Deliverables

1. Storytelling; 2. Overall environment painting (rendering) and CAD; 3. 3D walkthrough animation for project; 4. Project model

This checklist provides a working overview of the new concept design process that has been developed in this dissertation. It considers the cultural and technical elements necessary to design an animated installation for immersive spaces able to enhance the experiences of cultural heritage. This design process has been developed on the basis of both theoretical research developed in this thesis and a practical concept design project that used the Western Xia Imperial Tombs Museum and Archaeological Site as a case history as described in Chapter 7.

7. Western Xia Imperial Tombs Museum and Archaeological Site as a Case History to Enhance the Experiences of Cultural Heritage Using Animated Installations for Immersive Spaces in China

Most definitions of design share three attributes. First, the word design refers to process. Second, the process is goal-oriented. Third, the goal of design is solving problems, meeting needs, improving situations, or creating something new or useful (Friedman, 2003, p. 507).

Before being built or completed or released in the market, most products undergo market research, determination of the design goal, conceptual design, prototype design and inspection. Our project—with animated installations, Chinese cultural heritage and immersive experiences as the carriers, content and goals respectively—requires this design process.

According to Christoph Meinel and Larry Leifer, design thinking shall follow four principles:

- 1. The human rule, which states that all design activity is ultimately social in nature.*
- 2. The ambiguity rule, in which design thinkers must preserve ambiguity.*
- 3. The re-design rule, where all design is re-design.*
- 4. The tangibility rule: making ideas tangible always facilitates communication.*

(Meinel & Leifer, 2011, p. XV).

The first principle stresses that the design should centre on the users; the second and third principles indicate that the design should be based on open mindedness; the last principle underlines the importance of the materialized prototype for the whole design. These four principles are also suitable for the design of animated installations.

“In 2015, the municipal government of Yinchuan (the capital of the Ningxia Hui Autonomous Region in China) and the Museum of Western Xia Imperial Tombs’ (MWXIT) administration began preparations to apply for the UNESCO world cultural heritage list for the Western Xia Imperial Tombs archaeological sites. The Yinchuan municipal government signed a contract with the school of Art, Design and Media (ADM) of Nanyang Technological University (NTU) in Singapore, which had been assisting the Western Xia Imperial Museum to design a new immersive tunnel between the new museum and the site” (Luo et al., 2018, p. 2).

Based on Operational Guidelines for the Implementation of the World Heritage Convention, the application area needed to maintain “authenticity” (WORLD HERITAGE CENTRE, 2017, p. 26), “integrity” (p. 27) and “boundaries for effective protection” (p. 29) of the site. No new landscape architecture is allowed above ground within the site area. The author, who led the design team changed the design from a surface building and adopted an abandoned underground fire tunnel to carry out the design.

In this concept design, the author combined the previous design experiences with the newly summarized design process, and started from the three aspects: perceived immersion space design, Chinese narrative structure design, and interactive design. At the same time, the author used the design process in Chapter

6 to carry out practical operations, from the initial investigation and research, to the determination of themes, to the writing of scripts, to the selection of space and equipment, to visual rendering, and finally to inspection and delivery.

7.1. Historical Background: The Tangut People and the Western Xia Dynasty⁶¹

The earliest historical evidences of the Tangut people appear in the *Book of Sui* (Tang dynasty, 618-907), which calls them “[the] Dang Xiang [Ordos tribe / people of the] Qiang [ethnic group]” (in traditional Chinese 黨項羌, in simplified Chinese 党项羌 / dǎng xiàng qiāng),⁶² and as Tangyud (tañut) in the Old Turkic inscriptions of the memorial monument erected in 735 CE in honour of the Turkish prince Bilgä Ka⁶³.

61 This Chapter 7.1 has been already published in *SCIRES it* (Luo et al., 2018, pp. 1- 30).

62 “Dang Xiang Qiang, who with Tan Chang and Bai Lang are descendants of the Three Miao (ethnic group). They said their ancestor was the macaque” (党项羌者, 三苗之后也。其种有宕昌、白狼, 皆自称猕猴种 / dǎng xiàng qiāng zhě, sān miáo zhī hòu yě. qí zhǒng yǒu tàn chāng, bái láng, jiē zì chēng mí hóu zhǒng; Wei, 1990, p. 298). According to the Book of Later Han (6-189 CE) written by Fan Ye (398-445), “the Qiang nation belongs to the Three Miao ethnic group” (西羌之本, 出自三苗 / xī qiāng zhī běn, chū zì sān miáo, Fan, 1990, p. 570). The other Chinese authors continued to use the same terminology, even having had some first-hand experience with the Tangut (e.g., Shen Kuo 1956 / 沈括 / Shěn Kùo, 1031-95).

63 The monument is located in today’s Mongolia “near the lake Kocho Tsaidam, to the west of the river Orkhon, about 50 miles north of the monastery of Erdentso (the site of the ancient city of Kara Korum)” (Ross, 1930, p. 861). In 1896, the Turkic inscriptions have been published by Vilhelm Thomsen, who provides the transcription “tañut budunyy buzdy, oylın jo[taz]yn jylyqsyn barymyn anda_ıtym. säkiz_jigirmi jaşyma aıty_ç[ub soıdaq” (Monument II East 24, 123) and its translation into French “Dans ma vingt-septième [read 17] année, je fis une expedition contre les Tangout. Je dévastai le peuple des Tangout, et j’y pris leurs fils, leurs gens (?), leurs chevaux et leurs biens” (Thomsen, 1896, p. 123). In 1930, the same text has been published with the English translation “At the age of seventeen I made a campaign against Tangut. The Tangut people I destroyed; their young men and households, their horses and belongings I took away from there” (Ross, 1930, p. 873). In 1965 for his dissertation, Talat Tekin provided a new English translation “When I was seventeen years old, I went on a campaign against the Tañut. I put the Tañut people to rout; there I took their wives and children, their horses and possessions” (Tekin, 1968, p. 275).

The same name is used in the *Compendium of languages of the Turks* (a dictionary of Turkic languages, in Arabic *الترك لغات ديوان* *Dīwān Lughāt al-Turk*), compiled in 1072-1074 by Mahmud al-Kashgari (Kwanten 1982, 55 referring to “*Dīwān lughāt al-Turk*” (1982-1985).

In the *Secret History of the Mongols*, the language and the people of the state of Xia are referred to as *Tangyud* (Kwanten, 1982, p. 55). This name is usually explained as being a Mongol plural of the first part of the Chinese name Dang Xiang of the main ethnic group within the state of Xia, as it appears also in *The Travels of Marco Polo* where the word *Tangut* is recorded as the plural of the Mongol term *Tang* (Marco Polo, 1982, p. 707). “Although the etymology of the name has not been yet established⁶⁴, the Mongol explanation cannot be accepted” according to Luc Kwanten (1982, p. 55).

As mentioned by Nancy Shatzman Steinhardt (1992, p. 379, footnote 3), “one can consult the index of John Andrew Boyle, trans., *Successors of Genghis Khan*, [by Rashid al-Din,] (New York and London, 1971) for the many references to the Tanguts”⁶⁵.

Some scholars propose that a tribe of the Qiang nation may be the lineal ancestor of Tanguts on the basis of the fact that they both share the same culture (Li & Bai, 2003, p. 449; Gu, 1980; Yang, 1956). Others link the origin of the Tangut people to the Xianbei people (Wu, 2009, pp. 10-11; Tang, 1955).

The Tibetans called the Tanguts *Mi-nyag* (Beckwith, 2009, p. 172; Li & Bai, 2003, p. 450; Stein, 1972, pp. 70-71). The Tanguts themselves provide evidence of four

⁶⁴ See also the entry “Tanguts” in the *Encyclopaedia of Asian History* (1988).

⁶⁵ See also Rashid al-Dīn, 1971; Rashid al-Dīn, 1995; and Rashid al-Dīn, 2014.

self-appellations: *Mi* and *Mi-niaw* are used in common language texts; *Lhiwe* and *Lhiwe-ndzei* are used in the ritual language (Kepping, 2001, p. 37).

The Tangut were allies of the Tuyuhun and extended their territories towards the intersection of the current Gansu, Qinghai and Sichuan provinces during the 7th century CE. Threatened by the conquering Tibetans, the Tanguts moved from the north of the Qinghai-Tibet plateau to the southern banks of the Yellow River and around 631 asked permission to the Tang emperor to enter the Tang empire territory before settling definitely around Yinchuan (Li, 2005, p. 74; Zhang-Goldberg, 2012, p. 48).

After the anti-Tang rebellion led by An Lushan and Shi Siming (755-763), the Tanguts crossed the Yellow River, and the Tang emperor gave them permission to settle down on what is currently the Loess plateau (Bao, 2011, p. 97). Towards the end of the Tang dynasty the Tanguts increased their power. At the beginning of the Northern Song dynasty, they took advantage of the internal wars within the Song territories and gained control of the middle and upper Yellow River.

In 1020, Li (or Zhao) Deming (984[?]-1032, elevated to 太宗 / *tài-zōng* by Yuanhao^[OBJ])⁶⁶ the sovereign of the Tangut people, founded his capital city and called it Xing Zhou (i.e., New City, which today is the downtown area of Yinchuan, in emulation of Bian Liang, the capital of the Northern Song dynasty, according to Li & Bai, 2003, p. 479). The merchants from the East and the West continued to stream into the territory of the Xia, thus bringing and sharing a wide variety of goods and different ideas (Li & Bai, 2003, p. 569; Li, 2005, pp. 67).

⁶⁶ Li Yuanhao (reign 1032-1048), after having started the construction of the mausolea for his grandfather (Li Jiqian, 963-1004) and father (Li Deming), followed the tradition of the Tang and other Chinese dynasties to name Taizu and Taizong their founder and son respectively (Shatzman Steinhardt, 1992, p. 369 and pp. 370-371).

Li Deming's son, Li Yuanhao (b. 1003), after his coronation (reign 1032-1048) changed the imperial family name from Li (the family name of Tang royal household, Shatzman Steinhardt, 1992, p. 369) into Wei-ming, a native Tangut name (Tong, 2010, p. 88; Dannel & College, 1994, p. 101, with footnote 53 for the primary sources: Nevskiy, 1960, pp. 48-49, and Wu, 1983, pp. 30-33), and renamed the capital city Xing Zhou into Xingqing Fu (Li, 2005, p. 148; Shi, 2005, pp. 1095). In 1038, Yuanhao, officially proclaimed himself emperor (Wuzu in Tangout; Zhang-Goldberg, 2012, p. 48, footnote 10), founded the "Great Xia" (Li, 2005, p. 3, on the basis of Men'shikov, 1984, p. 500, p. 502, p. 505; in today's simplified Mandarin 大夏 / dà xià, Shi, 1986, p. 4; Li & Bai, 2003, p. 482), also call "Great State of White and Lofty" (Li, 2005, p. 3, on the basis of Wang, 1932, p. 266, and Li, 1984, p. 29; in today's simplified Mandarin 大白高国 / dà bái gāo guó, Xu, 2000, pp. 274-277), and started the construction of mausolea for his grandfather and father (Shatzman Steinhardt, 1992, p. 369, and pp. 370-373). Great Xia was called Western Xia by the Song emperors because of its geographical position to the west of the Northern Song dynasty (Li & Bai, 2003, p. 482; Shatzman Steinhardt, 1992, p. 369).

Shen Kuo in his Dream Pool Essays reports that "In the Baoyuan year (1038-1039), the Tangut crossed the border many times, [the Song dynasty] recruited a new army [that they] named Wansheng [10,000-time-winner], however this army which never fought before had no time for training, thus when it encountered the enemy it was always defeated" (Shen Kuo, 1956, p. 462 宝元中, 党项犯塞, 时新募万胜军, 未习战陈, 遇寇多北).

In 1041, an armed force of the Northern Song dynasty attacked Western Xia. It is recorded that an army of 100,000 soldiers lead by Yuanhao ambushed it at Haoshuichuan and 100,000 Song soldiers were killed. Even if this battle did not grant to Yuanhao the official recognition of emperor of Western Xia, the Song emperor had to accept the de facto independence of this neighbor state (Shi, 2005, p. 1155; Su and Ma, 2014, p. 323; for both the source is Tuo, 1990b).

In 1044, the Northern Song accepted to negotiate a peace with Western Xia (Shi, 2007, p. 6). According to the historiographical work completed in 1183 by the Northern Song dynasty historian Li Tao (1115-1184), “In the Yiwei year (1044), the emperor conferred Yuanhao the title of Lord of the Kingdom of Xia... .. and allocated border markets within the districts of Bao'an Protectorate [today's Zhidan County, Shaanxi Province] and Gaoping Stockade [today's Guyuan city in Ningxia Autonomous Region], and did not allow them to have lake salts ⁶⁷ communicate through them” (English translation and identification of the place names by Michael Baker, Nanyang Technological University Singapore, based on Li Tao 1985, p. 3723: 乙未, 冊命元昊為夏國主... .. 置榷場於保安軍及高平寨, 第不通青鹽)⁶⁸.

⁶⁷ According to the “Tangut law code” (1987-1989), the salt trade was a state monopoly (Shi, 2007, I, p. 154, based on the Mandarin translation by Shi, Nie & Bai, 1994, p. 566).

⁶⁸ For the historical context, see Li, 2005 and Shi, 2007. The locations of the town of Gaoping Stockade and the Bao'an protectorate were identified by Michael-Stanley Baker using the ability to combine the points provided by the Dharma Drum Buddhist Place Name Authority Database (<http://authority.dila.edu.tw/place>, accessed on April 27, 2018) with the online tools of DocuSky's Geoport (<http://docusky.digital.ntu.edu.tw/docusky/docuTools/GeoPort> accessed on April 27, 2018), which is based at National Taiwan University's Centre for Digital Humanities Research. The backdrop map is from Academia Sinica's regional time-period Song map: 北宋歷史地圖 [Northern Song dynasty historical map] 1111 <http://gis.sinica.edu.tw/ccts/file-exists.php?img=ad1111-png-{z}-{x}-{y}> accessed on April 27, 2018. Generated by 中華文明之時空基礎架構 [The Space-time Infrastructure of Chinese Civilisation] WMTS service. Reference from 譚其驤先生中國歷史地圖集 [Tan Qichen, Chinese Historical Atlas].

Under Yuanhao, Western Xia adopted characters based on strokes to write its own language (Shi, 1986, pp. 12-22; Kychanov, 1996, pp. 228- 230; Li, 2005, p. 151). In the later period of Renxiao (1139-1193), Confucianism (Li, 2006, pp. 26-32; Shi, 1986, pp. 117-127) and Buddhism (Shi, 1986, pp. 64-74; Shi, 1995, pp. 51-88; Dunnell, 1993, p. 228; Shi, 1988; Shatzman Steinhardt, 1997; Shi, 2007, II, pp. 546-623; Solonin, 2014) flourished in Western Xia. Religious texts were translated into the Tangut language. The Tangut “venerated the Buddha together with Confucius, creating an organic combination between spiritual solace and political practice” (Shi, 2014, Abstract).

According to Han Xiaomang, after Buddhism, Taoism was the second most important religion in Western Xia. He finds the reason in concomitant internal and external elements: Taoism has similarities with the traditional Tangut shamanism, and during Tang and Song dynasties the Chinese emperors highly priced Taoism (Han, 1988, pp. 58-59; Shi, 2007, II, pp. 624-629).

According to Xingqun Sun and Manzhong Yang, the Tangut had been greatly influenced by the music of the Tang dynasty after moving to the middle and upper reaches of the Yellow River (Sun, 2006, p. 36; Yang, 2016, p. 235). Yuanhao reformed Western Xia's music after becoming supreme sovereign (Li & Bai, 2003, p. 601; Yang, 2016, p. 235). However, after Renzong succeeded the throne, Jinbo Shi insisted that Western Xia music was influenced by the Northern Song in the central plains region because of Confucianism (Shi, 1986, p. 142; Yang, 2016, p. 236). After the demise of Western Xia, the Mongols adopted the rhythm of Western Xia music as its court music (Shi, 1986, p. 143; Yang, 2016, p. 232).

In 1227, after the death of Genghis Khan the Mongol army besieged Xingqing Fu. The people pledged to fight to the death in defending their country until Weiming

Xian, the last emperor, surrendered (Hartog, 2004, p. 135; Li, 2005, p. 338), after having had a period of one month to transfer a considerable number of imperial family members and other people (Li & Bai, 2003, p. 507).

The Mongol army sacked the site and completely subjugated the Tanguts, and this seems to have marked the end of Western Xia (Li & Bai, 2003, p. 507). As a consequence, the Tangut culture and language seem to have gradually disappeared from the historical landscape for three concurrent reasons.

1. The Western Xia dynasty did not have official historiographers (Li, 2005, p. 8).
2. The Mongols intentionally deleted as much as possible of Western Xia's memories and identity (Shatzman Steinhardt, 1992, p. 369).
3. The Han Chinese, since the contemporary Northern Song dynasty, and the Yuan dynasty provide very few historiographical records of Western Xia and the Tangut people (Li, 2005, p. 4; Qian, 2015).

In 1909, at the archaeological site of Khara-Khoto (黑水城 / hēi shuǐ chéng, i.e., Black River City in Mongolian, at the mouth of the Edzin-Gol river at the southern edge of the Gobi Desert),⁶⁹ the Russian expedition led by Pyotr Kuzmich Kozlov found a large number of Western Xia documents that contributed to identify the area as the site in which the Western Xia dynasty established the so-called “Yan Army Office of the Khara-Khoto” to control the market place (Kozloff, 1909-1910; Kozlov, 1923; Kozlov, 1955, p. 383; Kycgabov, 1995, pp. 39-44; Shatzman

⁶⁹ Khara-Khoto is located 15 miles southeast of today's town of Dalaihubu (Shatzman Steinhardt, 1992, p. 369 and p. 379, footnote 4 for bibliographical references in Russian and English).

Steinhardt, 1992, p. 369; documents translated into Mandarin, “Documents of Khara-Khoto”⁷⁰.

The German pilot Wulf-Diether Graf zu Castell-Rüdenhausen (1905-1980) captured the first photograph of the Western Xia mausoleums during his *Chinaflug* expedition (1933-1936) published in 1938 (p. 185 and p. 114) (see Fig. 102). The archaeological site was then recognised as the burial area of the imperial family of the Western Xia dynasty (1038-1227).

⁷⁰ Chinese scholarship claims the primary in the recognition of Western Xia archaeological relics, because in 1804, in a Buddhist temple at Wuwei in the Gansu region, the Chinese scholar Zhang Shu discovered a stele with a bilingual inscription (in Chinese and another unknown language, which he hypothetically recognised as Tangut) that he dated 1094 on the basis of the Chinese text (Zhang, 1837, Vol. 19s; Devéria, 1897, p. 489; Devéria, 1898; Li, 2005, p. 16; Wu, 2011, p. 209). Even if the Qing dynasty scholar He Ling was the first who succeeded in deciphering some Tangut characters (mainly numbers) in the Buddhist *Lotus Sutra* (Nevskiy, 1932, p. 391; He, 1986, p. 53; Li, 2005, p. 32), and Gérard Morisse, an interpreter at the French Embassy to China, after having purchased in 1900 the three-volume *Lotus Sutra* annotated by He Ling (Morisse, 1904; Nevskiy, 1960, I, p. 22; He, 1986, p. 53; Li, 2005, p. 32, Kychanov, 2005, pp. 162-163), was “able to provide the pronunciation and the meaning of a small number of Tangut characters as well as a sketchy grammatical outline” (Kwanten, 1982, p. 57); “the discovery of the dead city of Khara- Khoto in 1907-1908 by Ts. Badmazhapov and P. K. Kozlov marked a turning point in the then nascent field of Tangut studies. The Tangut ‘dictionary of 1190, ‘a jewel in a palm which meets the needs of the time’, printed as xylograph, significantly eased the difficulty of deciphering Tangut writing” (Kychanov, 2005, p. 163).



Figure 102 The archaeological site of Western Xia Imperial Tombs. Detail of Tomb 1, that hypothetically belongs to Yunhao's grandfather Li Jiqian (963-1004) (Shatzman Steinhardt, 1992, p. 371). Aerial photo taken by Wulf-Diether Graf zu Castell-Rüdenhausen (Wulf, 1938, p. 185 and p. 114).

One of the pioneers in Tangut studies was the Russian scholar Evgenij Ivanovich Kychanov (1932-2013), whose academic life and works have been recently investigated by Irina F. Popova (2014). In 1992, Nancy Shatzman Steinhard provided a detailed story of the (re)discovery of the site (1992, p. 369; Shi, 2005, p. 2556).

7.2. Concept Design Process of Western Xia Imperial

Tombs Project

In professional design practice, we often find that design requires interdisciplinary teams with a transdisciplinary focus" (Goldschmidt, 2014, p. xi).

In 2015, the municipal government of Yinchuan (the capital of the Ningxia Hui Autonomous Region in China) and the Museum of Western Xia Imperial Tombs' (MWXIT) administration began preparations to apply for the UNESCO world cultural heritage list for Western Xia Imperial Tombs archaeological sites. In this framework, the existing museum seemed to become obsolete and the idea was to build a new one in the suburbs of Yinchuan on the eastern side of Western Xia Imperial Tombs archaeological site. Between the new museum and the site, an abandoned, fireproof, underground tunnel was built in the 1980s with an east-west length of 350 m and a north-south width of 19 m. The maximum distance between the surface and the passage's deepest level is 9 m. The Yinchuan municipal government decided to reuse this underground tunnel to let visitors enter the archaeological site without affecting on the landscape.

In the meantime, the underground tunnel can display the legendary history of Western Xia to tourists. In December 2015, the MWXIT delegated the School of Art, Design and Media of NTU Singapore (ADM-NTU) to be responsible for the digital concept design of the underground tunnel.

In the following, the author will illustrate the design process with the case of the Museum of Western Xia Imperial Tombs.

7.2.1. Concept Design Materials

In June 2015, the author visited MWXIT with the organization Beijing Top Production Co., Ltd (BTP) (see Fig. 103). ADM-NTU was asked to propose a concept design for an underground tunnel linking the museum to the Western Xia Imperial Tombs archaeological site. This conceptual design aims to enhance

visitors' experience in the cultural heritage space with the application of animated installations and other digital media.



Figure 103 The author visited Western Xia Imperial Tombs in June 2015. Photo by Luo ShenShen, 2015.

7.2.1.1. Subject

A. Title

After negotiations with MWXIT, the project name was preliminarily designated as *The Western Xia Space-time Corridor*.

B. Theme: Short description

The theme is to review the 354 -year rise and fall of the Tangut history (873-1227).

C. Immersive space location and plan

The site is an underground corridor between the newly established MWXIT and the archaeological site.

7.2.1.2. Data

A. Consultant advice

Soliciting opinions from Professor Jinbo Shi, who specializes in Western Xia history, and other experts from the Western Xia Research Institute of Ningxia University, we selected the most prominent part of Western Xia history, thus determining the historical facts to be presented. According to the advice of a BTP director who filmed a documentary on Western Xia, we selected the sectional display method to interpret Western Xia history.

B. CAD mapping of immersive space location

MWXIT has provided the CAD engineering drawing of the underground passage (see Fig, 104). According to this map, the distance between the deepest part of the passage and the surface is 9 m. According to MWXIT, the earthwork can be carried out at the deepest part of passage, and the excavation shall stop at 100 m from the surface. The tunnel's widest point is 183.5 m. The red line shows a special area; with a national highway passing through here, the width of the tunnel must within 110 m. Because of this, there is a sudden tightening in the tunnel, thus presenting a huge challenge during the design process.

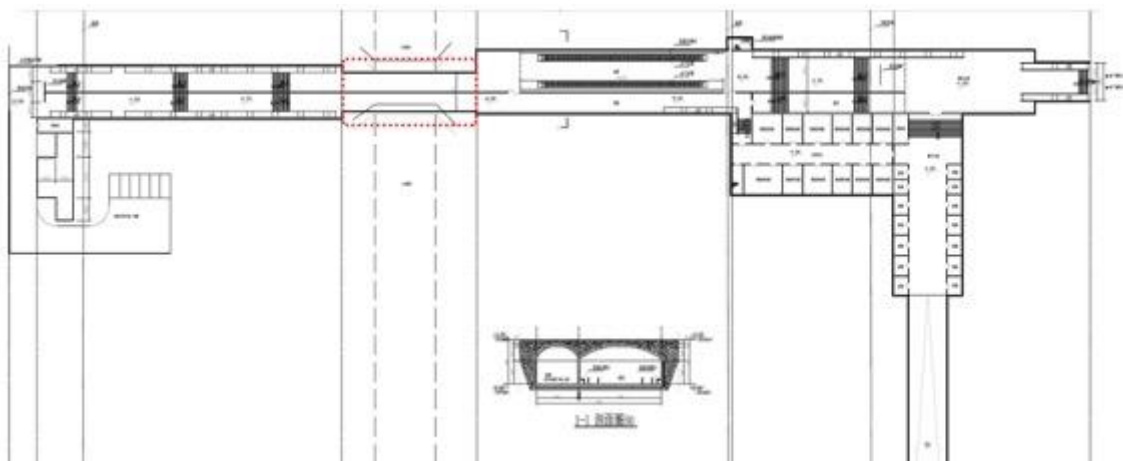


Figure 104 A CAD map of the fireproof underground tunnel to the Western Xia Imperial Tombs. Image from Western Xia Imperial Tombs Museum.

C. Key academic references

We have referred to the writings and papers of famous Chinese and Western scholars who specialize in Western Xia history (see bibliography for main references).

D. Archaeological sites

In June and November 2015, the author visited the archaeological site of the Western Xia mausoleum and inspected the original underground tunnel. Then, he read numerous textual and graphic files provided by MWXIT (especially the frescoes of Western Xia palace, architecture in the third grotto of Yulin grottoes and the existing Western Xia pagoda image data; see Fig. 105).



Figure 105 This extant Western Xia period's Buddhist architecture (1. Pagoda of Kangji Temple; 2. Pagoda of Hongfo Temple; 3. Pagoda of Chengtian Temple; 4. Dafo Temple and Tu Pagoda at Zhangye; 5. One Hundred and Eight Stupas; 6. Twin Pagodas of Baikou Temple; 7. Pagoda of Baisigou); the related Buddhist murals (8. The south side wall of Yulin Cave 3; 9. The north side wall of Yulin Cave 3); and Buddhist block printing (10. Liang Huang Bao Chan Tu; 11. Avatamsaka Sutra; 12. Zhuan Shen Nu Jing; 13. Yi Jing Tu) in China. Image by Beijing Top Production Co., 2015.

E. Museum collections

MWXI has collected a number of architectural ornaments and unearthed funerary objects related to the Western Xia mausoleum, especially ornaments Chi-Wen, pigeons, dragon fish, the quadruped and other mascots (Shi, 1986 pp. 152-158). Therefore, during the survey carried out in June 2015, MWXIT provided a large collection of pictures and research data as a creation blueprint. Then, based on the field visit and these historical data, we can confirm that white and green were emphasised in Western Xia (Li, 2006, p. 166). That is why this design is dominated by white and greens (see Fig. 106), drawn directly from the artifacts.



9 殿堂楼阁，作歇山顶或攒尖顶，中脊陡立，饰以脊兽，屋角翘起，如鸟展翅飞翔。

Figure 106 Selection of archaeological findings from the heritage site of the Western Xia Imperial Tombs. [A & B. Drawings made by Beijing Top Production Co. Ltd. in 2015. 1-8. Photographs taken by Luo ShenShen in the Museum of the Western Xia Imperial Tombs: 1. Hornless-dragon mouth. 2. Floor tile. 3. Head of Chi. 4. Dragon fish. 5. Makara-like sea dragons. 6. Lion. 7. Eaves tile. 8. Kalaviṅka-the exquisite sounding bird. 9. The halls of the temples, they are the gable and hip roof or pyramidal roof, decorated with the beasts on the ridged purlin; turn-up the tail of roof like a bird spreading its wings to fly (The Western Xia Imperial Tombs 2016)].

F. Documentary and narrative (primary) sources.

This design is based on references to the vast number of cultural relics and architectural images from the Western Xia dynasty, especially the building system of Xingqing Fu. It is extremely fortunate that BTP, who are cooperating with us, has just filmed the first Chinese documentary about Western Xia titled *The Mysterious Tangut* (Jin, 2015). They visited numerous experts on Western Xia history and interviewed scholars at the Institute of Oriental Studies at the Russian Academy of Sciences in St. Petersburg to research Western Xia documents related to the historical site of Khara-Khoto.

G. Music and sound materials

During this project, we find few historical records about the music melody and rhythm of Western Xia. However, according to Manzhong Yang, there were various musical instruments in Western Xia (e.g., Sanxian, Liuxian, Chinese lute, Qin, Zheng, Konghou, Guan, flute, Xiao, Sheng, Hichiriki, Qixing, Bass drum, Zhanggu, Paiban) (Yang, 2016, p. 238), also Yang insisted that the Western Xia Music is characterized by collectivism, entertainment and strong rhythm (Yang, 2016, p. 239). According to Fuli Wang's research, only one music score has survived-*Ye Ge Tang Wu / 也哥倘兀* [Great Xia] (Wang, 2003, p. 74; Yang, 2016, p. 240) (see Fig. 107).



Figure 107 The music score *Ye Ge Tang Wu* was preserved in the historic record of Yuan dynasty (Yang, 2016, p. 240), and it was converted to a five-line spectrum by Manzhong Yang in 2016.

7.2.2. Concept Design Feedback (Proposed by the Designer)

After collecting and analysing the data, the design team notes there are two main challenges to be discussed and negotiated with MWXIT. The script of the Western Xia project has something to do with a real history. From day one for the design, we took into account the mentality of tourists. The first challenge is how to bring them back to historic scenes from more than 700 years ago. The design team has to respect the history and also stimulate tourists' interest to understand the history instead of forcing indoctrination. Apart from the immersive technology and the real stage settings, a reliable and attractive story is the most important component.

The story runs through the whole design process from the formation of the concept to the specific item-by-item design. The story plays a decisive role in the

design as the main thread to facilitate the development of the various design tasks.

In any design dispute, other factors must make room for the story design.

How can we demonstrate the changes of over 200 years of Western Xia rule in a tunnel measuring 265.6 meters? We must compress the history to focus on the most important content and plots for representation. While paying attention to the historical facts, we highlight the key plots and events to describe Western Xia history as a story. For this challenge, the author has first clarified the design principles of the project: I am not a bystander. I am a participant. I want to join them, fit into their stories, understand their history and create my hero.

1. Through digital or non-digital methods, the designer should create an immersive space for visitors. When visitors enter the space, they will be immediately involved.
2. Based on research of the authentic history and story, the designer needs to create a new story. Visitors understand the story's background but do not know the new content. They are interested to know the story of the narrative.
3. Based on the narrative story, "design" a history of emotional subjective cognition and lead the visitors to take the initiative to actively understand it.
4. Based on the previous step, visitors have the desire to actively participate. Designers should provide an opportunity for visitors to communicate with and change history.

The second challenge is how to guide the visitors. The visitors' experience will directly determine the success or failure of the project. It is easy to feel claustrophobic in an underground passage. Therefore, we must constantly

distract visitors from these feelings via design, thus guiding them through the dark and narrow passage. That is why we use animated installations and various image devices to create an outdoor experience in the passage. We also have to design a safe mode of transit that will not affect visitors' experience. In the first stage, track-type transmission and free movement were proposed.

The last challenge is that the design must comply with the state's requirements, mandatory criteria and technical safety norms. It shall be noted that the necessary fire and emergency exits must meet China's building safety standards. Although this is an architectural issue, we insist that it should be taken seriously at the beginning of the project because these requirements will affect the final design. Finally, we solved the challenge of safety standard with the help of Ningxia Academy of Building Research Co., Ltd.

7.2.3. Concept Design Elements (Proposed by the Designer)

After the initial communication with MWXIT, the author led the NTU design team to develop the proposed design elements of the overall animated installation project.

7.2.3.1. Animated Installations

A. Animation Video

The author first communicated with MWXIT about the resolution of animated images. Combined with production costs and space, the final decision was to use 2K images and surround sound. Stereoscopic images were also possible.

B. Display Equipment

The author strongly recommended using as many display methods as possible to achieve an immersive effect since the animated installation was used to change

the immersion. According to the agreement, the author use flat screens, panorama theatre, dome theatre, projection mapping and a Pepper's ghost device. Holograms and CAVE devices are eliminated, and HMDs be used in the specific design.

7.2.3.2. Other Installations

A. Gigantic Sculpture

Sculptures, which are regarded as stage properties and set off in the surrounding space of the image, made of silicone.

B. Ride Systems

From the beginning, the author thought that the friendliest method to make the visitors move would be through guidance or other means. Therefore, we designed an interactive method to guide the visitors movement from one scene to the next. However, we changed this design when we saw how numerous visitors attended during the peak tourism season in 2014. These numbers showed the possibility of security issues if enough visitors flooded into the narrow passage or if visitors made irregular movements (such as reverse or static movements). Designer must control and restrict visitors' movement, so the dark ride mode is applied here. This mode has three advantages: (1) the security challenges in the passage can be resolved; (2) the designer can control a visitors' viewing angle and viewpoint; (3) the interval time of the vehicle can be adjusted through a central control system to ensure maximum delivery capacity.

7.2.3.3. Overall Stage Design

A. Lighting Systems

The overall visual atmosphere is dark because of the image-based display method. Spotlights will be used as the special stage lighting.

B. Sound Systems (directional/surround speaker system)

The dark ride method is applied, so the design team decided to use a single vehicle with a loudspeaker to deal with sound effects in order to avoid visitors being influenced by sound effects from different scenes.

7.2.3.4. Costs Estimation (Hard cost and Soft cost)

Based on the overall budget assessment, the overall cost of the project is under 40,000,000 RMB (not including construction costs).

7.2.4. Agreeing on the “Immersive Space” Elements (Contract)

7.2.4.1. Number and Kind of Each Chosen Element

In November 2015, the NTU design team and BTP signed the design agreement, according to which they shall design (1) the underground immersive experience project for MWXIT and (2) six different experience areas on Western Xia history.

7.2.4.2. Costs Allocation

BTP pay the design fee to NTU in two instalments; 50% of the fee will be paid in the first instalment, and the rest will be paid after submitting and modifying the project. Officially established in November 2015, the NTU design team is composed of four conceptual designers, two scriptwriters, four conceptual illustrators, three 3D model-makers and animators, two project consultants and one technical adviser.

7.2.5. Pre-visualisation Proposal

Pre-visualisation is an effective method that assists the whole team in understanding the location of the program's space and the atmosphere of each theme. Pre-visualisation allows the designer or director to represent the script content of the story, performance and the lighting design as well as calculate the cost of the entire project to control the budget. Based on the comprehensive research and in combination with the settings and images, they can prepare and produce the design sketches and 3D animations, which will co-exist with the research work for us to find the demonstration model, combined with modern aesthetic standards based on historical research.

The optimal advantage of pre-visualisation allows the designer to free the experiencer's imagination. In drawing the design sketches for each scene, the designer may incorporate various factors, including the tourist experience model, the location of the tourist, the perspective of the tourist experience, the film content, the content of the scene, immersive screens and lighting effects, to recreate historical events.

7.2.5.1. Drawing Out The Cultural Symbols

Each culture has its own tradition of symbols that are repeatedly used and magnified in today's media world, and cultural heritage is no exception. Russell Staiff calls this phenomenon heritage iconography (Staiff, 2014, p. 84), and this is the basis of numerous exhibition design efforts. Multitude-displaying design work has been commonly based on this kind of cultural symbol. Chinese people's understanding of the Western Xia dynasty comes mainly from *Demi-Gods and Semi-Devils*, a martial arts novel by Jin Yong. Even Shi, Jinbo, a scholar of Western

Xia, thinks Jin Yong has played a significant role in popularizing Western Xia culture (Qian, 2015). However, for the museum design, to address the legends of Western Xia history, we are including research and documents from academia.

Through the collation of historical material and research, we have confirmed the most important cultural symbols of Western Xia: nomadic people making use of green and white (Bai & Li, 2003, pp. 449-452); violence (Bai & Li, 2003, pp. 470-479, p. 526); the coexistence of ghost-god and Buddhist beliefs (Shi, 1986, pp. 60-74; Shi, 1995, pp. 15-49; Bai & Li, 2003, pp. 584-593); a distinctive writing system (Laufer, 1916; Shi, 1986, pp. 11-22; Bai & Li, 2003, pp. 595-597); a major section of the Silk Road (Bai & Li, 2003, pp. 566-569); and the bloody war with Mongolians (Bai & Li, 2003, pp. 498-507).

Another major challenge is how to determine the narrator's identity. In view of history, we first need someone to introduce the historical background to tourists. The team spent a considerable amount of time and energy identifying such a guide. We need to give audiences an identity orientation and bring them into the scene before they visit. Western Xia was defeated by Mongolia in 1227 AD. Yet, as the legend goes, before the Mongols besieged the town, they gave Weiming Xian, the last emperor, one month to prepare for surrender, during which time Weiming Xian helped a considerable number of people in the imperial family and other persons escape. Therefore, we identify Li Xian as the narrator and the viewers as the escaping members of the royal family. Li Xian gives the whole account of the story to look back on the history of the Western Xia dynasty.

We decided to start the story with a Qiang sacrifice ritual. According to historical research, the Tanguts advocated shamanism, and a tribe of the Chinese Qiang was the lineal ancestor of the Tanguts. The Tanguts have disappeared, but modern

Qiang people still reside in northwest China. Historical records show that the Qiang people involved in the sacrifice ritual were called *Shibi* (释比 / shì bǐ) (Han, 1988, p. 58; Dang, 2008; Deng, 2013). *Shibi* in the Qiang religion were cultural inheritors who were familiar with the social history, myths and legends of the Qiang. With their abundant social experience and considerable medical knowledge, they recited scriptures and engaged in witchcraft. We designed a character according to the features of such a profession, and this role witnesses the rise, decline, loss and demise of the Tanguts. This role, imbued with mysterious myths, can take the viewers into the history and perform the narration and interpretation.

7.2.5.2. Storytelling

We decide to write a script based on Chinese aesthetic and moral evaluation criteria. Traditional Chinese narrative features refer to *Tso Chuan*, as discussed in the foregoing context. We use a symbolic narrative that combines space and time to tell the story of Western Xia. We objectively describe specific events according to historical data, and emphasise the results caused by moral choices. This conforms to not only traditional Chinese narrative principles, but also to the educational purpose of museums.



Figure 108 Research meeting at Beijing Top Production Co., Ltd. (18 December 2015). From left to right: Mr. Ji Guorui, Ms. Ma Ming, Mr. Luo Fujian, Mr. Luo ShenShen, Mr. Zhang Yan, Mr. Luo Fujian, Ms. Xie Yupeng, Mr. Li Chong. Photo by Mrs. Jiang Yan (Luo et al., 2018)

Based on the summarised cultural symbols, we have designed six narratives:

- 1) *Migration of the Tanguts from the Qinghai- Tibet plateau to the southern banks of the Yellow River (before the 7th century CE) and the crossing of the Yellow River (post- 763 CE);*
- 2) *Foundation of the capital city as Xing Zhou (1020, by Li Deming) and then renamed Xingqing Fu (1038, by Yuanhao);*
- 3) *Battle of Haoshuichuan (1041);*
- 4) *The Origins of the Tangut script (1032-1048);*
- 5) *Flourishing of Confucianism and Buddhism during the reign of Renxiao (1139-1193);*
- 6) *Destruction of Western Xia (1227)” (Luo et al., 2018).*

7.2.5.3. The Visitor's Path

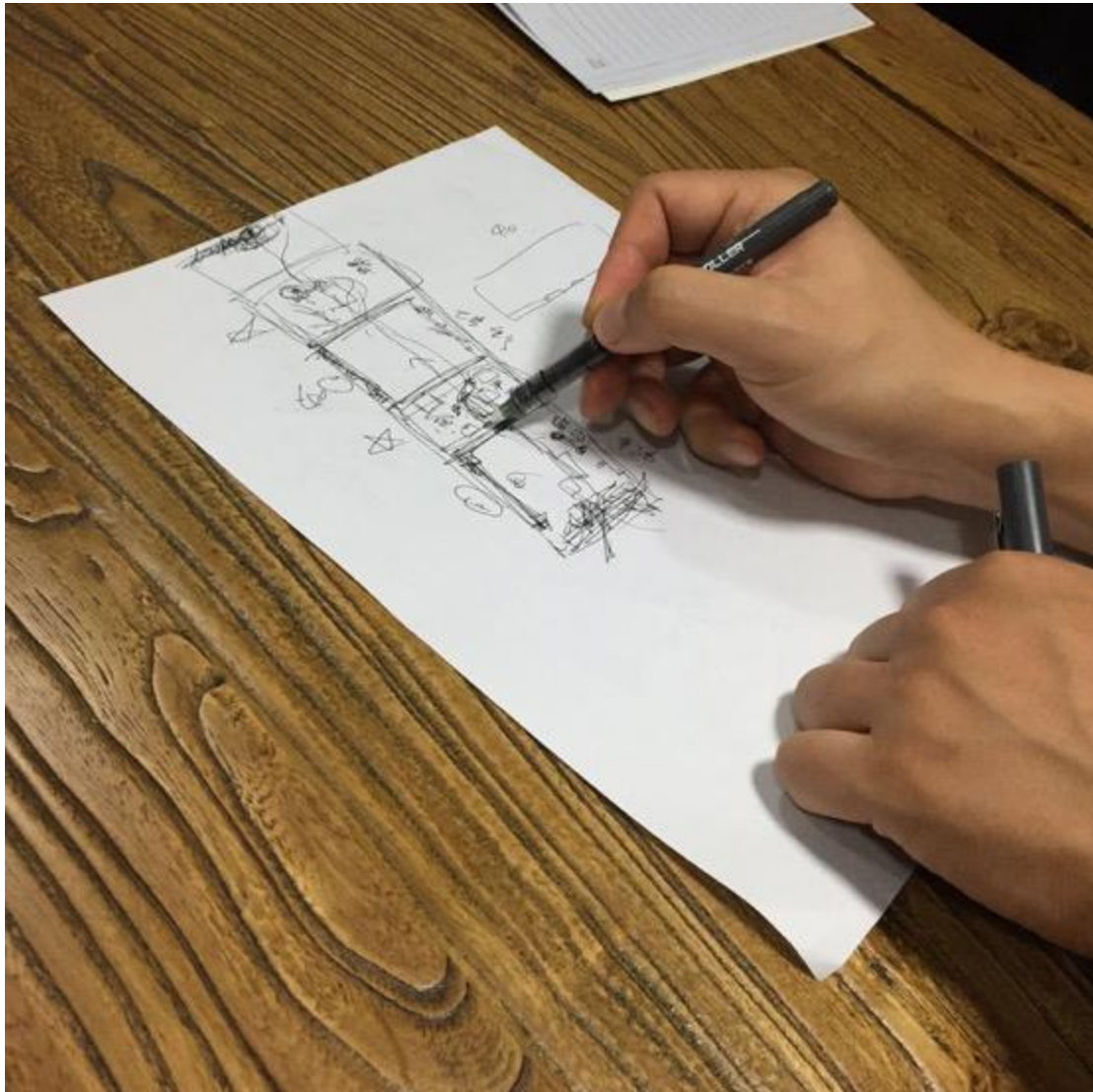


Figure 109 User's path design. Photo by Yan Jiang, 2015.

Each vehicle can take up to 12 visitors, so we need 20 vehicles in total to circulate and pick up visitors during peak tourism season. For the vehicle, we will consider adopting tri-axial moving technology. The distance between the vehicle and its surroundings cannot be less than one meter, according to the Chinese National Safety Standards. After this calculation, the length and width of the vehicle shall be within 3.5 m and 3 m respectively. As to the design of vehicle, we have referred to the design of Western Xia carriages (see Fig. 110). As our stories happen in

different scenes, some stories happen indoors and some outdoors (the outdoor effect is shown through images).

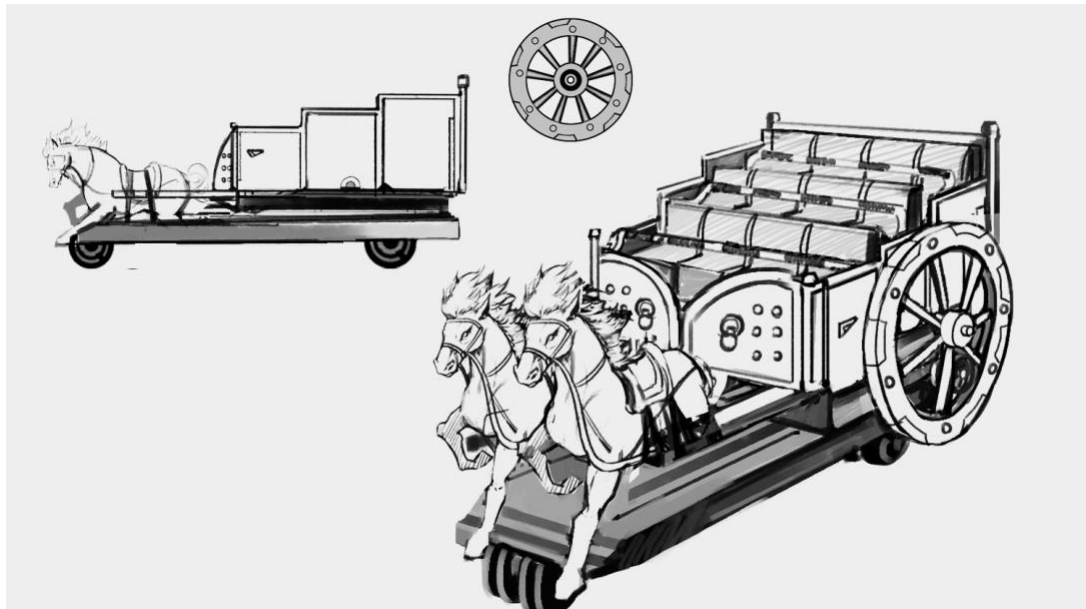


Figure 110 The preliminary vehicle design. Image by Luo ShenShen. (Luo et al., 2018)

The use of the horse-drawn carriage is not a best choice, so we made an ambiguous vehicle to transport the tourists to experience scenes from the Western Xia Dynasty. We designed the vehicle like a Western Xia carriage. However, visitors have to look up or down at the scenes on the screens, so we removed the ornaments at the front and rear to ensure a better view (see Fig 111).



Figure 111 Final 3D vehicle design model. Image by Luo ShenShen, 2015.

7.2.5.4. During of the Visitor's' Experiences

In order to help with the visitors' understanding, we set the screen time to 20 minutes to give them time to explore the information and to control business and operating costs. According to the preliminary calculation, visitors' will stay 200 seconds for the first act, 240 seconds for the second act, 220 seconds for the third act, 150 seconds for the fourth act, 130 seconds for the fifth act and 230 seconds for the sixth act.

7.2.5.5. Setting the Elements in the Space

Act 1

Space length	Number of screen	Number of projector	Narrator time	The audience residence time
43 m	2	2	110 s	200 s

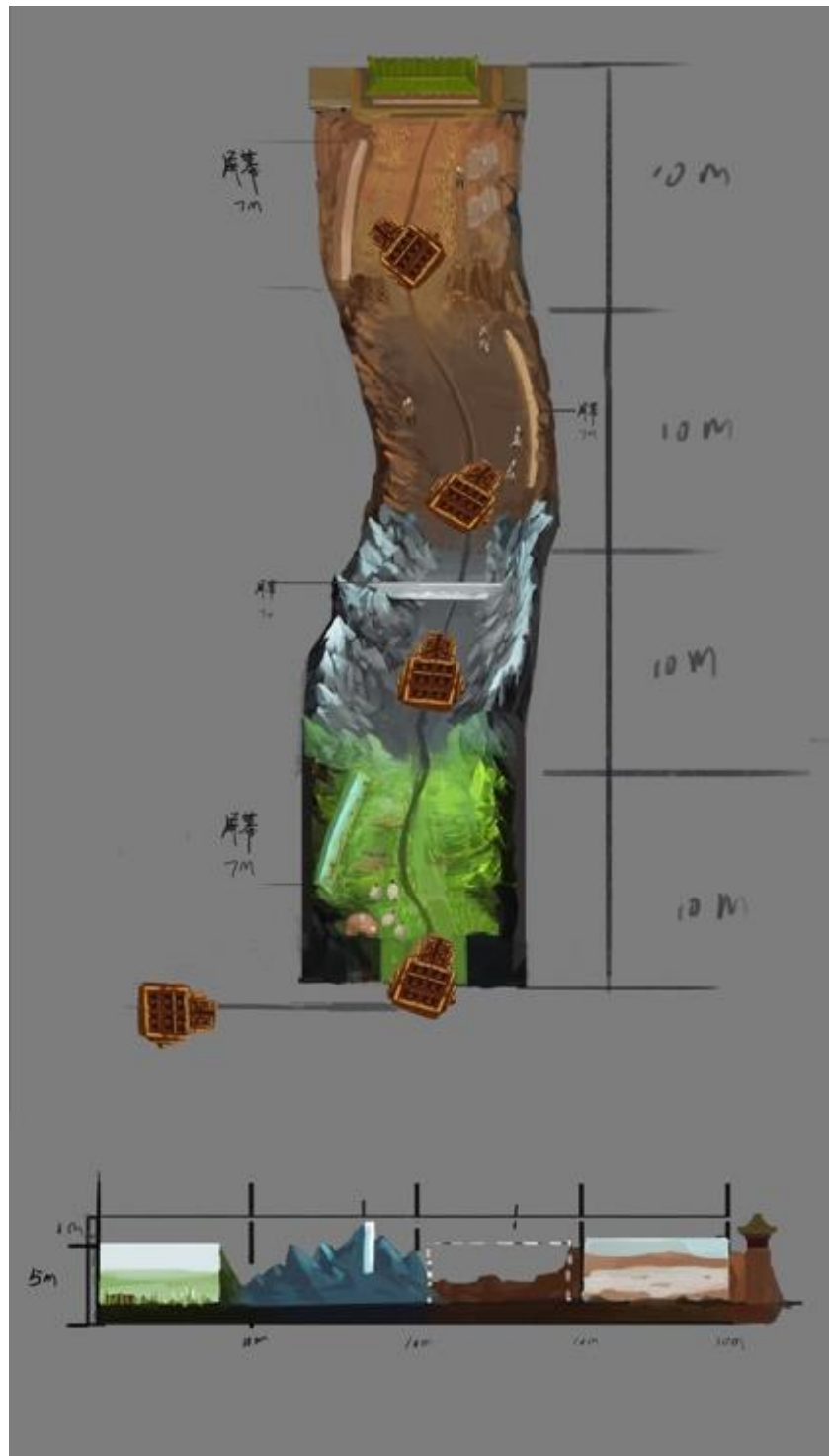


Figure 112 Scene design of Act 1. Design by Luo ShenShen. Drawing by Fujian, Luo, 2015 (Luo et al., 2018).

Act 2

Space length	Number of screen	Number of projector	Narrator time	The audience residence time
51 m	2	2	185 s	240 s

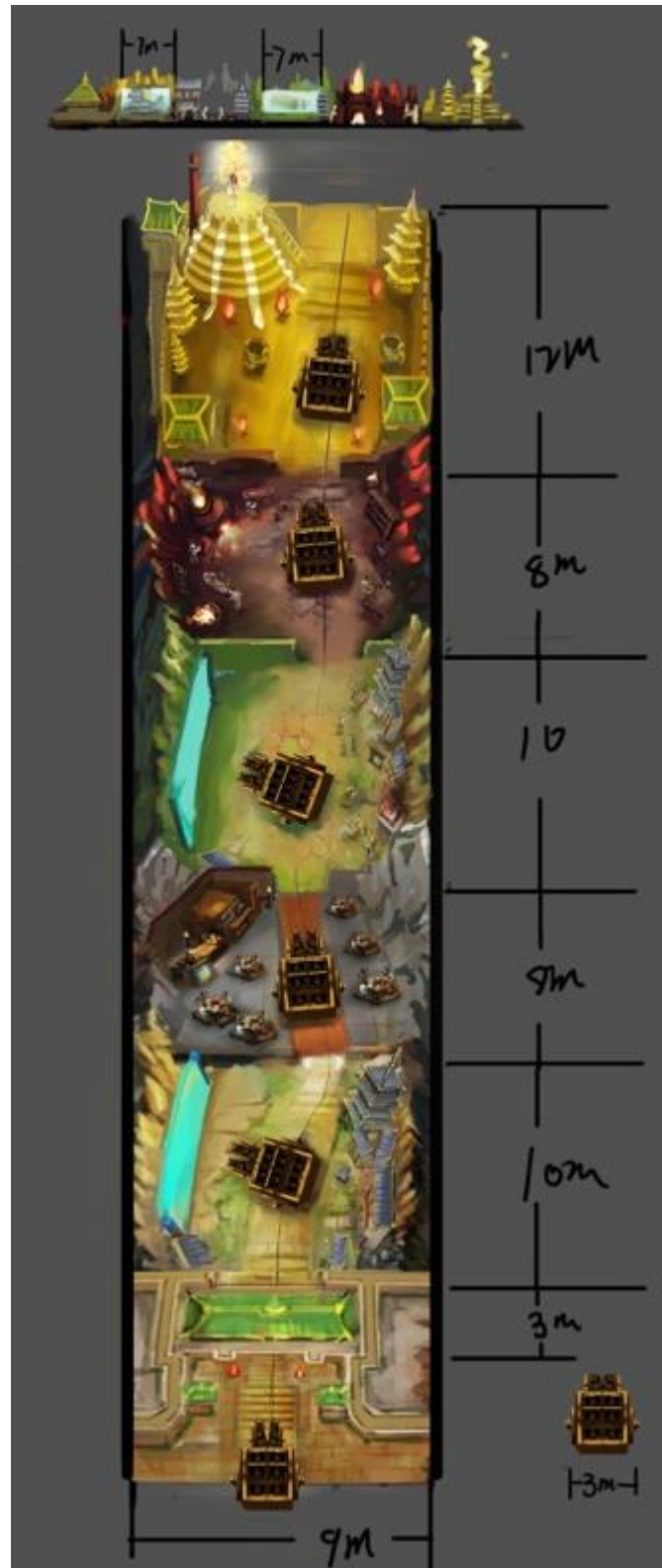


Figure 113 Scene design of Act 2. Design by Luo ShenShen. Drawing by Fujian, Luo, 2015 (Luo et al., 2018).

Act 3

Space length	Number of screen	Number of projector	Narrator time	The audience residence time
26 m	2	7	110 s	220 s



Figure 114 Scene design of Act 3. Design by Luo ShenShen. Drawing by Fujian, Luo, 2015 (Luo et al., 2018).

Act 4

Space length	Number of screen	Number of projector	Narrator time	The audience residence time
44.6 m	8	8	45 s	150 s



Figure 115 Scene design of Act 4. Design by Luo ShenShen. Drawing by Fujian, Luo, 2015 (Luo et al., 2018).

Act 5

Space length	Number of screen	Number of projector	Narrator time	The audience residence time
33 m	1	1	100 s	130 s



Figure 116 Scene design of Act 5. Design by Luo ShenShen. Drawing by Fujian, Luo, 2015 (Luo et al., 2018).

Act 6

Space length	Number of screen	Number of projector	Narrator time	The audience residence time
68 m	8	8	130 s	230 s



Figure 117 Scene design of Act 6. Design by Luo ShenShen. Drawing by Fujian, Luo, 2015 (Luo et al., 2018).

7.2.5.6. Approval of consultants

In December 2015, Prof. Andrea Nanetti attended the NTU team's project presentation in Beijing. Then, he suggested perfecting the first act and having visitors watch the last act collectively. This indicated the completion of the first stage (see Fig. 118).



Figure 118 Professor Andrea Nanetti is guiding the design team. Photo by Yan Jiang, 2015.

7.2.6. Feedback from Content Consultants and Discussion with the Cultural Institution that Commissioned the Project, and Endorsement of the Above

In December 2015, the Museum of Western Xia Imperial Tombs (MWXIT) endorsed the above design.

7.2.7. Storyboard (One per element)

7.2.7.1. Blueprint

After perfecting each act and completing the concept drawing, we needed to turn the concept drawing into a detailed CAD construction blueprint. In the meantime, the specific visiting mode and time were calculated and planned in detail.

A. Layout of stage (CAD)

Due to the specialization of CAD architectural drawing, we asked relevant personnel of the China Architecture Design & Research Group for help. Based on their professional advice, we finally determined the position of mandatory security settings in the design drawing (e.g., firefighter access, escape corridor). Meanwhile, we learned that the steering angle of the vehicle exceeded the safety standard of the tunnel according to their calculations. As a result, we adjusted the entire arc of the tunnel and the steering mode of the vehicle so that our design would meet national safety standards.

B. Environment Painting (Stage and tourist)

This story can't fully represent the history, even if we were to have detailed paintings and historical records. The image design for the historical culture experience project shall be based on detailed historical evidence. In the second place, it should be compared with historical images of similar cultures, which can ultimately be added based on the rational imagination of the artists. For example, take the image of the *shibi* in the Western Xia Project. We need to identify the narrator at the start as well as the *shibi*'s clothes and dialog. We consulted the Western Xia literature, which did not give any specific accounts on *shibi*. However, there are abundant pictures, materials and historical research on *shibi* among

modern Qiang people. We designed the image of an old *shibi* based on these materials by comparing clothing from the Song Dynasty and the Liao culture from the same period as the Western Xia dynasty.

For the description of environment thumbnails, the design team adhered to several principles. First, the overall atmosphere of the environment was presented, including the colour and lighting of each act. Second, the design of each act needed to be clearly displayed in the drawing, including the screen in the animated installation, the image on the screen and other props in space. Third, the relationship between visitors and the stage, such as distance and viewing angle, was presented.

C. Angle of view (Tourists view)

See final deliverable painting.

D. The key frame of animation content (the screen)

See final deliverable painting.

7.2.7.2. Written Report

In the below table there is an exemplification of how scholarly materials are usually introduced in the concept design phase of animated installations for immersive spaces in theme parks and museums.

	Stage description	Character aside	Animation content	Performance description	Interactive description	Lighting effect description	Scenery	Music and sound effect description	Key technology description	Expected time
Act 1	The story told by Shibi at the journey's beginning. Shibi tells visitors about the Tanguts who originated in the Qinghai-Tibet Plateau and what led them to migration. The contrast is between the romance of rural life and the hardships of	The ancestors of the Tangut originally lived in the southern snowy mountains and grasslands. Boundless, the sky was so blue; the wilderness seemed boundless, too. Rippling through the pastures, northern winds blew. The grass bent low, and the cattle and sheep did too. It was the nearest place to heaven. These children thought that their comfortable life would last forever; however, the rise of the Tubo would not consider their opinions. The cattle and sheep were taken away, and the	On the Qinghai-Tibet Plateau, where the Sky was so blue. The wilderness seemed boundless, and the ancestors of the Tangut were herding sheep and horses. Later, the Tubo cavalry broke the peace. They burned the Tanguts' camp and took their cattle and sheep. The Tanguts were forced to leave their home and set out on the road of migration. The Tanguts	Shibi is waiting at the entrance for the arrival of the vehicle. In the process of carrying forward, Shibi beats a drum until the lights go dark.	As the vehicle advances, near the ground, we will use light to create the visual effects of the grass. In the highland meadow scene, we create an olfactory experience of subtle grass and earth smells. The air-conditioner will create a relatively cold environment for tourists. In the image,	Taking a vehicle after the visitors enter, the spotlight will be placed on the actor's body, and the light will gradually dim as the vehicle becomes farther away. The ambient light is dim so that visitors' attention is focused on the content of the image. The brightness of the environment is slightly higher than that of the grassland, creating a reflection effect of snow on the plateau. Using	Five yak sculptures, 10 sheep sculptures, two nomadic herdsman sculptures and three camps are simulated on the grassland surface. Simulation of snow cover and bare rocky surfaces. About 10 square meters of pool, creating the effect of water flow. The reeds on the banks of the Yellow River.	A bamboo flute plays as with the introductory solo of a violin, creating the pastoral atmosphere of Tangut life. After the Tubo invasion, the violins make a broken, sharp whistle and then join the bass to create a tense atmosphere. The music slows as the violin joins a trombone, trumpet, bass and other brass instruments, showing the hard and heavy	Two HD projectors match the stage performance.	200 s

	<p>migration. The ancestors of the Tangut crossed the Yellow River and went through many hardships to reach the Loess Plateau promised by the Tang dynasty. For hundreds of years, the Tangut have lived and adapted to the environment here, changing their way of production and life.</p>	<p>tribe was destroyed. The Tanguts were driven out of their homes. Just as the Tanguts were displaced, the great Tang dynasty came to the rescue, and the Tangut Qiang people embarked on a long migration under the protection of the Tang dynasty. They were going to settlements that have never been seen. Even though the snow-capped mountains were hard to climb and even if they were in front of a terrible mountain and snow, the Tanguts never stopped. In the rolling Yellow River, the Tangut people beat the choppy waters, even if they only had sheepskin rafts to use. The Loess Plateau is a barren land.</p>	<p>struggled to climb the vast, snow-capped mountains. Under the guidance of their leader, the Tangut people carried their primitive sheepskin rafts and crossed the turbulent Yellow River. As the change of image, the Tangut tribes came to northwest China under the Helan mountain, a seemingly barren, yellow earth. The Tangut people planted slopes of wheat and rape flower and built a humble village settlement.</p>		<p>the Tangut farmers who work on the yellow land will beckon to the tourists. In the scene of the yellow land, an olfactory experience in the fields of wheat and rape flower is produced.</p>	<p>yellow light, the bold Yellow River waves and the solemn and stirring of the Tangut people across the Yellow River are built. Using warm colour tones, the simple sense of a yellow geomorphology is highlighted.</p>	<p>Simulate the surface of the Yellow River. Simulate the surface of the yellow land with a cornfield.</p>	<p>traffic on the road of the Tanguts. Use a string orchestra to create a sad, strong atmosphere and join the flute, Xiao or Bili (an ancient wind instrument) and other woodwinds. Orchestral music is used, but the tone and tempo tend to be gentle.</p>		
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	Stage description	Character aside	Animation content	Performance description	Interactive description	Lighting effect description	Scenery	Music and sound effect description	Key technology description	Expected time
Act 2	<p>After gaining a foothold in the yellow land, the leader of the Tangut people, Tuoba Sigong, is appointed military commissioner and given the name Li by the Tang dynasty for his military achievements. Generations later, Tangut leader Li Deming built Xingqing Fu. It is located within the territory of Ningxia Yinchuan. It is on the path of the Silk Road in Western Xia, which not only attracted businessmen but also collected cultures from the East and West. In order to gain a foothold in this chaotic world, the once chastened Tanguts forge a tradition of martial arts, and they had</p>	<p>Unknowingly, under Helan Mountain on the banks of the Yellow River, the frontier town formerly known as Huaiyuan became the great city Xingqing Fu. Xingqing Fu was the pride of the Tangut people and would become the capital of the Tanguts' country and witness the glory and decline of the Tanguts. Because it was located on the major thoroughfare of the Silk Road, there were groups of travellers and businessmen from the East and West. Developed businesses brought abundant supplies and civilised information to the Tanguts.</p>	<p>People from different ethnic groups walk through the street in the foreground. There are Tangut officials, Han Confucian scholars and Western merchants riding camels. Craftsmen are building new buildings along the street. The streets are crisscrossed, the imperial palace is resplendent, the temple is magnificent, and the pagoda is soaring into the clouds in the background,</p>	No	<p>On the left side of the figure sculpture, there are one or two real actors. Uses shadows to create the visual effect of flying sparks. The air conditioning system will create a hot environment when smelting iron.</p>	<p>The light around the gate begins to light up, outlining the city gate first and then illuminating the whole building. The lighting system will illuminate the circular mound, highlight its main body and set a light source in the setting of the palace.</p>	<p>Restoration gate of Xingqing Fu (up to 4.5 metres). There are six bonfires in front of the gate and four sculptures of soldiers on the towers. The mechanical device that opens the gate. On the left side of the restoration street, there are building scenes and character sculptures. A bartender in front of a tavern is attracting customers; a butcher is cutting</p>	<p>The first part is to enter the city before entering the military zone. It is played as the main melody with the more cheerful bangdi and the accompaniment of three strings. The yangqin and other traditional Chinese instruments create a cheerful atmosphere for the market. After entering the military zone, the second part is played on the Pipa with drums and shouts. It is played as a lead on the Qiang flute and the cello. Brass</p>	Two HD projections. One Pepper's ghost screen	240 s

	<p>the most far-reaching impact on military technological innovation. In the palace of Xingqing Fu, Li Yuan Hao, the founding emperor of Western Xia ascended the circular mound to worship heaven with the support of civil service officials and then held the solemn ceremony of his accession to the throne.</p>	<p>The city, modelled after Bianliang of the Song dynasty, was the most spectacular city in northwest China at the time, and its founder was the Tangut royal who came here 100 years ago. In the Five Dynasties and Ten Kingdoms period, the leader of the Tangut people was given the name Li for his military achievements and was appointed the Ding Nan Jun military commissioner of the Tang dynasty. Although the great Tang dynasty had passed, the resilient Tanguts created their own history in these chaotic times. After several generations, the Tangut people had the capital to preserve themselves, while Xingqing Fu and the Tangut</p>	<p>which shows the bustle and splendour of Xingqing Fu. Li Yuan Hao is wearing the royal crown of the emperor of Western Xia and stands above the circular mound's altar tower. Through Pepper's ghost techniques, combined with the actors' performance, the sky changes and a flying white dragon is projected upon it.</p>				<p>meat; a merchant with a camel is in front of a grocery store; soldiers are patrolling the streets; women are with children; and vendors are selling baked rolls. On the second floor of the street building, there is a woman poking her head out. At the end of the street, there is a gate to the temple, and there are monks walking out of the gate. The circular mound is</p>	<p>music is added as the foil to create a brilliant and sacred atmosphere for Li Yuan Hao's coronation.</p>		
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		<p>government had been inherited by their leader's son, Li Yuan Hao. The young man was a man of great intelligence and ability. With his ambition, he carved out 1,000 miles of land for the Tanguts. As conditions matured, he was crowned emperor of the Great State of White and Lofty. The state was called Western Xia by the Song dynasty.</p>					<p>about 3 metres high. There are 10 sculptures of Western Xia civil and military officials. The palace gate is located in the distance.</p>			
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	Stage description	Character aside	Animation content	Performance description	Interactive description	Lighting effect description	Scenery	Music and sound effect description	Key technology description	Expected time
Act 3	In 1041 AD, when Yuan Hao was proclaimed emperor, the war between Western Xia and the Northern Song dynasty broke out. The main force of the 70,000 Song soldiers led by Ren Fu came to lay an ambush at Haoshuichuan. Under the command of Emperor Yuan Hao, the Western Xia army was victorious, and the existence of their country was respected and acquiesced by both the Song and Liao.	At the same time as Li Yuan Hao's accession to the throne, the frontier of Great State of White and Lofty was confronted with a serious threat. Here is the ravine and crisscrossing yellow land, and we will go to Haoshuichuan below the Liupan Mountains to witness a battle for the fate of the Tangut people. The Song and Liao dynasties were true superpowers. In their eyes, the Western Xia was insignificant.	The image content creates the subjective visual effect of bumps and slopes in the ravines of the Loess Plateau. In this process, visitors can see the cavalry units passing by and the infantry and crossbowmen under the command of the general reaching the predetermined position of the ambush. With huge screen images, visitors see the whole Haoshuichuan battlefield. Under the cliff, hundreds of white doves rise, and the soldiers of the Western Xia, who are lying in ambush, hold up their bows and shoot	No	Through changing the perspective of the vehicle itself, the scene of the mountain road with the image can create an intuitive feeling of a bumpy road trip.	The lighting is dimmed. The visitors' attention is drawn to the dome screen image.	Simulate the surface of the yellow land; Low shrub vegetation. Cliffs that the vehicle can sit on. A number of banners and military supplies. The camp of five Western Xia troops; A sculpture of two triumphant Western Xia soldiers.	The music creates the tense atmosphere of war using the quick tempo of the drums, the lower piano keys and the music of the pipa. After the battle begins, trumpets begin the music, and the orchestral joins to create an atmosphere of tension on the battlefield. The solo of the violin with lighthearted woodwinds creates an atmosphere of joy after victory.	Seven HD projectors, screen theatre.	220 s

		<p>The Great State of White and Lofty was surrounded by two great powers, and war was the only way to make them recognise the nation that the Tangut people founded. The Tangut warriors were strong, and the army was not resisted. In the end, the 70,000 Song troops failed. After the battle of Haoshuichuan, no one dared underestimate the courage and strength of the Tangut people. Under the leadership of Yuan Hao, The Great State of White and Lofty shared the main land with the Liao and Song.</p>	<p>endless arrows onto the Song army under the cliff. At the bottom of the image, the Western Xia army deploys and launches an assault on the Song army. As the vehicle moves, the image shows a large number of well-equipped and armoured Tiejaozi heavy cavalry. The cavalry charge and the cavalry on opposite the cliff swoop down. In the end, the heavy cavalry approach the fierce Song army.</p>							
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	Stage description	Character aside	Animation content	Performance description	Interactive description	Lighting effect description	Scenery	Music and sound effect description	Key technology description	Expected time
Act 4	<p>After Li Yuan Hao became emperor, he ordered Yeli Renrong, the minister, to create Western Xia writing characters. In three years, there were more than 5,000 words. The structure imitated Chinese characters, which has its own unique place. The people of Western Xia have long used wooden movable type to print Buddhist texts. The use of printed movable type in Western Xia was almost at the same time as the book <i>Dream Pool</i></p>	<p>Although the Tangut people were well versed in war, peace and civilisation, which were the demands of the Great State of White and Lofty. After establishing the country, Yuan Hao and his chief minister, Yeli Renrong, drew inspiration from Chinese characters and created unique Western Xia characters for the Tangut people. To this day, we still see countless printed</p>	<p>Li Yuan Hao and Yeli Renrong's actors passionately discuss characters and sit beneath the stars.</p>	No	<p>The projection is shown on the top and sides of the visitors, and the animation begins with the stars. It transforms into Chinese characters, and the image of Chinese characters float in the sky. Splitting into Chinese character components, these sections turn into Tangut character components. If the visitors reach out, they will</p>	<p>Mainly with Pepper's ghost; there is no significant light source in the scene itself.</p>	<p>The four walls of the scene require mirrors to enhance the sense of space.</p>	<p>A combination of Chinese zither and violin.</p>	<p>Eight HD projectors, Pepper's ghost system.</p>	150 s

	Essays, which records typography.	books of Western Xia classics. The Tangut people were good at creating and learning, and it was because of their efforts that the Western Xia civilisation could be so unique and gorgeous.			find that the words can be touched and moved around.					
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	Stage description	Character aside	Animation content	Performance description	Interactive description	Lighting effect description	Scenery	Music and sound effect description	Key technology description	Expected time
Act 5	<p>Emperor Li Renxiao was the fifth emperor of the Western Xia dynasty. During his 54 years in office, he paid much attention to Confucianism and culture, which culminated in the prosperity of the Western Xia dynasty.</p> <p>Li Xiaoren's second empress, Luo, was the mother of Emperor Li Chunyou. With the arrival of Queen Luo, Renxiao, who had entered old age, regained his longing for life. During the last period of his life, Renxiao created Western Xia's last glory under the care of Queen Luo. After his death, Queen Luo, who had no political</p>	<p>After nearly 100 years of operation and development, it was not until the fifth emperor, Li Renxiao, that the power of the Great State of White and Lofty reached its full height. Renxiao was deeply loved by the Tangut people and advocated the Confucian ideology during his reign. He was first the emperor of the Tangut people who revered Confucius. The young and beautiful Queen Luo was the emperor's most cherished concubine in his later years. With their joint</p>	<p>In the image, Li Renxiao and Queen Luo are moving forward with their backs to the audience, and the landscape around them is constantly changing from the temple and the Buddhist pagoda to the magnificent Western Xia mountains (Helan Mountain, Yellow River).</p> <p>The figure of Li Renxiao gradually disappears, Queen Luo becomes the Queen Mother and the crown is more magnificent. But as she moves on, the sky gradually darkens, and the background is in the form of a silhouette during the palace coup. In the end, the treacherous Li Anquan ascends to</p>	No	No	The scene is designed to show the environment and sculptures, and it needs to have a sufficient light source.	<p>A statue of Confucius; a sculpture of Li Renxiao and Queen Luo; 10 sculptures of the royal children. The palace lamp, pen, ink, scroll and other related furnishings in the school hall. Simulated desert. The restoration of the Khara-Khoto Pagoda.</p>	<p>Guqin or guzheng, playing a quaint melody. The tone changes after Li Renxiao leaves, suggesting tension and a sense of crisis.</p>	One HD projector.	150 s

	<p>experience, listened to the slanders of his nephew, Li Anquan. She ruined her son's throne, and set up Li Anquan as the emperor. Li Anquan caused the political turmoil and diplomatic disaster in the late summer.</p>	<p>efforts, the rich Great State of White and Lofty translated many scrolls and built many pagoda temples, making Western Xia a Buddhist country that revered the dharma. After emperor Li Renxiao's death, Queen Luo became the Queen Mother of the Great State of White and Lofty. However, the Queen Luo, who lost her spiritual support, was unable to cope with her thoughts about the emperor. She made a series of irreparable mistakes.</p>	<p>the throne, and Queen Luo is alone in the middle of the desert. She enters a Buddhist pagoda and is plunged into darkness.</p>							
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	Stage description	Character aside	Animation content	Performance description	Interactive description	Lighting effect description	Scenery	Music and sound effect description	Key technology description	Expected time
Act 6	In 1227 AD, half of the Western Xia was occupied; Genghis Khan led hundreds of thousands of Mongols to besiege Xingqing Fu. The last emperor, Li Xian, resisted them. In order to save the city, the people of Xingqing Fu were determined to defend their country and civilisation with steel and blood. In the battle of Xingqing Fu, the army and people of Western Xia lost their lives, and after paying a heavy price,	In the last years of Western Xia, the Mongol army rising from the Mobei Plateau and led by Genghis Khan occupied half of the Great State of White and Lofty. In April 1227, Genghis Khan sent 400,000 troops and besieged Xingqing Fu again. Because of the commitment of the warriors of the Great State of White and Lofty, Xingqing Fu still stood. But when people celebrated the victory, a plague and an earthquake followed. You were witnesses to the Western Xia civilisation. Today, the glory	On the left side of the city: Officials and people in Xingqing Fu are actively moving supplies to the front lines. A giant catapult hurls a flaming stone into the city, the buildings turn into burning ruins and countless civilians collapsed. The right side of the city: the Mongol army is approaching, and the two armies compete on the wall. A battering ram held by dozens of people slams into the closed gates; The soldiers who climb the wall by ladder are	The actor, stood on the battlements of the high platform, faces the tourists, delivers inspiring speeches to the city. Shibi appears again. His spells have failed. After he experiences the demise of Western Xia, the old man is particularly sad, and he shows his last wish to the tourists.	The vehicle will moved several times during the journey to show more details of the attack and defence of Xingqing Fu.	The light illuminates Li Xian. As Li Xian begins to speak, it begins to spread throughout the scene. The light source in the scene is first centred on Shibi, and a certain amount of light source will be placed near the imperial tomb model in the rear. After the vehicle passes, the light on Shibi is gradually dimmed, and lighting on the imperial tomb is raised.	The surface of a damaged wall; A messy placement of materials; Scattered bricks and mud.	With a faint violin solo as the introduction, it transforms into a heavy brass ensemble, stirring the atmosphere of the last war. Use an impassioned brass band as a base. Add a human voice. With the progress of the war, one or two changes will be made to show the cruelty of war and the unshakable determination and conviction of the Tanguts.	Eight HD projectors.	230 s

	<p>they repelled the invincible Mongol army. A sudden earthquake destroyed the city. Then came a plague, which defeated the once-indestructible faith of the Tanguts.</p>	<p>of the Tanguts and the Great State of White and Lofty has been destroyed, leaving only Helan Mountain and the Western Xia Imperial Tomb. These valuable legacies are the last remnants of the Western Xia civilisation. The story is over, my friends, I hope the wheat sprouts green, the earth is full of the fragrance of flowers, the sword rusts, the peace is long.</p>	<p>swallowed by the flame of the fire-oil tank. On both sides: the walls are further damaged, countless soldiers are swallowed by collapsing bricks, the glorious Xingqing Fu is completely destroyed and the Mongol cavalry charge into the city.</p>							
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7.2.8. Discussion with the Cultural Institution that commissioned the project, and Endorsement of the Above

In January 2016, the NTU design team, Prof. Andrea Nanetti, Prof. Ben Alvin Shedd and Luo ShenShen traveled to Yinchuan to visit the Western Xia mausoleum protection zone, aiming to make a detailed report on the overall design and progress of the project for MWXIT. MWXIT has confirmed and positively evaluated our work (see Fig. 119, 120).



Figure 119 The NTU-ADM research team (from left: Andrea Nanetti, Luo ShenShen, Ben A. Shedd) in the Western Xia Imperial Tombs heritage site (15 January 2016). Photo by Ms. Ma Ming (Luo et al. 2018).

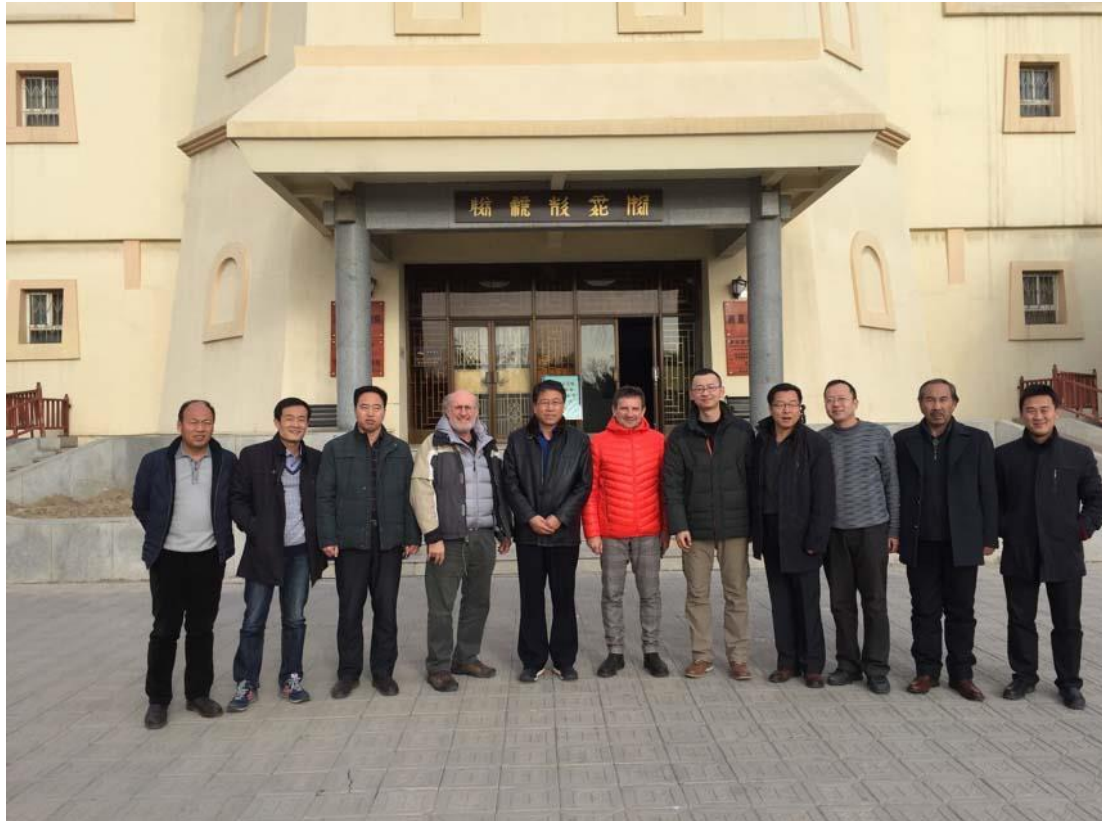


Figure 120 Research meeting with the staff of the Museum of the Western Xia Imperial Tombs (15 January 2016). Photo by Ms. Ma Ming (Luo et al., 2018).

7.2.9. Deliverables

7.2.9.1. *The storytelling*

Act 1: Migration of the Tanguts from the Qinghai- Tibet plateau to the southern banks of the Yellow River (before the 7th century CE) and the crossing of the Yellow River (post- 763 CE).

In the first scene, the visitors enter a winding passage, after which they will see *Shibi* under the spotlight and hear the origin story of the Tangut. Visions of the prairie, mountain and Loess Plateau are displayed, and a 10-metre screen is placed on the left, from which images of war between Tangut and the Tibetan Empire as well as of the Tanguts crossing the Yellow River are displayed.

Act 2: Foundation of the Capital City as Xing Zhou (1020, by Li Deming) and then Renamed Xingqing Fu (1038, by Yuanhao).

The visitors enter the second scene of the recreated Xingqing Fu. The gate opens to welcome the visitors and the sound effects are isolated at the same time. This scene is divided into three parts: (1) a 10-metre screen is placed at the right side of the passage; together with other decorations and stages, the visitors can see the prosperous Xingqing Fu; (2) the visitors will enter the simulated indoors, in which the suddenly warm temperature reminds them that this is the weapons workshop of Western Xia (Shi, 1986, pp. 162-165); (3) the visitors see how Yuan Hao proclaims himself emperor through the holographic screen.

Act 3: The Battle of Haoshuichuan (1041).

We identify the most representative war as the Haoshuichuan War. The third scene displays a fierce war. The visitors enter a dome whose diameter is 7 metres. They see the *Tieyaozi*⁷¹ crossing toward them from the rear. Then, the visitors see the cavalry going straight to Haoshuichuan, after which the vehicle rises and its front faces downward. Thus, the visitors should feel as though they are overlooking the battle from the mountain.

Act 4: The Origins of Tangut Script During the Reign of Yuanhao (1032-1048).

With the end of the last scene, the visitors enter the indoors formed by a Pepper's Ghost vision, which displays how Yuan Hao utilizes Chinese characters to create Western Xia characters. The Western Xia characters float in the air and mix with the stars, thus calming the visitors. Then, the visitors see how Western Xia applied movable type printing.

⁷¹ *Tieyaozi* is the cavalry established by Yuanhao in Song and Liao dynasty. As the cataphracts, the cavaliers are held together with the armours on the horses and equipped with thick armours, and they often contribute to breaking through infantry squares because of the extremely strong impact. The cavaliers will not fall down from their horses even when they have been killed. Therefore, the dead cavaliers can still hurt the enemies with their weapons fixed on the armours when the horses are running (Tuo 1990a, 220).

Act 5: Flourishing of Confucianism and Buddhism During the Reign of Renxiao (1139-1193).

In this scene, the visitors see not only the love story between Emperor Renxiao and his imperial concubine, but also the elegant and attractive Buddhist treasures in the Khara-Khoto pagoda through the screen on the left.

Act 6: Destruction of Western Xia (1227).

For the last scene, the vehicle travels among eight giant screens, the width of each being 10 metres. With the defence forces of Western Xia displayed on the left and the siege scene of Mongol troops commanded by Genghis Khan shown on the right, we hope that the visitors will feel that they are running on the giant walls of Xingqing Fu. The vehicle shakes with the surround sound, and the visitors will see how the Mongol troops invaded Xingqing Fu. Before completion, *Shibi* appears again with the panorama of the Western Xia Imperial Tombs behind him.

B. Overall Environment painting (rendering) and CAD

In the first act, the whole stage is green, and following the spotlight on the left of the image, *Shibi* can be seen. The image is located on the left of the vehicle, and there many stage props (e.g., sculptures of cattle and sheeps) among the images and visitors (see Fig. 121).



Figure 121 Environmental design of the Tibetan plateau. Design by Luo ShenShen, Drawing by Chong Li, 2016 (Luo et al., 2018).

In the second half of the first act, the whole stage is golden yellow. Visitors will see the giant screen on the right. Similarly, there are many models of boats and sheepskin rafts, which were used to cross the Yellow River, between the screen and vehicle (see Fig. 122).



Figure 122 Environmental design of the Yellow River crossing. Design by Luo ShenShen, Drawing by Chong Li, 2016.

At the beginning of the second act, visitors enter the simulated Xingqing Fu. Visitors ride in the vehicle, and the gate of Xingqing Fu will open. The simulated fires on both sides of the door will also be lit (see Fig.123).



Figure 123 Entering Xingqing Fu. Design by Luo ShenShen, Drawing by Fujian Luo, 2016 (Luo et al., 2018).

After entering the gate, visitors see downtown Xingqing Fu. According to the drawing, a giant screen is used on the left, and the stage is set on the right. The overall atmosphere adopts the light yellow in the early morning sun, symbolizing the prosperity of the Western Xia regime. Visitors are arranged between the screen and stage, so they can observe both sides (see Fig. 124).



Figure 124 Environmental design of Xingqing Fu. Design by Luo ShenShen, Drawing by Fujian Luo, 2016 (Luo et al., 2018).

In the third act, purple is the main colour to exaggerate the atmosphere of war.

Visitors are located at the centre of the dome (see Fig. 125).



Figure 125 Environmental design of the Haoshuichuan war in the dome. Design by Luo ShenShen, Drawing by Chong Li, 2016.

In the second half of the third act, visitors are arranged at the upper right side in the vehicle, so they can overlook the fight scene on the screen (see Fig. 126).



Figure 126 Environmental design of the Haoshuichuan War. Design by Luo ShenShen, Drawing by Pao, 2016 (Luo et al., 2018).

After entering the fourth act, we adopt the interactive design of Pepper's ghost. Visitors on the right side can use their fingers to command the Western Xia characters in the air. Meanwhile, Yuan Hao and his ministers create Western Xia characters on the left (see Fig.127).



Figure 127 Environmental design of the birth of Tangut script. Design by Luo ShenShen, Drawing by Pao, 2016 (Luo et al., 2018).

In the second half of the fourth act, our design centres on the stage set. Visitors enter the scene from the right, and they see the sculptures used to show Western Xia movable type printing (see Fig. 128).



Figure 128 Environmental design of movable type printing. Design by Luo ShenShen, Drawing by Fujian Luo, 2016.

In the fifth act, we select the dark tone for the decline of Western Xia. According to the drawing, two vehicles gather to collectively watch the last act on the left-side screen: the love story of Emperor Renxiao and his imperial concubine and his concubine's banishment to the pagoda in Khara-Khoto after her death (see Fig. 129).



Figure 129 Environmental design of Renxiao and his concubine. Design by Luo ShenShen, Drawing by Sanli Hou, 2016.

The last act shows the war between Mongolia and Western Xia. The whole stage is designed in bright red. Visitors are above the city wall, and the stereoscopic images on both sides show the war participants. The city wall is also designed with movable sculptures to reinforce the war scene (see Fig. 130).



Figure 130 Carriage running along the wall. Design by Luo ShenShen, Drawing by Chong Li, Fujian Luo, 2016.

In the next drawing, the top-down view is used. The city wall, visitors and scenes on both sides are described in a large-scale space (see Fig. 131).



Figure 131 Environmental design of the destruction of the Western Xia. Design by Luo ShenShen, Drawing by Fujian Luo, 2016 (Luo et al., 2018).

At the end of the viewing, blue is the main colour in the picture, so as to calm down visitors. Meanwhile, Shibi fantastically disappears under the spotlight. Visitors then see the Western Xia mausoleum on the screen in the distance (see Fig. 132).



Figure 132 Shibi and the Western Xia Mausoleum. Design by Luo ShenShen, Drawing by Chong Li, Fujian Luo, 2016 (Luo et al., 2018).

7.2.9.2. Overall environment painting (rendering) and CAD

In Figure 133, the design team has spliced the concept design drawings of all scenes (including the entrance hall, the six main acts and the exit hall). The drawing on the left shows the devices and stage settings needed for each act. The specific quantity of vehicles and their optimal spacing distance are also included based on calculations. The CAD drawing on the right shows the actual scene size and space. It is worth emphasising that we have designed an S-shaped curve at the beginning of the passage to increase the experience time, to avoid mutual interference between the front and back vehicles and to use the extra space to increase fire safety with regard to escape routes and the device storage room.

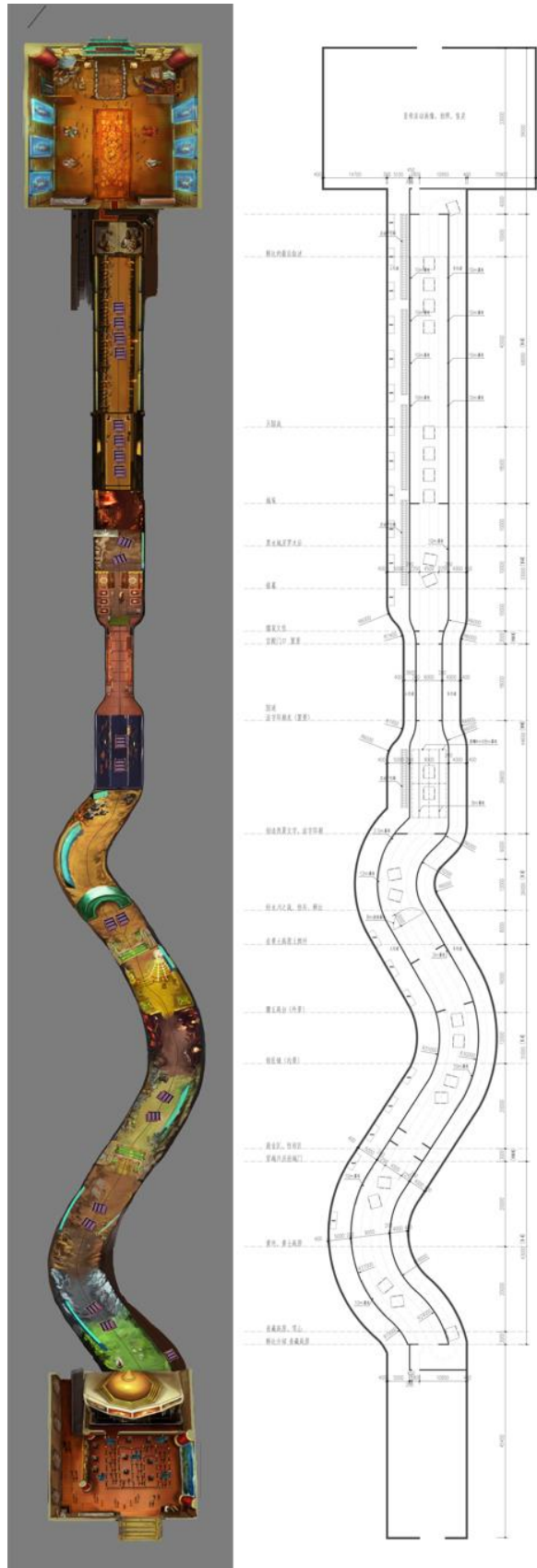


Figure 133 Conceptual design map of *The Western Xia Space-time Corridor*. Image by Luo ShenShen, 2016 (Luo et al., 2018).

7.2.9.3. 3D Walkthrough animation for project

We have submitted a demo (duration: 6 min and 30 s) in which the following contents are recorded: (1) how visitors can ride the vehicle to take the tour; (2) the content displayed by the animated installations; and (3) the technological means used in each act (see Fig. 134).

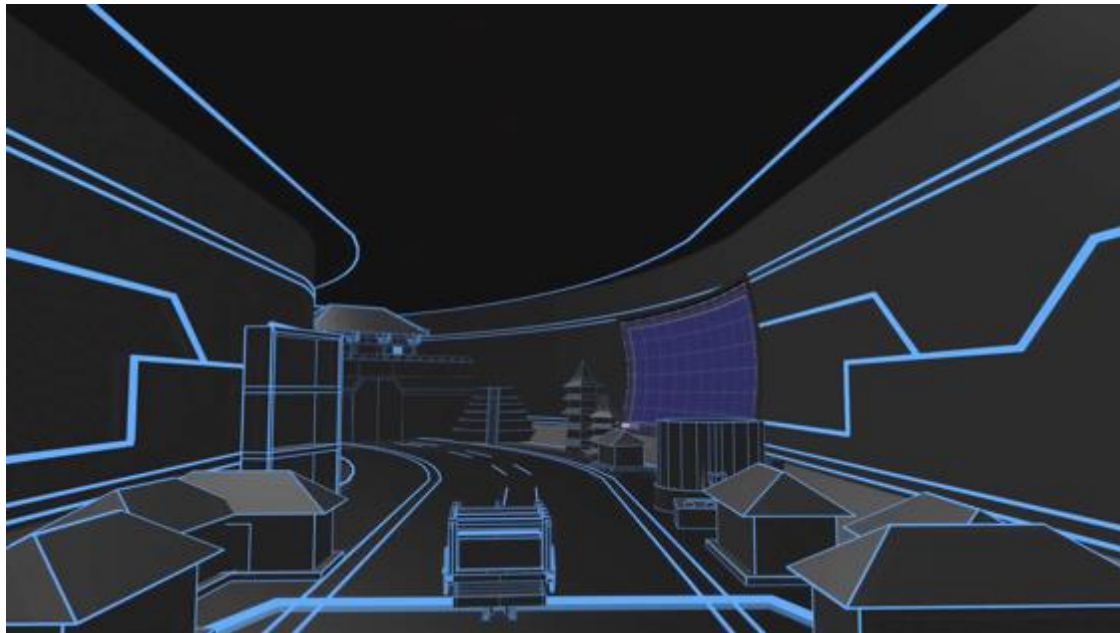


Figure 134 Demo animation screenshot. Image by Luo ShenShen, 2016.

7.2.9.4. Project Model

The author has produced a 1:50 scale passage model to give MWXIT a more intuitive impression. The model is first made with mud with hand. After moulding, resin material is used for partial duplication. The total length of the model is 5.14 metres (see Fig. 135, 136).



Figure 135 The author making the scale model. Photo by Yan Jiang, 2016 (Luo et al., 2018).



Figure 136 Workers making resin casts. Photo by Luo ShenShen, 2016.

8. Conclusions: Animated Installations to Enhance the Experiences of Cultural Heritage in Immersive Spaces in China

8.1. Use Animated Installations to Create Immersive Spaces

As observed in Sections 2 to 5, the combination of animations and installations creates spaces with both three-dimensional objects and two-dimensional images. Since the *Phantasmagoria* was created by Etienne-Gaspard Robertson in 1798, the attempt to combine animation and installation art has never stopped. With the industrialization of animation, the application of animated installations in business and academic fields has deepened, thus forming the definition and research scope for this thesis.

This research goal to develop design rules for creating cultural heritage stories applicable to 3D space, and animated installations becomes the material medium of this research. The scope of this research is limited to a device for art with the property of 3D space expressed in animations or images as well as related sensory experiences.

Immersive space is a kind of closed artificial space in pursuit of a virtual world. Various means to create immersive experiences have been made since ancient times. From cave wall paintings to grotto frescoes to virtual reality and augmented reality technology, "immersive space" involves numerous fields. William Sherman, Alan B. Craig and Oliver Grau define "immersive" as a virtual surrounding environment that can completely alter reality. Such a virtual environment can fuse

the observer and the image, thus affecting the observer's senses and consciousness.

Authors have found that the creation of immersive spaces requires different steps. It is the process by which sensory experience gradually transitions towards final mental immersion. Three cognitive steps are involved: 1) the complete immersion of sense experiences; 2) narrative immersion related to understanding and memory (such as the unique Chinese storytelling system); and 3) the interactive experience with regard to flow theory. The animated installation, as the tool involved in the process, has played a significant role in promoting and creating immersive experiences.

The author posits that immersive space is applicable in both the virtual and physical world. However, the following conditions must be met: (1) there shall be a relatively independent, hermetically artificial space and (2) the space can provide the user with a dynamic process involving perception and narrative experiences.

The giant screen, panorama screen, dome theatre and head-mounted displays (HMD) systems are devices using animation to present immersive spaces. When they are combined with real spaces, the so-called hybrid immersive space is created.

After the film projector appeared, panorama and projector were combined to create a new form of projection panorama. This kind of immersive display mode, which blends the photography, animation and panorama art, is still used today. In expanding the panorama, projection mapping, dome theatres, Pepper's ghost illusions and CAVE displays are man-made tools for creating immersive

experiences. With scientific and computational progress, they have begun to be used in theme parks and museums.

With the popularity of diminutive devices and GPS technology, an increasing number of augmented reality (AR) technologies are used for travel, tours and other practices that are based on hand held displays. It is foreseeable that such technologies will broaden digital immersive space and become a major representation of Scott Lukas's *lifespace* theory.

Research on auditory immersion and immersion in other sensory systems is obviously behind that of vision. However, as there is a need for overall immersive experiences, immersive research on other sensory systems will receive more attention.

Relying on the sensory illusions, artists and designers have created narrative texts or performances that give audiences joyful mental states and immersive experiences. The process of obtaining such a mental state and an immersive experience is called aesthetic illusion. Aesthetic illusion and immersive experience are fully reflected in the design of Chinese private gardens.

Interactive storytelling (IS) is a narrative method that combines modern media and interactive technologies. Being superior to the traditional narrative method, Interactive storytelling can provide readers/players with an opportunity to influence the story. Interactive storytelling reflects a dynamic and nonlinear structure in accordance with audiences' independent choices. Stephen E. Dinehart note that the concept of interactive storytelling can be traced back to Wagner.

Meanwhile, narrator, narratee and point of view vary in IS and new narrative modes. In the traditional narrative mode, the narrator and narratee are mutually contradictory, meaning they are respectively responsible for releasing and

receiving information. While in interactive storytelling, the narrator becomes the narratee. Users no longer act as onlookers, but as active narrators to create stories. Altug Isigan's notes that (game) designers should design from the perceptual point-of-view, ideological point-of-view and point-of-view of interest so as to better attract users and help them have an immersive experience.

The traditional Chinese visual storytelling still follows *Tso Chuan's* principles. The character in different times and spaces is integrated into a unified image for presentation. Meanwhile, a special visual reference is used to guide audiences' vision. In this regard, traditional Chinese visual narrative helps the audience obtain an immersive experience through its unique visual expression.

For the manipulation step, flow theory is a corresponding explanation. When designing an interactive immersive space, understanding people's behaviour and mental activity in the cognitive process is particularly important for enhancing the interactive experience. According to flow theory, a positive attitude will help people to enter flow. Therefore, we must understand how to create a positive environment for users in space design to help users enter the flow state.

The author argues that flow theory can be added to the interactive design of immersive spaces as a guiding design index, thus blending the task challenge in manipulation, navigation and communication and better triggering users' positive mental attitudes to enter a flow state and go deeper into a state of immersion.

For different environments and needs, we must select different immersive devices during the design process. For special situations, some modifications are also required. The author proposes that the relationship among space, stage and perception (or space, content, exhibition mode and users' viewing angle) should be specified first. Different immersive devices should be selected according to

these different challenges. Furthermore, in modern commercial society, this mode is often used in dark rides to form a unified, narrative, immersive space in theme parks.

For the application of cultural heritage, the author agrees with Staiff's theory of "heritage iconography", which indicates that a fixed impression of cultural heritage has been formed by the influence of mass media. Therefore, people constantly compare real heritage with the stories, signs, symbols, and rituals in our minds. Based on this, the author argues that understanding the storytelling and symbolic images of cultural heritage is a key to establishing an authentic cultural heritage protection project.

Virtual heritage has been widely used in academic research. For virtual heritage, it is important is to understand Alonzo C Addison and Nazrita Ibrahim's discussion of documentation, representation, and dissemination (see page 206). Researchers use animation, interactive devices and even VR technology to reconstruct or recreate cultural relics, immersing users in the virtual environment to share the meaning and knowledge of cultural heritage, thus pointing to the method for creating a meaningful virtual heritage. Based on these studies and conclusions, the author has summarised the process of the immersive experience in real and virtual environments as Perception–Memory and Association–Manipulation. This is a gradually deepening immersive experience process.

8.2. Immersive Cultural Heritage Spaces: Design for *Lifespace* in China

8.2.1. Immersive Cultural Heritage Spaces in China

In Section 6, due to market expansions and audiences' needs, more places are beginning to apply animated installations in their designs. Audiences are interested in experiential visiting modes. Because of this, the concept of *lifespace* has been added to the design of modern immersive experiences. According to Scott Lukas, *lifespace* is a design concept that combines new media and cognitive science. It advocates using mobile devices and other media to connect users to the exhibition space in real time in order to fully understand and experience the exhibition. This design concept can be applied not only to entertainment (e.g., theme parks) but also to academia (e.g., education and research).

Based on Lukas and other scholars' conclusions on immersion space studies, the author has determined three components that are equally applicable to immersive space design and immersive space experience. Because of these three components, users can transition from perception to narrative elements and generate the desire to interact, thus completing the process of deep immersion. The designer shall start with the theme and script design based on narrative elements, after which the design shall be made visually accessible. Then, the interactive design can be added to further attract visitors. However, the whole design process is not a linear unilateral circulation experienced by visitors, but a directional repeated bilateral circulation.

8.2.2. Implanted Cultural Heritage in Chinese Immersive Space

Design

Although contemporary theme parks and museums are getting closer in terms of representation modes, they are designed with different intentions. Theme parks only focus on entertainment and business principles, while museums centre on authenticity as educational institutions. For theme parks, cultural heritage is turned into symbols and added to the entertainment experience. For museums, cultural heritage is the core content; thus, more attention is paid to discussions and studies in adopting an attitude of exploration and research.

For immersive spaces centering on cultural heritage, there are two trends in visual design: realistic restoration and non-realistic restoration. The former insists on 3D reconstruction in accordance with the schematic and perspective ratios in the real world, and the latter focuses on the original structure and principles of historical archaeology and using artistic creativity to focus the expression of cultural heritage. However, both rely on the Staiff's "heritage iconography" principle of extracting the most representative visual or cultural symbols for restoration and use.

Starting from this point, the author concentrates on how to research, extract and use cultural heritage symbols. Therefore, the case of *The Theme Park of ORIENTAL IMPERIAL VALLEY* is selected as an example to analyse the content development process, including the initial questionnaire survey, comparison of known cultural symbols and the final determination.

After determining the cultural symbols, more emphasis should be put on how to use such symbols to make a re-creation. Taking *Find Serica* as an example, the

author suggests using the historical record as a blueprint and rearranging the historical space and time in accordance with narrative laws, thus creating a complete narrative combining cultural heritage and clues in a different space and time.

An important challenge arising from this is how to ensure historical accuracy without breaking the integrity of narrative. Today, many historical movies put more emphasis on visual effects and narrative integrity than on historical accuracy. Similarly, it is a challenge to balance visual effects, narrative fluency and historical accuracy when designing an immersive space. Therefore, the author suggests that priority be given to story integrity instead of historical accuracy when designing a theme park and historical accuracy be given priority when designing a museum. Sensory effects should be emphasised on the condition that the story integrity is maintained to the greatest possible extent.

After discussing the narrative and theme, the author explains how to design an immersive space centring on interactive experience. As a popular interactive narrative method, interactive storytelling has been widely used in the field of cultural heritage. Therefore, based on the virtual exploration project *Han Chu* and Hunan Provincial Museum, the author analysed the current interactive narrative designs of contemporary cultural heritage in China. The author also analysed the design points of interactive narrative with the combination of "nodes" theory proposed by Maria Teresa Linaza, in which the designer tries to provide the nodes and rationalise the structure among them.

When talking about designs that use immersive devices to represent the connotation of cultural heritage, the authors uses the *Silk Road* animation as an example to explain the differences among user experiences with different

immersive devices. The conclusion is that the designer should make corresponding adjustments and amendments to the original images for different display media. For the virtual interactive system, the author analysed the large-scale interactive device at Wu Kingdom Helv Relic Museum. The author concludes that the appropriate interactive experience provided to users in an immersive space can arouse their curiosity and give them a greater opportunity to be educated by or participate in the project.

8.3. A New Method Using Cultural Heritage to Design

Immersive Spaces Using Animated Installations

8.3.1. A Concept Design Process

In Section 7, before proposing the new process to design a cultural heritage immersive space with animated installations as the carrier, the author first reviews the discussion about the historical design process of immersion space. According to these discussions, Alex McDowell divides the process into design and production. For design, he states that the designer shall start from the script, and the resulting story design shall turn through the whole process. He advocates that the stage, character and prop designs should be integrated at the same level during the design process to create a mutual influence among them.

On the other hand, Michael Daut, a designer of dome immersion spaces, thinks that immersive space design is a dynamic, organic process rather than a linear one.

Based on the above immersive space design processes and numerous cases, the author proposes a new design concept of Chinese cultural heritage immersive space to include using the virtual to simulate reality; using two-dimensional

images to present multidimensional ideas; using sensory experience to inspire mentality; and using interactivity to enhance immersion. Meanwhile, the author also puts forth a practicable concept design process of how to use the animated installation to create an immersive space centring on Chinese cultural heritage. The overall design process can be divided into three periods. In the first period: (1) the investigation shall be made, and the data shall be collected; (2) the commercial agreement shall be signed; and (3) the team shall be established. In the second period, the following matters shall be completed: (1) extracting culture symbols; (2) writing the script; (3) drawing the effect picture; and (4) flow planning and selecting a device. In the last period, (1) the design drawing shall be completed; (2) the blueprint shall be drawn; and (3) the demo animation and model shall be made. The author leading the NTU design team has verified the above concept design process in the practical project.

8.3.2. Concept Design Process of Western Xia Imperial Tombs

Project as a Test

For cultural heritage experience projects, the design team needs to take numerous factors into consideration, including the authenticity, integrity of experience as well as business and operating costs. For museum experience projects, the design team should also consider the challenge of appropriate investment and operating costs when considering the design parameters. The realisation of a complete design must balance different interests with cultural authenticity at the forefront. The practical component of this thesis, through NTU, is on animated installations and other creative solutions that could be developed to have a comprehensive and culturally aware experience in the Western Xia Imperial Tombs Complex, as

documented by the artefacts excavated from the Western Xia archaeological site. The team designed an experience venue planned mainly with the rising, flourishing, wars and disappearance of the Western Xia dynasty as the theme. We recreated the Western Xia dynasty through image and environment.

It took four months to develop the animated installation. Under the condition of reusing Western Xia cultural heritage symbols and historical stories, the design team tries to utilize the new display technology and immersive experience theory to show a visual cultural heritage through dynamic narration and appropriate storytelling within an animated installation. In this project, we have complied with the background research and analysis, symbol extraction, arrangement of narrative structure, visual effect and experience as well as the technical support to visualise the Chinese cultural heritage, among which the symbol choices and arrangement of narrative structure within the Tso Chuan principles were top priorities.

Our team has revised and tested the concept design process of immersive space, and this design process of animated installation and cultural heritage content, which has been proven to be standard and feasible, will save considerable time and capital for similar design projects in the future.

8.4. *Lifespace* is Our Goal

The research goal is to design a physical and digital space that influences people's minds through their sense organs, relationships and the space they are in.

In this study, the author has focused on the digital representation of Chinese cultural heritage. Therefore, the author has attempted to establish a people-centred immersive experience design system using various representation

methods. This design concept, which focuses on Scott Lukas's *Lifespace*, has combined human consciousness and the exhibition space.

There is a continuous renewal of technical means in the modern exhibition space, and all technical means (e.g., dome, IMAX, HMD, CAVE, dark ride) have brought new narrative methods and information communication modes. However, as greater sensory satisfaction and information access can be ensured, have we reached a crossroads at which the communication mode between humans and the world is changing? Such a change will no longer limit our perceptions of space and time. Through technology, we can truly perceive the lives of different people in different spaces and time, and we can even communicate or share experiences with them. This method far exceeds the current VR representation method. If cultural heritage experiences can be developed based on this method, a bridge connecting the past and present will be built, thus bringing cultural heritage into contemporary life.

Human imagination continues to push the boundaries of cognition, and technical development never stops satisfying our ever-growing desire for immersive experiences. When we are completely immersed in virtual worlds, some questions emerge: How can we connect the virtual world and the real world? How can we habituate to the real world after we exit a virtual status? If we extend this question, would real objects of cultural heritage be needed if the world were filled with virtual cultural heritage? With these questions the author concludes his dissertation and opens the field for future work and research.

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