HISTORICAL APPISTEMOLOGY: THE MAPPING OF THE EXPANDED FIELD OF CULTURAL HERITAGE AUGMENTED REALITY (AR) APPS AS A CREATIVE TOOL

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ABSTRACT | Today, augmented reality (AR) apps for museums, archives, and cultural heritage sites are popular among visitors and institutions alike. While AR apps make a significant impact on our engagement with cultural memory and narratives, these projects are usually discussed either in isolation or as a part of a larger consideration of the contemporary culture of digital heritage. This paper expands the individual analysis of AR projects in the context of cultural heritage sites by conceptually adjusting the Expanded Field to map the varying modes of this cultural practice. This comparative approach helps to develop an understanding of AR as a creative tool while illuminating the politics of this form of cultural production. I demonstrate how these in situ, synchronized mobile interactions illustrate specific social and cultural conditions, and spatial dynamics, through the mixing of virtual and actual pasts and futures. I further discuss how this diagram can be used as a practical tool in the development of future projects, and how it is useful in mapping and thinking through some of the essential issues that underlie many AR projects, such as digital memory, the centralization of narratives, and the linearity of history.

KEYWORDS | augmented reality, cultural heritage, data-driven narratives, GLAM institutions, locative media

Introduction: Turning a Technological Gimmick into a Meaningful Interaction

Over the past few decades, digital technologies have gradually been adopted by museums, archives, and heritage sites. With the contemporary advancements of technology and the seeming ubiquity of mobile devices, many cultural institutions invest in the development of their own augmented reality (AR) mobile apps. Defined as a layering of dynamic digital data over a physical space, AR enables new opportunities to enrich both the display and the visitor experience in numerous ways.[1] Yet, despite the widespread use of this technology and its potential, it seems that many cultural heritage AR projects offer little more than a technological spectacle that can neither sustain visitors' attention nor facilitate more meaningful interactions with historical content. As recently observed by Erkki Huhtamo, in many cases "the user interface had become The Thing, instead of serving as a gateway."[2]

Recognizing this problem, this paper concentrates on six modes of practice for mobile AR apps in the context of cultural heritage sites. By exploring some common ways in which AR apps mediate our experience of cultural heritage, I call attention to some of the politics and aesthetics that underlie this practice. Acknowledging that cultural heritage AR integrates multiple digital representations of pasts and futures with immediate environments in real time, I observe that AR's temporal mode includes various practices that exceed and expand linear chronology. Following Lev Manovich's insightful observation that we are immersed in an "Augmented Space," this paper explores how such augmented space is produced by means of this expanded temporal mode.[3]

Ultimately, this paper considers two related questions: (1) how can cultural institutions employ AR's temporal mode to create a compelling visitor experience; and (2) which strategies may heritage sites consider to produce engaging and meaningful projects that avoid gimmicky interactions? In a way, the discussion here resonates with the question posed by new-media heritage scholar Yehuda Kalay over a decade ago: "How might we abstract operative principles from seemingly disparate virtual

heritage projects in ways that go beyond the demonstration of technical virtuosity and implementation details?"[4] To answer this question, I have modified the diagram of the Expanded Field (popularized by Rosalind Krauss's publication from 1979) and used it to map different practices of cultural heritage AR apps.[5] This serves to address some of the underlying themes of cultural heritage AR by comparing the various approaches currently used in the production of these apps.

The Expanded Field of AR Temporality

Today we can generally observe two leading types of AR applications: marker-based and location-based. While the first is based on image identification technologies (such as face recognition), the second uses spatial movement and GPS technology. This amalgamation of actual and digital elements is usually site-specific or object-specific, and most often occurs in real time through participants' engagement with a device.[6] As such, AR can generally be understood as a relational and synchronous medium, establishing creative—factual or fictional—links between a non-virtual element (such as an object or a place) and virtual content. In the context of cultural heritage, virtual representations of pasts and futures are being intertwined with material objects and physical environments.

This perspective of AR as a relational medium is the primary reason why the Expanded Field diagram is a lens through which AR use in cultural heritage sites might be better understood: this mapping allows us to account for the inherent relationality between actual and virtual elements, and invites us to consider the entire practice of cultural heritage AR in a comparative manner.

Table 1 maps AR apps use in cultural heritage sites. The table is structured around two distinct concepts (Past and Future) and their virtual counterparts (Virtual Past and Virtual Future). Each intersection of concepts reflects how AR technology can be employed in cultural heritage contexts, thus providing a contemporary overview of this practice. The six categories identified here are: Historical Annotation, Activation of the Past, Counterfactual Histories, Repressed Past, Future Potentialities, as well as Historical Modeling and Reconstruction. (see Table 1)

The application of this diagram to cultural heritage AR follows the tradition of two leading art historians: Jack Burnham (in his *Structure of Art* from 1971) and Rosalind Krauss (in her mapping of minimalist sculpture from 1979).[7] This form of mapping also proved useful for the interpretation of cultural production in the mid-2000s, when it was adapted by George Baker to map the practices of contemporary photography.[8] Krauss and Baker's choice of binary concepts aims to demonstrate how the Expanded Field is usually developed in relation to, or based on, the defining dichotomies of some earlier and more conventional practices. My own adaptation of the diagram as a tool to reflect on the practice of cultural heritage AR operates in a similar manner, mapping AR apps in relation to an essential dichotomy commonly used in more traditional forms of cultural heritage and preservation: past and future.

What we often encounter in cultural heritage AR projects is either an actively present representation of the past, designed for contemporary and future generations, or a present representation of an imagined or assumed future, in order to reconsider both present and past. It is this temporal condition that the diagram illustrates. The categories described here are distinguished from one another based on the different ways in which pasts and futures are represented, as well as how these representations relate to one another and to their immediate environments.

This diagram also differs from previous adaptations in three meaningful aspects. First, it is based on vectors that represent temporal movement. These vectors expand the traditional perspective of linear progression by indicating a direction and movement from one concept to the other, thus signifying a variety of temporal perspectives that can be represented through AR. The primary vector at the base of this model is the line moving from past to future, sustaining the time-space continuum. It indicates a perspective of temporal progress, chronology, and historical linearity that is usually fundamental to traditional practices of cultural heritage and preservation. Second, while the bidirectional vertical lines usually symbolize opposition, the vertical lines in this diagram are also vectors indicating a back-and-forth movement between the concepts. This leads to the third and perhaps most fundamental difference, which shows that this model is not based on negational terms. Adoption of the common mapping structure (that is, contrasting "past" with "non-past," and "future" with "non-future") would not accurately map or shed light on the practices of AR. Not only are the concepts of "non-past" and "non-future" meaningless in this context, but they also fail to reflect the diversity of AR technology as it is employed in and by cultural heritage sites. In fact, as shown, all forms of cultural heritage AR constantly employ the concepts of past and future as fundamental and operative ideas; past and future are neither negated nor dismissed, but rather activated and present at the same time. In order to illuminate the ongoing connections and tensions between the actual and virtual elements in AR, I have chosen to contrast the pairing of "past" and "future" with the ideas of "virtual past" and "virtual future." Using these terms also shows how virtual content actively informs and influences practices that produce collective memories and social realities.
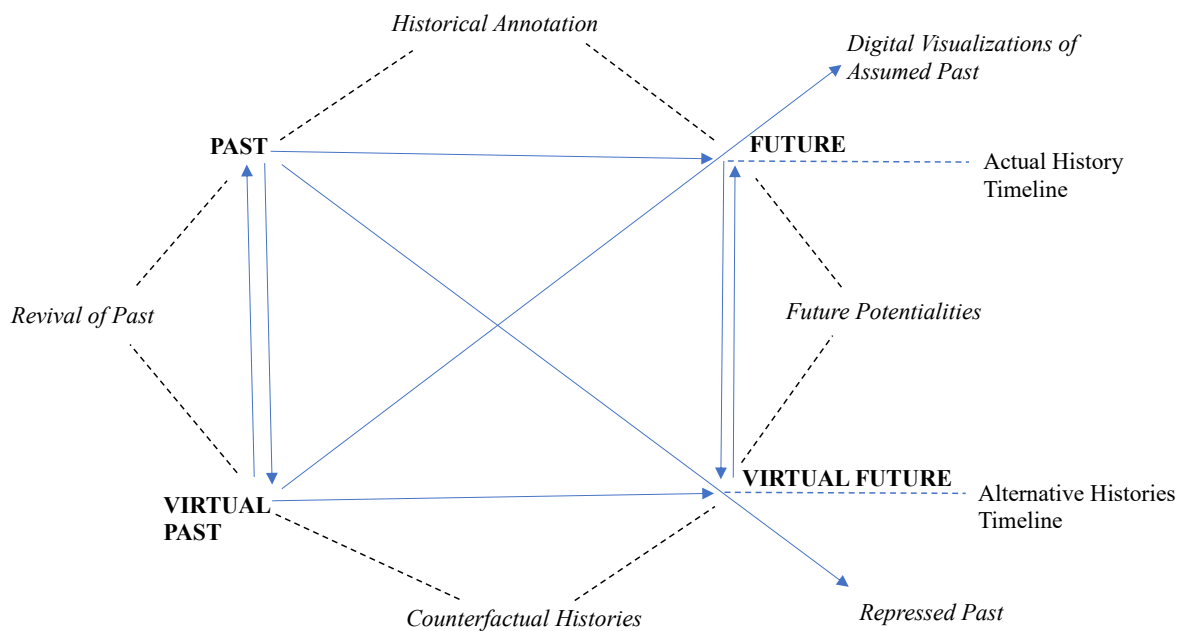
Table 1. The Expanded Field of Cultural Heritage AR.

Before reviewing the six practices, two issues need to be briefly considered. First, while the diagram in Table 1 focuses on temporal modes, these should be understood and analyzed based on their relationship with the physical space they occupy. In other words, our interpretation of certain content as actual or virtual past is site-specific and depends on such contents' correlation with the material environment. Time is not a stand-alone concept that is stripped from spatial context; time in AR is always contextualized by spatial movement and mapping.[9] Second, in the context of this model, "virtual past" has a dual meaning. On the vector forming the practice of counterfactual histories, the concept of virtual past relates to what is usually understood as "alternative pasts;" that is, things that could have happened but did not.[10] On the vectors forming the categories of "Activation of the Past" and "Historical Modeling and Reconstruction," virtual past means digital expressions or visualizations of the past, such as digital reconstructions of ancient structures or destroyed monuments. Although mentioned here only briefly, this duality will become more straightforward once the categories are further outlined. The following section explores the categories presented in Table 1, beginning with "Historical Annotation" and thereafter moving counterclockwise.

From Theory to Practice: Six Ways to Employ AR Temporality for Cultural Heritage

1. **Historical Annotation**: In this category, dominant narratives and histories reflecting actual events of the past are validated by means of superimposing digitized archival materials onto physical space. Photos, letters, news reports, maps, testimonials, video and audio recordings, as well as other forms of documentation, are geo-located to correspond with relevant physical places in real time. The aim of this functionality is usually to further preserve, reinforce, and perpetuate the authenticity and significance of these narratives for future generations. One example of this common practice is the Berlin Timetraveler app (2014–ongoing), in which videos and other documents showing Berlin's history are superimposed onto their original place of occurrence [Fig.1, Fig. 2].[11] Another example is the Philadelphia City Archives' project PhillyHistory (2013–ongoing), which geo-locates scans of photos and written documents from the archives in relevant locations in the city.[12]

This recontextualization of archival contents emphasizes the role archives play in shaping the present social and cultural experience. In this form of AR, archives are clearly seen as what Wolfgang Ernst calls "meaning generators."[13] Such

Fig. 1. Timetraveler app.

Fig. 2. Timetraveler app.

virtual content can be used because it was collected and digitized, and the ongoing application of these materials is used to perpetuate existing meanings and social narratives.[14] Adopting this strategy of spatial archiving, the practice of Historical Annotation turns the archive into a hyper-productive medium, as it constantly revitalizes its own relevance by means of establishing a mutually-constitutive, site-specific experience.[15] Employing the AR Historical Annotation practice can, therefore, operate to further strengthen the status of archives as knowledge repositories. In its AR form, the archive can not only record or "remember" events but also produce, curate, and perpetuate collective narratives, by integrating them with personal experiences in situ.

2. **Activation of the Past**: In this category, virtual contents are used to activate, animate, or illuminate past occurrences or conditions. While virtual content relates here to actual past events, this practice usually involves limited use of archival materials. Instead, these apps use designated digital contents to visualize some aspects of past conditions. Accordingly, the focus of this practice is centered neither on perpetuating archival agency nor on supporting institutionalized narratives. Rather, Activation of the Past projects may include unarchived materials or creative, digital representations of past events to expose additional—and sometimes neglected—factors that helped shape the present. One example of this practice is Resurrecting (New York, 2016), in which digital models of the last three white rhinos were geo-located outside of their natural habitat in NYC to raise awareness of the species' extinction and of environmental sustainability.[16] Another example is the "Memory of Amnesia" AR tour (São Paolo, 2015), which traces the removal, replacement, and repositioning of historical monuments in São Paolo, thus providing real-time documentation of the dynamic production of urban history and spatial development [Figs. 3, 4 and 5].[17]

Fig. 3. Memory of Amnesia AR tour (phone screenshot), São Paolo, 2015 (credit: Giovanna Casimiro, Marina Lima, and Giselle Beiguelman).

Fig. 4. Memory of Amnesia AR tour, São Paolo, 2015 (credit: Giovanna Casimiro, Marina Lima, and Giselle Beiguelman).
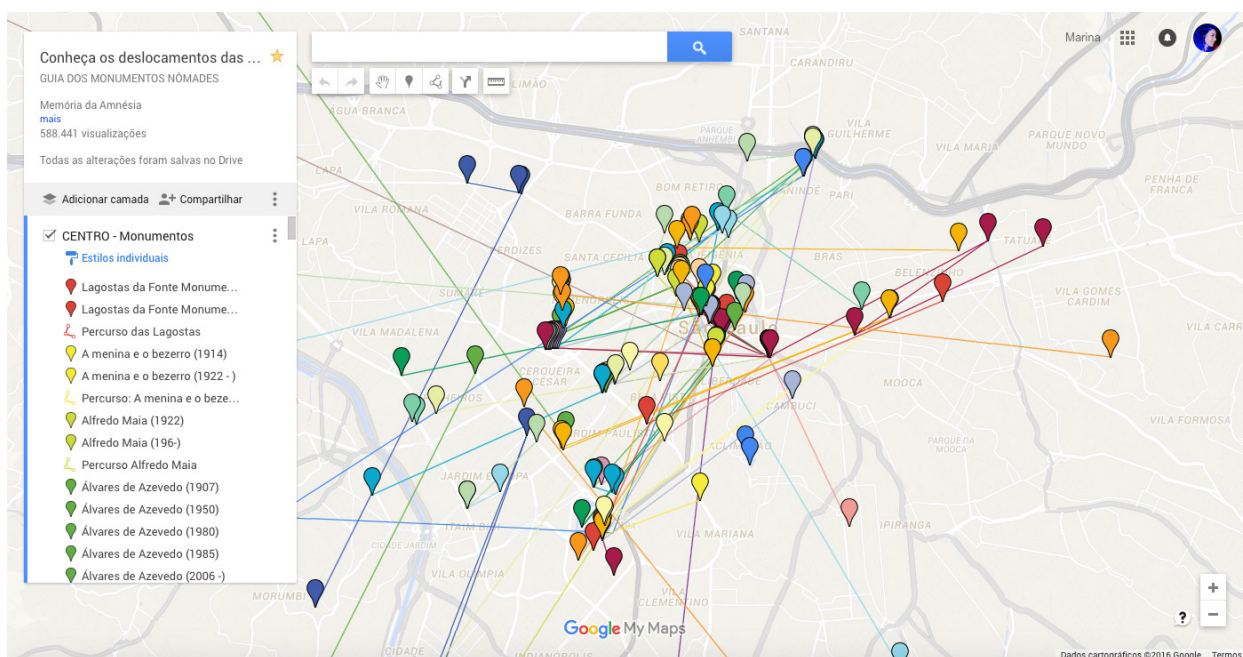

Fig. 5. A map showing monuments' removal and replacement in Memory of Amnesia AR tour (credit: Giovanna Casimiro, Marina Lima, and Giselle Beiguelman).
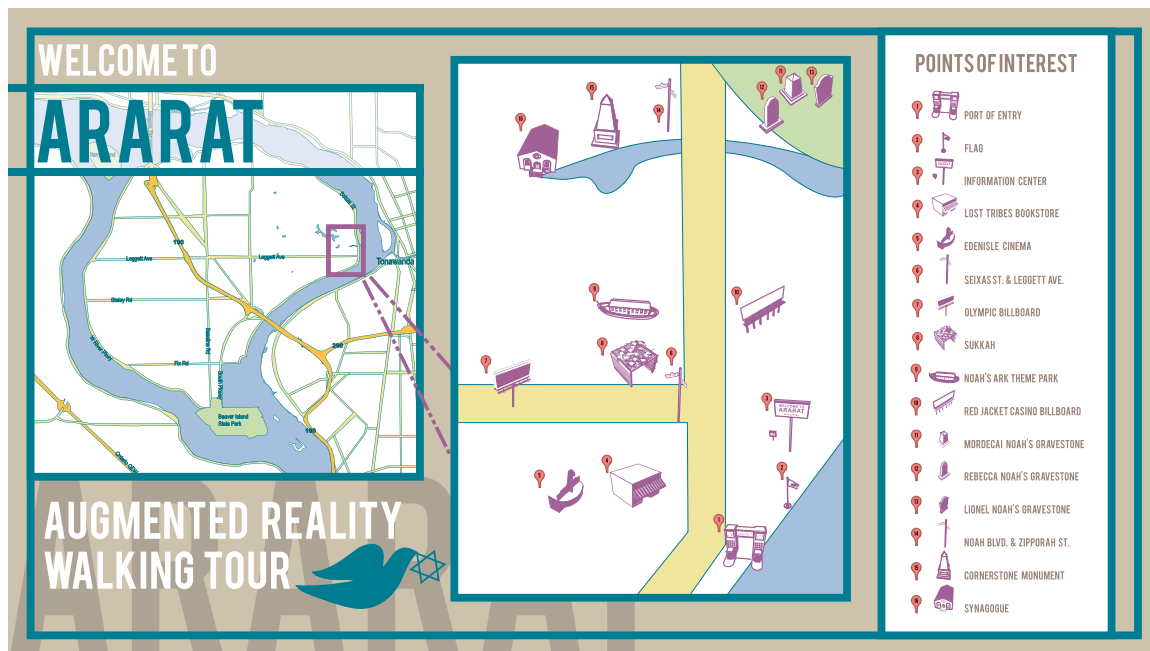
Fig. 6. Mapping Ararat Tour Stops (credit: Melissa Shiff).

Fig. 7. Ararat's Synagogue (credit: Melissa Shiff, Louis Kaplan, and John Craig Freeman).

Fig. 8. Ararat's Cornerstone Monument (credit: Melissa Shiff, Louis Kaplan, and John Craig Freeman).

These digital representations assume a temporal mode of historical causality, and thus have the potential to catalyze reflections on how (and why) the present differs from the past, as well as how present conditions have been influenced and shaped by occurrences in the past. More importantly, these projects can initiate a comparative mode of thinking in which visitors are invited to draw their own conclusions, or be somehow motivated into action as a result of comparing between "then" and "now."

3. Counterfactual Histories: Counterfactual history, also known as virtual history, is a form of historiography that explores and evaluates speculative scenarios. Beyond providing additional explanations to actual past events, these

explorations may also shed new light on present beliefs.[18] In this category, digital contents are used to visualize and further develop counterfactual narratives in order to pose questions concerning the alternative pasts, futures, and historic timelines. Although portraying alternative heritage, these AR projects are not complete fiction. Usually, the events they describe have a strong factual basis and were, in an absolute sense, real possible outcomes that were never materialized.[19] However, despite the availability of documents related to the counterfactual scenarios described, in many cases these apps do not superimpose archival materials themselves onto physical space. Instead, Counterfactual Histories AR apps use these materials as primary sources to digitally visualize the unfulfilled vision such documents portray. In this case,

spatial archiving is used not as a tool for the authentication of narratives, but rather as a creative technique through which virtual histories are imagined in situ, and through which we can contemplate speculative pasts and futures.

One example of how this can be put into practice is Melissa Shiff and Louis Kaplan's "Mapping Ararat" (Grand Island, New York, 2014), which digitally actualizes a plan for a prospective Jewish state in New York initiated and patronized by Mordecai Noah in the early nineteenth century. Noah purchased the land, his ambitious plan was approved, and Ararat was represented in contemporary maps.[20] In the Mapping Ararat app, visitors to Grand Island are invited to explore the never realized Ararat community through Shiff and Kaplan's vision, imagining how such a Jewish colony would look if it had been developed. The tour contains 24 digital monuments and structures accompanied by audio tracks describing the settings [Fig. 6].[21] Some of these monuments, including the synagogue, the movie theater, and the entry port, are entirely imagined [Fig. 7]; others, including the cornerstone and the cemetery monuments, involve digital (re)constructions based on historical evidence and archival documentations [Fig. 8]. The audio tracks are equally ambiguous: some are fictional, while others are based on actual historical documents and testimonials.[22] One of the most complex and thought-provoking monuments in the Mapping Ararat AR tour is a digital construction of a metal plaque commemorating a Native American land acknowledgment, attributing the land of Ararat and Grand Island to the Seneca people. This strategy of intertwining actual yet unspoken histories with alternative and virtual scenarios has the potential of producing a long-lasting reflection.[23] Here, AR is employed to activate a counterfactual narrative, thus raising awareness to repressed pasts and historic struggles.

The temporal perspective reflected in this practice is twofold: on the one hand, at the content level, this practice maintains some notions of historical causality and linearity, as it tells the story of Ararat as if it had existed; on the other hand, this strategy counters historical chronology, as it presents the historical moment as a combination (or as a clashing) of multiple timelines and histories.

4. Repressed Past: In this category, digital content is used in order to geo-locate and bring to life historically repressed narratives in a site-specific manner. The goal of such projects is usually to include marginalized or silenced narratives as a valid form of heritage, and thus to imagine another—virtual yet possible—shared future. This practice is usually employed to challenge, intervene, and decentralize dominant narratives, as it operates to portray history as a social (and often exclusionary) construct.[24] Since AR technology allows creators to circumvent institutionalized mechanisms of curatorial control over heritage, this strategy often serves to visualize and give voice to tangible and intangible histories

of Indigenous peoples and other marginalized groups. Two examples of this practice are: Ghosts of the Horseshoe (South Carolina, 2012), a project that exposes the repressed history of slave labor used to build the university campus in South Carolina; and Wikiup (Vancouver, 2017), an app that geo-locates intangible, verbal traditions and memories of First Nations in the Vancouver area. While Ghosts uses the haptic interface of mobile AR to simulate a handshake between participants and the enslaved narrators (an act which is required to activate the digital content), Wikiup uses our sense of mapping and proprioception to transform our perception of the immediate surroundings.[25] Both cases use AR to perform what Christine Ross calls "affective historicity."[26] By means of soliciting emotional, cognitive, and physical responses, Ghosts and Wikiup personalize history and actively connect the past with the present, a link which is enabled by the participants' bodies.

In addition to drawing attention to the politics of heritage production, there are two advantages to this strategy of AR. First, since mobile AR can be relatively cost-effective (especially in comparison to the production of VR environments, and also because it mostly runs on users' own devices), it is suitable for a field that often suffers from limited resources and funding. Second, since counter-dominant histories are often based on immaterial, oral traditions, the presence/absence of AR objects seem to be the perfect media for the recollection and reconnection of intangible legacies with relevant sites and landscapes. Consequently, the category of the Repressed Past is also useful in the excavation of multiple histories, as they are invisibly embedded in the process of transformation and realization of places.

5. Future Potentialities: In this category, digital content portrays multiple possible and speculative futures for the same material space. While one of the options portrayed is to be actualized, the others are feasible or potential, but will not be actualized. With the ability to describing multiple futures for one space-time simultaneously by incorporating them into a present AR experience, the practice of future potentialities can be deployed as a powerful strategy when attempting to defamiliarize temporal or historical conventions.

One example here is UAR, Urban Augmented Reality (Rotterdam/Amsterdam, 2013), which showcases approved architectural future plans of Amsterdam and Rotterdam alongside alternative plans that had been under consideration.[27] Another example is the mobile platform Future City (California and multiple locations, 2014), developed by the Re+Public collective. This app invites urban planners, designers, architects, engineers, artists, and activists to upload their plans and visions for urban environments, whether these are completely imagined, actually being considered, or have been approved by the municipal authorities.[28]

While the Future City platform reimagines urban space as a democratic place of exchange among users who share their visions for the city and speculate on its futures, it also reimagines cultural heritage as an ongoing practice concerned mostly with the future, rather than with the past. What this category demonstrates, therefore, is an alternative concept of heritage: the heritage to be preserved here is not what was or is, but what could or might be. In the context of future potentialities, cultural heritage itself is rediscovered as a process of content production. It is neither a tool for nor the outcome of documentation and preservation of past conditions. Rather, borrowing from Kalay, the practice of future potentialities establishes a "new cultural heritage" that enables innovative options for place-making and cultural identity building.[29]

6. Historical Modeling and Reconstruction: In this category, digital visualizations of an assumed past are imposed onto a relevant physical location, such as an archeological site. Although it often relies on archeological findings and archived documents, this practice is usually the result of processing such research materials. Therefore, it reflects an educated assumption about the past. A common use of this category is 3D modeling of ruins, monuments, or excavation sites, usually aimed to help visitors envision how these settings originally looked or were engaged with.

AR apps in this category are mainly commissioned or supported by leading cultural organizations. The apps' authors creatively interpret archival and archeological materials to produce 3D models and semi-historical narratives. In this respect, although this category is closely related to the category of Historical Annotation, these representations often exceed the limitations of the materials upon which they are based. Offering immersive digital designs of past environments, this category is about re-producing and re-interpreting the past in a contemporary digital format in situ.

One example of this practice is Mobile Optical Illusions (MOPTIL), a company for 3D computer graphics that produces digital AR, VR, and 3D reconstructions for archeological and historical sites in Greece and the Mediterranean (2014–ongoing) [Fig. 9].[30] While MOPTIL declares that all of its models are closely examined and approved by certified archeological institutions, MOPTIL's founder Michael Kokkinos also explains that his projects are "a compromise between a commercial product and a scientific product."[31] Accordingly, MOPTIL's projects also include mock historical scenes. And yet, the scientific authentications these projects carry serve to camouflage the fact that historical visualizations (digital or not) are interpretations. The result is what we may understand today as "faction": a combination of actual history with branches of pseudo-histories, of facts with their interpretations, and of markers of the past with contemporary remodeling into the present.

Other examples in this category are the Israeli interactive hiking apps The Sanhedrin Trail (Shvil HaSanhedrin) and The Trail of Independence (Shvil HaAtzmaut), both launched in 2018. Both apps are commissioned and funded by municipal and governmental authorities and, accordingly, they strictly tie digital modeling and historical reconstructions with a clear sense of national narrative through offering additional content to supplement and interpret archeological sites and urban settings. The Sanhedrin Trail presents visitors with 3D AR models of structures from the first century BC. It is meant to provide a guided, illustrated tour of the actual Sanhedrin Trail, serving to represent early Jewish settlements in the area of the Lower Galilee [Fig. 10]. The Trail of Independence, on the other hand, employs AR to reveal the history of Tel Aviv as the first Hebrew city.[32]

Since many of these projects are designed for already established heritage sites, they often support and perpetuate dominant perspectives and historical narratives, as these are promoted by the material objects of preservation. Nevertheless, projects can also be developed to produce immersive 3D models for alternative heritage sites. Developing counter-dominant Historical Modeling and Reconstruction ARs has the potential to present potent and convincing challenges to many omissions and discrepancies extant in dominant narratives. More significantly, this kind of project may also demonstrate a possible combination of the categories of Repressed Past and Historical Modeling and Reconstruction. While the narratives in the category of Repressed Past do not usually rely on archival or archeological materials, since many of those narratives have been actively silenced and removed from material space, coupling such narratives with actual archeological settings and 3D modeling may indeed be highly efficient in questioning accepted histories or other discursive truths. This duality also reflects the twofold potential of AR: on the one hand, it can enhance existing social constructs, while on the other hand, it is able to expose what Henri Lefebvre terms the "transparency" and "realism" of spatial construction.[33]

Why Does It Matter?

Considering the compositional temporality of AR and the practices mapped by the diagram of the Expanded Field, AR can be seen as an effective and creative tool that challenges traditional notions about concepts like past, future, virtuality, and history. As demonstrated, AR applications bring nuance to these terms and reflect on some of the underlying views, questions, and agendas that are at the base of AR as a producer of heritage. Moreover, because the practice categories may overlap, this model may be helpful in further developing and diversifying our use of AR in the field of cultural heritage.

Fig. 9. An AR reconstruction of the Cartagena archeological site in Spain, MOPTIL, 2020.
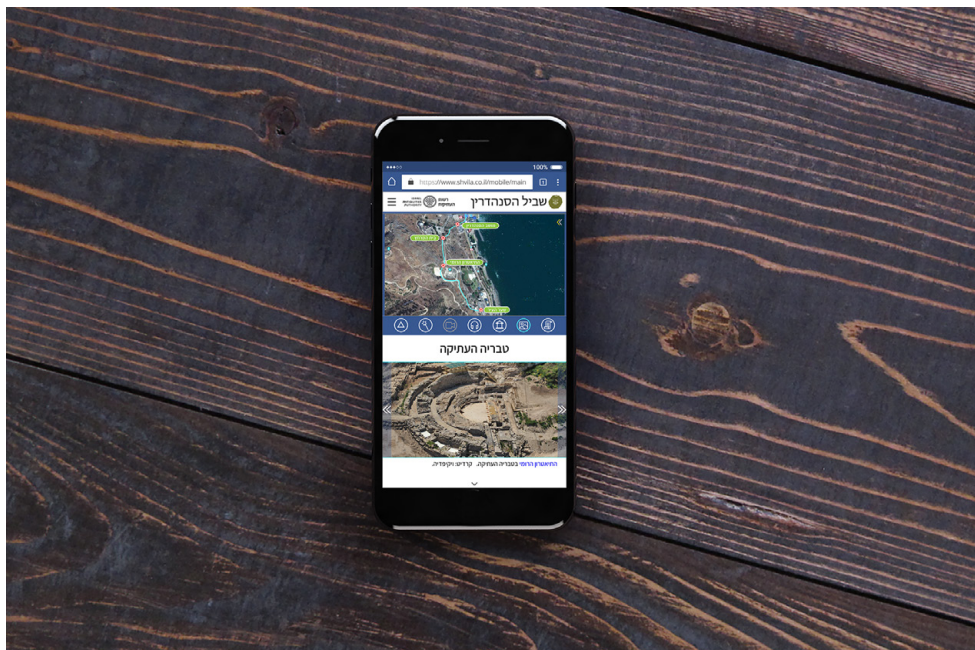

Fig. 10: The Sanhedrin Trail's mobile interface (credits: Israel Antiquities Authority, Tetitu, Amir Kubo, Liat Weinblum, and Yair Amitzur).

While some of these practices result in a disruptive performance, others conform to and reinforce existing spatial and social hierarchies. This mapping, therefore, provides us with a tool to critically consider and evaluate the workings of AR heritage. It illuminates the ways in which the production of AR heritage reflects on issues such as: digital memory; the value and meaning of preservation; social narratives' centralization vs. decentralization; the linearity and chronology of history; and the diffusion of fact and fiction, and of real and virtual domains. We should also acknowledge that, in many cases, there is no one in the position of monitoring the data quality and accuracy in AR. This can easily lead to the implementation of manipulated or misleading information and, considering the increasing proliferation of fake news, to the establishment of what Shanlon Gilbert terms "the wild west of AR."[34]

This analysis also exposes the nature of heritage as an already constructed field that interprets both past and future as cultural ideas rather than as points in time. Here it is also useful to consider Jay David Bolter and Maria Engberg's concept of "polyaesthetics," which relates to a condition in which we apply multiple aesthetic paradigms to interpret a single experience while being both "here and there."[35] In this context, the temporal polyphony portrayed by the expanded field of AR demonstrates a multiplicity of pasts and futures as they are being remediated by present terms and platforms.[36] This observation also requires that we perceive the digital production of AR heritage as an act of interpretation rather than as documentation or preservation, in which past and future are translated into present terms and are reproduced by contemporary means. Reconsidering previous perspectives on AR heritage, such projects may not necessarily turn the need for material preservation into a "moot point."[37] Instead, they can illuminate the complexity of preservation practices and their social implications. Recognizing this also allows us to engage more critically with the materials created and presented via AR platforms.

NOTES

[1] Paul Milgram, Haruo Takemura, Akira Utsumi, and Fumio Kishino, "Augmented Reality: A Class of Displays on the Reality-Virtuality Continuum" (paper presented at the SPIE [The International Society for Optical Engineering] Proceedings 2351: Telemanipulator and Telepresence Technologies, 1994). See also: Ronald T. Azuma, "A Survey of Augmented Reality," *Presence* 6, no. 4 (1997).

[2] Erkki Huhtamo, "Museums, Interactivity, and the Tasks of "Exhibition Anthropology"," in *Museum and Archive on the Move: Changing Cultural Institutions in the Digital Era*, ed. Oliver Grau, Wendy Coones, and Viola Rühse (Berlin: DeGruyter, 2018), 65.

[3] Lev Manovich, "The Poetics of Augmented Space," *Visual Communication*, 5, no. 2 (2006): 219–40.

[4] Dave Bharat, "Virtual Heritage: Mediating Space, Time and Perspectives," in *New Heritage: New Media and Cultural Heritage*, ed. Yehuda E. Kalay, Thomas Kvan, and Janice Affleck (London: Routledge, 2008), 41.

[5] Rosalind Krauss, "Sculpture in the Expanded Field," *October* 8 (1979), 30–41.

[6] Horea Avram, "Augmented Reality," in *Encyclopedia of Aesthetics* (Oxford: Oxford University Press, 2014), 232–36. Some of the common devices used for this purpose are handheld, such as smartphones or tablets. However, AR apps can also be designed for see-through devices or head-mounted displays (HMD) like Microsoft HoloLens.

[7] Jack Burnham, *The Structure of Art* (New York: George Braziller, 1971), 57. Here I should also mention that this type of diagram can also be linked to both the structuralist approach to visual culture and the mathematical concept of the Klein Group. See: Art Brenner, "The Structuralism of Claude Lévi-Strauss and the Visual Arts," *Leonardo* 10, no. 4 (1977). See also: Algirdas Julien Greimas and François Rastier, "The Interaction of Semiotic Constraints," *Yale French Studies* 41 (1968); Krauss, 37.

[8] George Baker, "Photography's Expanded Field," *October* 114 (2005), 120–40.

[9] Nanna Verhoeff, "A Logic of Layers: Indexicality of iPhone Navigation in Augmented Reality," in *Studying Mobile Media: Cultural Technologies, Mobile Communications, and the iPhone*, ed. Larissa Hjorth, Ingrid Richardson, and Jean Burgess (New York: Routledge, 2012); Jason Farman, *Mobile Interface Theory: Embodied Space and Locative Media* (New York: Routledge, 2013).

[10] Niall Ferguson, ed., *Virtual History: Alternatives and Counterfactuals* (New York: Basic Books, 1997), 83–4.

[11] Jay Donovan, "Timetraveler App Allows You to See the Berlin Wall Story in Augmented Reality," https://techcrunch.com/2014/09/22/timetraveler-app-allows-you-to-see-the-berlin-wall-story-in-augmented-reality/ (accessed January 31, 2019).

[12] "PhillyHistory," https://www.phillyhistory.org/PhotoArchive/Home.aspx (accessed January 31, 2019).

[13] Wolfgang Ernst, *Digital Memory and the Archive*, Electronic Mediations 39 (Minneapolis: University of Minnesota Press, 2013), 93.

[14] John Tagg, *The Disciplinary Frame: Photographic Truths and the Capture of Meaning* (Minneapolis: University of Minnesota Press, 2009), 209–34.

[15] According to Beiguelman, the archive is transformed "from a repository of documents to an art medium." Giselle Beiguelman, "Aesthetics of the Digital Ruins and the Future of Art Conservation" (paper presented at the ISEA, 2015).

[16] INDE, "Mobile AR: Resurrection." https://www.indestry.com/mobile-ar/ (accessed January 31, 2019).

[17] Giovanna Graziosi Casimiro, "Memory of Amnesia," https://www.ggcasimiro.com/memory-of-amnesia.html (accessed January 31, 2019).

[18] Richard J. Evans, *Altered Pasts: Counterfactuals in History* (Waltham, MA: Brandeis University Press/Historical Society of Israel, 2013), 9–10, 124–5.

[19] This observation follows Niall Ferguson's perspective on the nature of counterfactual history, as he argues that there should be an important distinction between all alternative scenarios. While there are unlimited opportunities to imagine alternative events, the narratives that actually deserve scholarly attention are those that are based on the most plausible scenarios. Scenarios are thus distinguished to be either plausible or implausible.

Investigating a plausible but alternative scenario is where virtual history gains its meaning and value. See: Ferguson, 18, 83–6. See also: Evans, 95.

20 Mapping Ararat, http://www.mappingararat.com/portfolio-item/maps/ (accessed January 31, 2019).

21 Louis Kaplan, "Mapping Ararat: Augmented Reality, Virtual Tourism, and Grand Island's Jewish Ghosts," *C/R: The New Centennial Review* 13, no. 2 (2013), 239–64.

22 Ibid., 243.

23 Kaplan, 254–5. This point was also explored in a seminar talk given by Shiff at the University of Toronto on October 29, 2015.

24 Jorge Otero-Pailos, "Experimental Preservation," *Places: Public scholarship on architecture, landscape, and urbanism* (September, 2016), https://placesjournal.org/article/experimental-preservation/?cn-reloaded=1 (accessed January 31, 2019).

25 Heidi Rea Cooley and Duncan A. Bull, "Ghosts from the Horseshoe, a Mobile Application: Fostering a New Habit of Thinking About the History of University of South Carolina's Historic Horseshoe," in *Annual Review of Cultural Heritage Informatics*, ed. Samantha K. Hastings (Laham, MD: Rowman & Littlefield, 2014).

26 Christine Ross, "Movement That Matters Historically: Janet Cardiff and George Bures Miller's 2012 'Alter Bahnhof Video Walk'," *Discourse: Journal for Theoretical Studies in Media and Culture* 35, no. 2 (2013): 215–7.

27 "UAR Underground," http://en.nai.nl/museum/architecture_app/item/_pid/kolom2-1/_rp_kolom2-1_elementId/1_1320525 (accessed March 15, 2016).

28 Heavy, "Experimental Augmented Reality: 'Future City'," https://www.heavy.io/future-city (accessed January 31, 2019).

29 Yehuda E. Kalay, "Introduction: Preserving Cultural Heritage through Digital Media," in *New Heritage: New Media and Cultural Heritage*, ed. Yehuda E. Kalay, Thomas Kvan, and Janice Affleck (London: Routledge, 2008), 11. Also, Erik Champion and Bharat

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30 MOPTIL, http://moptil.com/sites/ (accessed January 31, 2019).

31 This is based on an interview I conducted with Michael Kokkinos, founder and CEO of MOPTIL, on December 3rd, 2018.

32 The Sanhedrin Trail: https://www.davar1.co.il/62200/ (accessed January 31, 2019); The Trail of Independence: https://www.ynet.co.il/articles/0,7340,L-5341550,00.html#autoplay (accessed January 31, 2019).

33 Henri Lefebvre, *The Production of Space*, trans. Donald Nicholson-Smith (Cambridge, MA: Basil Blackwell, [1974] 1991), 27.

34 Shanlon Gilbert, "Explode the Museum: Echoes of the Explosion and the "Wild West" of Interpretation," *The iJournal: Graduate Student Journal of the Faculty of Information* 2, no. 3 (2017), 8. See also: Adam Greenfield, *Radical Technologies* (London: Verso, 2017), 76.

35 Maria Engberg and Jay David Bolter, "Cultural Expression in Augmented and Mixed Reality," *Convergence: The International Journal of Research into New Media Technologies* 20, no. 1 (2014), 6. See also: Jay David Bolter, Maria Engberg, and Blair MacIntyre, "Media Studies, Mobile Augmented Reality, and Interaction Design," *Interactions* 20, no. 1 (2013), 44.

36 The term "remediation" is used here in the same way as by Jay David Bolter and Richard Grusin in *Remediation: Understanding New Media* (Cambridge, MA: MIT Press, 2000).

37 Roger McKinley and Areti Damala, "ARtSENSE and Manifest.AR: Revisiting Museums in the Public Realm through Emerging Art Practices," in *The annual conference of Museums and the Web*, ed. Nancy Proctor and Rich Cherry (Portland, OR: Museums and the Web, 2013), http://mw2013.museumsandtheweb.com/paper/artsense-and-manifest-ar-revisiting-museums-in-the-public-realm-through-emerging-art-practices/.

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