VARDHI White Paper Lit Review August 2020. Rosalind Rothwell

This literature review/annotated bibliography surveys recent (since c. 2015) academic and popular literature on VR, AR, and the digital arts and humanities. A few major themes appear throughout the academic and popular literature. These include VR/AR as it relates to pedagogy; university-wide implementation of VR/AR; cultural heritage and VR/AR; VR/AR as an artistic medium; accessibility and equity (in terms of public access and disability accommodations) and VR/AR; and ethics, empathy, and health as they relate to VR/AR; and VR/AR as both a boon and hindrance to decolonial efforts. Finally, the COVID19 pandemic has spurred greater public interest in virtual reality. Academic publications note the need to bring literature on VR/AR beyond "descriptive" focus on "single courses or projects" to a "higher-altitude view."¹ Nonetheless, the publications listed below show that individual projects continue to be the focus of literature in the academic and public spheres.

Pedagogy and AR/VR

Although it is clear that AR/VR can and has been used in the university classroom, much of this use is still experimental. Some publications suggest AR/VR projects that had not yet been evaluated or implemented at the time of publication.² One report suggested that librarians be involved in the process of helping instructors match AR/VR with learning outcomes, though that work has not yet been done.³ The publications that do attempt to assess learning outcomes have found that AR/VR can absolutely help

¹ Quotation: Jeffrey Pomerantz, *XR for Teaching and Learning: Year 2 of the EDUCAUSE/HP Campus of the Future Project* (ECAR research report. Louisville, CO: EDUCAUSE, October 2019), 7-8. See also: Malcolm Brown, Mark McCormack, Jamie Reeves, D. Christopher Brooks, and Susan Grajek, with Bryan Alexander, Maha Bali, Stephanie Bulger, Shawna Dark, Nicole Engelbert, Kevin Gannon, Adrienne Gauthier, David Gibson, Rob Gibson, Brigitte Lundin, George Veletsianos, and Nicole Weber, *2020 EDUCAUSE Horizon Report, Teaching and Learning Edition* (Louisville, CO: EDUCAUSE, 2020). Jeffrey Pomerantz, *Learning in Three Dimensions: Report on the EDUCAUSE/HP Campus of the Future Project* (ECAR research report. Louisville, CO: EDUCAUSE, August 2018).Amanda Licastro, Angel David Nieves, Victoria Szabo, "The Potential of Extended Reality: Teaching and Learning in Virtual Spaces," *Journal of Interactive Technology & Pedagogy*, Iss. 17 (May 20, 2020). ² Emory Craig and Maya Georgieva, "VR and AR: The Art of Immersive Storytelling and Journalism,"

EducauseReview, February 8, 2018. Craig and Georgieva, "VR and AR: Learners as Creators and World Builders of Our Immersive Future," *EducauseReview,* December 15, 2017.

³ Matthew Hannah, Sarah Huber, and Sorin Adam Matei, "Collecting Virtual and Augmented Reality in the Twenty-First Century Library," *Collection Management*, Vol. 44, No. 2-4 (March, 2019), 277-295.

students master material. Many reports emphasize experiential learning (especially as it relates to STEM fields).⁴ However, there has also been some attention to humanities and social sciences. For example, one study in Spain found that a VR experience depicting the medieval town of Briviesca positively affected students' understanding of the history of architecture and urban planning.⁵ EDUCAUSE reports and other publications have attempted to evaluate various types of projects and determine how they can most effectively be implemented in the classroom. Two publications have produced tables suggesting effective "matches" of AR/VR technology with specific types of learning goals or lesson plans.⁶ Many such reports emphasize that faculty cannot simply drop AR/VR into their classrooms, but must incorporate them within a "holistic" pedagogical framework.⁷

Implementation at the University Level

EDUCAUSE reports in particular have addressed the adoption of AR/VR in higher education at an institutional level.⁸ Problems in institutional adaptation include the need for a variety of offices, notably IT, to work together toward common goals.⁹ Additionally, it is essential to provide training and equitable access to technology for faculty and students.¹⁰ Skill level is important when considering student contributions to projects.¹¹ Cost is another major concern, although technologies like Google Cardboard

⁴ Michael Sano, "Can AR/VR Improve Learning? Integrating Extended Reality Into Academic Programs #DNLChat" <u>EdSurge.com</u>. July 19, 2018.

⁵ David Checa and Andres Bustillo, "Advantages and limits of virtual reality in learning processes: Briviesca in the fifteenth century," *Virtual Reality*, Vol. 24 (2020): 151-161.

⁶ Pomerantz, 2018. Kent Bye and Erica Southgate, "Podcast #927: Erica Southgate's Book on VR Pedagogy & Teaching Higher-Order Metacognition Skills," *Voices of VR Podcast*, July 15, 2020.

⁷ Malcolm Brown, Mark McCormack, Jamie Reeves, D. Christopher Brooks, and Susan Grajek, with Bryan Alexander, Maha Bali, Stephanie Bulger, Shawna Dark, Nicole Engelbert, Kevin Gannon, Adrienne Gauthier, David Gibson, Rob Gibson, Brigitte Lundin, George Veletsianos, and Nicole Weber, *2020 EDUCAUSE Horizon Report, Teaching and Learning Edition* (Louisville, CO: EDUCAUSE, 2020), 30.

⁸ Jeffrey Pomerantz, *Extending XR Across Campus: Year 2 of the EDUCAUSE/HP Campus of the Future Project.* May 12, 2020. (N.P.)

Pomerantz, 2019. Pomerantz, 2018.

⁹ Karen Wetzel, Betsy Reinitz, Susan Grajek, Christopher Brooks, Eden Dahlstrom, Marc Stith, and Veronica Diaz, "7 Things You should Know About Digital Transformation," Educause, 2018.

¹⁰ Pomerantz, 2018.

¹¹ Emory Craig and Maya Georgieva, "From VR and AR to Our XR Future: Transforming Higher Education," *EducauseReview*, August 22, 2018.

show promise for increasing affordability.¹² Further, despite the "virtual" elements of AR/VR,

scholarship has also attempted to delineate appropriate physical spaces in which to create and use AR/VR; some have suggested the importance of creating lab spaces to encourage interactivity.¹³ Others proposed designing separate spaces intended for creation and implementation.¹⁴ A more recent publication has suggested that AR/VR can be most effective when it is implemented in the traditional classroom space, in addition to lab spaces. (Note that this last publication concerns K-12 education.)

Cultural Heritage & Libraries

Recent scholarship has also explored the application of AR/VR in cultural heritage settings,

especially museums. Among publications reviewed here, AR/VR has been most commonly applied to sites or objects involving ancient art and culture. These include a VR game at a Neolithic site; a VR game at a Cycladic sculpture museum; an augmented ancient Egyptian tomb; augmentation of certain objects at the DIA, such as fragments of the Ishtar Gate; and an exhibition on the Terracotta Warriors.¹⁵ Other projects have centered on contemporary and 20th-century history, with social justice elements.¹⁶ Still more have made physical objects and architectural spaces available for online viewers or visitors.¹⁷ One

¹² Craig and Georgieva, "From VR and AR to Our XR Future: Transforming Higher Education," *EducauseReview*, August 22, 2018. Craig and Georgieva, "A New World: VR and AR Tech Developments," *EducauseReview*, July 17, 2017.

¹³ Craig and Georgieva, "Designing Immersive Learning and Storytelling Experiences with 360° Video," *EducauseReview*, January 9, 2019. Pomerantz, 2020.

¹⁴ Jeffrey Pomerantz, *Extending XR Across Campus: Year 2 of the EDUCAUSE/HP Campus of the Future Project.* May 12, 2020. (N.P.)Craig and Georgieva, "VR and AR: Designing Spaces for Immersive Learning," *EducauseReview*, October 31, 2017.

¹⁵ Panayiotis Koutsabasis and Spyros Vosinakis, "Kinesthetic interactions in museums: conveying cultural heritage by making use of ancient tools and (re-) constructing artworks," *Virtual Reality*, 22 (2018): 103-118. Anna Puig, Inmaculada Rodríguez, Josep Ll. Arcos, Juan A. Rodríguez-Aguilar, Sergi Cebrián, Anton Bogdanovych, Núria Morera, Antoni Palomo, and Raquel Piqué, "Lessons learned from supplementing archaeological museum exhibitions with virtual reality," *Virtual Reality* (2020) 24, 343-358. Isabel Pedersen, Nathan Gale, Pejman Mirza-Babaei, and Samantha Reid, "More than Meets the Eye: The Benefits of Augmented Reality and Holographic Displays for Digital Cultural Heritage," *ACM Journal on Computing and Cultural Heritage*, Vol. 10, No. 2 (March 2017): 1-15. [Note that this last project does not appear to have been implemented.] Jon Hurdle, "Arming China's Terracotta Warriors—With Your Phone," *The New York Times*, September 29, 2017.

¹⁶ Lucy May, "COLUMN: New Freedom Center exhibit helps you feel what Rosa Parks experienced on the bus in 1955: 'It brought it to life'," WCPO Cincinnati, September 23, 2016.

Jacob Greene and Madison Jones, "Articulate Detroit," <u>http://cconlinejournal.org/articulatedetroit/</u>. c. 2017-2019. ¹⁷ James Barron, "Stepping Into a 1920s Paris Apartment, From Fifth Avenue," *The New York Times*, Jan 1, 2017.

VR experience sought to use VR to bring museum visitors to inaccessible spaces in Syria and Iraq, highlighting both architectural destruction and personal stories.¹⁸ Academic museum-related publications have engaged with and assessed issues such as audience engagement, clarity of learning goals and instruction, and accessibility.¹⁹ Both academic and popular publications repeatedly assert that AR/VR experiences positively contribute to visitor experiences and are not simply gimmicks.²⁰

AR/VR and Visual Arts

Popular media such as major newspapers, magazines, and blogs have focused heavily on the

visual arts in relation to AR/VR. In some cases, AR/VR platforms have been used to make works of art

more accessible to the general public.²¹ Others have reconstructed historic exhibitions, including now-lost

works of art.²² Of particular interest are works created specifically in AR/VR. Most often, popular media

has highlighted art created specifically for AR/VR.²³ Numerous such exhibitions have appeared in New

York City--sometimes with corporate tie-ins--and other projects exist nationwide.²⁴

Graham Roberts, "Capturing an American Icon for Augmented Reality. For a new A.R. project, we combined 675 photos of the original torch of the Statue of Liberty to allow readers to see it up close as never before.," *The New York Times,* November 19, 2018.

¹⁸ Vanessa H. Larson, "At the Sackler Gallery, take a virtual-reality tour of cities ravaged by ISIS and war," *The Washington Post*, March 4, 2020.

¹⁹ (I'm going to guess that these institutions have such specific aims in part due to their need to follow specific institutional missions and work with specific exhibitions.)

²⁰ Mafkereseb Kassahun Bekele, Roberto Pierdicca, Emanuele Frontoni, Eva Savina Malinverni, and James Gain. "A Survey of Augmented, Virtual, and Mixed Reality for Cultural Heritage." *ACM Journal on Computing and Cultural Heritage*, Vol. 11, No. 2, Article 7 (March 2018): 1-36. Megan DiRienzo, Andrea Montiel de Shuman, Alicia Vieri, "Humanizing Augmented Reality with Lumin," in Suse Anderson, Isabella Bruno, Hannah Hethmon, Seema Rao, Ed Rodley, and Rachel Ropeik, eds., *Humanizing the Digital: Unproceedings from the MCN 2018 Conference* (Ad Hoc Museum Collective: March 2019), 39-45.

Joshua J. Paladino, "DIA to launch 'Lumin' augmented reality tour," *The Detroit News*, January 9, 2017. Jon Hurdle, "Arming China's Terracotta Warriors—With Your Phone," *The New York Times*, September 29, 2017.Nina Siegal, "Want to See All the Vermeers in the World? Now's Your Chance," *The New York Times*, December 3, 2018. Jake Cigainero, "European Museums Get Adventurous With Virtual Reality," *The New York Times*, March 12, 2018. ²¹ Nina Siegal, "Virtual Reality Lets Rare Works of Art Take a Field Trip," *The New York Times*, March 10, 2018. ²² Jennifer Schuessler, "Fora Shakespeare Anniversary, an Online Re-creation of a 1796 Show," *The New York Times*, December 16, 2015.

 ²³ Rebecca Schmid, "Virtual Reality Asserts Itself as an Art Form in Its Own Right," *The New York Times*, May 1, 2018. Ted Loos, "A Walk on the Frontier of Art, Where the Sky Is the Limit. Augmented reality and virtual reality are opening doors to new experiences for artists and the public.," The New York Times, November 27, 2019.
 ²⁴ Sophie Haigney, "Apple Transforms Central. Park Into an Augmented Reality Gallery. Works by Nick Cave, Nathalie Djurberg, John Giorno and others have been choreographed into the landscape for an Apple-New Museum walking tour.," *The New York Times*, August 9, 2019.

Collections and Libraries

Collections management and library professionals have attempted to create standards for preserving and sharing 3D data. A publication on libraries and AR/VR/3D images featured multiple essays that offered different solutions to managing 3D data.²⁵ While this and like publications have attempted to create space to streamline and standardize approaches toward AR/VR/3D, any such standards are still very much tentative.²⁶ The emphasis librarians place on the management and accessibility of 3D data appears particularly important in light of the COVID19 pandemic. By contrast, individuals in physical cultural heritage institutions have emphasized the need to increase audience engagement with their spaces, at times choosing to restrict access to digital experiences to in-person users. ²⁷ On the opposite end of the spectrum, at least one popular article has criticized libraries for being (in the author's view) too high-tech, rather than focusing on basic essentials like physical books.²⁸

Accessibility and Ethics

Popular media has emphasized the effects of AR/VR on ethics, empathy, and mental health

(though there are also a few academic articles which discuss these themes). Many AR/VR creators and

commentators have suggested empathy as a major positive goal of their programs. However, critics have

suggested that a short AR/VR experience cannot fully allow people to understand certain lived

Hilarie M. Sheets, "Mel Chin to Sound the Call, All Over New York," *The New York Times*, November 21, 2017. David Colman, "'Liberty Bell' Tolls for Sites Where History Is Alive and Kicking. Nancy Baker Cahill uses augmented reality to explore the meaning of historical sites from the Rockaways in New York to Selma, Ala. Is public art embellishing our heritage, or defacing it?," *The New York Times*, July 2, 2020.

²⁵ 3D/VR in the Academic Library: Emerging Practices and Trends. Jennifer Grayburn, Zack Lischer-Katz, Kristina Golubiewski-Davis, Veronica Ikeshoji-Orlati, eds. Feb 2019.

https://www.clir.org/wp-content/uploads/sites/6/2019/02/Pub-176.pdf. Fred Limp, Angie Payne, Katie Simon, Snow Winters and Jack Cothren, "Developing a 3D digital heritage ecosystem: from object to representation and the role of a virtual museum in the 21st century," *Internet Archaeology* (July 2011)

²⁶ Hannah, et al.

²⁷ Paloma Díaz, Andrea Bellucci, Chien-Wen Yuan, Ignacio Aedo, "Augmented Experiences in Cultural Spaces through Social Participation," ACM Journal on Computing and Cultural Heritage, Vol. 11, No. 4 (December 2018), 19:1-14.

²⁸ Alia Wong, "College Students Just Want Normal Libraries," *The Atlantic*, October 4, 2019.

experiences, and even result in harmful impressions of others' experiences.²⁹ Ethics commentators have also raised concerns about the appropriateness of creating embodied experiences of certain individuals, or of augmenting certain spaces. Nazi Germany and the Holocaust appear repeatedly in both academic and popular literature as particularly ethically questionable topics. The presence of AR games (notably Pokémon Go) at Holocaust sites, and proposed VR experiences in which users would embody Nazi executioners.³⁰ Such topics have received more positive reception in the context of forensics investigations. The VR recreation of Auschwitz-Birkenau helped prosecute a Nazi guard in 2016.³¹

Accessibility for people with disabilities appears as a recently emerging topic of discussion and research within academic scholarship on AR/VR. In particular, literature has emphasized the need to create materials that are accessible for people with hearing and visual impairments.³² Few projects have engaged with these issues, though some have mentioned the need to further develop and test accessible AR/VR experiences. Some have also mentioned the role of 3D scanning and imaging in creating learning tools for people with visual impairment.³³ Finally, one project allows children to create their own VR worlds as a form of non-verbal communication with child therapists.³⁴ These interests have appeared

 ²⁹ Paul Bloom, "It's Ridiculous to Use Virtual Reality to Empathize With Refugees. The technology isn't the moral game-changer that some make it out to be.," *The Atlantic,* February 3, 2017.
 ³⁰ Jonah Engel Bormwich, "Where Pokémon Should Not Go," *The New York Times,* June 12, 2016.

Erica L. Neely, "Augmented reality, augmented ethics: who has the right to augment a particular physical space?," *Ethics and Information Technology*, Vol. 21, (2019): 11-18. Andrew E. Kramer and Maria Varenikova, "Victim or Executioner? Let the Computer Decide. An interactive plan for a Holocaust museum envisioned sorting visitors into victims, executioners and collaborators. Backlash ensued," *The New York Times*, May 11, 2020.

³¹ David Friend, "Nazi VR," *The Atlantic*, April 5, 2019.Marc Cieslak, "Virtual reality to aid Auschwitz war trials of concentration camp guards," BBC, 20 November 2016. https://www.bbc.com/news/technology-38026007.

³² Amy Hetherington and Peter Pavement, "'Virtual Accessibility': Interpreting a Virtual Reality Art History Experience for Blind and Partially Sighted Users," in Suse Anderson, Isabella Bruno, Hannah Hethmon, Seema Rao, Ed Rodley, and Rachel Ropeik, eds., *Humanizing the Digital: Unproceedings from the MCN 2018 Conference* (Ad Hoc Museum Collective: March 2019), 39-45. Patricia Chang, "Inclusivity of VR and AR Accessibility for the Visually and Hearing Impaired," *AR Post*, September 18, 2018.

³³ Will Rourk, "3D Cultural Heritage Informatics: Applications to 3D Data Curation," *3D/VR in the Academic Library: Emerging Practices and Trends* (Arlington, VA: Council on Library and Information Resources, Feb 2019), 24-38.

³⁴ Kent Bye and Jessica Stone, "Podcast #928: Play Therapy in VR with Virtual Sandtray & Dr. Jessica Stone," *Voices of VR Podcast*, July 21, 2020.

simultaneous to movement toward creating fully embodied VR experiences with visual, auditory, and haptic stimulation.

AR/VR and Decolonization

Finally, VR/AR and 3D imaging has been considered in the context of decolonizing academic and collections practices. For example, some individuals have used 3D imaging to virtually repatriate indigenous objects (while also protecting their delicate physical status).³⁵ Others have attempted to apply decolonial theory to teaching and AR/VR, observing, for example, that the technologies used to create AR/VR experiences themselves hold biases that are sometimes reproduced in works. They therefore "naturaliz[e] problematic historical and political narratives."³⁶ Each of these articles suggests productive ways to decolonize collections standards and AR/VR creation through critical techniques. Others have noted the importance of involving Indigenous communities when producing AR/VR projects involving their histories or cultures.³⁷

Public/Commercial Life, COVID19 Pandemic, and VR/AR

Popular publications have regularly commented on VR/AR's intrusion into everyday life, and have recently noted the effects of the COVID19 pandemic on interest in virtual realities. Athletics has become one popular realm for VR; some experiences help professional or college athletes train, while others make at-home fitness more enjoyable and physically worthwhile.³⁸ Although AR shopping existed pre-COVID, it has become increasingly popular as retailers hope to survive the pandemic.³⁹ Pre-COVID

³⁵ Medeia Csoba DeHass and Alexandra Taitt. "3D Technology in Collaborative Heritage Preservation." *Museum Anthropology* 12 no. 2 (2018): 120–153.

³⁶ Lorena Gauthereau, Jessica Linker, Emma Slayoton, Alex Wermer-Colan, "Immersive Pedagogy: Developing a Decolonial and Collaborative Framework for Teaching and Learning in 3D/VR/AR," *Journal of Interactive Journal of Interactive Journal of Interactive Technology & Pedagogy*, Iss. 17 (May 20, 2020).

³⁷ Amy J. Lueck, Lee M. Panich, "Representing Indigenous Histories Using XR Technologies in the Classroom," *Technology & Pedagogy*, Iss. 17 (May 20, 2020).

³⁸ Kit Ramgopal, "Virtual Reality Companies Are Changing How Athletes See Practice," *The New York Times,* November 24, 2017. Vickey Hallett, "Tired of biking in the gym? Virtual reality lets you cycle in Iceland, instead," *The Washington Post,* February 24, 2020.

³⁹ Abha Bhattarai, "Virtual try-ons are replacing fitting rooms during the pandemic," *The Washington Post*, July 9, 2020.

efforts to digitize Jerusalem and other major holy sites gained sudden relevance as the pandemic affected travel during Ramadan, Easter, and Passover.⁴⁰ Animal lovers have also benefited from VR zoo and aquarium experiences during lockdown.⁴¹

The pandemic has increased uses of AR/VR in social media apps and as forms of social media themselves. AR filters on Instagram have added interest and humor to now-perpetual and mundane video chats.⁴² *Animal Crossing: New Horizons* has gained viral status during COVID19 as people have used the game as an alternative to video chat communication with friends; some have speculated that the pandemic may increase popularity of VR and AR games among the general public.⁴³

⁴⁰ Debra Kamin, "For Shut-In Pilgrims, the World's Holiest Sites Are a Click Away. The pandemic has closed holy sites across the globe, but virtual reality is providing worshipers a digital window into ceremonies during touchstone holidays.," *The New York Times*, March 30, 2020.

⁴¹ Laurel Graeber, "Virtual Encounters With Purring Cheetahs and Curious Penguins. Zoos are beginning to open, but digital experiences allow visitors to see ecosystems from a different perspective.," *The New York Times*, July 23, 2020.

⁴² Kaitlyn Tiffany, "It's Cool to Look Terrifying on Pandemic Instagram," The Atlantic, May 11, 2020.

⁴³ Alice Power, "Pandemic Objects: Animal Crossing," *V&A Blog*, July 24, 2020. Sam Desatoff, "Animal Crossing: New Horizons and its impact on a pandemic-stricken world," *GameDaily.biz*, May 11, 2020.

EDUCAUSE AR-VR SERIES - Craig and Georgieva [This series consists of short articles that provide very general overviews of certain issues.]

Emory Craig and Maya Georgieva, "Introducing the VR and AR Series: Stepping Into the New Frontier of Learning Series," *EducauseReview*, June 30, 2017.

• The articles in this series are based on the authors' experiences with VR/AR in a variety of settings across Europe, US, and Canada. The articles will focus on the potential of the field.

Craig and Georgieva, "A New World: VR and AR Tech Developments," *EducauseReview*, July 17, 2017. <u>https://er.educause.edu/blogs/2017/7/introducing-the-vr-and-ar-series-stepping-into-the-new-frontier-of-le</u> <u>arning-series</u>

• New technology in headsets makes it easier to participate in VR on campus, including Google Cardboard, Oculus Rift, HTC Vibe.

Craig and Georgieva, "VR and AR: Transforming Learning and Scholarship in the Humanities and Social Sciences," *EducauseReview*, October 6, 2017. https://er.educause.edu/blogs/2017/10/vr-and-ar-transforming-learning-and-scholarship-in-the-humanities-and-social-sciences

• This article lists a few different projects ongoing in the humanities in 2017. Among them are literary video games, reconstructions of ancient monuments, VR Dalí painting experiences, and museum VR experiences. The authors emphasize the "multisensory" and "public" nature of these projects.

Craig and Georgieva, "VR and AR: Designing Spaces for Immersive Learning," *EducauseReview*, October 31, 2017.

• This article outlines how educational spaces can best support or be designed with VR/AR learning in mind. The authors recommend an "Immersive Learning Lab," which would include various spaces that allow different kinds of interaction with VR, whether designing, testing, or observing users.

Craig and Georgieva, "VR and AR: Learners as Creators and World Builders of Our Immersive Future," *EducauseReview*, December 15, 2017.

• This article outlines some possible activities for student-created VR projects. In classes, students learn how to use technology and targeted projects to local public history institutions/museums and K-12 institutions.

Craig and Georgieva, "From VR and AR to Our XR Future: Transforming Higher Education," *EducauseReview*, August 22, 2018.

• Discusses changes to AR/VR in education since the 2017 series. In particular, the authors are interested in how improvements to technology and price range can make student participation in projects easier. They also note trends in accessibility, ethics, and forthcoming studies on VR and learning.

Craig and Georgieva, "VR and AR: The Art of Immersive Storytelling and Journalism," *EducauseReview*, February 8, 2018.

• This article concerns "storyscapes" or immersive storytelling and its possible uses for advocacy or journalism. Among the immersive technologies are VR, AR, 360 video, theater, data visualization. The authors note that is a very new area that has produced many failures thus far.

Craig and Georgieva, "Designing Immersive Learning and Storytelling Experiences with 360° Video," *EducauseReview*, January 9, 2019.

• This article discusses technology changes that make it possible for faculty to implement 360 video in their classes and research. Faculty must consider how to guide users through a 360 experience. Benefits include experiential learning.

EDUCAUSE REPORTS

Dx: Digital Transformation of Higher Education

Jim Phillips and Jim Williamson, "Dx in Practice: Triggers, Impacts, and Outcomes," EducauseReview, June 3, 2019. <u>https://er.educause.edu/articles/2019/6/dx-in-practice-triggers-impacts-and-outcomes</u>

• This article raises general questions about "Dx." The authors discuss the difficulty of defining Dx—"new strategic approach" or "data processing"?—and asks whether technology will have negative effects on society. They also suggest that ongoing higher education engagement with AR/VR has "forever altered" IT.

Karen Wetzel, Betsy Reinitz, Susan Grajek, Christopher Brooks, Eden Dahlstrom, Marc Stith, and Veronica Diaz, "7 Things You should Know About Digital Transformation," Educause, 2018. https://library.educause.edu/resources/2018/10/7-things-you-should-know-about-digital-transformation

• The authors argue that technology is transforming higher education—apparently for the better. Overall the authors recommend developing new collaborative workflows and offices on campus, to handle IT changes in particular. The author notes that technology can strengthen, rather than detract from, educational goals, including access to education and diversity.

John O'Brien, "Digital Ethics in Higher Education," *EducauseReview*, May 18, 2020. https://er.educause.edu/articles/2020/5/digital-ethics-in-higher-education-2020

• This grim article outlines the ethical implications of scientific research/innovation, AI, and immersive technology since the 2010s. The article frames the story in the context of dystopian films and other popular media. *Minority Report* included nefarious uses of targeted AR advertising, for example. The article discusses campus concerns, including the implementation of big data analytics to surveil students and potential recruits. O'Brien suggests that universities hire Chief Privacy Officers to protect student privacy. The article further suggests that universities can bring positive change to future technologies by integrating ethics in STEM programs. O'Brien applauds Northwestern University president Joseph Auon's aim to create a new "humanics" discipline in which there is "a central role for human agency."

Jeffrey Pomerantz. *Learning in Three Dimensions: Report on the EDUCAUSE/HP Campus of the Future Project*. ECAR research report. Louisville, CO: EDUCAUSE, August 2018. https://library.educause.edu/-/media/files/library/2018/8/ers1805.pdf?la=en&hash=6D6BE338BD689480 7A5236B0913A35165574E111

Eleven schools used AR/VR/3D scanning and printing technologies from HP. This report includes some key takeaways from the project. XR technologies contribute positively to learning, especially experiential and collaborative learning. Nonetheless, successfully managing and implementing these technologies requires a campus-wide approach, and patience. The report addresses these questions: "What educational activities lend themselves to the use of 3D technologies?" and "What are the most effective 3D technologies for various learning goals?" (7) The report describes the technology that HP provided to each school. The report found that faculty in particular needed encouragement and training to learn how to use 3D technology, whereas students were eager to learn and explore. Faculty must combine technology with existing pedagogy. The report suggests various uses for 3D technology in different disciplines, including a table matching technologies or assignments with various learning goals.

Jeffrey Pomerantz. XR for Teaching and Learning: Year 2 of the EDUCAUSE/HP Campus of the Future Project. ECAR research report. Louisville, CO: EDUCAUSE, October 2019. https://library.educause.edu/-/media/files/library/2019/10/2019hpxr.pdf?la=en&hash=306474918AA2F10 1DDDCABD59E4366AD7244D572

• This report on XR in higher education aims to move beyond current "descriptive" literature that focuses on "single courses or projects" to a "higher-altitude view." (7-8) This report echoes several of the findings from the 2018 report, based on interviews at 17 schools. Among them are

the positive effects of XR on learning in general, but especially to three categories: "(1) Supporting skills-based and competency-based teaching," "(2) Expanding the range of activities with which a learner can gain hands-on experience," and "(3) Experimenting by providing new functionality and enabling new forms of interaction." (pg 4) Again, concerns about technology training for students and staff and the need to integrate existing pedagogy with technology arise. The report also raises concerns about costs. Recommendations include: the need to restructure IT services to operate in more collaborative ways; the need for adaptation to occur at the institutional level; and the importance of pedagogy.

Jeffrey Pomerantz, *Extending XR Across Campus: Year 2 of the EDUCAUSE/HP Campus of the Future Project*. May 12, 2020. (N.P.) https://library.educause.edu/resources/2020/5/extending-xr-across-campus

• This report, also on the HP/EDUCAUSE project, focuses on campus-wide approaches to XR. The article emphasizes that faculty, staff, IT, libraries, and leadership must collaborate on initiatives. It asks, "What factors influence institutional deployment of XR technology?" Pomerantz suggests that institutions can effectively deploy XR if they build XR labs and studios; encourage faculty to report on experiments in XR pedagogy; integrate IT and libraries in the process; and ensure equitable access to technology among students. He also makes suggestions about purchasing XR technologies for higher education vs. corporate or personal packages.

Malcolm Brown, Mark McCormack, Jamie Reeves, D. Christopher Brooks, and Susan Grajek, with Bryan Alexander, Maha Bali, Stephanie Bulger, Shawna Dark, Nicole Engelbert, Kevin Gannon, Adrienne Gauthier, David Gibson, Rob Gibson, Brigitte Lundin, George Veletsianos, and Nicole Weber, *2020 EDUCAUSE Horizon Report, Teaching and Learning Edition* (Louisville, CO: EDUCAUSE, 2020). https://library.educause.edu/-/media/files/library/2020/3/2020_horizon_report_pdf.pdf?la=en&hash=08A9 2C17998E8113BCB15DCA7BA1F467F303BA80

• The 2020 Teaching and Learning Report focuses on trends in education broadly, including social, economic, and other factors that affect the application of technology in higher education. A few pages of the report discuss XR specifically. (29-31) They identify major challenges in the cost of technology and training needs, but emphasize that it is a proven pedagogical tool. It "augment[s]" rather than replaces other pedagogical tools and can ultimately "reduce overall institutional costs." (30) The report also emphasizes the need to intentionally and strategically incorporate XR within a "holistic" pedagogical framework. (30)

CULTURAL HERITAGE/LIBRARIES

Mafkereseb Kassahun Bekele, Roberto Pierdicca, Emanuele Frontoni, Eva Savina Malinverni, and James Gain. "A Survey of Augmented, Virtual, and Mixed Reality for Cultural Heritage." *ACM Journal on Computing and Cultural Heritage*, Vol. 11, No. 2, Article 7 (March 2018): 1-36.

- This essay surveys literature on cultural heritage (CH) and immersive reality (IR, i.e. AR, VR, and MR) from the early 2000s. Its three aims are
 - (1) "to outline state-of-the-art research and applications of augmented, virtual, and mixed reality for the CH domain," (pg2)
 - (2) "to reveal areas of research concentration and deficiency in the field," (pg2) and
 - (3) "to provide a framework for comparing state-of-the-art systems and to understand which solutions are most appropriate for a given application." (pg2)
- First, the essay surveys technologies utilized in immersive reality projects, including types of modeling, tracking, devices, interfaces, and development tools. Next, it categorizes CH efforts into the following five categories:
 - (1) "Education aims at enabling users to learn the historical aspects of tangible and intangible CH," (pg.16)
 - (2) "Exhibition enhancement is intended to improve the visitor experience at physical museums and heritage sites," (pg.16)
 - (3) "Exploration supports users in visualizing and exploring historical and current views of CHs to discover, interpret and acquire new insight and knowledge," (pg.16)
 - (4) "Reconstruction aims at enabling users to visualize and interact with reconstructed historical views of tangible and intangible CHs," (pg.17) and
 - (5) "Virtual museums stimulate and present tangible and intangible CHs in digital museum form to the public." (pg.17)
- The authors emphasize the positive engagement and learning effects of IR. However, they caution that museums must take into account a wide range of visitors who may be unfamiliar with technology. Overall, CH sites most commonly use IR in the form of AR enhancement of physical exhibitions or archaeological sites (indoor and outdoor spaces). VR requires technology and space indoors. CH uses of VR include digital reconstructions of museums with gamified elements. The authors identify three major barriers to use of IR in CH:
 - "(i) technological limitations,
 - (ii) content complexity, and
 - (iii) human factors." (29)
 - Their six suggested areas of research to improve the use of IR in CH are:
 - "Robust Tracking;"
 - "Standardization" of methods and implementation;
 - "User-Driven Semantics;"
 - "Tangible AR;"
 - "Fully Immersive VR," especially as technology has become more affordable; and
 - "Multimodal Interfaces." (29)

Medeia Csoba DeHass and Alexandra Taitt. "3D Technology in Collaborative Heritage Preservation." *Museum Anthropology* 12 no. 2 (2018): 120–153.

• This article discusses 3D technology in the context of Indigenous cultural heritage repatriation and decolonial museum/collections practices. The authors provide the following definition: "In its

most elementary form, digital repatriation neither negates the possibility of nor promises to achieve the physical repatriation of collection pieces to origin communities. Its central tenet is to provide a connection between institutional collections and origin communities in a digital space by sharing information, facilitating discussion, and returning some form of cultural knowledge." (127) The authors argue that using the term "repatriation" to 3D modelling is "fully accurate and signifies the return of intangible cultural heritage that is prized by the origin community." (144) The authors contrast the static, unseen nature of non-Indigenous collections with the active use of Indigenous objects in their appropriate cultural contexts. They outline a variety of Indigenous perspectives toward collections and repatriation. Nonetheless, they also note that Indigenous people living today are not necessarily familiar with some of the older objects in collections. Due to the challenge of maintaining objects, some communities prefer combinations of virtual repatriation, easy access to non-Indigenous-maintained collections, and opportunities to interpret and educate the public about objects within non-Indigenous museums.

Paloma Díaz, Andrea Bellucci, Chien-Wen Yuan, Ignacio Aedo, "Augmented Experiences in Cultural Spaces through Social Participation," *ACM Journal on Computing and Cultural Heritage*, Vol. 11, No. 4 (December 2018), 19:1-14.

• This article describes the implementation of a Social Display Environment (SDE) at literary community center in Madrid. The authors wanted visitors to be able to generate and share knowledge at an exhibit. They created an exhibit in which various books were placed behind clear computer displays. Visitors could record videos with their responses to the books, and react to previous visitor videos. The authors did not set up a management system to organize the videos. Visitors enjoyed using the technology and expressed that it helped them think more deeply about the books on display. The authors suggest that this technology should be limited to the cultural spaces themselves, rather than hosted online, to encourage engagement with cultural heritage sites.

Jennifer Grayburn, Zack Lischer-Katz, Kristina Golubiewski-Davis, Veronica Ikeshoji-Orlati, eds. *3D/VR in the Academic Library: Emerging Practices and Trends*. Arlington, VA: Council on Library and Information Resources, Feb 2019.

https://www.clir.org/wp-content/uploads/sites/6/2019/02/Pub-176.pdf

- This publication, based on a symposium, discusses issues involving the storage and curation of 3D/VR data. It "aimed to identify points of tension and gaps in existing practices and knowledge in order to foster common understanding for the librarians and digital curators tasked with supporting and managing these new data types." (4) The essays are particularly interested in establishing standards in the field. They establish goals including: "(1) treat the academic outputs that use 3D/VR as scholarly products; (2) build a 3D/VR scholarly community to support knowledge exchange across a range of stakeholder groups; and (3) develop technical tools, training, and infrastructure to support a 3D/VR research ecosystem." (pg. 7)
- Individual essay topics range from collaborative approaches in the Duke Wired! Lab [Szabo] to LIB3DCHI (3D Cultural Heritage Informatics) [Rourk] and CS3DP (Community Standards for

3D Preservation) [Moore, Rountrey, and Kettler] standards; and from documenting physical spaces [Wood, William, and Copeland; Whiteside] to documenting live animals [Bot and Irschick].

Jacob Greene and Madison Jones, "Articulate Detroit," <u>http://cconlinejournal.org/articulatedetroit/</u>. c. 2017-2019.

• This project is an AR mobile app that centers on Woodward Avenue in Detroit. It focuses on Detroit's history "as a networked rhetorical space." Overlays include narrated video and audio relating to various spaces on Woodward Avenue, a site of gentrification and the tensions of popular notions of the declining and rising Detroit. The creators aim to use AR to reveal the layered histories and "counter-narratives" of the city's space. They particularly draw on theory of "choric" space. Finally, the authors reflect on the discontinuation of the technology they used to produce the original tour, in the context of technology access and social justice in Detroit and elsewhere.

Matthew Hannah, Sarah Huber, and Sorin Adam Matei, "Collecting Virtual and Augmented Reality in the Twenty-First Century Library," *Collection Management*, Vol. 44, No. 2-4 (March, 2019), 277-295.

• This article asks how libraries can support VR/AR research, implementation, storage, and access. They are especially interested in the humanities context for VR/AR. Some issues that concern the authors are storage, provenance, metadata, and cataloguing criteria. They suggest that new standards are needed in cataloguing and storage. Citation and authorship emerge as concerns due to the quantity of anonymous VR/AR materials available online, which should be preserved with proper attribution. Librarians can also play a role in determining how learning outcomes intersect with VR/AR, to make sure that these materials are used effectively and that visitors know how to engage with materials. The authors discuss the then-in-the-works Community Standards for 3D Preservation (CS3DP), which can help maintain repositories. Ultimately, the authors' goal is to create fully accessible and free collections of VR/AR materials.

Amy Hetherington and Peter Pavement, "'Virtual Accessibility': Interpreting a Virtual Reality Art History Experience for Blind and Partially Sighted Users," in Suse Anderson, Isabella Bruno, Hannah Hethmon, Seema Rao, Ed Rodley, and Rachel Ropeik, eds., *Humanizing the Digital: Unproceedings from the MCN 2018 Conference* (Ad Hoc Museum Collective: March 2019), 96-100.

• This chapter focuses on one project's efforts to make VR accessible to partially sighted and blind individuals. Hetherington and Pavement of Surface Impression outline their experience working for the Royal Collection Trust in London, UK. They describe a multi-stage process that included the virtual reconstruction of elements of the Charles I collection; the development of audio elements, in conjunction with a local accessibility organization; and the inclusion of partially

sighted testers, who provided feedback to the creators. The authors highlight the fact that visually impaired people are interested in VR and should be considered part of the VR audience, and the need for collaboration in creating accessible work.

Panayiotis Koutsabasis and Spyros Vosinakis, "Kinesthetic interactions in museums: conveying cultural heritage by making use of ancient tools and (re-) constructing artworks," *Virtual Reality*, 22 (2018): 103-118.

• This article describes a VR experience at the Museum of Cycladic Art in Greece. The creators wanted visitors to learn about sculpture by embodying ancient Cycladic craftsmen. The authors emphasize that VR allows museum visitors to interact with—and learn about—ancient sites and objects in ways that are impossible in traditional museum galleries. Kinect and Leap Motion make such projects more readily accessible to museums/CH institutions. The authors' VR game tasked users with creating a sculpture using three different tools of increasing difficulty. They tested the game first in a lab setting, which helped them adjust the difficulty and physical requirements of using the tools. The users responded very positively to the experience, despite some issues in depth perception and tracking. Users also wanted more freedom in the kinds of designs they could create. The authors found it was valuable to allow users to make mistakes without forcing them to restart or quit the experience. Overall, the authors conclude that the small physical size and costs of the VR experience, combined with learning experience, make it a worthwhile project.

Fred Limp, Angie Payne, Katie Simon, Snow Winters and Jack Cothren, "Developing a 3D digital heritage ecosystem: from object to representation and the role of a virtual museum in the 21st century," *Internet Archaeology*, 30/30 (July 2011).

• This article suggests standard scholarly approaches to the creation of and uses of 3D digital cultural heritage object archives. It addresses the following subjects: "a. recordation methods and metadata, b. digital object discovery and access, c. citation of digital objects, d. analysis and study, e. digital object reuse and repurposing and f. the critical role of a national/international digital archive." (2) One of the key impediments to creating valuable 3D image archives is the cost of 3D scanning technology. They authors provide guides to standards for metadata, based on the Guides to Good Practice 2 concerning metadata and 3D imaging. The authors make suggestions as to how 3D images can be made accessible to the public. They suggest that 3D image search engines may be soon available for use.

Erica L. Neely, "Augmented reality, augmented ethics: who has the right to augment a particular physical space?," *Ethics and Information Technology*, Vol. 21, (2019): 11-18.

• This article considers the ethical implications of augmenting public and private spaces. Issues of property are difficult to consider because "an augmented object is neither purely virtual nor

purely physical." (14) Do property owners have control over whether their spaces can be augmented by other people? This question is especially challenging for public spaces—e.g. Pokémon Go at the Holocaust Museum.

Anna Puig, Inmaculada Rodríguez, Josep Ll. Arcos, Juan A. Rodríguez-Aguilar, Sergi Cebrián, Anton Bogdanovych, Núria Morera, Antoni Palomo, and Raquel Piqué, "Lessons learned from supplementing archaeological museum exhibitions with virtual reality," *Virtual Reality* (2020) 24, 343-358.

• This article concerns a self-guided exhibition involving a display of physical objects, a 3D model, and a VR game centered on the La Draga Neolithic settlement in Spain. The authors aimed to utilize VR not only to contextualize objects in their historical/cultural setting, but also to "make participants aware of their learning about objects of La Draga." (348) The process involved collaboration with archaeologists, museum experts, and VR experts. The various elements of the exhibition were meant to complement one another rather than lead visitors to use VR and ignore other elements of the project. VR users provided universally positive responses to the combined educational and entertainment elements of the VR experience. However, the user survey also revealed a conflict between a need to limit the duration of the experience on the one hand (to prevent long lines of visitors) and to allow visitors time to fully understand how to interact with VR on the other. Data analysis revealed a further conflict between visitors' desires to explore a virtual space versus interest in the game element. Problems with the survey language itself made it difficult to know whether visitors found the experience can provide an important supplement to archaeological exhibitions, and do not distract from exhibits/sites.

Isabel Pedersen, Nathan Gale, Pejman Mirza-Babaei, and Samantha Reid, "More than Meets the Eye: The Benefits of Augmented Reality and Holographic Displays for Digital Cultural Heritage," *ACM Journal on Computing and Cultural Heritage*, Vol. 10, No. 2 (March 2017): 1-15.

• This article describes TombSeer, a holographic AR experience in the Royal Ontario Museum ancient Egyptian galleries. The primary goal of the project was to give users embodied, physical, and interactive experiences in the tomb. The museum team used AR to add visual details to certain empty internal spaces in the tomb, add historical objects (such as offerings), and written descriptions of tomb features. Handheld devices/displays were particularly useful for AR. The museum conducted four different test runs, including one in the tomb itself, in order to identify and resolve problems. Persistent problems included those related to peripheral vision and gestural recognition. According to the authors, approximately "35% of museums in Europe have already started to develop some form of 3D representation of cultural objects," and they aimed to bring such efforts to North America. (3) User experience and learning goals were not evaluated at this stage. [A Google search suggests that ROM has not yet implemented this AR experience.]

DETROIT INSTITUTE OF ARTS "LUMIN" TOUR

Megan DiRienzo, Andrea Montiel de Shuman, Alicia Vieri, "Humanizing Augmented Reality with Lumin," inSuse Anderson, Isabella Bruno, Hannah Hethmon, Seema Rao, Ed Rodley, and Rachel Ropeik, eds., *Humanizing the Digital: Unproceedings from the MCN 2018 Conference* (Ad Hoc Museum Collective: March 2019), 39-45.

The team at the Detroit Institute of Arts worked to develop an AR experience that "w[ove] together human-centered functionality and human-centered content." (40) Through multiple stages of testing, the team found that simple AR features with minimal, if any, gaming elements were more appealing and accessible to audiences. In particular, visitors learned from AR features that showed hidden or missing elements of objects (such as skeletons inside mummies and the full scale of the Ishtar gate). The team concludes with the following takeaways: "Plan for sustainability," "Design in three dimensions, but don't assume your visitors will think spatially," "Acknowledge that AR is exhausting," "Avoid thinking you know your audience," and "You might not need AR." (44-45)

Cassandra Mansuetti, "'Don't touch the art,' unless it's on your phone screen: augmented reality and the future of art education," *Michigan Daily*, March 19, 2018.

• This enthusiastic review of the DIA's Lumin system favorably views its educational value and its engaging nature, observing that "it sits perfectly at the crossroads of explanation and exploration." The AR experience includes static and moving visuals, informational text, and sound (music). Nonetheless, the author reported feeling silly using a noisy smartphone prominently in the galleries and wondered whether its technology interfaces were too challenging for some visitors, especially children.

Joshua J. Paladino, "DIA to launch 'Lumin' augmented reality tour," The Detroit News, January 9, 2017.

• This article emphasizes Lumin's ability to contextualize works of art rather than distract from them.

Ashley Zlatopolsky, "Like Pokemon Go for art lovers, Lumin brings augmented reality to the DIA," *Detroit Free Press*, January 21, 2017.

• This article emphasizes the technical elements of Lumin. It uses Google Tango, a Lenovo Phab2 Pro phone. The tour includes clear signage for directions. As the first tour of its kind in the art world (at least according to this article), the staff is still working out various challenges. Staff have also not yet equipped the experience to accommodate people with disabilities. The article then outlines seven major stops on the tour and their objectives.

FREEDOM CENTER ROSA PARKS EXPERIENCE

National Underground Railroad Freedom Center, "The Rosa Parks Experience: Press Page," September 15, 2016.

• Through VR, users become Rosa Parks, as she refused to give up her seat on a bus. This VR experience was created by Möbius Virtual Foundry. It is housed at the National Underground Railroad Freedom Center in Cincinnati.

Lucy May, "COLUMN: New Freedom Center exhibit helps you feel what Rosa Parks experienced on the bus in 1955: 'It brought it to life'," WCPO Cincinnati, September 23, 2016.

• This article portrays the Rosa Parks VR experience as an engaging experience that makes it possible for visitors to empathize with Parks' experience. Various users are quoted, all with positive takeaways from the experience. The experience was designed by Möbius Virtual Foundry and was then moved to the Cincinnati museum. It uses simple VR technology and automated bus seats.

HIGHER EDUCATION CLASSROOM

Beth and Beckie, "Not Just for Video Games: Virtual Reality Joins the Classroom," *The Chronicle of Higher Education*, June 21, 2018.

• This short article discusses a few VR projects at universities, including digital storytelling and community engagement. The overall financial and time costs in supplying and mastering VR technology were primary faculty concerns.

David Checa and Andres Bustillo, "Advantages and limits of virtual reality in learning processes: Briviesca in the fifteenth century," *Virtual Reality*, Vol. 24 (2020): 151-161.

• This article outlines the creation and implementation of the Briviesca VR experience, and its success in teaching university students about medieval urban history. The authors first explain how the experience was modelled and implemented for Oculus Rift. The creators were attuned to pedagogical strategies and teaching outcomes. They compared the results of a 13-min film about Briviesca with a VRE tour of Brieviesca. The VRE tour included short video clips and a 2D map. The VRE tour was also implemented between two groups, each using a different locomation system. Students appeared to slightly prefer VRE over video. Teleportation caused greater motion sickness than gamepad motion. VRE users scored more highly on questions about visually-acquired historical knowledge and questions about building locations than those who watched the video. However, one potential pitfall of VRE is that the VRE did not require students to visit certain educational signposts or did not make those signposts obvious, and thus not all participants reaped the full benefits of the experience. The authors suggest greater gamification of or control over VRE to encourage interaction will all educational elements.

Marta Figlerowicz and Ayesha Ramachandran, "How an Experiment in 3-D Printing Illuminated Our Humanities Classroom," *The Chronicle of Higher Education*, October 22, 2017.

• This article discusses 3-D printing and 3-D scanning in undergraduate courses. Although the article is framed as being about 3-D printing, the students in the experiment found the process of scanning particularly interesting. They were able to create non-existent objects in through scanning. The scanners were also unable to reproduce certain objects. These experiments led students to more critically think about 3D imaging, media, reproduction, and "reality."

Michael Sano, "Can AR/VR Improve Learning? Integrating Extended Reality Into Academic Programs #DNLChat" <u>EdSurge.com</u>. July 19, 2018.

https://www.edsurge.com/news/2018-07-19-can-ar-vr-improve-learning-integrating-extended-reality-intoacademic-programs-dlnchat

• This article concerns the #DNLChat — which involved staff and faculty in the Digital Learning Network. They identified problems and opportunities in AR/VR and learning. Experiential learning practice and the learning benefits for users with disabilities were listed among the positives. Others pointed out that VR/AR development has to look realistic without being "uncanny." Overall, it seems that there are more questions than answers in the uses of VR/AR in higher ed.

POPULAR MEDIA

Patricia Chang, "Inclusivity of VR and AR Accessibility for the Visually and Hearing Impaired," *AR Post,* September 18, 2018.

https://arpost.co/2018/09/18/inclusivity-of-vr-and-ar-accessibility-for-the-visually-and-hearing-impaired/

- This article lists a few technologies geared toward people with disabilities. Google Daydream and Microsoft Canetroller both provide depth-perception assistance to visually impaired people.
- It's worth noting that many of these technologies have already existed, they are just being migrated onto new apps.

Andrew E. Kramer and Maria Varenikova, "Victim or Executioner? Let the Computer Decide. An interactive plan for a Holocaust museum envisioned sorting visitors into victims, executioners and collaborators. Backlash ensued," *The New York Times,* May 11, 2020.

https://www.nytimes.com/2020/05/11/world/europe/ukraine-holocaust-babyn-yar.html?searchResultPosition=1

- This article discusses plans for a VR Holocaust experiment at the Holocaust Museum in Kyiv. The experience would psychologically profile visitors, and then assign them various roles, such as victim or executioner. The goal of the project directors was to encourage visitors to think about how everyday people became complicit in atrocities or resisted them. The project proposal drew a major public backlash and resignations in protest of a "Holocaust Disney," to quote one former curator.
- (This is one of very few history-related articles I found.)

Nina Siegal, "Virtual Reality Lets Rare Works of Art Take a Field Trip," *The New York Times*, March 10, 2018. <u>https://www.nytimes.com/2018/03/10/arts/virtual-reality-art.html?searchResultPosition=7</u>

- This article highlights the online-only Kremer Museum, which features a private art collection now available to the public. The seventeenth-century Dutch and Flemish paintings appear in VR, based on composites of 3,000 photographs each. The project is still working on improving pixelation issues. The project uses Google Daydream.
- The Kremer Museum: <u>https://www.thekremercollection.com/the-kremer-museum/</u>

Jake Cigainero, "European Museums Get Adventurous With Virtual Reality," *The New York Times*, March 12, 2018.

https://www.nytimes.com/2018/03/12/arts/european-museums-get-adventurous-with-virtual-reality.html?s earchResultPosition=2

• This article discusses the efforts of museums to engage-- and educate--modern audiences with VR. These include the Tate Modern, French National Museum of Natural History, and the entirely online Kremer Museum. They range in scope from experiential learning (such as virtual sea diving) to virtual/online tours of exhibitions. The National Museum of Finland allows visitors to

step inside of paintings. Institutions have found a wide range of visitors interested in VR but are concerned about the financial reality of creating such experiences.

- Links to featured projects:
 - Tate Modern Modigliani Retrospective: The Ochre Atelier: <u>https://www.tate.org.uk/whats-on/tate-modern/exhibition/modigliani/modigliani-vr-ochre</u> <u>-atelier</u>
 - Cabinet de Réalité Virtuelle at the National Museum of Natural History in France: <u>https://www.mnhn.fr/en/visit/lieux/cabinet-realite-virtuelle-cabinet-virtual-reality</u>

Rebecca Schmid, "Virtual Reality Asserts Itself as an Art Form in Its Own Right," *The New York Times,* May 1, 2018.

https://www.nytimes.com/2018/05/01/arts/art-leaders-network-berlin-vr-virtual-reality.html?searchResult Position=3

• This article discusses a few different current VR art projects, including the Modigliani project at the Tate Modern. It raises such issues as intellectual property, the teamwork involved in creating projects, and methods for bringing artworks to viewers or collectors.

Graham Roberts, "Capturing an American Icon for Augmented Reality. For a new A.R. project, we combined 675 photos of the original torch of the Statue of Liberty to allow readers to see it up close as never before.," *The New York Times*, November 19, 2018.

https://www.nytimes.com/2018/11/19/reader-center/statue-liberty-torch-augmented-reality.html?searchRe sultPosition=1

- The NYT asserts that AR is a form of visual journalism. It "reduce[s] the distance between the information we journalists gather and the understanding we can convey to readers." The article describes how the NYT staff created the AR experience, and their decision to use AR to document a single object. The project itself describes the history of the original torch, and provides historical photographs, including stereoscopic images.
- Context: the new Statue of Liberty museum opened in May 2019.
- The project: <u>https://www.nytimes.com/interactive/2018/11/13/nyregion/statue-of-liberty-torch-ar-ul.html?rref=</u> <u>collection%2Fspotlightcollection%2Faugmented-reality&action=click&contentCollection=multi</u> <u>media®ion=rank&module=package&version=highlights&contentPlacement=1&pgtype=collection</u> <u>n</u>

Sophie Haigney, "Apple Transforms Central. Park Into an Augmented Reality Gallery. Works by Nick Cave, Nathalie Djurberg, John Giorno and others have been choreographed into the landscape for an Apple-New Museum walking tour.," *The New York Times*, August 9, 2019. https://www.nytimes.com/2019/08/09/arts/design/central-park-augmented-reality-tour.html?searchResultPosition=2

- This article describes a New Museum-Apple collaborative AR project in Central Park. Apple Stores serve as starting points for the art walks, and the AR art walk [apparently] was only visible through iPhones provided by the Apple store. Five other cities are listed as participants (San Francisco, Tokyo, Hong Kong, London, and Paris).
- The New Museum's role in the project is completely omitted from the NYT article and headline.
- This article from the New Museum website emphasizes the museum's role in spearheading digital art initiatives, including this [AR]T initiative. The New Museum provides more detail about the content of the tour and their physical locations in each city. https://www.newmuseum.org/pages/view/ar-t
- [It is interesting that the art walks are centered on "iconic" locations near Apple stores rather than urban parks or gardens. Shinjuku and Central Park are very different spaces in which to view the artworks—the commercial element of the AR experience was clearly more important than any relationship between the art and its surrounding physical environment.]

Ted Loos, "A Walk on the Frontier of Art, Where the Sky Is the Limit. Augmented reality and virtual reality are opening doors to new experiences for artists and the public.," *The New York Times,* November 27, 2019.

https://www.nytimes.com/2019/11/27/arts/augmented-reality-exhibitions.html?searchResultPosition=5

• This article discusses Augmented Reality and art, including recent efforts on the High Line and the New Museum/Apple [AR]T Walk. It goes into much greater detail about the [AR]T walk than other articles. For example, it explains that the six cities had slightly different versions of the same art walk. It also discusses how the artists had to work with technical teams. The article also weighs the pros and cons of artistic employment of VR vs. AR. A group of indigenous artists used AR to augment physical artworks with their own perspectives, in the Whitney Museum's "Wolf Nation."

Jane L. Levere, "Meeting Old Masters, Rowing With Vikings—in Augmented Reality," *The New York Times*, March 12, 2019.

https://www.nytimes.com/2019/03/12/arts/augmented-reality-app-exhibits.html?searchResultPosition=3

- This article lists a few different AR experiences that museums around the world have implemented. They include:
 - The Morgan Library & Museum—the AR experience provides interpretation on the visual and architectural features of the museum, and also allows visitors to interact with past librarians. <u>https://www.themorgan.org/exhibitions/online/j-pierpont-morgans-library</u>
 - The Royal Alberta Museum—an interactive Viking exhibition including opportunity to use a Viking sword and row with Vikings. https://royalalbertamuseum.ca/visit/galleries/feature-gallery/past/vikings
 - The Victoria & Albert Museum—David Bowie Is: <u>https://www.vam.ac.uk/collections/david-bowie https://davidbowieisreal.com</u>

- NYT article accompanying the AR show: <u>https://www.nytimes.com/interactive/2018/03/20/arts/design/bowie-costumes-ar-3d-ul.html?searchResultPosition=6</u> The article provides 360 views of a select number of costumes and context for the costume's creation.
- Pérez Art Museum Miami Felice Grodin: Invasive Species <u>https://www.pamm.org/ar</u> A contemporary art exhibition that uses AR to impose "invasive" objects in the museum space, as commentary on climate change and invasive species.
- Natura Obscura <u>https://www.naturaobscura.org/</u> An exhibition that marries AR, nature, and surrealist art.
- Carnegie Museum of Natural History Appalachian Wildflower Gardens https://carnegiemnh.org/press/augmented-reality-app-brings-appalachian-wildflower-gard ens-to-life-on-smartphones/ - an app that overlays native Appalachian plants, which have declined due to deer overpopulation, onto physical spaces.
- Maria Abramovi'c, *The Life*, a mixed reality recorded performance piece. Serpentine Galleries. <u>https://www.serpentinegalleries.org/whats-on/marina-abramovic-life/</u>

Hilarie M. Sheets, "Mel Chin to Sound the Call, All Over New York," *The New York Times,* November 21, 2017.

https://www.nytimes.com/2017/11/21/arts/design/mel-chin-augmented-reality-times-square.html?searchR esultPosition=4

• This AR art project emphasizes the potential affects of climate change and rising sea levels in Manhattan. It will complement physical exhibitions.

Jon Hurdle, "Arming China's Terracotta Warriors—With Your Phone," *The New York Times,* September 29, 2017.

https://www.nytimes.com/2017/09/29/science/china-terracotta-warriors-augmented-reality.html?searchRe sultPosition=11

• This article discusses the Franklin Institute (Philadelphia) exhibition of the famous Chinese terracotta warriors. The museum produced the 3D models of the warriors, and an app allows visitors to add historically-accurate weapons to the warriors. Most statues originally held weapons that no longer exist. The article then goes on to discuss how phones can engage, rather than distract, visitors.

Nina Siegal, "Want to See All the Vermeers in the World? Now's Your Chance," *The New York Times*, December 3, 2018. https://www.nytimes.com/2018/12/03/arts/design/meet-vermeer-google-app-mauritshuis.html?searchResu https://www.nytimes.com/2018/12/03/arts/design/meet-vermeer-google-app-mauritshuis.html?searchResu

• This article details a Mauritshuis- and Google-led effort to create a digital exhibition of all Vermeer paintings. Viewing the paintings "physically" rather than as online images has an added

benefit of understanding how the paintings appear in relation to one another. Again, this article remarks that curators see technology as engaging visitors rather than distracting them.

David Colman, "'Liberty Bell' Tolls for Sites Where History Is Alive and Kicking. Nancy Baker Cahill uses augmented reality to explore the meaning of historical sites from the Rockaways in New York to Selma, Ala. Is public art embellishing our heritage, or defacing it?," *The New York Times*, July 2, 2020. <u>https://www.nytimes.com/2020/07/02/arts/design/liberty-bell-nancy-baker-cahill.html?searchResultPosition=19</u>

- This article places an AR exhibit within the context of contemporary debates over statues and historical memory. The exhibit places various red, white, and blue abstracted, moving shapes of streamer-like material over places of significance to US history. The shapes fall apart by the end of the animations.
- <u>https://www.4thwallapp.org/liberty-bell</u>

Jonah Engel Bormwich, "Where Pokémon Should Not Go," *The New York Times,* June 12, 2016. <u>https://www.nytimes.com/2016/07/13/technology/where-pokemon-should-not-go.html?searchResultPosition=30</u>

• This article discusses the presence of Pokémon Go AR activities at sites such as Auschwitz-Birkenau. Several other memorials and museums also

Jennifer Schuessler, "For a Shakespeare Anniversary, an Online Re-creation of a 1796 Show," *The New York Times,* December 16, 2015.

https://www.nytimes.com/2015/12/17/arts/design/for-a-shakespeare-anniversary-an-online-re-creation-ofa-1796-show.html?searchResultPosition=47

- Describes a UT Austin online recreation of a 1796 London show of paintings depicting Shakespeare's works. The process involved recreating the architectural space, and figuring out dimensions of now-missing artworks.
- Link to website: <u>http://www.whatjanesaw.org/</u>. The website is devoted to two of Jane Austen's visits to London.

Debra Kamin, "For Shut-In Pilgrims, the World's Holiest Sites Are a Click Away. The pandemic has closed holy sites across the globe, but virtual reality is providing worshipers a digital window into ceremonies during touchstone holidays.," *The New York Times*, March 30, 2020. https://www.nytimes.com/2020/03/30/travel/coronavirus-virtual-reality-religion.html?searchResultPositio n=34

• Focus on the Museum of the History of Jerusalem's online VR project that displays Jewish, Christian, and Muslim religious sites. It was debuted in April 2020, during which Passover,

Easter, and Ramadan occurred. The project was originally planned before the COVID19 pandemic to allow greater access to holy sites. <u>https://www.tod.org.il/en/holy-city-vr/</u>

- VR Mecca app available for download
- VR Vatican City, Papal Basilicas: <u>http://www.vatican.va/various/basiliche/index_en.html</u>

James Barron, "Stepping Into a 1920s Paris Apartment, From Fifth Avenue," *The New York Times,* Jan 1, 2017.

https://www.nytimes.com/2017/01/01/nyregion/stepping-into-a-1920s-paris-apartment-from-fifth-avenue. html?searchResultPosition=36

Discusses a VR experience at a Jewish Museum exhibition on Pierre Chareau, a Jewish French architect/designer. The VR experience recreated a Chareau-designed Parisian living room, c. 1920s; the design was created for a Jewish family. The VR recreation held special meaning for the granddaughter of the homeowners.
 https://theiewishmuseum.org/vr-tour/farhi-final-mono/index.html

Laurel Graeber, "Virtual Encounters With Purring Cheetahs and Curious Penguins. Zoos are beginning to open, but digital experiences allow visitors to see ecosystems from a different perspective.," *The New York Times*, July 23, 2020.

https://www.nytimes.com/2020/07/23/arts/design/zoos-aquariums-virtual-virus.html?searchResultPosition =37

- Highlights online and VR zoo options during the pandemic.
- Shedd Aquarium:
 <u>https://www.sheddaquarium.org/educators/classroom-resources/penguin-expedition</u>

Kit Ramgopal, "Virtual Reality Companies Are Changing How Athletes See Practice," *The New York Times,* November 24, 2017. https://www.nytimes.com/2017/11/24/sports/virtual-reality-athletes.html?searchResultPosition=17

• This article discusses "STRIVR," the VR program originally used to train college football players and since adapted by many professional sports leagues. One benefit of VR training is its contact-less football experience. Players can stay safe while improving performance.

Alice Power, "Pandemic Objects: Animal Crossing," *V&A Blog*, July 24, 2020. <u>https://www.vam.ac.uk/blog/projects/pandemic-objects-animal-crossing</u>

• This slow-paced, live Animal Crossing game series (*New Horizons*) has become incredibly popular during the pandemic. The article emphasizes the prominent role of enjoy (virtual) nature in real time, while players live under lockdown. The game also encourages non-pandemic-related conversation and activities through gameplay. On the other hand, the game has served as a space for dissemination of social movements information; thus serving as "a para-reality." The author connects the realistic natural depictions of the game to seventeenth-century painting.

Sam Desatoff, "Animal Crossing: New Horizons and its impact on a pandemic-stricken world," *GameDaily.biz*, May 11, 2020.

https://gamedaily.biz/article/1737/animal-crossing-new-horizons-and-its-impact-on-a-pandemic-stricken-world

• This article emphasizes the popularity of *Animal Crossing* as a simulator for safe, real-time interaction during the pandemic. Mat Piscatella of NPD [Nintendo Product Development?] emphasized that *Animal Crossing* is meant to encourage "developing communities and forging connections." In addition to encouraging real-time interaction between players, museums, politicians, and others have tried to partner with *Animal Crossing*. The chat *Animal Talking* has caught the attention of politicians like Alexandria Ocasio-Cortez. Both the Metropolitan Museum of Art and the Getty have allowed players to display their collections in game spaces. *Animal Talking* producer Gary Whitta has suggested that *Animal Crossing's* popularity could be a sign that the pandemic is accelerating interest in VR/XR.

Vanessa H. Larson, "At the Sackler Gallery, take a virtual-reality tour of cities ravaged by ISIS and war," *The Washington Post*, March 4, 2020.

https://www.washingtonpost.com/goingoutguide/museums/at-the-sackler-gallery-take-a-virtual-reality-tou r-of-cities-ravaged-by-isis/2020/03/04/593250c4-58e8-11ea-9b35-def5a027d470_story.html

• This digital exhibition shows three destroyed Syrian and Iraqi cities in minutes-long VR experiences. It shows both reconstructions of the historical buildings and their present destroyed states, as seen via drone footage. It is a collaborative project from UNESCO, the Arab World Institute in Paris, and Ubisoft. Additionally, the exhibition includes a film of interviews with local people.

Vickey Hallett, "Tired of biking in the gym? Virtual reality lets you cycle in Iceland, instead," *The Washington Post*, February 24, 2020. https://www.washingtonpost.com/lifestyle/wellness/tired-of-biking-in-the-gym-virtual-reality-lets-you-cy

https://www.washingtonpost.com/lifestyle/wellness/tired-of-biking-in-the-gym-virtual-reality-lets-you-cy cle-in-iceland-instead/2020/02/21/498e1612-361f-11ea-bf30-ad313e4ec754_story.html

This article focuses on the rise of "indoor 'outdoor' exercise" via VR. It surveys a few technologies with built-in screens, such as the "VZfit" VR product, and Peleton machines. Some technologies sync with Google streetview, allowing users to visit meaningful locations, such as childhood hometowns. Scientific studies show that VR cycling lessons exercise-related pain. [This article was perfectly timed before the pandemic!]

Abha Bhattarai, "Virtual try-ons are replacing fitting rooms during the pandemic," *The Washington Post,* July 9, 2020.

https://www.washingtonpost.com/business/2020/07/09/virtual-try-ons-are-replacing-fitting-rooms-during-pandemic/

• This article describes how AR fitting rooms have exploded in popularity since the start of the pandemic. It weighs the pros and cons of safe access to shops and potential privacy risks. It also

discusses the potential business benefits of using AR for online shopping—customers spend more and return fewer items.

Philip Marcelo, "Black soldiers monument faces scrutiny after racial reckoning," *The Washington Post,* July 27, 2020.

https://www.washingtonpost.com/national/black-soldiers-monument-faces-scrutiny-amid-racial-reckoning/2020/07/27/f38aa0ac-d004-11ea-826b-cc394d824e35_story.html

• This article largely discusses the monument to the Union 54th Regiment in Boston. The NPS has created an AR app to provide historical context for the monument.

Paul Bloom, "It's Ridiculous to Use Virtual Reality to Empathize With Refugees. The technology isn't the moral game-changer that some make it out to be.," *The Atlantic,* February 3, 2017. https://www.theatlantic.com/technology/archive/2017/02/virtual-reality-wont-make-you-more-empathetic /515511/

• Contests the notion that VR elicits empathy in its users. It first lists numerous projects based on VR and empathy, ranging in topic from refugees to pregnancy. Instead, the author argues that VR is "dangerously misleading." In particular, he finds that the short duration of VR and user safety mitigates any potential positive effects. For example, disability simulations have been shown to create negative perceptions of disabled people. Finally, the author suggests reading books.

Chris Milk, "How virtual reality can create the ultimate empathy machine," TED2015. March 2015. Video.

https://www.ted.com/talks/chris_milk_how_virtual_reality_can_create_the_ultimate_empathy_machine

• Milk argues that VR can help people empathize with others, because it elicist strong emotional reactions. His VR Syrian refugee camp experience has been shown at the UN.

Monica Kim, "The Good and the Bad of Escaping to Virtual Reality," The Atlantic, February 18, 2015.

• The author describes various opinions about VR. Some believe that the increasingly realistic technology will lure people to spend all their time in VR. Some people become so addicted to video games, for example, it leads to mental and physical health issues. Others have suggested that over time, humans will become less interested in in-person social interaction.

David Friend, "Nazi VR," *The Atlantic*, April 5, 2019 [video]. https://www.theatlantic.com/video/index/586567/nazi-vr/

• Documents the creation of forensics VR recreation of Auschwitz-Birkenau. The recreation contributed to the prosecution a former Nazi prison guard.

Marc Cieslak, "Virtual reality to aid Auschwitz war trials of concentration camp guards," BBC, 20 November 2016. <u>https://www.bbc.com/news/technology-38026007</u>.

• This article outlines why forensics VR helps to prosecute low-level SS guards and other individuals charged with accessory to murder. One interviewee suggests that VR forensics will become essential to future policing.

Alia Wong, "College Students Just Want Normal Libraries," *The Atlantic*, October 4, 2019. <u>https://www.theatlantic.com/education/archive/2019/10/college-students-dont-want-fancy-libraries/59945</u> <u>5/</u>

• In this article, Wong argues that student interest in libraries centers on physical books and access to other traditional library resources. She uses surveys from NOVA CC and Duke to suggest that newer technologies, including VR, do not hold wide interest among students.

Kaitlyn Tiffany, "It's Cool to Look Terrifying on Pandemic Instagram," *The Atlantic*, May 11, 2020. https://www.theatlantic.com/technology/archive/2020/05/augmented-reality-instagram-zoom/611494/

• Tiffany describes how AR features on Instagram have become increasingly popular during the pandemic. AR adds new and entertaining features to daily routines of video chatting. AR creators are also gaining large followings. According to Maya Georgieva, AR on Instagram has enabled users to share feelings "of fear, shock, loneliness, wanting something" rather than hanging out with friends.

Kent Bye and Jessica Stone, "Podcast #928: Play Therapy in VR with Virtual Sandtray & Dr. Jessica Stone," *Voices of VR Podcast,* July 21, 2020. https://voicesofyr.com/928-play-therapy-in-vr-with-virtual-sandtray-dr-jessica-stone/

• Interview with Dr. Jessica Stone, a child/adolescent therapist who has used VR to help children express themselves and their experiences by modifying VR worlds. She and her husband developed their own program specifically designed for younger patients. She relates VR to her past use of Pokemon cards [presumably in the 90s/early 00s] to connect with patients and understand their mental state. An iPad version is available on the App store, but Dr. Stone isn't able to find a suitable platform for the VR program to make it publicly available.

Kent Bye and Erica Southgate, "Podcast #927: Erica Southgate's Book on VR Pedagogy & Teaching Higher-Order Metacognition Skills," *Voices of VR Podcast*, July 15, 2020. https://voicesofvr.com/927-erica-southgates-book-on-vr-pedagogy-teaching-higher-order-metacognition-s kills/

- Interview with Erica Southgate, author of *Virtual Reality in Curriculum and Pedagogy: Evidence from Secondary Classrooms*, published by Routledge in May 2020.
- Southgate emphasizes thinking skills, collaboration, and other non-training applications for VR in the classroom. She observes that VR has the potential to damage the educational setting if not integrated pedagogically and intentionally within the curriculum. Additionally, she observes that STEM education applications of VR can lend themselves to creativity rather than training or more traditional lesson plans. Technology does not actually come with the lesson embedded. It also

cannot replace other forms of pedagogy; it must be integrated into hybrid models. Collaboration is an element of effective learning. VR encourages play even for students less interested in the subject. Southgate's team found that students were able to describe their VR experiences—and what they learned—in great detail afterwards. She also argues that it is important to have VR integrated in the classroom, rather than exclusively in labs. [Other issues specifically deal with school-age children.]

• The above link provides a copy of a table from the book, which shows "The Actioned Pedagogy for Immersive Learning (APIL) framework." It also outlines the "four types of psychological immersion."

PROJECTS

Touching Masterpieces: a project that brings sculpture to visually impaired people. <u>https://touchingmasterpieces.com/</u>

Virtual Harlem Project: documents Harlem c. 1920s-30s. https://www.evl.uic.edu/cavern/harlem/

4th Wall App <u>https://www.4thwallapp.org</u>

- "Battlegrounds," Fulcrum Arts. 30 AR artworks in New Orleans related to the theme "battlegrounds" or debates on themes such as environmentalism and gentrification. The creators envision AR as a "subversive public art which asks no permission, but attempts to prompt thoughtful discourse," and as an environmentally friendly artform.
- Nancy Baker Cahill and Debra Scacco (curators), "Defining Line," an LA-based AR project that includes text, sound, and artworks geocoded along the Los Angeles River.
- "EVER NOW," Facebook Artist in Residence AR/analog installation at the Facebook LA HQ.
- "Desert X," AR artworks with environmentalist message.
- "In Plain Sight," imposes AR skywriting related to #AbolishICE
- "Legacy," a SXSW 2020/21 AR project with messages about environment and gentrification.
- "Liberty Bell" see NYT article on this Nancy Baker Cahill project.

Modigliani VR at Tate Modern <u>https://www.tate.org.uk/whats-on/tate-modern/exhibition/modigliani/modigliani-vr-ochre-atelier</u>

Jewish Museum: https://thejewishmuseum.org/vr-tour/farhi-final-mono/index.html

Shedd Aquarium: https://www.sheddaquarium.org/educators/classroom-resources/penguin-expedition

Age Old Cities: A Virtual Journey from Palmyra to Mosul; visiting exhibition at the Sackler Gallery, Washington, D.C.: <u>https://asia.si.edu/exhibition/age-old-cities/</u> WETA Video: <u>https://watch.weta.org/video/age-old-cities-7ru3oi/</u>

The Kremer Museum: https://www.thekremercollection.com/the-kremer-museum/

Cabinet de Réalité Virtuelle at the National Museum of Natural History in France: <u>https://www.mnhn.fr/en/visit/lieux/cabinet-realite-virtuelle-cabinet-virtual-reality</u>

Meet Vermeer: https://www.mauritshuis.nl/en/explore/the-collection/meet-vermeer/

Statue of Liberty Torch:

https://www.nytimes.com/interactive/2018/11/13/nyregion/statue-of-liberty-torch-ar-ul.html?rref=collection%2Fspotlightcollection%2Faugmented-reality&action=click&contentCollection=multimedia®ion=rank&module=package&version=highlights&contentPlacement=1&pgtype=collection

[AR]T: New Museum/Apple: https://www.newmuseum.org/pages/view/ar-t

Morgan Museum: visual and architectural features of the museum, and also allows visitors to interact with past librarians. <u>https://www.themorgan.org/exhibitions/online/j-pierpont-morgans-library</u>

The Royal Alberta Museum—an interactive Viking exhibition including opportunity to use a Viking sword and row with Vikings. <u>https://royalalbertamuseum.ca/visit/galleries/feature-gallery/past/vikings</u>

The Victoria & Albert Museum—David Bowie Is: <u>https://www.vam.ac.uk/collections/david-bowie</u> <u>https://davidbowieisreal.com</u>

NYT article accompanying the AR show:

https://www.nytimes.com/interactive/2018/03/20/arts/design/bowie-costumes-ar-3d-ul.html?searchResult Position=6 The article provides 360 views of a select number of costumes and context for the costume's creation.

Pérez Art Museum Miami - Felice Grodin: Invasive Species - <u>https://www.pamm.org/ar</u> A contemporary art exhibition that uses AR to impose "invasive" objects in the museum space, as commentary on climate change and invasive species.

Natura Obscura — <u>https://www.naturaobscura.org/</u> An exhibition that marries AR, nature, and surrealist art.

Carnegie Museum of Natural History - Appalachian Wildflower Gardens https://carnegiemnh.org/press/augmented-reality-app-brings-appalachian-wildflower-gardens-to-life-on-s martphones/ - an app that overlays native Appalachian plants, which have declined due to deer overpopulation, onto physical spaces. Maria Abramovi'c, *The Life*, a mixed reality recorded performance piece. Serpentine Galleries. https://www.serpentinegalleries.org/whats-on/marina-abramovic-life/

What Jane Saw: Link to website: <u>http://www.whatjanesaw.org/</u>. The website is devoted to two of Jane Austen's visits to London galleries.

VR Jerusalem: https://www.tod.org.il/en/holy-city-vr/

VR Mecca app available for download

VR Vatican City, Papal Basilicas: http://www.vatican.va/various/basiliche/index_en.html