Matei Interdisciplinary Research Collaboratory   College of Liberal Arts

3-1-2019

Collecting Virtual and Augmented Reality in the Twenty-First Century Library

Matthew Hannah
Purdue University, hannah8@purdue.edu

Sarah Huber
Purdue University, huber47@purdue.edu

Sorin Adam Matei
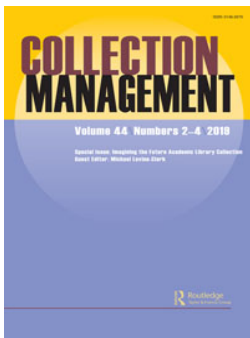*Purdue University*, smatei@purdue.edu

Collecting Virtual and Augmented Reality in the Twenty-First Century Library

Matthew Hannah, Sarah Huber & Sorin Adam Matei

Routledge
Taylor & Francis Group

Check for updates

Collecting Virtual and Augmented Reality in the Twenty-First Century Library

Matthew Hannah, Sarah Huber, and Sorin Adam Matei

Purdue University, West Lafayette, Indiana

ABSTRACT

In this paper, we discuss possible pedagogical applications for virtual and augmented reality (VR and AR), within a humanities/social sciences curriculum, articulating a critical need for academic libraries to collect and curate 3D objects. We contend that building infrastructure is critical to keep pace with innovative pedagogies and scholarship. We offer theoretical avenues for libraries to build a repository 3D object files to be used in VR and AR tools and sketch some anticipated challenges. To build an infrastructure to support VR/AR collections, we have collaborated with College of Liberal Arts to pilot a program in which Libraries and CLA faculty work together to bring VR/AR into liberal arts curricula.

"Virtual reality is the 'ultimate empathy machine.' These experiences are more than documentaries. They're opportunities to walk a mile in someone else's shoes." – Chris Milk[1]

Introduction

In this paper, we address the potential of building a 3D object file respository, so that the 3D object files can be used in virtual reality (VR) and augmented reality (AR) as tools for learning in the humanities and social-science classroom. Virtual reality is used for creating an environment, allowing users to explore entirely simulated worlds through headsets, which translate software into immersive worlds. Augmented reality superimposes computer-generated images onto views of the real world, viewed through an interface such as architecture in an ancient Roman village. Companies such as Google and Facebook are developing applications for VR/AR software on their platforms, such as Facebook Spaces, but these technologies are gradually appearing in the university classroom as well. Faculty in the Humanities and Social Sciences are increasingly integrating VR/AR tools

into their courses to enhance learning in their fields of study. Departments such as History, Classics, Engineering, Architecture, Communications, Literature, and Design, among others, are ripe for VR/AR applications, which offer experiential learning opportunities to revamp traditional curricula. Adding virtual or augmented reality to a class in History or Classics, for example, would enable the teacher to usher students through ancient Acropolis or *Beowulf*'s great hall Heorot, touring both real and fictional sites through digital interfaces and engaging content beyond the classroom. Or perhaps a professor of Art History assigns students to recreate historical art exhibitions such as the 1913 Armory Show in New York or the First Russian Art Exhibition in Berlin in 1922. With VR, professors can recreate the experience of attending important or celebrated events. VR/AR might also provide opportunities for schools to supplement travel abroad with virtual tours of sites that are inaccessible or through augmenting real locations with historical or cultural metadata. Assignments such as these launch epistemological adventures, requiring students and their teachers to approach classroom knowledge through a multi-sensory experience. Such digital tools have become widely available, now offering possible ways to supplement existing pedagogies and connect students to course material more directly and immediately.

Because of the increasing visibility and viability of VR/AR technology and the development of inexpensive options for users, more universities are investigating such educational possibilities. As tech companies produce and market more affordable devices, university researchers interested in exploring VR/AR for the classroom can now experiment without dedicated equipment budgets. Whereas a lab initially required over $100,000 to set up, costs now have a much lower entry point with high-quality devices available for purchase at affordable prices (Castelvecchi 2016). Such changes in the accessibility of this technology offer unique opportunities for educators to design new courses to include VR/AR in their teaching but also to imagine new pedagogies informed by virtuality itself, which we return to later. Such accessibility will also produce new avenues for academic libraries to play a central role in developing innovative relationships with faculty and students to respond to the swelling demands for new acquisitions, but with such opportunities come distinct challenges. Currently, 3D objects to be viewed in VR/AR tools – such as landscapes, architecture, characters, and items – exist in privately-owned online repositories, some of which are freely available (Sketchfab and Thingiverse, for example), but supporting academic research and teaching necessitates access to a collection of 3D object files central for academic study.

Throughout this essay, we refer to VR/AR objects to designate the developed software component that can be viewed through VR/AR technology

and which represents some virtual object, whether a landscape, building, or fictional character. These objects provide the various components that make immersive or augmented experiences possible, and, we argue, it is the responsibility of libraries to organize, preserve, and make discoverable items that support learning, research, and teaching. It can be said that not all teaching material needs to be made available through the library, but we see VR/AR objects specifically as collections. Not only do we see a role in organizing and making available these resources, but also in defining and controlling the quality of the objects. As people download items online or create original materials, who evaluates accuracy, attribution, and accessibility? How do we guarantee the provenance and determine the intellectual property rights of VR/AR objects? How should we release such objects and with what limitation? Libraries can provide both access and standards. Just as academic libraries collect and make searchable e-literature, physical books, archival materials, and multimedia, we envision future avenues for such processes in collections of VR/AR experiences. Virtual and augmented reality artifacts are products of knowledge generation processes that encourage users to explore new information through the virtual environment. Ultimately, they should be treated like any other journal, book, map, or art album, which serve as repositories of new knowledge.

We imagine supporting 3D object preservation as serving the larger mission of libraries, namely, information literacy with a new type of research infrastructure, and we believe the rewards of such developments will especially benefit the next generation of humanities and social science scholars. As information in this 3D visual form becomes experiential, we see opportunities to engage literacy in exciting and innovative ways that enhance learning through interaction. Students can re-engage information discovery and learning in more direct ways through experience. Overlaying digital models and objects onto the immediate reality through AR may spark new questions and restore an interest in knowing more about the world around us. Because information literacy is about the critical use of information, VR/AR can recreate places and events that spark a desire to learn more and seek accurate and authoritative information in a way that stories or histories cannot. An example of this is the work that library researchers at the University of Illinois are doing to create the HoloBook: an immersive, VR book (Hahn 2017). Designing a digital book with all of the characteristics of a print book makes it more mobile but not necessarily engaging. Scrolling a digital format as though it was print, can be cumbersome and off-putting. Changing the structure of the format to meet the medium opens a door to engagement.

There are many tools to utilize 3D objects in order to engage students in information seeking, but there are also information literacy standards we

can teach through the tools. Facilitating VR/AR in the classroom through having quality 3D objects available, we can specifically foster students' visual literacy. Supporting the Association of College and Research Libraries' definition of visual literacy, through curating and assisting in the creation of accurate and authoritative 3D objects, students will be able to find, evaluate, and use visual objects for their learning and create "meaningful" visual media, and "understand many of the ethical, legal, social, economic issues surrounding the creation and use of images and visual media, and access and use visual materials ethically ("ACRL Visual Literacy Compentency" 2011, n.p.).

Adding space in existing repositories for VR/AR seems a natural mission for a twenty-first century library. We anticipate challenges in optimizing our existing repository structure to house a functioning repository for 3D objects, developing metadata that fosters open access, sharing, and preservation, as well as developing a way to view the 3D object files. Currently, traditional library cataloging applies Library of Congress Subject Headings to catalog their collections (Library of Congress). There are several approved subject headings for virtual reality, but they are designed either for equipment or for subjects (i.e. virtual reality in fiction). Where might we go for subject headings for software within the repository to store files depicting environments or objects and how might we add such tags to our existing metadata structure? We are only beginning to think about the possibilities now and are pursuing avenues for developing this project into an implementation phase. There are controlled vocabularies available online, and librarians will need to develop and adapt indexable terms to existing metadata. Assembling, using, and displaying the objects in a way that is accessible to the average student or faculty member and that can be controlled for intellectual property reasons are also issues to be dealth with. For example, how do we check out a software file for an augmented reality experience, which may have been built by a student or faculty member, and ensure that intellectual property is honored? How do we encode such an object so it is searchable and accessible within our existing metadata structures, which have no tags for VR/AR? Any attempt to collect VR/AR objects will necessarily have hurdles to overcome, but the possibilities for thoughtfully applying such technology in higher education are immense, and we believe the effort will be worth it.

Furthermore, we anticipate significant challenges in navigating permissions and ownership of VR/AR content. One of the great benefits of beginning these conversations and instantiating a process for developing a VR/AR collection within the library's repository is the possibility of preserving VR/AR content developed by faculty and students. But there are huge collections of materials spread across the Internet, from which we would likely

draw in designing a substantial catalog. However, many objects on the Internet are designed, programed, and shared online, often anonymously. If we want to develop a robust enough collection of VR/AR content so patrons will find our holdings useful, we will need to determine how to deal with objects that do not have clear developers or copyright holders. In this paper, we will address some of the challenges, but we focus more on the theoretical implications of adding VR/AR to the college curriculum and of collecting the objects necessary for entering immersive environments in the classroom. We focus primarily on some practical applications in the Humanities and Social Sciences, but our work is only beginning.

Literature review

Virtual and augmented reality has long been the provenance of science fiction, imagined as a Holodeck or a Matrix and inhabited by both virtual and real figures. Although the term is quite old, having been first proposed almost 30 years ago by technology writers , popular culture is still fascinated with VR/AR, which appears in many books and films, including *Total Recall, Star Trek*, *Strange Days, Johnny Mnemonic, Inception*, and many more. Indeed, Ernest Cline, author of *Ready Player One*, claims that many of the developers behind VR/AR tech (such as Facebook's Oculus Rift) cite his novel as a prime influence in their design. "What's really astounding to me," Cline says in a recent article in *Fortune*, "is a lot of the guys at Oculus VR and other companies who were creating VR tell me that *Ready Player One* is like required reading for new employees" (Gaudiosi 2015, n.p.). Thus, the relationship between culture and technology is already central in the origins of the tools themselves, and we believe that such a relationship can be fruitful for the academic environment both in terms of investigating the cultural and theoretical components of VR/AR but also, and more importantly for our argument here, applying that technology in the classroom. Scholars describe a shift in awareness and availability with new challenges and uses from therapy to sociocultural applications (Skibba 2018). We are no longer living in the world of the virtual but in the world of the virtually real. Furthermore, teenagers since the early 2000s grew up with highly realistic video and computer games that are in fact virtual-reality worlds. The players of these games are used to seeing the world of digital interaction in a new way and demand so much more from the world of knowledge surrounding them. Meeting these expectations requires new learning outcomes, which VR/AR technologies can provide.

Advocates for the affordances of VR/AR technology come from many fields of study, sharing an investment in new educational perspectives

offered by the technology. It is true that virtual reality creates new methods of visualization, but it also has the ability to expand the realm of the possible. Virtual reality can go beyond recreating past worlds or objects. It can be used for creating new spaces, new scenarios, and possible universes. For example, the gigantic virtual reality simulation, Second World, was an exercise in creating communities, built landscapes, and business models. Similarly, and more recently, Minecraft, a 3D world-building game, thrives on the creative abilities of millions of people. In education, learners and educators use both world building universes for creating memorable educational spaces. Minecraft, initially a simple game for middle scholers and teens, has now developed a whole new suite of educational tools and environments. Students can learn chemistry, physics, math, or principles of architectural design in this environment ("Minecraft" n.d.). The more sophisticated authoring and display tools surrounding head mounted display technologies, such as Oculus Rift, have generated their own ecosystem of learning, covering domains as diverse as mathemathics, anatomy, environmental sciences, or astronomy. A version of "Google Translate," which turns the image of any written sign into its equivalent into another language in real time and projected onto the physical object is another exciting application of VR/AR for learning (Lynch 2017).

While applications abound, a lingering question remains. How can virtual reality help learning? At least two theoretical perspectives can shed light on this question. On the one hand, there is the well-known theory of "dual encoding," which proposes that information presented through several channels, simultaneously, is more engaging and memorable. A simple example of this would be an oral lecture accompanied by powerpoint presentations. Movies with powerful soundtracks could be another example. Presenting information in a VR environment has the added benefit of encoding in a contextual and holistic manner, rather than simply encoding the information *via* multiple channels. Another theoretical perspective is that proposed by cognitive research on encoding of information in spatial objects. Spatial representations, which are connected to deeper cognitive process including those that situate our own bodies in a live experience, may have a higher capacity to help the human mind store and retrieve information. The cumulative contribution of the spatial-memory theory of learning, dual coding and other theoretical advances in scaffolding learning with experiential tools leads us to conclude that virtual reality technologies can have a demonstrably positive effect on learning.

Because of the immersive nature of VR/AR, the technology powerfully supplements current approaches in many disciplines. As Budzynski (2017) articulates, "VR is more than just putting on a headset. It is an interactive, immersive visualization tool that can be used to construct highly interactive

scenes for presentations, public outreach, planning, and design" (23). Accessing artificial environments which can be designed, modified, curated, and collected suggests an immense number of possible uses who approaches topics from new perspectives. Furthermore, such experiences demonstrate that virtual worlds offer immense possibilities for processing and remembering information due to the unique environmental effect on cognition. As articulated by Matei, Madsen, and Bruno (2010), the benefits of VR/AR "are derived not only from the fact that the user has a larger array of situations and contexts to explore and to use for constructing knowledge and social groups, but also because contextual information is easier to remember and the type of spatial environment that we propose can affect in a direct and profound manner our ability to learn" (n. p.). Rather than only existing in the realm of science fiction then, VR/AR has the potential to modulate fields, to disturb the way things have always been done but also to alter dramatically the ways in which we humans navigate and negotiate space and time. By reorienting our approach to information through spatiotemporal coordinates in a virtual space, we can actually change the way we process and retain data. Because we are experiencing information, we may retain it more readily than reading it in a book.

VR/AR is already profitably used in architectural and construction work, allowing designers to build immersive environments showcasing proposed projects. Implementing VR/AR into construction and architectural projects allows stakeholders to visualize finished projects in a much more immediate way, which has a direct effect on planning efforts. Construction projects all over the country are being designed virtually so that communities and investors can "see" the future design in "reality." For example, one team designed an interactive immersive version of the city of Zillah, Washington, which included a proposed parkway (Budzynski 2017). Because the visualization is interactive, viewers can navigate around the parkway and gain a clear image of the finished project. The availability and affordability of such technology will likely become more and more popular in construction and design quarters as more companies realize the potential in designing virtual prototypes for their projects. Researchers in digital humanities believe that what has been done for the present, can very well be done for the past (Matei, Madsen, and Bruno 2010).

But the promise of VR/AR is being touted for many other fields as well, including science, medicine, and therapy. Some of the most prominent suggestions for VR/AR are in this area. For example, researchers have argued that VR/AR can be an important tool in clinical rehabilitation, suggesting innovative applications for "clinical VR" (Lange et al. 2012, 1864). Because of game-based developments in virtual reality, Belinda Lange and her team argue that the technology can assist with physical rehabilitation, "VR

provides numerous assets that are well matched to the various require-
ments and standards for creating effective rehabilitation tasks" (1865).
Immersing patients in immersive environments assists clinics with rehabili-
tation and therapy by designing simulated spaces in which "repetitive and
hierarchical performance can be tested and trained in a systemic fashion"
(1865). Other researchers study the effect of VR/AR for students with dif-
ferent learning and cognitive abilities. For example, Lee and Wong (2014)
explore the applicability of using desktop VR to improve learning for stu-
dents with low spatial ability. By reducing extraneous cognitive load of
information transmission in a traditional classroom, Lee and Wong found
that VR actually "engages learners in active processing of instructional
material" (49). Adapting the teaching method to the student using VR tools
produces better outcomes for those students. VR/AR is also posited as a
possible tool for studying animal behavior because VR simulates real world
environments and can reveal much about the ways in which animals pro-
cess stimuli (Minderer et al. 2016). Thus, virtuality is a natural method to
explore and study spatiality and human or animal cognition without exten-
sive physical environments.

Because VR/AR challenges the way information is processed and shared,
it has also been explored as a possible way to supplement teaching at both
primary and secondary levels, as the Minecraft program mentioned above
suggests. With the rise of the Digital Humanities and digital scholarship
initiatives being launched at many universities, incorporating the teaching
of liberal arts with the technical affordances offered by VR/AR is increas-
ingly discussed, studied, and advocated. As Allison (2008) points out in the
context of History education, "virtual reality technologies show great peda-
gogical promise for both teachers and learners" (343). But this promise also
raises challenges too. Allison traces some of these, pointing out that VR/AR
does not meet the standard for traditional education, which he calls the
"trinity of the archive, the library, and the book" (343). Further, Allison
questions the notion that VR/AR can replace the classroom of traditional
research methods. In a similar vein, Fowler (2015) traces a gap in peda-
gogical theory in the current discussion about VR/AR in educational con-
texts, arguing that "very few of the studies [he] reviewed had a clear
theoretical (pedagogical) model to inform the use and design of the EVEs
[educational virtual environments]" (412). Because the incorporation of this
technology into the humanities and social sciences, in particular, is so new,
there are significant questions about the pedagogical applications for
such tools.

Regardless of the application of VR/AR objects in higher education,
immersive environments will likely play a big role in future courses. We
believe partnering VR/AR with the Humanities and Social Sciences

curricula and theorizing the role of such technology is timely. Dalgarno and Lee (2010) make the case that such technology will become central to learning environments:

> Internationally, educators and educational institutions envisage great potential in the use of 3D simulations, games, and virtual environments (VEs) for teaching and learning, as they provide the possibility of rich learner engagement, together with the ability to explore, construct, and manipulate virtual objects, structures, and metaphorical representations of ideas. (11)

Educators are drawn to VR/AR precisely because the immersion into virtual or augmented realities challenge the existing pedagogy and opens new doors for course work. Notably, they point to the creation of original virtual objects as also part of the educational process. Thus, the affordances of VR/AR include both new frames of references for existing courses and new projects for students to design and create. Students can explore immersive environments as a way to connect more immediately with course topics, but they will also be building new environments for others to explore.

But inserting VR/AR technology into the Humanities and Social Sciences classroom also raises possibilities for advancing new areas of study. As more and more outlets discuss the capacities for VR/AR to support or supplement traditional practices, various fields turn to virtual technology to inform their work. Most visibly and perhaps least controversially, this technology has already provided revolutionary possibilities for History and Archeology. As early as the 1990s, significant intellectual and material investments were made in massive and significant efforts of digitizing and representing past realities in 3D and VR for the benefit of the budding history and archeology scholars. The "Rome Reborn" project is such an example, probably the most ambitious ("Rome Reborn"). At one time featured in Google Earth, the project aims to recreate a game-like vision of ancient Rome the way it looked at the end of Antiquity, in the fourth century. The Roman Forum, most monuments of Rome, including the apartment buildings and the fortifications straddling the Tiber river have been reconstructed in great detail. The learning scenarious for such an environment could touch on multiple learning outcomes and domains. The environment can be used in history classes, serving as a re-enactment scene for some of the most momentous events in Roman history, from the ritual killing of Remus by his brother and founder of the city, Romulus, to the ultimate sacking and demise of the first capital of the European world in the fire of the fifth century sackings. It can also serve as a backdrop for learning Latin in a classical environment, conversing with the "natives." Finally, it can be used as life-size theater, inviting the learners to immerse themselves in Marc Antony's oration at Caesar's funeral, as depicted in Shakespeares' famous play. Despite promise and at times hype, the

utilization of "Rome Reborn" in the classroom is sporadic and waiting for more mature means of pedagogical distribution. The reasons, which will be discussed below, include a clear pedagogical strategy and theoretical justification for VR technology use in the classroom. This is compounded by a lack of clear understanding of the technical and skill needed of both the educators and the librarians responsible for supporting VR-enhanced learning scenarios.

As we explore and implement VR/AR, we should also consider ways to critique and question the notion of virtuality itself. Exploring virtual technology raises questions about notions of the real, of space and place, and of information and the way humans process it. Such philosophical questions are not simply adjuncts to the technology but are already embedded in the technology itself and in our contemporary sociopolitical moment. As information becomes more and more digitally mediated, we must teach students to think carefully about the nature of the virtual and of the reality. In our digital world, philosopher Brey (2014) approaches VR/AR as a question of ontology, that is, the study of being and existence. Brey raises questions about the relationship between virtual and real, arguing that while there is a clear distinction between physical objects such as rocks and apples, which have clear mass and chemical properties, and the virtual representations of those objects, there are other areas in which the virtual can become real: "I have argued that certain types of visual objects, actions and events qualify as real, in the sense that they do not just simulate but ontologically reproduce the entity that they are an imitation of" (54). In areas where ontology relies more on experiences or inputs, or exists in a social form, the virtual can become as real as so-called reality. Exploring such questions with students can provide fruitful opportunities for teaching and learning, and such education will prove increasingly important as we navigate the twenty-first century world of multi-sensory digital information.

Building a VR/AR library collection

At Purdue University, we are beginning to imagine such a repository, hoping to expand the existing mission for library collections. Because we already have exciting developments happening in VR/AR on campus, we imagine this repository as a natural complement to such existing initiatives. We have faculty across campus building VR/AR labs, but we also have a VR/AR facility on campus called the Envision Center, which offers space and equipment for students and faculty to explore virtual reality. The Envision Center offers training in the technical aspects of VR/AR, demonstrating the affordances of simulated environments for data visualization and research. They have also dedicated space to an immersive environment

with which to enter fully simulated environments. Furthermore, faculty and students working with the Envision Center, especially those coming from STEM fields, design original 3D objects to suit their research and teaching. Faculty in Biology, for example, designed a virtual space so students could conduct soil analyses in virtual space on various soil strata designed from original scientific data. These objects currently remain dispersed throughout the university. We believe they should be preserved and shared beyond individual projects, so duplication is avoided and preservation and discovery is enhanced. Thus, centers such as this are key campus partners that demonstrate the need for a repository of 3D objects in order to capture and preserve the innovative work being done locally while also expanding access to wider collections of VR/AR materials from developers around the world.

Because of our specific focus on Humanities and Social Sciences, we imagine that any progress will need partners in the College of Liberal Arts. Inspired by the possibilities found in the Envision Center, the Associate Dean of Research in the College of Liberal Arts is building a VR Media Studio collaboratory in which students and faculty can experience virtual reality. This space will cater to students and liberal arts faculty but, through the Libraries efforts, we hope to partner faculty in Humanities and Social Sciences with STEM colleagues to build engaging and sustainable curricula around VR/AR learning experiences. We are also interested in designing VR and AR scenery and environments for teaching Humanities classes, such as "Great Communicators," which exposes students to public speaking through focused studies of famous speeches through time, or re-casting history classes in new virtual reality environments, especially those that deal with issues of military conflict or global strategy. Imagine students watching a virtual Winston Churchill declaim "We shall fight on the beaches" as a supplement to reading the speech. We believe there will be powerful synergy and innovation through these collaborations.

Meeting with these campus stakeholders for focused discussions of cross-campus developments in VR/AR, our team coalesced around the notion that VR/AR could be particularly advantageous in the Humanities and Social Sciences, in addition to the STEM fields, but that we would need significant outreach to these departments. We have theorized how best to reach out to departments across campus that are not located in technology-rich areas but who might benefit from new methodologies in teaching and research, and we are hoping to host a symposium specifically organized for liberal arts with an eye toward pedagogical redesign using VR/AR technology. We also plan to develop a starting list of crucial 3D objects to be explored in the Humanities and Social Sciences. Such a collection would allow us to begin collecting and curating objects and would provide clear

benchmarks for a library collection. Combined with the objects being developed by the VR/AR Center and the VR Media lab, we believe we will have a robust and significant collection.

Currently, we are not aware of any academic library that actually has a 3D object repository to be used for VR/AR tools, and literature on the topic is sparse, but that could change quickly. Technical knowledge is being shared across different types of libraries and museums through working groups and forums to discuss best practices for 3D object preservation, such as the Community Standards for 3D Preservation (CS3DP), funded by an Institute of Museum and Library Services grant. Through two national forums and an online, collaborative environment, librarians at Washington University of St. Louis, University of Michigan, and University of Iowa comprise CS3DP, which is greatly informing the conversation of how to develop standards for 3D data preservation. Topics include: how to standardize the metadata, so files can not only be shared on campuses, but potentially in open access repositories; a standardized process for creating and saving files, so files do not get lost in proprietary issues is a concern; and having software and hardware for both creation and viewing as a library service (Moore et al. 2017). Having a repository is one thing, but interacting with the 3D objects in another. Our libraries have designated library stations for viewing some collections, so it is not unprecedented to require campus access to view parts of a collection, but we prefer online access to view and interact with 3D objects with limited barriers. We have determined how to store 3D objects in our library repository, but we are still figuring out how to enable patrons to view and make changes to those files within the library portal. In the short term, we are looking to host the 3D objects in our repository, build a discovery interface, and direct patrons to online viewing software, such as Sketchfab, where the objects can be uploaded, and to existing labs with VR/AR tools.

Researchers at Virginia Tech University, Indiana University, and the University of Oklahoma were also recently awarded an Institute of Museum and Library Services grant to host national meetings organized around library adoption of 3D object preservation, which will result in a white paper collating and analyzing the results garnered from the events ("3D Collection Strategies" n.p.). When we learned about the IMLS grant, we contacted their principle investigator, asking if we could attend their "3D/VR Repository Practices and Standards" forum meeting that occurred September 17–18, 2018 in Rosemont, Illinois. Perspectives from different parts of the library community were brought to the table, and we talked about such issues as what happens when the VR or AR experience becomes the scholarship itself and subject to peer review. It became clear that having ongoing conversations about what other libraries are doing and what

information and resources we can share will be important as we start to think differently and build a repository service that meets the needs of future collections.

As the academic library collections undergoes changes, librarians must adapt their interventions, structures, and services to reflect these new materials, both in terms of navigating new ways to store, preserve, and make discoverable collections, but also in the way we interpret content and lead patrons to the new types of information they are seeking. As we build new collections, we must also attend to the pedagogical missions of librarians, thinking carefully about the role of information literacy in the application of virtual reality. In his foreword to a handbook on critical library pedagogy, Elmborg (2016) points out that the institutional structure of the library has been changing dramatically: "Indeed, the entire infrastructure of the library has been undone by social and technological changes. In an increasingly global and diverse world with new technologies creating disintermediated access to information, the social reality traditionally produced by our professional apparatus no longer serves us well" (Foreword, x). Perhaps more than any other technology, VR/AR offers the possibility of disintermediated access to information, in that users have the ability to engage information directly within simulated environments rather than simply read about such objects or view 2D representations of them. For example, students may be able to experience the trenches of World War I or wander Paris in the nineteenth century through the development of VR/AR tools. Due to this disintermediated access, VR/AR must be interrogated by librarians and scholars both in terms of seeking new possibilities but also in terms of critical reflection. Incorporating new collections into pedagogy thus demands new forms of critique and reflection related to information access and literacy.

While our purpose in this article is to describe our efforts to collect and curate VR/AR objects within the academic library repository, we recognize that pedagogical development and critical reflection are central to this effort. Thus, we turn to critical library studies in an effort to infuse our efforts with critical reflection, and we anticipate further analysis and discussion going forward, including a planned symposium on VR/AR technology with pedagogical applications and working groups with collaborators in liberal arts. Watson and Ellenwood (2016) argue that such collaborations are central to critical library pedagogy: "Collective conversation draws on the variety of knowledge and experience at your institution to imagine and develop new approaches to teaching and learning" (203). We will draw on our unique campus climate to foster critical conversations about VR/AR pedagogy, bringing together colleagues from STEM and liberal arts to explore and critique the applications of VR/AR technology in the classroom, and we envision the library as a central place to organize this conversation. Due to the

proximity to information access, perhaps more than any other campus entity, the library can and should facilitate the development of innovative pedagogy supported by library collections and resources.

Imagining the future collection plan with VR/AR

Reconceptualizing the parameters of a library collection that incorporates a collection of 3D objects for VR/AR represents the cutting edge of twenty-first century collection practice and poses new relationships among patrons, students, faculty, and staff. But such an effort also opens new avenues of association with other institutions. For now, we envision libraries as part of a larger consortium, working to imagine new processes for curating and preserving 3D objects, which should be a part of a larger community of knowledge. In this way, we are responding to Smith's (2008) diagnosis of the role of twenty-first century academic collecting: "In its networked role, the library will be able to support research and dissemination to the extent that it is tightly networked into the increasing cluster of inter-institutional collaborations that enable the creation and use of scholarly content" (18). Rather than reinvent the wheel, we hope to heed Smith's call for "inter-institutional" collaboration by connecting to the existing contemporary conversations, debates, and developments surrounding the inclusion of virtual reality in library collections and hosting platforms for discussions ourselves. We hope this paper serves to advance further conversations and collaborations about the future of library collecting in the age of virtual and augmented reality.

Such an initiative raises significant technological questions and opportunities related to VR/AR object collections even before dealing with the immediate issue of the collection itself. Most immediately, there is a question of hardware: the headsets, high-powered computers, and spaces that enable VR/AR to function. Although developments in hardware have made headsets more affordable and ubiquitous, there are still questions of quality and availability. For example, to develop a fully immersive virtual reality experience, in which sensors attached to the users' headsets allow full ranges of movement, requires designating enough space so that participants do not crash into one another or furniture or walls as they move around the room, and the room must be wired with sensors to interoperate with both the headsets and the high-performance computers that run the software. Secondly, hardware requires software. While some online repositories offer access to VR/AR objects, availability is still scattered around the internet and often requires a purchased subscription to access. As institutions of higher education begin incorporating VR/AR into the curriculum, it will become more imperative that students and faculty have access to 3D objects and the software and hardware to view them with which to design

course assignments. While there are objects available in online repositories such as Google's Poly or Sketchfab, we contend that access to VR/AR experiences should also be part of the libraries' mission regarding collections. Currently, such a collection exists only in the realm of possibility, but we believe adding such materials to the library catalog is an important pursuit as more universities begin including VR/AR in curricula.

But hardware is only the first challenge in our effort to facilitate such collection development. We are also exploring ways to restructure our repository to include 3D objects for VR/AR viewing that could be checked out and downloaded by patrons alongside headsets that could process such objects. Currently, library collecting has no infrastructure for capturing or curating such objects. As we mentioned earlier, most VR/AR software files are scattered around the internet, held in private repositories owned by private tech companies. For example, Google has developed a VR/AR repository called Poly, which features a range of VR experiences and objects, including tours of historical and geographical locations such as the Richard Nixon White House, Walden Pond, or Olympic National Park but also of fanciful pop-culture objects such as scenes from *Princess Mononoke* or *He-Man*. These objects are meant to be experienced via the Poly website and are made available to users. Amazon is also developing VR/AR, launching Amazon Sumerian, a site that allows novice users to build original VR/AR objects. Searching the web can lead to objects, yet there is no central location with which to access files that would appeal especially to academics. Indeed, the sheer amount of internet traffic devoted to VR/AR makes searching for specific content daunting, especially for new users.

Because of the diffuse nature of the materials available online, academic libraries have a unique opportunity to collect VR/AR files responsibly and thoughtfully and organize them according to academic subjects. Unlike online repositories, libraries would be freely available to patrons, searchable, and organized according to different subjects. Library liaisons could collaborate with departments to incorporate VR/AR into courses. For example, subject liaisons to liberal arts might offer workshops and training opportunities for faculty and students to explore VR/AR for course work but also as a mode of inquiry. Leveraging the liaisons would build on the library's strengths as collaborators but could also provide new opportunities to discuss the role of information literacy in an increasingly visual and experiential information economy. Collecting these objects positions the library at the forefront of collecting practice in academic libraries, and will help to lay the groundwork for collecting new developments in technology that we will also want to consider as collections.

It will take some time to creating such a collection, both in terms of logistical realities for adding new objects to the collection and also in terms

of selecting a manageable range of objects to collect. To begin, we plan to build a library guide of freely available resources, databases, and repositories that can be accessed on the web. Such a guide will centralize existing collections that are scattered around the internet and will direct interested users to possible resources. Our library guide will also produce a launching point to serve as a conversation starter across campus regarding collection needs going forward. However, objects collected in existing online repositories are randomly added and constructed and may not serve every user's needs, especially in higher education initiatives. In addition, some objects are built and shared online, but the software developers may not be cited properly so we'll need to consider more permanent and official collecting practices, which will take into account metadata that supports discovery, file structure, provenance, and preservability.

Creating an official catalog of objects hosted by the library also requires us to begin planning and imagining what a canon of VR/AR objects might look like. Which experiences are indispensable for higher education contexts? Which historical sites or locations should be available immediately to students and faculty? How do we start such a collection, especially given the large number of possibilities? To begin such an undertaking requires planning and collaboration with multiple groups across campus in order to gain insights about the kinds of educational VR/AR experiences that faculty and students might require. It also requires collaborating with libraries faculty that oversee our respository. We have to have expand our own institutional standardized process to the extent of our repository's possibilities and limits. And even though we do not want to limit who can put objects into the repository, we do not want to end up with objects that do not meet our educational needs and take up unnecessary space. Building a repository of VR/AR objects is pointless if the collection is not used so we must carefully consider what our collection might hold. To generate such data, we hope to host a campus-wide symposium around virtual reality with the express purpose of determining what a canonical list of objects might look like. Once we have compiled such a list, we plan to begin collecting these objects into a repository, creating an interface to help navigate the collection for discoverability and checkouthardware and access the downloadable.

We are currently exploring various ways to organize objects, exploring the possibilities of curating by field of study or by object type. For example, we might add search terms to a VR rendering of nineteenth century Paris that locates it in European history, geography, or architecture. Incorporating VR/AR into our existing collections requires consideration for potential use cases and client experiences. But we also plan to collaborate with colleagues across campus to develop teaching guides for these collections so that patrons can access the files but also generate ideas for how best to use them.

Conclusion

While much of our effort in collecting VR/AR objects is still in theoretical stages, and we are just beginning to organize conversations and collaborations across campus, we believe it is time for new permutations of the academic library collection. Universities across the country are exploring VR/AR possibilities, and we believe we can contribute to such developments, leveraging our existing strengths in Digital Humanities, data science, digital literacy, and technology. What innovations might be possible in the world of affordable virtual and augmented reality? We anticipate that such collections will prove important for our colleagues across campus but especially for faculty and students in the liberal arts, where such technology initially seems distant from the traditional discourses in those departments but in reality offers exciting new supplements to high-quality teaching and learning in liberal arts. We believe that liberal arts will provide an energetic test case for our library collection and that the library can lead the way in developing and launching cutting-edge pedagogical conversations. We hope to use VR/AR to spark new cross-disciplinary relationships that advances knowledge across the university.

As academic libraries navigate the changing terrain of the twenty-first century university, collection needs will evolve. Virtual reality is one area that is ripe for such evolution. Now that hardware is increasingly affordable and accessible, many are inspired by the possibilities for VR/AR in the classroom. To keep pace with such interests, libraries must anticipate a growing desire for carefully curated, high quality objects, which are accessible to faculty and students who want to use them in the classroom. While much of this article has been theoretical, positioning the collection within existing scholarship and gesturing toward future avenues for collecting, we believe that library collections supporting VR/AR may be right around the corner, and we want libraries to be part of such cutting-edge developments in higher education. The future of library collecting will certainly involve navigating challenging and difficult waters, but we believe that the value of such technology extends throughout the university and will provide exciting new possibilities for both the university and the academic library to develop and support cutting-edge pedagogy and research.

Note

1. Qtd in Emily Jane Fox, "Director Chris Milk Wants to Be Virtual Reality's First Auteur." *Vanity Fair* (Dec. 2015). Retrieved from www.vanityfair.com.

References

"3D Collection Strategies". 2018. University Libraries, Virginia Tech. (n.d.). Accessed August 12, 2018. https://lib.vt.edu/research-learning/lib3Dvr.html.

ACRL Visual Literacy Competency Standards for Higher Education. 2011, October. Accessed February 7, 2019. http://www.ala.org/acrl/standards/visualliteracy.

Allison, John. 2008. "History Educators and the Challenge of Immersive Pasts: A Critical Review of Virtual Reality 'Tools' and History Pedagogy." *Learning, Media, and Technology* 33 (4):343–352. doi:10.1080/17439880802497099.

Brey, Philip. 2014. "The Physical and Social Reality of Virtual Worlds." In *The Oxford Handbook of Virtuality,*. edited by M. Grimshaw, 42–54. Oxford: Oxford UP.

Budzynski, Brian. 2017. "Reality in Advance: Virtual Reality and 3D Technology may Direct the Future of Construction Planning." Roads & Bridges. n.p. https://www.road-sbridges.com/reality-advance.

Castelvecchi, Davide. 2016. "Low-Cost Headsets Boost Virtual Reality's Lab Appeal." *Nature* 533 (7602):153–154. doi:10.1038/533153a.

Dalgarno, Barney, and Mark W. J. Lee. 2010. "What Are the Learning Affordances of 3D Virtual Environments?" *British Journal of Educational Technology* 41 (1):10–32. doi:10.1111/j.1467-8535.2009.01038.x.

Elmborg, James. 2016. "Foreword." In *Critical Library Pedagogy Handbook: Essays and Workbook Activities*, edited by Nicole Pagowsky and Kelly McElroy,. vii–xiii. Chicago, Illinois: Association of College and Research Libraries, ProQuest Ebook Central. https://ebookcentral.proquest.com.

Fowler, Chris. 2015. "Virtual Reality and Learning: Where Is the Pedagogy?: Learning Activities in 3D Virtual Worlds." *British Journal of Educational Technology* 46 (2):412–422. doi:10.1111/bjet.12135.

Fox, Emily Jane. 2015. "Director Chris Milk Wants to Be Virtual Reality's First Auteur." The Hive, December 2015, n.p. https://www.vanityfair.com/news/2015/11/director-chris-milk-virtual-reality.

Gaudiosi, John. 2015. "How this Author's Fictional World inspired real VR." Fortune. n.p. http://fortune.com/2015/07/10/ready-player-one-vr/.

Hahn, Jim. 2017. "Virtual Reality Library Environments." In *Mobile Technology and Academic Libraries: Innovative Services for Research and Learning*, edited by Robin Canue and Chad Crichton, 237–248. Chicago, Illinois: Association of College and Research Libraries.

Lange, Belinda, Sebastian Koenig, Chien-Yen Chang, Eric McConnell, Evan Suma, Mark Bolas, and Albert Rizzo. 2012. "Designing Informed Game-Based Rehabilitation Tasks Leveraging Advances in Virtual Reality." *Disability and Rehabilitation* 34 (22):1863–1870. doi:10.3109/09638288.2012.670029.

Lee, Elinda Ai-Lim, and Kok Wai Wong. 2014. "Learning with Desktop Virtual Reality: Low Spatial Ability Learners Are More Positively Affected." *Computers & Education* 79:49–58. http://linkinghub.elsevier.com/retrieve/pii/S0360131514001614. doi:10.1016/j.com-pedu.2014.07.010.

"Library of Congress Subject Headings." 2018. Library of Congress. Accessed November 21. http://id.loc.gov/search/?q=Virtual%20Reality%20memberOf:http://id.loc.gov/authorities/subjects/collection_LCSHAuthorizedHeadings&start=1.

Lynch, Matthew. 2017. "20 of the Best Virtual Reality Games in Education." *The Edvocate*. n.p. https://www.theedadvocate.org/20-best-virtual-reality-games-education/.

Matei, Sorin, Lance Madsen, and Robert Bruno. 2010. "Information Acquisition and Recall in Location-Aware and Search Engine Retrieval Systems." *International Journal of Information Technology and Web Engineering (Engineering* 5 (2):32–52. doi:10.4018/jitwe.2010040103.

Matei, Sorin, Chris Miller, Laura Arns, Nick Rauh, Chris Hartman, and Robert Bruno. 2007. "Visible past: Learning and Discovering in Real and Virtual Space and Time." First Monday 12 (5)n. p. http://www.firstmonday.org/ojs/index.php/fm/article/view/1836/1720.

Minderer, Matthias, Christopher D. Harvey, Flavio Donato, and Edvard I. Moser. 2016. "Virtual Reality Explored." *Nature* 533 (7603):324–325. doi:10.1038/nature17899.

"Minecraft." Accessed February 18, 2019. https://education.minecraft.net/get-started/.

Moore, Jennifer, Rountrey, Adam Hannah Scates, Kettler, Tassie Gniady, Nicholas Polys, Monique Lassere, Kristy Golubiewski-Davis, and Cynthia Hudson-Vitale. 2017. CS3DP (Community Standards for 3D Data Preservation). https://osf.io/ewt2h/.

"Rome Reborn." Accessed February 18, 2019. https://www.romereborn.org/content/home-0.

Skibba, Ramin. 2018. "Virtual Reality Comes of Age." *Nature* 553 (7689):402–403. http://www.nature.com/doifinder/10.1038/d41586-018-00894-w.

Smith, Abby. 2008. "The Research Library in the 21st Century: Collecting, Preserving, and Making Accessible Resources for Scholarship." In No Brief Candle: Reconceiving Research Libraries for the 21st Century, 13–20. Washington, DC: Council on Library and Information Resources.

Watson, Megan, and Dave Ellenwood. 2016. "Starting Small: Practicing Critical Pedagogy through Collective Conversation." In Nicole Pagowsky and Kelly McElroy, *Critical Library Pedagogy Handbook: Essays and Workbook Activities*, 203–206, Chicago, IL: Association of College and Research Libraries, ProQuest Ebook Central. https://ebook-central.proquest.com