Digital Traumatic Memory:

The Reflection on Digitization in the Contemporary Memorial Museum

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Content

1 Introduction

1.1 Motivation

Our world is shaped by digital technologies. Since the first commercially available computer was released in 1951, a digital revolution was started across contexts - exposing new ways to connect disparate fields.[1] Digital geographers Sarah Elwood and Katharyne Mitchell concluded that digital approaches inevitably change ways of knowing, remembering, and communicating across space, time, and collective memory.[2] When it comes to trauma-related museums, the rise of digital initiatives allowed the public to access traumatic collective memory beyond space and time limits. Moreover, by the beginning of 2020, with worldwide lockdown measures under the Covid-19 pandemic, digital developments have become a new impulse. To deal with new challenges, some museums started providing online virtual tours via web conferencing software to the public who cannot visit museums physically.[3] The study of the impact of digital media on memorial museums helps to grasp trends in museums' digitization and explore the possibilities of memorial museums' development in an interdisciplinary way.

1.2 Significant Studies

Memory study has been a well-researched field since the early twentieth century. Since the term "collective memory" was first proposed by the French sociologist Maurice Halbwachs in 1925, memory studies have focused not only on physiology and neurology but also on sociology and history.[4] In the1990s, with the popularity of digital media such as the internet and mobile phone applications, cultural memory became easier to be manipulated by the media, which led to a heated debate in the field of memory study.[5] Digital development of memory-work is supported by some scholars who argue that digital possibilities enrich the field and can be highly useful.[6] On the contrary, others retain a sensitive and cautious attitude. For example, Andrew Hoskins, a scholar in media and collective memory, argues that digital memory is an electronically mediated and manipulated phenomenon. Therefore it is "increasingly contested" by the public.[7] These opposite views and discussions have aroused concern about properly displaying history in trauma-related museums under the digital era.

Memorial museum is a new form of memorial architecture that emerged in the 1980s with the digital revolution and the "memory boom".[8] Digital strategies contribute to memorial museums with efficient and expressive approaches. Several studies have concluded that the impact of digitization on cultural heritage management is mainly reflected in data management, replication, simulation, and virtual experience.[9] However, museums' digitization is not always without problems, especially when it comes to memorial

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[1] For example, the connection between robotics and arts, wearable computing devices and perceptual sciences. See Michael Fox and Miles Kemp, *Interactive Architecture* (New York: Princeton Architectural Press, 2009), 7.

[2] Sarah Elwood and Katharyne Mitchell, "Technology, Memory, and Collective Knowing," *cultural geographies* 22, no. 1 (2015/01/01 2014): 147-54, 47. https://doi.org/10.1177/1474474014556062.

[3] For example, the National September 11 Memorial and Museum provides virtual tours via zoom meeting. See "Virtual Tours | National September 11 Memorial & Museum," 911Memorial.Org, 2020, accessed April 9, 2021, https://www.911memorial.org/visit/virtual-tours.

[4] Maurice Halbwachs, *La MéMoire Collective* (Paris: A. Michel, 1997). See also Henry L. Roediger and James V. Wertsch, "Creating a New Discipline of Memory Studies," *Memory Studies* 1, no. 1 (2008/01/01 2008). https://doi.org/10.1177/1750698007083884.

[5] Digital media is a term to describe media that are encoded in machine-readable formats. For more about digital media and memory study, see Motti Neiger, Eyal Zandberg, and Oren Meyers, *On Media Memory: Collective Memory in a New Media Age* (2011).

[6] Alice Bell, "Memory in the Digital Age," The Guardian, 2012, accessed April 4, 2021, https://www.theguardian.com/lifeandstyle/2012/jan/14/memories-in-the-digital-age.

[7] Andrew Hoskins, "New Memory: Mediating History," *Historical Journal of Film* Radio and Television (10/01 2001): 333-46,34. https://doi.org/10.1080/01439680120075473.

[8] The "memory boom" refers to the social and academic interest in the prominence and significance of memory study from the mid-twentieth century. More about the "memory boom" see Jay Winter, "Notes on the Memory Boom," in *Memory, Trauma and World Politics* (London: Palgrave Macmillan, 2006).

[9] Ezra Zubrow, "Digital Archaeology: A Historical Context," in *Digital Archaeology. Bridging Method and Theory* (London: Routledge, 2006), 8-26,9. See also J. John Lennon and Malcolm Foley, "Interpretation of the Unimaginable: The U.S. Holocaust Memorial Museum, Washington, D.C., and "Dark Tourism"," *Journal of Travel Research* 38, no. 1 (1999/08/01 1999): 46-50,47. https://doi.org/10.1177/004728759903800110.

museums. Jewish studies scholar Oren Baruch Stier, when visiting the Beit Hashoah Museum of Tolerance (MOT), pointed out that digital technologies erase the existence of the past and marginalize authentic historical items. Moreover, Stier argued that digital media confuses visitors' identities by inviting them to imagine themselves as victims from the past.

Another heated discussion occurs at the National September 11 Memorial and Museum.[10] Although some scholars believe that these digital approaches resonate with visitors from global cultural backgrounds, controversies arose from both sociological and psychological aspects. For the sociological part, Journalist Christine Sisto's criticism focuses on the neglect and disrespect for the deaths caused by digitization.[11] For the psychological aspect, psychologist Billie Pivnick and disaster psychologist Grady Bray warns that playing recordings of survivors and victims in the exhibition hall could traumatize listeners.[12] In any event, there are advantages to digitization because of the rising number of visitors, which indicates it attracts more and more public interest.[13] Notwithstanding, all the above critics underline that commemorative culture requires more sensitive approaches when corresponding to digitization, and the boundary between physical and digital should be placed.

1.3 Research goals

Against these backgrounds, this article aims to investigate the role of digital media technologies in contemporary trauma-related museums - especially memorial museums. The objective is to critically reflect on the digitization of traumatic memory and explore the boundary between physical articles and digital artefact. Moreover, this study hopes to raise key issues for media scholars more broadly in terms of developing critical practice concerning new technologies, as well as for historians, museum and memorial curators.

1.4 Methodology

To achieve the above aims, an overview on the notion of digital memory, especially the traumatic memory, first provides insight into the theoretical framework, and the paper then continues by referring to the digitization of contemporary memorial museums in order to give a closer understanding; after that, a case study of the National September 11 Memorial and Museum is going to examine the theoretical background; finally, the paper concludes with boundary and potential of digitization in trauma-related museums. For the theoretical framework, I am going to look at the information in journals, newspaper articles, books and archives. For the case study, I considered the combination of theoretical approaches and virtual visiting.

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[10] The National September 11 Memorial and Museum tells the story of the 9/11 terrorist attack through multimedia displays and monumental artefacts. See Karissa Rosenfield, "National September 11 Memorial Museum/ Davis Brody Bond," 2012, accessed March 17, 2021, https://www.archdaily.com/272338/national-september-11-memorial-museum-davis-brody-bond.
[11] Christine Sisto, "Why the 9/11 Museum Failed | National Review," Nationalreview.Com, 2014, accessed April 9, 2021, https://www.nationalreview.com/2014/05/why-911-museum-failed-christine-sisto/.
[12] Cliff Kuang, "The near-Impossible Challenge of Designing the 9/11 Museum," Wired, 2014, accessed April 9, 2021, https://www.wired.com/2014/05/911-museum-3/.
[13] Jukka Ekholm, "Popularity of Museums Rising All over the World," Statistics Finland, 2016, accessed March 18, 2021, https://www.stat.fi/uutinen/popularity-of-museums-rising-all-over-the-world.

2 Digital Traumatic Memory

2.1 Memory: from individual, collective to cultural

The term "collective memory", which describes memory can be constructed, transmitted, and passed on by social communities, was first proposed by Halbwachs in his book *La mémoire collective (1925)*.[14] Most studies took Halbwachs's work as their primary theoretical reference point and developed it further from various angles.[15] The first controversial area of memory study is the relationship between individual and collective memory. Cognitive neuroscientist Yadin Dudai considers memory as the experience-independent internal representation that can be reserved and reconstructed by human brains.[16] However, our ability to reconstruct and reshape individual experiences of the past cannot be isolated from the perception which we have gained from more comprehensive social surroundings. According to this idea that individual memory reconstructs past experiences based on social frameworks, Halbwachs suggested that individual memory is socially determined and rejected separating individual memory from its social context. Scholar Paul Connerton explains Halbwachs's anti-individual intention in the book *How Societies Remember* (1989), arguing that individual memory is a meaningless abstract concept when it is absolutely independent from society.[17] From this perspective, personal remembering is an activity that relies on its context. It is socially situated and closely meshed with the social environment.

Reflecting on Halbwachs's research, German historian Wulf Kansteiner argues that although individual memory cannot be discussed without social context, the collection of individual memory does not mean collective memory.[18] Here, the difference between "collected memory" and "collective memory" should be clarified. For Kansteiner, the collected memory is only an individual memories' collection, while collective memories have their own dynamics.[19] This idea was consistent with Sociologist Michael Schudson who mentioned that: "Once (collective) commemoration gets underway, it operates by a logic and force of its own."[20] That means the members of social groups are not able to direct the recreation of collective memory. It can only be reconstructed within constraints of historical social commemoration. Therefore, if the study is exclusively based on emotional situations of individual remembering while overlooking the social context of individual memory and the inner dynamics of collective memory, it will lead to a bias in study results.

However, drawing a sharp distinction between individual and collective memory is also a mistake. It marginalizes individual memory's contribution to the construction of collective memory and misrepresents the formation of collective memory. In this context, historian and archaeologist Jan Assmann first came up with the term "communicative memory" and "cultural memory" in his 1988 essay "Collective Memory and Cultural Identity".[21] From his perspective, the communicative memory is constructed by an individual's daily communication about the past events of a certain period (usually eighty to one hundred years).[22] For cultural

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[14] Maurice Halbwachs (1877-1945) was a French philosopher and sociologist known for his study on collective memory. See also Halbwachs.

[15] For example, American physicist James E. Young has introduced the term "collected memory" to explain memory's inherently fragmented, collected and individual character. See James E. Young, *The Texture of Memory: Holocaust Memorials and Meaning* (Yale University Press, 1994). Besides, historian Guy Beiner has criticized the unreflective use of the adjective "collective" in memory study, see Guy Beiner, "Troubles with Remembering; or, the Seven Sins of Memory Studies," *Dublin Review of Books* (11/01 2017).

[16] Yadin Dudai, "Memory: It's All About Representation," in *Science of Memory: Concepts* (New York: Oxford University Press, 2007), 13-16.

[17] Paul Connerton, *How Societies Remember*, Themes in the Social Sciences (Cambridge: Cambridge University Press, 1989), 37.

[18] Professor Wulf Kansteiner is a cultural-intellectual historian of 20th century Europe and focuses on the representation and collective memory of World War II and the Holocaust in Germany. For her research on memory study, see: Wulf Kansteiner, "Finding Meaning in Memory: A Methodological Critique of Collective Memory Studies," *History and Theory* 41, no. 2 (2002): 187.; More about the difference between "collected memory" and "collective memory" see also Jennifer L. Geddes, "An Interview with James E. Young," *The Hedgehog Review* 2007, 68+.

[19] Kansteiner, 185.

[20] Michael Schudson, "Dynamic of Distortion in Collective Memory," *Memory Distortion: How Minds, Brains, and Societies Reconstruct the Past* (1997): 346-64.

[21] Jan Assmann and John Czaplicka, "Collective Memory and Cultural Identity," *New German Critique*, no. 65 (1995): 125. https://doi.org/10.2307/488538.

[22] Kansteiner, 183.

memory, it consists of objective culture to look back at the fateful events in collective history. Assmann's finding shows that an individual's daily communications can only form unstable and disorganized collective memory within a specific time span. Suppose we want to explore collective memory that can be passed down steadily and continuously over generations. In that case, we should put it under the cultural scheme because that makes memory comprehensible and meaningful through different social groups.

In conclusion, collective memory organizes individual memories and establishes a common cognitive model that integrates people's memories across time and space under a cultural scheme. Since memory is a prerequisite for the narrative construction of our identities, the study of collective memory is an essential part of collective identity. Each individual tries to locate his or her identity in society through collective memory.

2.2 Traumatic memory and media

French historian Pierre Nora, one of the fathers of the memory study among historians, made a cryptic remark: "Whoever says memory, says Shoah."[23] By saying this, Nora pointed out the closed relationship between memory study and trauma of the Holocaust. It is necessary to introduce cultural trauma into collective memory study because traumatic events play an essential role in constructing collective memory and identity. They strongly disrupt the process of memory construction and shake our definition of self-identity in society. Similarly, sociologist Jeffrey Alexander believes that cultural trauma is closely connected with the collective identity. He argues that cultural trauma leaves an indelible mark on the group's consciousness, changing the future identity of the collective in a fundamental and unchangeable way.[24]

In an attempt to define cultural trauma, American sociologist Neil Smelser discussed the difference between (individual) psychological trauma and cultural trauma.[25] An essential difference between psychological and cultural trauma is that cultural trauma is produced instead of congenital. Similarly, Alexander believed that cultural trauma is not a collective experience of suffering. For him, it is "the result of this acute discomfort entering into the core of the collectivity's sense of its own identity."[26] By saying this, he argued that cultural trauma was different from individual psychological trauma. According to Smelser and Alexander, cultural trauma usually implies an abstract and intermediary concept of collective identity.

The construction of cultural trauma can be considered as a process of socializing traumatic memories. In this process, members who have not been directed exposed to a traumatic event show their sympathy for the sufferers. When the spectators identify their emotional engagement with the survivors in terms of sympathy, cultural trauma occurs at the social level instead of only at the individual survivor's psychological injury. For example, people who did not experience the 9/11 terrorist attack heard about the trauma event from the news media and made their own trip to New York World Trade Center or U.S. embassies to pay their respect and sympathy to survivors and victims. On September 13, 2001, the U.S. authority proclaimed September 14 as a National Day in memory of the 9/11 terrorist attack victims, which illustrated this attack became a cultural trauma event in America.[27]

The process of cultural trauma's construction can be related to the construction of collective memory. For sociologist Jeffrey Olick, one dimension of collective memory is the "history of commemoration" that focuses

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[23] Pierre Nora is a French historian and political scientist. He is known for the work on French identity and memory. Also see Hue-Tam Ho Tai, "Remembered Realms: Pierre Nora and French National Memory," *The American Historical Review* 106, no. 3 (2001). https://doi.org/10.2307/2692331.

[24] Jeffrey C. Alexander et al., *Cultural Trauma and Collective Identity*, 1 ed. (University of California Press, 2004).

[25] Neil J. Smelser et al., "Psychological Trauma and Cultural Trauma," in *Cultural Trauma and Collective Identity* (University of California Press, 2004).

[26] Alexander et al., 10.

[27] "National Day of Prayer and Remembrance for the Victims of the Terrorist Attacks on September 11, 2001," The White House, 2001, accessed April 9, 2021, https://georgewbush-whitehouse.archives.gov/news/releases/2001/09/20010913-7.html.

on the change in forms of communication that are available to construct a collective memory.[28] In other words, memory representations are always transmitted and stored in certain formats. From this perspective, cultural memory and trauma are always built and transmitted through different media. Assman concluded these media include symbolic cultural heritage (such as texts, rites, monuments, sacred scriptures) and institutional communication (such as recitation, practice, observance).[29] In order to understand how traumatic memory spread in different social spaces, we should study both the forms of mnemonic representation and their "carrying capacities".[30] For instance, online news has a broader carrying capacity than books in the digital era because the former is more affordable and accessible to the public than the latter. Without sufficient carrying capacities, the media cannot impose a "simultaneous" memory on society within a particular time and space frame.

Media serves as the container for shared memory and leads to the absence of a direct connection between memory holders and past events. Since the twentieth century, with the rise of media culture, the relationship between past events and collective memory has become more unpredictable. It is due to the media's ubiquity blurring the line between authentic and inauthentic memories. When powerful memories are transmitted to the public that has not experienced the traumatic events via media, the absence of a natural, direct connection between the real experience and memory may lead to extreme attitudes towards past events such as indifference and obsession. On the one hand, some historical events would be excluded from particular groups. For example, German historian Christian Meier mentioned some historical cases that forgetting was imposed to overcome traumatic violence on a national level after civil wars.[31] On the other hand, some groups that did not participate in particular traumatic events will be involved. For example, people who do not participate in Holocaust events share traumatic memory with the Holocaust's survivors by watching a documentary film in a memorial. When people's memory is manipulated by the media, especially those who have not participated in the past events but share memories with the event's participants, their memory cognition will be easier to be affected and distorted due to the lack of genuine connection with the past.

2.3 Digital memory: re-articulating the past with digital media

As the first commercially available computer released in 1951 and the ARPANET network established in 1969, digital media makes memory study more complex.[32] Digital media is a term to describe media encoded in machine-readable formats, including software, mobile phone application, web pages, social media, digital data (databases), digital games, images, audios and videos.[33] Since the 1990s, cultural memory has become more democratic due to the widespread use of digital media, which differs from print media (such as a printed book, newspaper and magazine) and other traditional mass media (such as television and broadcast).

The prominence of electronic connectivity creates what Hoskins described as "new memory" which is a new form of memory constantly spreading, developing, and renewing through digital devices.[34] He mentions the key features of these new memories are: "the consistent pivotal dynamic of memory forged in the present

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[28] Jeffrey K. Olick, "Genre Memories and Memory Genres: A Dialogical Analysis of May 8, 1945 Commemorations in the Federal Republic of Germany," *American Sociological Review* 64, no. 3 (1999). https://doi.org/10.2307/2657492.

[29] Richard Meckien, "Cultural Memory: The Link between Past, Present, and Future," Institute of Advanced Studies of the University of Sao Paulo, 2013, accessed April 5, 2021, http://www.iea.usp.br/en/news/cultural-memory-the-link-between-past-present-and-future.

[30] Stephen Hilgartner and Charles Bosk, "The Rise and Fall of Social Problems: A Public Arenas Model," *American Journal of Sociology* 94 (1988): 53-78. https://doi.org/10.1086/228951.

[31] Christian Meier is a historian and professor of Ancient History with special reference to social and economic history. More about his study on memory see Christian Meier, *Das Gebot Zu Vergessen Und Die Unabweisbarkeit Des Erinnerns -: Vom öffentlichen Umgang Mit Schlimmer Vergangenheit* (Siedler Verlag, 2010).

[32] "Rise of the Machines," Science and Technology Facilities Council, 2018, accessed April 5, 2021, https://stfc.ukri.org/news-events-and-publications/features/rise-of-the-machines/.

[33] "What Is Digital Media?," Centre For Digital Media, 2013, accessed March 18, 2021, https://thecdm.ca/news/what-is-digital-media.

[34] Hoskins, 333-46.

of today, is manufactured, manipulated and above all, mediated."[35] It means that new memory is related less to the past. It is a phenomenon that is digitally mediated and manipulated, and therefore "new memory is a memory that is increasingly contested".[36] In another article released in 2011, Hoskins developed his opinion towards the impact of new media on memory, regarded as the popularity of new media such as the internet and social media. He argued that new media narratives come into their own identities and internal dynamics once they have been set up through visual presentation and commemorative process.[37] While to a certain extent, Hoskins believes that digital media does contribute to the memorial culture, he retains a sensitive and cautious attitude towards digitization.

In contrast to Hoskins, Alice Bell, a science communication scholar, has a more favourable view of digital memory. She comments that digitization would extend and enrich the collective memory and make it "incredibly useful".[38] Such discussions about digital memory have aroused scholars' attention to investigate how to display history in a digital-era museum properly.

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[35]   334.

[36]   334.

[37] "7/7 and Connective Memory: Interactional Trajectories of Remembering in Post-Scarcity Culture," *Memory Studies* 4, no. 3 (2011): 269-80, 77. https://doi.org/10.1177/1750698011402570.

[38] Bell.

3 Digitization of contemporary memorial museums

3.1 The Emergence of memorial museums

The emergence of the memorial museum is consistent with the "memory boom" since the 1980s and the needs of global society in response to past violence and atrocities. In the book *Exhibiting Atrocity: Memorial museums and the politics of past violence* (2018), Amy Sodaro, a sociologist from City University of New York, defined the memorial museum as a new "hybrid" cultural architecture form of collective memory to respond to cultural trauma.[39] The memorial museum's goal is to transform trauma into moral commitments to create a promising future through public education and social commemoration. On the one hand, a memorial museum is a kind of museum with the functions of public value education and historical preservation. It is widely considered to be trustworthy sources for collective information with its legitimizing position. On the other hand, a memorial museum is a place of commemorative ritual, which distinguishes itself from other types of museums such as history museums and science museums. Therefore, Sodaro summarized that there were three primary functions of the memorial museum.[40] Firstly, the memorial museum is a form of historical storytelling to preserve history and serve as a recording of past materials and evidence. Secondly, it is a place for public healing and restoration. Finally, it serves as a public moral education by sharing traumatic memories.

3.2 Contemporary memorial museums: a new form in the twentieth century

The contemporary memorial museum does not simply tell the story of the past but tries to allow visitors to "experience" its exhibitions. It provides a new kind of interactive engagement with the past that constitutes a brand new category of "experiential" museums that separates them from history museums of the nineteenth century. Digital media and interactive displays are used to draw visitors into the historical narrative, making the visitors play an active role and identify themselves in the story. For instance, the United States Holocaust Memorial Museum (USHMM) has a controlled circulation visiting route to lead visitors through the exhibitions.[41] The exhibits are displayed chronologically in USHMM, using text, photographs, artefacts, and video clips to tell the story in a straightforward way for those visitors who might not know it. Interactive elements such as touch screens and headphones were included to help visitors create a subjective and individualized experience. Following Sodaro's argument, although the artefacts and reproductions of cultural relics are essential to give the story its authenticity and emotional impact, the story's narrative is more important than the objects contained and displayed by museums.[42] This narrative approach to cultural trauma sets the contemporary memorial museum apart from traditional museums.

Framing visitors as survivors or inviting them to imagine themselves as victims in a traumatic event has been a key approach in memorial museums' narratives in order to evoke emotional resonance. The empathy between visitors and the sufferers is easier to achieve in the digital era. For example, MOT provides each visitor with a digital "Photo Passport", a machine-readable card containing profiles of children caught up in the Holocaust. Jewish studies scholar Oren Baruch Stier believes these passports encourage visitors' identification with the Holocaust victims.[43] In this way, memorial museums attempt to create "prosthetic memory", which is the memory that does not come from one's life experience.[44] It means that with

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[39] Amy Sodaro is an Associate Professor of Sociology at the City University of New York. Her research mainly focuses on memory and memorialization of violence and atrocity. See also Amy Sodaro, "Introduction," in *Exhibiting Atrocity*, Memorial Museums and the Politics of Past Violence (Rutgers University Press, 2018), 1-11, 4.

[40] 9.

[41] The United States Holocaust Memorial Museum (USHMM) is an official memorial to the Holocaust and opened to the public in 1993.

[42] Sodaro, "Memorial Museums: The Emergence of a New Form," 12-29, 24.

[43] Oren Baruch Stier, "Virtual Memories: Mediating the Holocaust at the Simon Wiesenthal Center's Beit Hashoah-Museum of Tolerance," *Journal of the American Academy of Religion* 64, no. 4 (1996): 841-42.

[44] Alison Landsberg, "Prosthetic Memory: Total Recall and Blade Runner," *Body & Society* 1, no. 3-4 (1995/11/01 1995): 2.

digital media, someone has a memory of the narrative events that transpired without experiencing those events. By prosthetic memory, it places spectators in the situation of the survivors who have suffered a traumatic event, thereby evoking empathy among the spectators. Therefore, memorial museums use experiential approaches to c visitors believe that they have had a personal experience of the past that will shape their present moral sensibility.

In general, the memorial museum carries public value education and historical preservation as traditional museums. It also pays more attention to constructing a subjective and individualized visiting experience by combining genuine articles of the past and digital techniques to achieve the effect of arousing collective empathy and commemoration.

3.3 The digitization of contemporary memorial museums

Traditional memorial museums mostly display authentic, tangible cultural objects in order to preserve and provide public access to collections of cultural memory. Along with the digital revolution, this situation has changed since the 1990s. In the International Society for Knowledge Organization (ISKO) Conference in 1994, Swedish information scientist Roland Hjerppe discussed the new connection between the World Wide Web and traditional social institutions such as libraries, archives, and museums.[45] His report has drawn scholars' widespread attention, suggesting that digital techniques as an emerging academic field had begun to be applied in contemporary museums. Since then, digital documents and appliances have been integrated into contemporary memorial museums and contributed to a new memory preservation mode for more than 30 years.

Digitization in museums can be described as transforming analogue objects into a digital format specifically for storage and processing on a computer.[46] Digital documents and appliances are the carriers of collective memory in memorial museums. As archaeologist Ezra B.W. Zubrow summarized, the digital revolution's impact on cultural heritage management was reflected in three areas, including reproduction, simulation and virtual reality, and worldwide information transmission.[47] There were similarities between cultural heritage institutions and memorial museums because of their function and the type of collections. Therefore, the roles of digitization in cultural heritage management also apply to memorial museums - many studies on memorial museums were consistent with Zubrow's conclusion.

3.3.1 Reproduction

The fundamental function of the memorial museum is historical preservation and collective storage. Thus the first issue of digitization that aroused scholars' attention is the reproduction of genuine articles of the past. There are various ways of digitizing a collection depending on the form of media. Flat print and painting are the simplest way to digitize by scanning the actual drawings or photographs. In 2009, following the commercial introduction of 3D scanners and printers, museums began using three-dimensional modelling techniques to reproduce some of their collections that were difficult to process using flat-scanning techniques.[48] These reproductions are helpful for conservation because the fragile original items can be stored safely while the replicas replace them in the museum exhibition. Besides, they are inspiring innovations for a memorial museum's accessibility because digital files could be sent to other institutions

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https://doi.org/10.1177/1357034X95001003010.

[45] The International Society for Knowledge Organization (ISKO) was founded in 1989 and is an academic institution for scholars of knowledge organization and management, classification studies, and information management studies. For more information about Roland Hjerppe's research, see Roland Hjerppe, "Mudding through Flux, Challenges of Change for Libraries and Archives,"   (1995).

[46] Kalina Sotirova et al., "Chapter 1: Digitization of Cultural Heritage – Standards, Institutions, Initiatives," in *Access to Digital Cultural Heritage: Innovation Applications of Automated Metadata Generation* (Plovdiv University Publishing House, 2012), 23-68, 26.

[47] Zubrow, 9.

[48] Charlotte Coates, "How Are Some of the World's Best Known Museums Doing Amazing Things with 3d Printing?," MuseumNext, 2020, accessed April 5, 2021, https://www.museumnext.com/article/how-museums-are-using-3d-printing/.

which provide exhibits outside the museums. Three-dimensional modelling represents a new frontier in the digitization of contemporary museums. Nowadays, both flat and 3D printers have been implemented in many memorial museums to serve digital databases of collections. For example, USHMM's digitization project started in 2015 with scanning and indexing different types of materials.[49] In 2020, 95% of collections in USHMM were available online, and visitors can browse the digital displays on its official website remotely.[50]

In general, several benefits help to continue pushing the museums' collections forward to digitization. One of them is accessibility - the public can access high-quality copies of the actual evidence online or physically in the museum. Sometimes, these digital reproductions provide an even better viewing experience than genuine articles because visitors can zoom in to look at some details through the computer screen. Another advantage of museum's digitization is to preserve historical evidence. Dr John Swanson, an American engineer and contributor of the digital reformatting and preservation of USHMM, talked about the priority of digitizing the USHMM in an interview with the publisher of Memory & Action.[51] For Swanson, the solid object can be destroyed or even lost in the accident, while a digital record can be duplicated and preserve evidence of history. Therefore, he believed that digitization is beneficial to historic preservation.

However, digital reproductions have limitations. Firstly, they cannot display all the information of historical materials because they are mainly visual acoustic reproduction. For example, digital copies of the Holocaust Diary can reproduce the readable information, but they cannot reproduce the paper's materials on which the diary is written.[52] Besides, Stier points out that digital technologies erase the existence of the past and marginalize the authentic, physical items of history in MOT.[53] From this perspective, visitors consider digital artefacts to be less trustworthy than original historical sources, which may undermine their trust in the museum's collections. Another issue of digital reproduction lies in the subjective choice in the processing. This situation often occurs in the processing of films and sound recordings. For instance, a video editor's personal emotion may magnify the crime of the perpetrator and influence the result of video clips. Even though the museum's distinctive value is its ability to select historical objects and enable visitors to engage with complex ideas about history, the collection itself needs to be objective.

3.3.2 Simulation and virtual reality

Digital media in memorial museums contributes to constructing cultural narratives and separates social remembering practices. After visiting the USHMM, J. John Lennon, the Director of the Moffat Centre for Travel and Tourism Business Development, argued that digital media often become the centre of remembrance recreation and memorial space, emphasizing simulation and virtual experience.[54] This virtual experience's core mechanism is that digital media provides visitors with an immersive tour inside the museum.

Some digital techniques that help memorial museums become an "experiential" museum include mobile applications, virtual reality systems, multi-touch tables, etc. The use of screens, visuals and simulation technologies to experience or rebuild traumatic memories in memorial museums is always associated with emotional dimension to evoke compassion. A case in point is MOT, where various immersive and virtual

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[49] Daria Mavrenkova, "Digitization of Gestapo Archives for the U.S. Holocaust Memorial Museum," Iguana, 2021, accessed April 9, 2021, https://iguana-idm.com/en-za/digitization-gestapo-archives-us-holocaust-memorial-museum/.

[50] "Us Holocaust Memorial Museum's Archival Digitization Project and the Sobibor Perpetrator Collection," Digital Transitions, 2020, accessed April 9, 2021, https://www.youtube.com/watch?v=XoPwVbh1Xtk.

[51] John Swanson helped to reproduce the digital reformatting and preservation of more than 7,000 hours of at-risk physical materials (videos and sound recordings) in USHMM. See "Digitizing the Collections: A Conversation with John Swanson," United States Holocaust Memorial Museum, 2015, accessed March 18, 2021, https://medium.com/memory-action/digitizing-the-collections-a-conversation-with-john-swanson-5128da3cd23. Memory and action is the online magazine of USHMM. See also "Memory & Action," accessed March 18, 2021, https://medium.com/memory-action.

[52] Jane E. Klinger, "Exploring the Limits of Digitization | European Holocaust Research Infrastructure," Ehri-Project.Eu, 2021, accessed April 9, 2021, https://www.ehri-project.eu/exploring-limits-digitization.

[53] Stier, 845-46.

[54] Lennon and Foley, 47.

exhibitions exist. A researcher for the exhibit, Nicola A. Lisus, described his experience of visiting MOT: "The format of the tolerance section is powerful. The visitor is bombarded with media simulation as stimulation."[55] These digital media that provide a virtual experience take various forms and encompass the human senses of sight, sound, and touch.[56]

Besides, interactive computer software not only impressively presents victims' profiles through screens but also encourages visitors to give effective feedback on their visiting experience. For example, one of the most popular MOT exhibitions called "Anne Frank" contains a 260-degree immersive theatre to rebuilt Anne's room in the secret annexe.[57] The film played in the theatre invites the well-known actress Hailee Steinfeld to play Anne Frank and recreates the scenes from Anne's diary. Besides, visitors are invited to experience the arrest and imprisonment which Anne Frank experienced during World War II in this experiential video clip. When the tour is completed, visitors are encouraged to write down their "pledge" at some multi-touch tables to respond to the exhibition (fig.1).[58] As Lisus commented in his article, these multimedia exhibitions intentionally directed the viewer into the dramatic story narrative. They made visitors felt like they were not only interacting with an exhibition but already stay in those stories.[59] All these digital screens allow visitors to become part of the staged environment because they convey a picture that is so familiar, so readable, and so tangible.

Figure 1: Multi-touch tables on exhibit "Anne Frank". Created by Cannon Design. [n.d.].

Figure 2: Tolerance Exhibit Entrance. Created by lcloriscreates.com. [n.d.].

As mentioned before, memorial museums serve as a place for public healing and restoration. Therefore, it is necessary to evoke visitors' sympathy for the sufferers through story narrative and heal the trauma. While digital visual artefacts do carry forward forms of memory that are immersive, immediate, or affective, still, there are some controversies. Stier criticized those digital techniques in MOT for confusing audiences by inviting them to frame themselves as survivors or victims from the past. This process "obscures the contemporary reality of the Holocaust" and results in the blurring of temporal and spatial distinctions.[60] Another criticism focuses on the fact that digital media marginalizes commemorative spaces in a memorial museum, distracting visitors' attention to the visual representation rather than the commemorative event itself. By quoting Jewish scholar Jeffrey Shandler's comment that MOT has become a "videogame arcade", Stier

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[55] Nicola A. Lisus and Richard V. Ericson, "Misplacing Memory: The Effect of Television Format on Holocaust Remembrance," *The British Journal of Sociology* 46, no. 1 (1995): 5. https://doi.org/10.2307/591620.

[56] For example, in MOT, visual-related digital media include electronic images and films. Auditory-related digital media include films and sound recordings played in theatres, and tactile-related ones include touchable screens.

[57] The exhibit "Anne Frank" is an immersive exhibit on the life and legacy of Anne Frank, who was a German-Dutch diarist of Jewish heritage and one of the most well-known Jewish victims of the Holocaust. For more about the "Anne Frank" exhibition, see "Visit Anne Frank Exhibit," Museumoftolerance.com, 2021, accessed April 4, 2021, https://www.museumoftolerance.com/visit/exhibits/visit-anne-frank-exhibit/.

[58] Cannon Design, "Multi-Touch Tables on Exhibit "Anne Frank"." https://www.cannondesign.com/our-work/work/museum-of-tolerance/

[59] Lisus and Ericson,   9.

[60] Stier,   846.

argues that the overwhelming digital images and sounds have captured visitors and entertained what is supposed to be a serious commemorative ritual (fig.2).[61]

3.3.3 Information transmission

Finally, digitization has created a new model of information dissemination. Guy Pessach, a residential fellow at the Information Society Project of Yale Law School, considered that the mechanism of digital documents in the museum works as a reverse mode as that of traditional collections.[62] This mode proposed that digital collections served as transmission and distribution instead of only being placed in memory institutions such as archives and museums.[63] Mobile applications and online tours on the memorial museum's official website demonstrate that the public can visit digital copies of artwork or cultural artefacts remotely without visiting the museum physically.

Although the reproductions of collections in museums had already existed before the emergence of the network platform, the internet significantly decreased reproduction cost.[64] Moreover, the scale and scope of reproduction distribution in the digital age are far more expansive than that in the mechanical age. Pessach believes that these changes are sufficient to demonstrate that a paradigm shifts in cultural preservation "from control to distribution".[65] The paradigm shift explains why digital information is becoming more dynamic and multidimensional - the information exchanges between organizations and individuals are continuous and complex. Collective memory is selected by memorial museums and then disseminated and distributed through the network platform. Every receiver at the end of the information flow may become the sender of the following information dissemination. In this way, the official commemorative rituals are better integrated with informal personal memorial activities, which have played a broader role in public education and historical reflection.

While the increasing number of museums with official websites confirms the positive effect of the digital dissemination of information, this innovation also means that the global dissemination of knowledge brings about risks and challenges to museum functions and management, such as copyright risk.

3.4 Critical deliberations and suggestions of memorial museums' digitization

In conclusion, it is clear that digital strategy in contemporary memorial museums has advantages. Research by the CSIRO suggests that museums' digitization will improve engagement with their audiences and maintain relationships with younger visitors.[66] Besides, collection management and knowledge sharing are also essential aspects of digital consideration. Whereas, some critics underline that commemorative culture does require more sensitive approaches when corresponding to digitization. Therefore, contemporary memorial museums should establish the boundary between physical and digital collections.

By analyzing the advantages and disadvantages of digitization's impact in the memorial museums, four suggestions are proposed for the digital strategies:

i.   Digital reproductions are the most basic and widely used field to deal with the fundamental function of memory institutions. As a result, there is an irreplaceable advantage in the memorial museums'

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[61]   840. See also Icloriscreates.com, "Tolerance Exhibit Entrance," (Icloriscreates.com).
https://www.cloriscreates.com/travel-diary/museum-of-tolerance
[62] Guy Pessach, "Memory Institutions: Social Remembering, Privatization and Its Discontents," *SSRN Electronic Journal*   (2008): 73-147,78.
https://doi.org/10.2139/ssrn.1085267.
[63] The term "memory institution" is used to discuss collective entities that collect, preserve and provide public access to collective documents, such as library, archive, museum, etc.
[64] For example, museums could reproduce their collections by printing, photographing and video recording before the appearance of the internet.
[65] Pessach,   79.
[66] "The Benefits of Digital Museums," the LEAD, accessed April 9, 2020,
http://theleadsouthaustralia.com.au/industries/education/the-benefits-of-digital-museums/.

digitization in terms of data management and information collection. Establishing a digital archive and indexing the collections will provide efficient management of physical articles in memorial museums.

ii. As mentioned before, digital reproductions cannot replace authentic artefacts considering information's integrity, objectivity, and authenticity. However, it can serve as a complement to authentic historical evidence and contribute to historic preservation.

iii. Digital media has created an accessible way of information dissemination and achieved extensive public education. Therefore, if the risks such as copyright risk are carefully managed, their benefits far outweigh the drawbacks in information transmission.

iv. Digital media helps to evoke visitors' emotional resonance. However, when it comes to their emotional and psychological perceptions of the visiting experience, enough transition space for visitors to rest should be placed between physical and digital collections in memorial museums.

4 The National September 11 Memorial and Museum as case study

4.1 Context: global traumatic memory

A traumatic event always sets the stage for broader public discussions. As media and memory scholar Barbie Zelizer said, traumatic events 'rattle what it means morally to remain members of a collective'.[67] In our memory, the 9/11 terrorist attack is regarded as case-related because mass media acted as a catalyst to turn this event into a worldwide collective memory (or transnational cultural trauma). On the morning of September 11, 2001, the news that the New York World Trade Center was attacked by terrorists shocked the world and spread like wildfire through mass media. Those who appeared to experience the attack live on T.V. and webpages were estimated at more than two billion worldwide, making the impact of this traumatic event truly international.[68] Psychologist William Hirst described this phenomenon as "...You feel like a part of history saying you saw it live, when really it was the 16th replay."[69] This is because the audience's memory is solidified with the constant references to 9/11 by the mass media.

The first memorials aroused online as hundreds of internet users posted their thoughts, photos, and eyewitness accounts. After that, numerous online 9/11 memorials began to appear.[70] Moreover, in the following months after the attacks, people spontaneously went to the ruined New York World Trade Center in remembrance. Gradually, many temporary memorials and monuments existed around the world.[71] The public concern prompted the National September 11 Memorial and Museum (also called the 9/11 Memorial and Museum) was officially planned in 2003, immediately after the attack.

Alice Greenwald, a former associate director of museum programs at the USHMM, was appointed as the 9/11 Memorial and Museum director in 2006.[72] During the discussions of planning the memorial museum, her team set out with a series of core considerations of this project: firstly, the particular requirements and sensitivities of memorial museums must balance the concerns of privacy with the imperative education; secondly, the museum has a responsibility to present the 9/11 attack visually without re-traumatizing the public; finally, the story narrative should echo critical themes of the American national narrative and play a role in civic renewal instruments. The above considerations carefully address the relationship between individual and collective memory and attempt to place the global trauma of 9/11 within the theme of American democratic culture, thereby evoking sympathy and serving the intention of healing and remembrance.

Along with these considerations and in-depth investigation, the team realized a striking fact that there were more than two billion people who witnessed the 9/11 terrorist attack through media such as newspapers, T.V. programs, and websites. After the head of media designer Tom Hennes and Jake Barton joined the creation of exhibitions, they came up with a guiding principle in the museum's exhibition design: let individuals tell the story of 9/11.[73] This idea has been realized through new digital technologies and allows visitors worldwide to witness historical evidence in the museum.

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[67] Barbie Zelizer, "Finding Aids to the Past: Bearing Personal Witness to Traumatic Public Events," 24, no. 5 (2002). https://doi.org/10.1177/016344370202400509.

[68] Sodaro, "The National September 11 Memorial Museum: "To Bear Solemn Witness"," 139.

[69] B. Murray Law, "9/11: A Media-Shaped Memory? The Media Coverage of an Event Impacts How Memories Are Solidified.," American Psychological Association, 2011, accessed April 9, 2021, https://www.apa.org/monitor/2011/09/media-memory.

[70] For example, an online memorial for remembering victims in the 9/11 terroris attack launched in September 2001 called Legacy.com Remembering 9/11 site, more information about it see: "Remembering 9/11," Legacy.com, 2001, accessed April 9, 2021, http://www.legacy.com/sept11/home.aspx.

[71] "The 9/11 Memorials and Artifacts Throughout Nyc," Untapped New York, 2020, accessed April 9, 2021, https://untappedcities.com/2020/09/11/9-11-memorials-artifacts-nyc/.

[72] "Alice M. Greenwald/ National September 11 Memorial & Museum," 911Memorial.Org, 2021, accessed March 17, 2021, https://www.911memorial.org/about/executive-management/alice-m-greenwald.

[73] Tome Hennes is one of the most sought-after exhibition designers in the world. He is the founder of "Thinc Design", an extension of practice in theatre design. Jake Barton is an American designer and the founder of an experience design firm, "Local Projects", for museums and public spaces in New York. More about the driving principle of museum design see also: Sodaro, "The National September 11 Memorial Museum: "To Bear Solemn Witness"," 142.

4.2 Intention of digitization: the visual and oral history in 9/11 memorial and museum

Based on the concept of presenting individual memories and stories in the museum, Barton decided to let the visitor access the stories about 9/11 from other visitors instead of hearing from a curator or historian. For him, the post 9/11 world was changing and evolving over time. Therefore, he hoped that the 9/11 memorial museum is not only a display space for historical events and cultural trauma but also an interactive collection platform for collective memory. In his interview, he mentioned that in order to avoid an official monolithic view, the 9/11 museum collected worldwide stories.[74] As Sodaro concluded, inside the 9/11 Memorial and Museum, the "collected memory" of many individuals was organized into one cohesive collective story.[75] While individuals are in different places with different 9/11 experience, their memories construct a collective story of 9/11 with digital techniques.

Another design that makes visiting the 9/11 memorial and museum an immersive experience is the "Remembering 9/11 Oral History Project".[76] Barton described the tour in the museum as a listening experience. He expected to allow visitors to reshape narratives on their own through various impacts on senses. The background audio started from the museum's entrance, continuously played in exhibition halls, and frame visitors within the trauma narrative. The soundtrack to the exhibit includes the voices of victims, survivors, and witnesses to the event. According to Hennes, the other lead designer, these auditory materials created conditions for visitors to raise empathy and feel closer contact with other witnesses by "maintaining the first-person voice throughout."[77] As oral historian Liza Zapol stated in her lecture, these sound recordings convey humanity which may be more powerful than graphic visual representations.[78] Therefore, the voices become one of the most influential and effective emotional triggers in the 9/11 memorial museum.

4.3 Digital story narrative in the 9/11 memorial and museum

In May 2014, the 9/11 Memorial and Museum opened to the public.[79] Along with genuine articles of historical evidence, digital media helps organize as complete as possible the 9/11 story. As concluded in the previous chapter, the impact of digital techniques on the 9/11 memorial and museum was reflected in three areas: digital reproduction, simulation and virtual reality, and worldwide information transmission. Firstly, the digital reproductions of 9/11 physical articles provide visitors with a vivid experience and organize physical articles into dynamic, historical displays. Secondly, digital media in the 9/11 memorial and museum simulates the plane's crash through both audio and video. Visitors seem to witness the tragedy themselves by watching the huge digital screens and listening to the sound recordings. Finally, the online tour and visitors' digital archive enhance the 9/11 memorial and museum's accessibility, enabling collections to be disseminated to the public through the internet.

4.3.1 Digital reproduction in the 9/11 memorial and museum

There are a series of exhibition halls where the authentic 9/11 relics, digital artefacts, and a constant audio background together reconstruct how the attack happened. On the wall of the main exhibition hall, a 34-foot projection called "Timescape" visualizes millions of news articles about the 9/11 attack (fig.3).[80] The time

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[74] Andrew Rothschild, "Inside the Tech of the 9/11 Memorial Museum," Finance.Yahoo.Com, 2015, accessed March 17, 2021, https://finance.yahoo.com/news/technology-brought-the-world-the-news-and-90600061439.html.

[75] Sodaro, "The National September 11 Memorial Museum: "To Bear Solemn Witness"," 157.

[76] The Remembering 9/11 Oral History Project is a database of recorded interviews with responders, survivors, 9/11 family members, and others deeply affected by the 9/11 terrorist attack. For more information about the use of the oral history project in the 9/11 memorial museum, see: "Oral Histories," 9/11 Memorial & Museum, accessed April 9, 2021, https://www.911memorial.org/learn/resources/oral-histories.

[77] Tom Hennes, "Reflections on the Opening of the 9/11 Memorial Museum, from the Lead Exhibition Designer," Blog. Ted. Com, 2014, accessed March 17, 2021, https://blog.ted.com/reflections-on-the-opening-of-the-911-memorial-museum-from-the-lead-exhibition-designer/.

[78] Liza Zapol, "The Museum as Ventriloquist: The Use of Oral Histories in the National September 11 Memorial Museum," in *NSSR Memory Conference* (New York2011), 4.

[79] Rosenfield.

[80] Local Projects, "Visualizing Media Coverage," (Local Projects, 2019). https://localprojects.com/work/interactive-installations/a-museum-of-collective-memory/

span of these news reports can be traced back to 2001, and they are still updated to include the most recent articles, reflecting the continued impact of 9/11.[81] Another exhibit that makes good use of digital technology to display historical articles is called "The Last Column" (fig.4).[82] There is a touch screen wall to identify each marking on the column's ruins and interpret their stories. On this screen, visitors can zoom in to look at some details of the remained column with its 3D scanning model. In these exhibitions, digital media serves as a reproduction that contributes to the visitor's view of history, which helps the physical museum collections dynamically interpret the past.

Figure 3: Visualizing media coverage. Created by Local Projects. [2019].

Figure 4: The Last Column. Created by Local Projects. [2019].

4.3.2 Simulation and virtual reality in the 9/11 memorial and museum

The first technique of recreating historical scenes is to stimulate visitors through a combination of video and soundtrack, making them feel as if they are listening to eyewitnesses retelling the story of the terrorist attack. The experiential tour starts with a screen with a photograph of the Twin Towers and a map showing the planes' trajectory on the morning of September 11 on it (fig.5).[83] When viewing the photo and map, visitors can hear audio backgrounds with various accents simultaneously. These audio backgrounds, called "We Remember" by Barton, are the testimonies of witnesses.[84] Barton placed them as an introductory experience that reminds visitors of the shocks of 9/11 that reverberated worldwide. Along with these voices, there are a series of columns with projected words from different languages (fig.6).[85] These words and the audios indicate that the museum tells stories of worldwide individuals' 9/11 memories. After selecting and designing the display of collected memories, the museum turns them into a collective memory of 9/11 and enables visitors to engage with complex ideas about the past.

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[81] Rothschild.

[82] Local Projects, "The Last Column," (Local Projects, 2019).
https://localprojects.com/work/interactive-installations/a-museum-of-collective-memory/

[83] "Storytelling Alcoves," (2020). https://www.localprojects.com/work/interactive-installations/a-museum-of-collective-memory/

[84] "A Museum of Collective Memory: National September 11 Memorial & Museum," Local Projects, accessed March 18, 2021,
https://localprojects.com/work/interactive-installations/a-museum-of-collective-memory/.

[85] Local Projects, "Echoes around the World," (Local Projects, 2019).
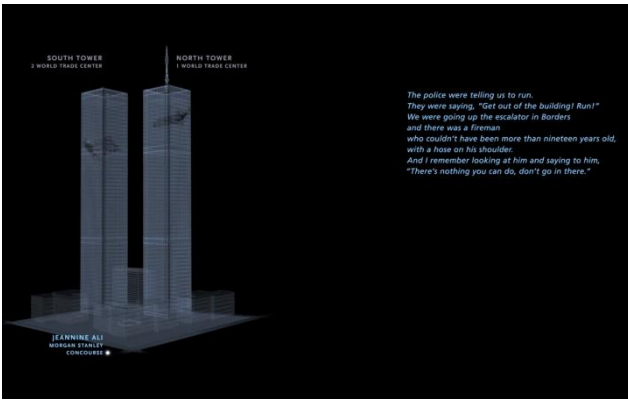https://www.localprojects.com/work/interactive-installations/a-museum-of-collective-memory/

Figure 5: Storytelling Alcoves. Created by Local Projects. [2020].

Figure 6: Echoes around the World. Created by Local Projects. [2019].

Another interactive exhibit called "Beam signing" is implemented besides the ruins' walls as a digital guest book (fig.7).[86] Visitors are invited to write down the words they want to convey to victims on touch screens, and these will be projected onto a 24-foot screen by electronic devices within thirty seconds. This interactive computer software allows visitors to create a sense of dialogue with the survivors (or victims) and express their emotions through handwriting.
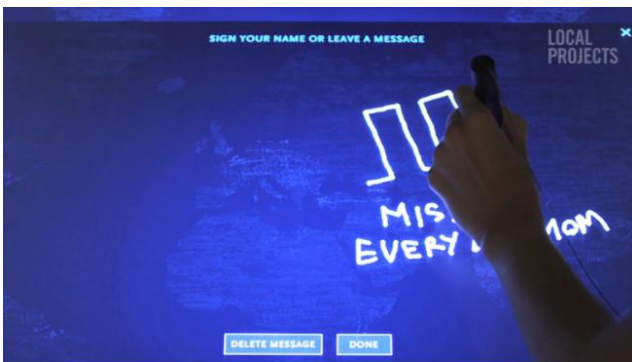
Figure 7: An unfinished story with visitors write a note of hope and remembrance. Created by Local Projects. [2019].
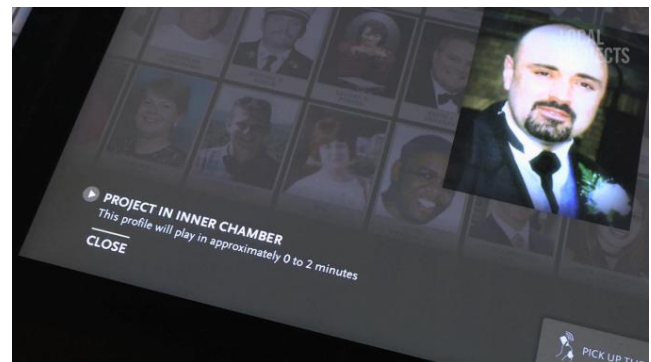
Figure 8: Profile of the victim on a touch screen. Created by Local Projects. [2019].

In addition, the exhibition attempts to frame the visitors inside the victims' perspective in order to evoke sympathy. There are several optional exhibitions about the victims' stories in the Memorial Wing of the 9/11 memorial and museum. Those who wish to have an immersive experience can enter these rooms to pay their respect to victims. In the darkness, there are documentary films projected on the wall with the simulation of the aeroplane and its crash. Visitors hear recordings from the black boxes of hijacked flights and some handsets hanging on the wall play the answering-machine messages that passengers of the crashed flight left for their loved ones. Inside a dark interior environment, the media clips and telephone recordings simulate the scenes before the crash, leaving visitors to feel as if they are going to experience the disaster. Besides, there are several touch screens with more than 1000 victims' photographs. If the visitor clicks on one of the victims' portrait on the computer screen, he or she has a choice to project the victim's profile onto a shared screen hanging on the chamber's wall to share it with other visitors (fig.8).[87] In this way, the victims' portraits, photographs, and video clips are constantly replayed on the digital screen. The digital media simulates the

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[86] "An Unfinished Story with Visitors Write a Note of Hope and Remembrance," (2019).
https://localprojects.com/work/interactive-installations/a-museum-of-collective-memory/
[87] "Profile of the Victim on a Touch Screen," (2019). https://localprojects.com/work/interactive-installations/a-museum-of-collective-memory/

plane's crash through audio and video, making visitors seem to witness the tragedy again and again, evoking a strong emotional resonance after viewing victims' profiles.

4.3.3 Information transmission: online virtual tour and the visitors' archive

In July 2020, the 9/11 Memorial and Museum started to offer a sixty-minute virtual tour on the official website for those who cannot visit the museum physically but want to experience the exhibitions.[88] This approach was in response to the lockdown measure caused by the COVID-19 pandemic since March 13, 2020. The interactive tour is led by museum staff using Zoom, which is a web conferencing software. The tour takes online visitors through the museum's key spaces by a regular route. However, visitors attending the online tour as a tour group can choose their own path and personalize their experience online. The New York Times praised the 9/11 Memorial and Museum's action as "sensitive and illuminating" during the quarantine.[89]

Although the virtual museum's concept has been around since the 1990s, virtual technology in memorial museums has not been widely accepted during the last twenty years.[90] On the one hand, this is due to technical and financial considerations; on the other hand, the emergence of virtual tours was related to the popularity of video games in the 1990s. As a result, virtual technology was considered as a medium for entertainment by the public initially. Memorial museums deal with the theme of cultural trauma that is not suitable to be represented in a game-like way.

Nevertheless, this situation changed in 2020 as the COVID-19 pandemic keeping people to stay at home. Along with technological innovation that made virtual visitings more feasible, many memorial museums start and continue setting up more virtual approaches. Since July 2020, the 9/11 Memorial and Museum has been offering virtual tours regularly and launched special online tours for specific groups such as students. In November 2020, a new official application for mobile phones was established to present memorial visitors and those at home about a forty-minute story of 9/11.[91] By offering interactivity and personalization, virtual tour enhances the experience and richness of content in the museum. What's more, it is possible to transmit information beyond the limit of time and space with a broader educational significance. These benefits make them valuable digital tools and gradually accepted by the public.

In addition to the virtual tour on the website, the 9/11 Memorial and Museum sought to establish a visitors' archive. They collect visitors' 9/11 experiences through a digital database from both the museum and their official website. They set up three audio/video recording booths in the museum, and visitors can sit down in front of a teleprompter and share their thoughts of the 9/11 attack through recording. Their answers are edited and projected onto a digital projection screen and become parts of the museum's archive. It creates an extensive library of oral history and uses it to construct the museum's narrative. Sodaro concluded the museum's development has highly relied on digital media and technologies in the twenty-first century.[92] In this way, the 9/11 memorial museum involves visitors in the museum's efforts to tell its history, demonstrating an interactive and broadly influential role of the contemporary memorial museum.

4.4 Critical deliberations and reflection

Visiting the 9/11 Memorial and Museum is an emotional and powerful experience. On the one hand, there are

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[88] "9/11 Memorial to Launch Virtual Tours," 9/11 Memorial & Museum, 2020, accessed April 9, 2021, https://www.911memorial.org/connect/blog/911-memorial-launch-virtual-tours.

[89] "New York Times Lauds Memorial Museum's "Sensitive and Illuminating" Virtual Tours for Children," 9/11 Memorial & Museum, 2020, accessed March 8, 2021, https://www.911memorial.org/connect/blog/new-york-times-lauds-memorial-museums-sensitive-and-illuminating-virtual-tours.

[90] Georgia Haseldine, "The Virtues and Vices of Virtual Museum Tours," *Apollo*2020.

[91] "9/11 Memorial Launches Audio Guide App," 9/11 Memorial & Museum, 2020, accessed March 18, 2021, https://www.911memorial.org/connect/blog/911-memorial-launches-audio-guide-app.

[92] Sodaro, "The National September 11 Memorial Museum: "To Bear Solemn Witness"," 154.

some typical exhibition methods, such as a chronological narrative organization, the stories from victims' perspective, the various audio and video testimonies, the memorial spaces constructed by multimedia and interactive displays; on the other hand, what makes the 9/11 Memorial and Museum distinct from other memorial museums is the narration of the traumatic collective memory from the perspective of the visitor's individual memory. [93] There are three reasons for this approach. First of all, in the age of mass media, digital media catalyzed the significant global impact and influence of 9/11 and its post-attack period. Besides, the development of digital media technology has led to the digitization of memorial museums on an unprecedented scale. Finally, the cultural context of American democracy and the worldwide epidemic COVID-19 in 2020 has further contributed to the digitizing the memorial museums.

Up until 2019, totally with more than 14,100,000 visitors over the past five years, the 9/11 Memorial and Museum is one of the most famous memorial museums in the world.[94] This number showed that in the 21st century, the memorial museum's digitization had gained public appreciation. Some scholars have recognized the advantages of digitization as a new form of the contemporary memorial museum. The proponents believe that these digital approaches resonate with visitors from different cultural backgrounds and respond to this global traumatic event.

However, some controversies arose from both sociological and psychological aspects. From a sociological perspective, Christine Sisto, an editorial associate at *National Review,* expresses her worry about digitizing the 9/11 Memorial and Museum in her article "why the 9/11 museum failed".[95] She mentioned these caused neglect and disrespect for the dead to some extent. Also, some scholars believe that there is an ethical problem with oral history. Zapol considered the oral history project was a deception on behalf of the historian because the oral stories were selected and conducted to serve the museum's ideological and political purposes. "These interviews are a kind of curatorial oral history" instead of the real history.[96] As stated in the previous chapter, the selection and editing process of digital documents is subjective and serves the ideology of collective memory. In general, visitors unconsciously assume that the historical evidence in museums is objective, and when they realize the 'subjectivity' of digital artefacts, they may question the authority of museums.

From a psychological perspective, psychologist Billie Pivnick expresses her concern about playing recordings of witnesses, survivors, and victims in the exhibition hall by warning that: "hearing victims' voices in the throes of terror could traumatize listeners."[97] Apart from the stimulus provided by visual evidence, digital media can provide acoustic and tactile stimulations that have a multi-sensory impact on visitors. Similarly, disaster psychologist Grady Bray highlights visitors' empathy affected by auditory materials in the 9/11 memorial and museum.[98] Without enough space for rest or emotional support, the compassion may even newly traumatize visitors. Therefore, it requires more sensitive approaches and arrangements when corresponding to digital techniques.

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[93] "The National September 11 Memorial Museum: "To Bear Solemn Witness"."

[94] "A Look Back at 2019," 9/11 Memorial & Museum, 2020, accessed March 18, 2021, https://reports.911memorial.org/2019-report/.

[95] Christine Sisto, "Why The 9/11 Museum Failed | National Review", Nationalreview.Com, 2014, https://www.nationalreview.com/2014/05/why-911-museum-failed-christine-sisto/.

[96] Zapol, "The Museum as Ventriloquist: The Use of Oral Histories in the National September 11 Memorial Museum," 6.

[97] Kuang.

[98] Zapol, "The Museum as Ventriloquist: The Use of Oral Histories in the National September 11 Memorial Museum," 4.

5 Conclusion: the boundary between physical and digital

5.1 Place the boundary in memorial museums

By exploring the digitization of contemporary memorial museums under the theoretical framework of memory study and studying the case of the 9/11 Memorial Museum, this paper demonstrated that when memorial museums respond to digitization, they require careful approaches and should establish the boundary between physical and digital memory collections. This boundary is established primarily based on three aspects of the impact of digitization on memorial museums, including reproduction, simulation and virtual reality, and information transmission. Furthermore, it is an important way to balance the physical and digital displays in memorial museums by comparing the strengths and weaknesses of digital influences.

In general, considering the public accessibilities and historic preservation, the advantages of digitalization far outweigh the disadvantages when it comes to the field of information transmission and collection management. Therefore, it is worth the time and dedication of resources to set up a digital platform for the memorial museum to reproduce and display collections online. However, it should be noted that digital replicas cannot completely replace authentic historical evidence. Otherwise, the authenticity of the memorial museum in the public cognition will be considerably diminished as a result.

Conversely, when it comes to the experiential display approaches and audiences' perception, digital strategies should be careful managed from both sociological and psychological perspectives.

i. The simultaneous presentation of many digital media can distract visitors' attention to the traumatic event itself. Therefore, space for rest should be placed between physical and digital displays.

ii. By providing visual, auditory and tactile stimuli, the digital media enhances visitors' ability to empathize with traumatic event's sufferers in memorial museums. Here visitors' psychological capacity should be taken into consideration. Especially in the presentation of reconstructions and simulations of disaster scenes, there should be a mechanism to allow visitors to stop the tour at any time considering their psychological health.

iii. Referring to the "Timescape" exhibition in the 9/11 memorial and museum, digital technologies excels at dynamically presenting visual information across space and time.

In summary, with the ubiquity of digital technologies in all walks of life, the digitization of memorial museum is inevitable and will become a major trend in the future. The innovative digital technologies prompt practitioners in the museum study field to understand the trends, choose suitable techniques and apply them to the collections, exhibitions, dissemination for the digital traumatic memory.

5.2 Limitations and Future work

The limitations and areas for future research in this paper can be concluded in two points. Firstly, based on the similarities of memory institutions in terms of their public functions and collections, this paper proposes three essential aspects of digitization's impact on memorial museums by analogy with the findings of cultural heritage management. In fact, in those areas where memorial museums are significantly different from the other cultural heritage institutions, the impact of digitization on memorial museums is not clear in this paper. Thus, further research should be conducted to extend the explanations of memorial museums' digitization. In addition, the boundary between physical and digital collections in this paper is established by comparing the benefits and drawbacks of digitization's impact on memorial museums, which is a non-quantitative definition. The establishment of a digital boundary would be more convincing if relevant data supported it.

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