Professional Leave Report Cover Sheet

Name: Chris Langer

Department: Henry Madden Library

College: Henry Madden Library

Leave taken: X Sabbatical Difference in Pay Professional Leave without Pay

Time Period: Fall

X Spring

Academic Year

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Extended Reality Services in Academic Libraries

Spring 2021 Sabbatical Report

Chris Langer

Introduction

For my sabbatical, I undertook a research project examining extended reality (XR) services and programs being offered by academic libraries. Extended reality is an umbrella term that includes virtual reality, augmented reality, and mixed reality. A short description and comparison of these terms can be found here. My interest in this topic came about for two reasons. First, the Henry Madden Library had just recently launched it's own XR service within the Innovation Space. Second, there is a faculty member in one of my liaison departments (construction management) that has been experimenting with XR technology in his classes.

In my research, I wanted to look at a number of different aspects of XR services. As a librarian with subject responsibilities, my main interest was learning if liaison librarians are involved in these services, and if so, how? Additionally, I wanted to learn what general XR services were being offered in libraries. I was also interested in learning the ways that different academic disciplines are using XR when working with libraries. Additional research questions included:

- What XR software applications are being commonly used in academic libraries?
- What kind of outreach efforts are libraries using to reach students and faculty?
- How is assessment being conducted on XR services?
- What are the future development plans for XR services in libraries?

My initial sabbatical proposal can be viewed in Appendix C.

Research Design

In order to investigate my research questions, I chose to utilize semi-structured interviews with XR service coordinators in academic libraries. In choosing libraries, I focused specifically on large, mostly public institutions similar to Fresno State. I aimed to include libraries that provided varying levels of XR services. I also identified libraries that were listed in the literature as having well-regarded XR programs. While I had hoped to interview coordinators from all CSU libraries that offer XR services, only three responded to my repeated requests for interviews. Interviews were conducted via

Zoom and lasted between 45-60 minutes. Interviews were recorded in Zoom, and I later went back through the recordings to code responses. This coding was then used to identify patterns and relationships between the research questions and the data gathered from interviews. In total I conducted 13 interviews with people representing 11 different institutions. A list of interviewees can be found in Appendix A. In addition to the interviews, my research included a review of academic literature related to XR services and usage in academic libraries. Finally, I extensively reviewed the websites of the libraries included in interviews, as well all CSU libraries that offer XR services.

A Very Brief Literature Review of Libraries and XR

Mentions of virtual reality in library literature can be found as far back as the early 1990's, but it wasn't until the mid 2010's when Oculus and HTC released their consumer VR headsets that it became feasible for libraries to begin offering XR equipment and services. A 2019 study (Cook, Lischer-Katz, et. al) offers one of the best overviews of the uses and challenges of XR in libraries and education more broadly, and is recommended reading for anyone looking for an accessible introduction to the topic. The study noted the current use of VR and the benefits it can provide in a variety of academic fields like digital humanities, archaeology, engineering, biology, medicine, and others. In addition to providing access to VR equipment, libraries have also begun to utilize equipment like 3D scanners and photogrammetry to create VR content. Also noted is the immense potential and unique role that VR can play in facilitating research. But also noted were many significant challenges for implementing VR services in libraries, including:

- costs for equipment remain high
- the potential for users to have "simulator sickness"
- lack of available VR curricula, and the difficulty of content creation
- lack of faculty and administrative buy-in on campus

Recent scholarship illuminates some current issues related to XR in libraries. A recent environmental scan of XR in academic libraries found that a significant number of

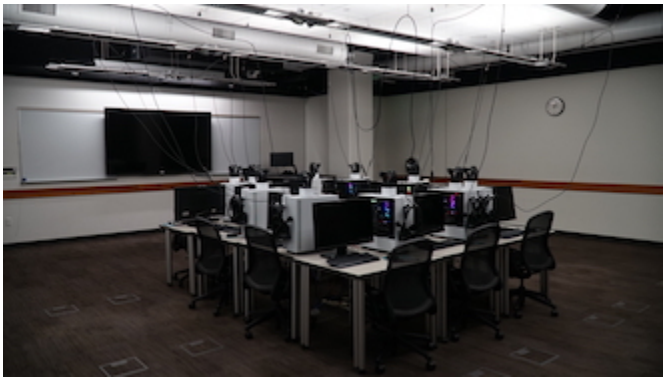
ARL libraries offer access to VR technology, while AR technology was much less widespread. In most libraries, access to VR technology only included in-house use (Greene & Groenendyk, 2021). Another recent study has documented the challenge of libraries archiving and preserving materials associated with VR (Lischer-Katz, 2020). A 2019 paper discusses the potential of the library to provide a repository for the preservation of 3D objects used in VR/AR (Hannah, Huber, and Matei). A 2020 study presents a case study of an evidence based approach to designing VR spaces and services (Rossmann & Young). An examination of the demographics of VR users at the library at Brigham Young University found that 71% of those who used VR were male, despite the student population being approximately 50% male (Fost, Goates, Cheng and Johnston, 2020). Users were also highly concentrated in STEM disciplines (62%), as opposed to humanities and social sciences (17% and 21% respectively).

Overview of XR Services in Academic Libraries

XR programs in libraries that were surveyed varied dramatically in terms of facilities, services, staffing, and level of support offered to students and faculty. One common refrain heard when talking to those who coordinate XR services in their libraries was not wanting to duplicate XR efforts or services that are offered elsewhere on campus, so XR services in libraries are greatly shaped by XR efforts that are ongoing elsewhere on campus. It was also clear in conversations that in many libraries, XR services had developed somewhat organically, often without a clear view of what level of services should be provided or how they fit within the greater services of the library.

Virtual reality is almost exclusively the type of XR equipment being provided by the libraries I examined. VR products from Oculus and HTC were by far the most commonly used. Libraries generally provided access from anywhere between one and six VR workstations, with most on the lower end of that range. Only the University of

Utah reported having VR classrooms, where they have two VR classroom spaces, each with 10 permanent VR workstations.



VR Classroom at University of Utah

At most libraries XR services are bundled with other services within the library, but there is no single model that is dominant. The build IT lab at San Diego State University and the Innovation Lab at CSU San Bernardino are examples of VR services being offered within a makerspace, which is a common model. But XR services are being offered in a number of different ways. The Digital Scholarship Lab at Michigan State University offers their VR services in conjunction with a 360 degree immersive video space utilizing Igloo Vision technology. The Digital Humanities Center at SDSU offers podcasting, one button recording, and an electronic literature studio in addition to VR. The University of Oklahoma Libraries space, The Edge includes 3D scanning and photogrammetry equipment. It is clear that libraries are grouping XR together with their other “innovative” services, whether the technologies interact with each other or not.

Also seen in the majority of libraries were digital media labs of varying types and sizes that provide access to software that can be used to create VR content. These labs are generally multipurpose, in that the software offered in them doesn’t just support VR. While these labs were an almost universal feature, libraries varied greatly in the level of support they offer with content creation, and whether that support is geared towards students, faculty, or both. This aspect is explored further in the Current Landscape of Educational Software Applications for XR section.

Course Integration

Most XR coordinators reported that they were working with a handful of professors to help them provide access to VR integrated into their courses. The extent of library involvement varied depending on the situation. Most every university had a few faculty who were VR champions and early adopters of the technology. In cases where professors had already adopted VR, libraries often simply provided access to VR headsets to students in those classes. In these situations, students would typically come into the library individually or in small groups to use the headsets to complete an assignment, either required or extra credit. Libraries that had larger spaces with multiple immersive technologies reported being able to bring in an entire class at the same time and breaking students into groups and having them rotate between technologies.

For a small number of libraries, their course integration work included offering robust application development assistance to faculty. In this service model, the course integration process was much more involved, as the application that faculty envision for their course usually doesn't yet exist, and they are able to approach the library with an idea and work together to make it happen. This process is explored more deeply in the section on Application Development in Higher Ed.

When trying to expand XR services to new faculty who are not currently using it in their courses, it was common for coordinators to express challenges and frustrations. Simply put, it can be a difficult conversation for someone in the library to approach a faculty member who is an expert in their field and try to suggest ways they can integrate VR into their course. Many faculty have very limited knowledge of VR and might not see the educational utility of the technology. Further, the limited number of fully-developed applications available is another major challenge, which is outlined in the Current Landscape of Educational Software section of this report. But there were a few interesting ideas that were offered to those who want to try to sell faculty on the use of VR in their classes. One coordinator reported success in targeting faculty who had won campus teaching awards, as they may be more likely to try new innovative

approaches to their pedagogy. Another reported that when he saw an opportunity for a VR application to be used in a class, he would contact that faculty member and ask them to send one of their TA's to look at whether it would be helpful. This would require little effort from the faculty member, and if the TA found the application to be useful, the faculty member would perhaps be more open to using it. Appealing to the vanity of faculty was another strategy offered. VR use in courses lends itself well to publicity and marketing, so if the library could broadcast it's VR success stories with faculty widely, other faculty may be tempted to try it as well.

Staffing

Because the level of services differs so much between libraries, it is natural that the staffing levels differ as well. Those heading XR services in libraries held a number of different job titles, and in most cases, XR services were only a portion of their job duties. Only in the largest libraries at well-funded R1 universities was it possible to find a person who had XR as their sole job duty. Most who coordinated XR services were librarians, but there were several robust XR services being led by someone in a staff role. On the low end, there were several examples of XR services being staffed by only a single full time staff member. But at larger libraries with robust programs, there were significant resources dedicated to staffing. For example, at the University of Oklahoma Libraries, the Emerging Technologies Department currently has five full time positions, as well as post-doctoral support. At North Carolina State University Libraries, the Learning Spaces and Services department, which contains XR and adjacent technologies and services has 19 staff members.

One thing all libraries, regardless of size, had in common was their reliance on student assistant staffing to keep XR services up and running. Student assistants often had responsibility for much of the day-to-day work, such as checking patrons in and out, assisting them with using VR headsets, and cleaning equipment after use. But innovative approaches were also being taken to get student assistants involved in a more significant way. At both SDSU and CSUSB, their makerspaces are for the most part student-run, and their student assistants were also involved in providing assistance

with content creation software to other students. John Hernandez, who heads the CSUSB program, is a firm believer in the benefits of a peer-learning model for their service. For libraries that are targeting their VR services mostly to students rather than faculty, this student-led model seems to work quite well. Some libraries also involved their students in leading workshops. For example, at NCSU, staff would develop workshops on XR content creation, which once created would then be led almost entirely by student assistants.

Tiers of Service

After examining the XR services provided by all libraries, I attempted to group them together according to the level of services and support they offer. Although not every library fits neatly into a category, I was able to identify four general tiers of XR services and support that are being offered by libraries. In the first tier, libraries are providing VR headsets and software that can be used to create VR content, usually in conjunction with other services or equipment in their library. This first tier would best be described as simply providing access to VR.

The second tier includes everything in tier one, but also includes some level of support to students using software that can be used to create VR content. In some libraries, this support is provided by student assistants, such as with CSU San Bernardino. In other instances, library staff offer individual assistance or workshops. Importantly, providing these first two tiers of service can be done without expending significant staffing resources. The CSU libraries I talked with fit into these first two tiers, and from examining the websites of other CSU's that offer XR services, it seems like they would fit into these tiers as well.

With tier three, the major difference is that there is a level of support for faculty to create VR content for their classes. In effect, a faculty member who is interested in using VR in their class can expect some level of assistance from the library with creating content. Offering this level of service typically requires dedicated staffing for developers who can create quality content suitable for education. More about the

staffing models used to offer this level of service can be found in the Application Development in Higher Ed section.

In the fourth tier, libraries are additionally offering high-level services in VR adjacent technologies like 3D scanning and photogrammetry, which can be used to create VR content used in the classroom. More about these services can be found in the 3D Scanning and Photogrammetry for 3D Modeling section.

Tier	Description	Schools
1	Provides access to VR headsets, usually in conjunction with other services/equipment (i.e. Makerspace). Also provides access to software that can be used for creation of VR content.	
2	Previous tier, plus provides some level of support to students using VR content creation software.	
3	Previous tiers, plus provides some level of support to faculty to create VR content.	
4	Previous tiers, plus access and high level support for XR adjacent services such as 3D scanning and photogrammetry offered	

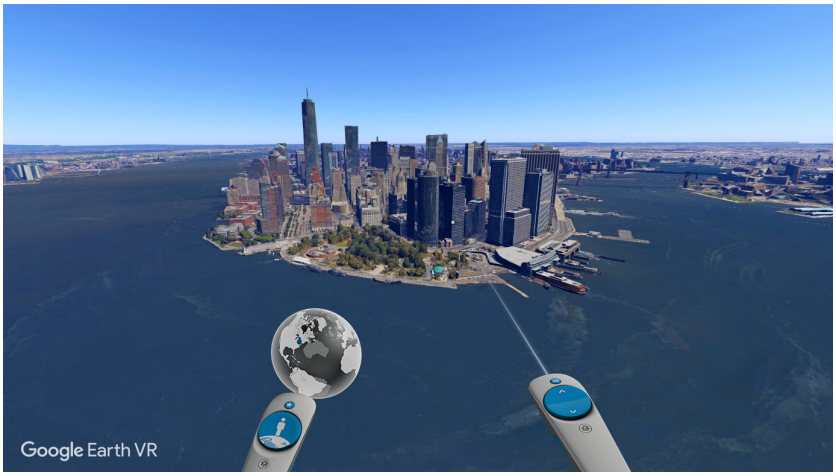
In general, the higher the tier of XR services a library wants to offer, the more resources they will need to expend in regards to staffing, funding, and library space. It is not a coincidence that nearly all the libraries in tier three and four are at R-1 institutions. These institutions also tend to have a high level of XR research and usage occurring elsewhere on campus, so the library's investment can more easily be justified.

Current Landscape of Educational Software Applications for XR

Fully Developed, Off-the-Shelf Applications

Software applications that can provide immersive learning experiences are key to unlocking the potential of XR for education. Yet for an educator who is looking for fully developed “off-the-shelf” applications that they can utilize in a class for learning, there is a distinct lack of options available, which was noted by many I talked to. As one XR service coordinator stated, “there are barely any triple-A games, and there’s zero triple-A education games.” Another said “there’s not a lot of dedicated software targeted to a specific discipline.” From browsing application stores like Steam or Oculus Store, it is clear that XR application developers are heavily focused on the commercial market, especially games, with education being an afterthought, if it is thought of at all.

But challenges notwithstanding, there are some fully developed, off-the-shelf XR applications that were reported as being often used by faculty for courses. Probably the most mentioned application was Google Earth VR. While disciplines like geography or history probably come immediately to mind as potential users of Google Earth VR, educational uses reported could be quite diverse. For example, one coordinator reported that a business course used Google Earth VR so students could look for potential spots to place a business. Another university had future study-abroad students use Google Earth VR to experience their study-abroad location before leaving.



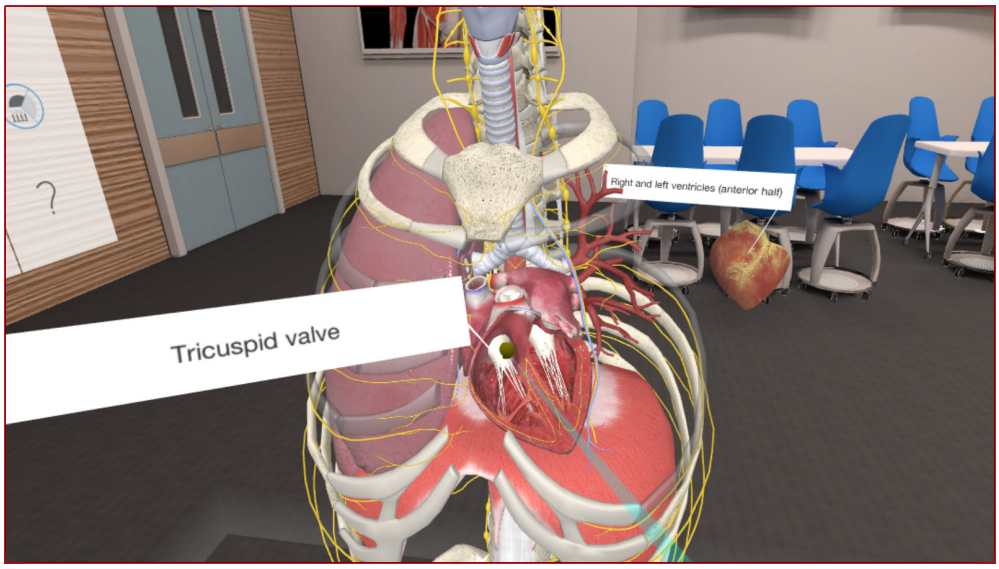
Screenshot from Google Earth VR

Another heavily used application being used in higher education was Tiltbrush, which was also developed by Google and is now freely available. Tiltbrush is a 3D painting application that allows users to create art in a virtual reality environment. This app was naturally used most heavily in art and design related fields, but there were other uses reported as well. One coordinator reported that some students were using Tiltbrush to write out scientific equations to help them remember them better.


Promotional Image from Tiltbrush

One field where VR has been highly touted as having potential for teaching is medicine. There are a number of applications being used in classes for anatomy and nursing. A few examples of applications being used in these areas are 3D Organon VR Anatomy, Body VR: journey inside a cell, Sharecare VR, and Medicalholodeck. These applications allow students to immerse themselves into the curriculum and explore 3D

models in a VR environment. And while most of the medical applications being used in libraries are not free, they are relatively inexpensive.



Screenshot from 3D Organon VR Anatomy

Architecture and interior design are additional fields of study that have been reported as being common users of VR. Software options such as Revit allow users to design intricate models, which can then be viewed in VR. VR provides students with a first-hand view of their designs, and can help them spot potential issues and problems that might not otherwise be obvious.

There were also a number of examples of XR games being used in innovative ways. One XR coordinator reported working heavily with the psychology department at his university to integrate VR experiences into their classes. In one example, a class was using Ritchie's Plank Experience to experience the psychology of walking a plank 80 stories high in VR. This same coordinator reported working with a dystopian literature class that would come in and play Blade Runner 2049. Because there are so few VR apps developed for education, this creativity in using games in varying ways is important if you wish to extend VR into the curriculum.

For more examples of fully developed applications, see Appendix B.

Application Development in Higher Ed - Bridging the Gap

In part due to the lack of apps, educators at some institutions are developing their own XR educational applications for their courses. Unreal and Unity are two game development engines that can be used to create full-scale VR experiences that can be used for education. But most faculty will lack the technical expertise to create their own VR applications without significant assistance. Most libraries are not offering application development support to faculty, and it's usually a matter of expertise, economics and limited resources. As one librarian said, "It's hard to create stuff for VR, I think that's the main thing. It doesn't make sense for us to invest to the point where we are Unity experts."

The University of Oklahoma, North Carolina State University, and University of Utah are rare examples of libraries that are able to offer fairly robust XR development services to faculty in-house. With staff dedicated solely to application development, teaching faculty are able to partner with the library to create VR content specifically for their course needs. This approach is resource intensive, as it requires dedicated staff with a unique skill set. But when these services are offered by libraries, they are reported to be very popular, and demand for application development services outpaces the resources available to provide the service, meaning the library often has to pick-and-choose who they work with, and the wait time from inception to deliverable can be significant.

Another model utilized by Western Michigan University is to offer VR application development services in coordination with their university's IT entity. In their situation, the developer works within the VR space in the library, but the salary does not come out of the library budget. But the most popular model seen for application development for faculty, if it exists at a university, is that the service is offered by another campus department outside the library. Some well-resourced schools, usually R1s, have dedicated campus departments with teams of developers that will work with faculty to develop XR software applications for their courses. North Carolina State University's Distance Education and Learning Technology Applications (DELTA), and Penn State's

Teaching and Learning with Technology are good examples of this. Another option that has been reported is faculty pursuing grants in order to fund application development with outside development companies that have the resources and expertise to develop high quality applications.

The Sharing and Discoverability Problem

While there is a good deal of local application development occurring at different institutions, a significant challenge is that for the most part, these applications are not being shared outside of the university where it's being developed. XR service coordinators offered a number of hypotheses for why faculty are not sharing their applications. One theory was that, unlike libraries that are in the habit of sharing and making information available, teaching faculty just aren't as interested in making their XR applications available. As one librarian said, "I think mostly it's a matter of priorities. They want to create this thing. They want to make sure it's accessible to their students. And getting it out there so that students at other universities have access to it just isn't a priority." Faculty may also be interested in monetizing their application down the road, or there could be copyright concerns to consider. Another issue may be that the applications being developed are too specific to the needs of a single class to be of much use to others. For example, Penn State's geosciences department has developed virtual field trips for their students, but the geology being explored is specific to their area of Pennsylvania and wouldn't be relevant in other locations.

But even when XR applications are being shared outside of a local campus, there are further issues of discoverability. Simply stated, there is no single platform available that provides access to educational XR applications that have been developed. Popular commercial platforms that host VR content, such as Steam and the Oculus Store, were not created with the education market in mind. One XR service coordinator opined at length and to great detail on this issue:

> "I think there is a major discoverability problem. I think that a major hole that exists within the educational sphere for these technologies now is just people building compendiums of useful applications. I think there would be

> a very dedicated market, I don't know how large it is, which is probably the reason it doesn't exist, for an education only XR store. We put our entire VR collection into our actual library catalog two years ago and per Worldcat we are the first library to list 80% of those applications in any library catalog worldwide, and that kind of shocked us that somebody else wasn't doing this already. I'm kind of consistently blown away by how little cataloging of all these great tiny little apps that are being put together."

So there is definitely a need and opportunity out there for someone to create a platform that specializes in hosting educational VR content. Perhaps something along the lines of MERLOT, that curates and makes VR applications available. For those interested, the most comprehensive curated list of VR content for education that I was able to find was compiled by Rob Theriault at Georgian College.

3D Scanning and Photogrammetry for 3D Modeling

Creating 3D models via 3D scanning or photogrammetry is another area where libraries are creating VR content and supporting learning. Some libraries, including Harvard, University of Oklahoma, and North Carolina State University offer high-level 3D scanning or photogrammetry services that faculty can use to create 3D models for use in their classes. There are many potential applications for 3D modeling. Using 3D scanning or photogrammetry, a 3D model can be created for nearly any object, from a small insect to a large building. And once the 3D model has been created, it can be viewed in VR. The potential of 3D scanning is perhaps greatest with rare materials such as those available in an archive or special collection. So, for example, 3D modeling could allow students to view and manipulate in VR a small fragile artifact like a fossil, or explore a historical building that is off-limits to the public. You can see some examples of 3D models created at Harvard and University of Oklahoma**.** Both are hosted on Sketchfab, which is one platform for sharing 3D models. Importantly, these models can also be viewed for those without a VR headset, making them more accessible.

3D scanning lab at University of Oklahoma

3D models can also be created from scratch using a variety of software products like Blender, 3DS Max, Maya, Mudbox, and SketchUp. Students of nearly any discipline could be potential users of 3D modeling software. One example cited was a kinesiology student creating a 3D model of a prosthetic device, which was then viewed in VR, and later 3D printed in the library makerspace. As previously mentioned, most libraries provide access to applications that can be used to create VR content in a media lab, though the level of support they provide varies greatly. It is also common for these programs to be used by students in courses in varying disciplines, so even though the library may not be teaching it, there may be faculty elsewhere on campus who are.

Role of Subject Librarians in XR Services

When undertaking this research project, one of my main research questions was to examine the role that subject librarians have in XR services. Given that subject librarians play an integral role in working with faculty to teach their students information literacy skills and develop knowledge and comfort with databases and other research tools, I anticipated that there would be a number of models and examples of innovative ways that subject librarians are involved in providing XR services. But instead, what I found was that almost universally, subject librarians play little to no role in XR services.

It may be helpful to first talk a bit more about the staffing model used for XR services. As previously mentioned, those heading XR services held a number of different job titles, and in most cases, XR services were only a portion of their job duties. In most cases where XR services were headed by a librarian, that librarian had no or minimal subject liaison responsibilities, but there were some exceptions, such as a subject librarian for Earth and Mineral Sciences who coordinated a VR service in the Earth and Mineral Science Library. So for the most part, those who coordinate VR services and those who provide subject liaison services are completely separate.

All institutions I looked at utilized a subject librarian model, and when asked what role subject librarians played in their services, VR coordinators continually reported that they played a minimal role in their VR services. Instead, subject librarians were often described as being a sort of “point of reference” for faculty in their departments, who could “hand-off” faculty to those working with VR if they showed interest. The one area where subject librarians were described as playing an important role was in faculty outreach, especially when VR programs were first being developed. This is understandable, as subject librarians know the research areas of their faculty and already have established communication channels. But the subject librarian's role, almost universally, did not extend beyond outreach and serving as a conduit for faculty who are interested in using VR in either their research or teaching.

When asked why subject librarians were not more involved with XR services, there were a number of reasons given. The most frequent answer given was that subject librarians were already overextended with their current workload. Another issue is that learning XR technology and keeping up-to-date with the specialized applications and tools associated with it is very time consuming, and most subject librarians do not already have this knowledge. Some also hypothesized that subject librarians just weren’t interested in XR and perhaps don’t see their role as having anything to do with it.

So while subject librarians are not currently playing any significant role in XR services in libraries, a natural question is, should they be? And if so, what should that role be? It can be hard to envision ways that the expertise and knowledge of subject librarians might be beneficial to XR programs in libraries. While it's probably too much to expect subject librarians to become XR experts, there could be other ways that they might be able to contribute. In one interview, it was hypothesized that subject librarians might be able to play a valuable role in consulting with those who are creating XR content that is being developed for education. But this question of how subject librarian involvement might benefit XR services is one that is unexplored in the literature and not on the minds of those providing XR services in libraries.

Assessment of XR Services and Spaces

There is a significant gap in the literature in regards to assessment of XR services in libraries. All those who were interviewed reported doing some assessment activities, though many were not confident that their assessment was effective. As one coordinator bluntly said, "I think we suck at assessment. I don't know anyone who's good at it though." The depth of assessment being conducted at most libraries was shallow and limited to usage. Most were eager to collect data on how many students are using their XR equipment or attending workshops. To collect identifying information from users, libraries typically log users by having them swipe an ID card or fill out a short form. This provides basic information on who is using the space, and also allows for statistical data to chart trends as to whether usage is increasing or decreasing. Some libraries also collect data on the major of students using the services, or include a question asking students for what purpose they will be using the equipment. Most libraries who conduct "open house" type activities also reported that they would track attendees of these events.

Another common assessment technique being used is surveys. Because libraries generally have extensive data on who is using or has used their XR services, it is easy for them to target their users with surveys. Again, the type of data being

collected was fairly basic, but could be helpful when looking to shape services going forward. The most asked questions from surveys were having them rate the level of satisfaction with the service, asking for general feedback, or asking them what services they would like to see added.

Collecting data to track which classes are utilizing XR equipment and services in their coursework was especially valued by libraries. But again, for the vast majority, they were simply tracking usage. To take assessment to the next step, are there any libraries that are attempting to assess whether their services are actually contributing to student learning? Jon Oakes at San Jose State reported that he was beginning to track the educational outcome from the class sessions, as he also was interested in eventually quantifying the impact of VR. He stated, “Right now it’s my opinion, which doesn’t carry a lot of weight. But how can we set up a test where, say, people who did a thing in VR are now better at that thing than people who didn’t do it in VR. And that’s challenging, what I’m finding out, because then it gets into are we experimenting on humans and does that require IRB and all that kind of stuff.” Probably the most innovative and extensive assessment on XR and learning in libraries was conducted at the University of Oklahoma and presented at the 2018 meeting of the Association for Information Science and Technology. In this study, the authors utilized surveys and interviews to measure students reported self-efficacy after completing a course integrated VR activity. Matt Cook, one of the authors of that study, is now at Harvard University, and has probably done the most work on VR assessment in libraries of anyone I could find.

Outreach Activities For XR Services

Outreach is an essential activity to ensure that students and faculty are aware of XR services being offered by libraries, especially because XR isn’t something that would naturally be associated with libraries. XR service coordinators mentioned a number of interesting and innovative ways they are promoting their services. Interviews

also made it clear that outreach strategies differed depending on if the target were students or faculty.

One outreach strategy that was popular involved targeting student groups and organizations that would be interested in XR, such as gaming, game development or computer science organizations. Targeting groups that would have a natural interest in XR is an easy way to get students in to use the services, who can then spread the word to others. One XR coordinator mentioned that he would contact student groups and market VR games as a way for groups to conduct team building activities, showing another way that VR can be used in innovative ways. Open house type events were also another common outreach method, especially when services were new. Open houses were reported as being effective for reaching both students and faculty. Other common outreach activities for students included tabling at events, digital signage, social media, and newsletters.

For outreach to faculty, many XR service coordinators mentioned leveraging subject librarians and the relationships they already have with faculty in their departments. Because subject librarians have already developed relationships with faculty and have established communication channels, they are a valuable outreach partner. Many service coordinators reported that their universities have extensive campus XR efforts outside the library, such as faculty developing XR apps, using XR for classes or research, and faculty learning communities. By tapping into the broader XR community, they are able to find partners, learn what others are doing, and make sure they aren't duplicating services that already exist elsewhere.

The Future of XR in Libraries

When asked about their future plans for XR in their libraries, XR service coordinators saw possibilities, but also great challenges.

COVID-19

The COVID-19 pandemic has understandably had a huge impact on how libraries view the future of their XR services. With most libraries having their services shut down for a year, they were very uncertain as to what their XR services will look like in the future. Simple logistical issues such as cleaning headsets were emphasized by many. Even with cleaning, there are concerns as to whether students will feel comfortable using headsets used by others. If headsets have to be quarantined after each use, it will be very difficult to support VR usage for classes. The pivot to virtual instruction during COVID has some wondering whether classes are increasingly going to be offered online, making it more difficult for students to access XR equipment in the library. It is not an understatement to say that COVID has completely changed how libraries are thinking about their XR services going forward, and because most XR services are not operating, the answers to these questions are mostly unresolved.

Oculus and Facebook

Another major concern for libraries revolves around Oculus, which was acquired by Facebook in 2014. In August of 2020, Facebook announced a major policy change where going forward, new Oculus headsets would need to be linked to an individual user's Facebook account. The requirement of an individual Facebook account raises significant privacy concerns. One staff coordinator states “I think all of us in education literally cannot use Oculus equipment anymore without violating FERPA because you have to link it to an actual Facebook account.”

Oculus products are very popular in libraries, with some being entirely locked into the Oculus ecosystem. In the past, libraries have typically created generic Oculus accounts for each headset, but in 2023, these Oculus accounts will no longer be supported. A generic Facebook account goes against the terms of service that users agree to, so libraries would be at risk of losing access to all their content if Facebook decided to crack down on these generic accounts. Libraries are still grappling with how to handle this situation going forward. Some are thinking of moving to other products like the HTC Vive or Valve Index. Others plan to continue on with Oculus using their

past practices and hope for the best. But for those who have made significant investments in Oculus products and are locked into the ecosystem for the foreseeable future, this is a significant concern.

Mobility and Equipment Check-outs

One clear direction that libraries are trending in regards to VR headsets was shifting from stations in the library to mobility. In interviews, most libraries didn't express plans to expand the number of VR workstations in their library. Instead, with the availability of stand-alone VR headsets like the Oculus Quest 2, libraries are increasingly looking to a tech lending model where headsets can be checked out to students. University of Oklahoma, one of the XR leaders in libraries, is taking mobility one step further with an innovative approach to making their VR technology equipment accessible for classes. Rather than investing in stations in the library, they have invested in high-powered laptops that can be packaged with a headset into a carrying case, making them easily transportable. So rather than bringing the class to the library, the library is bringing the VR technology to the classroom. Similarly, at Harvard University, they have 30 Oculus headsets that are available for checkout by students. If a faculty member requests headsets for a future class, they are reserved and then checked out to that class for the time needed.

Alternatives to VR Headsets

When talking with XR service coordinators, it wasn't uncommon to hear doubts as to whether libraries would need to continue to provide access to VR headsets in the future. With the emergence of stand-alone headsets that could be checked out by students, does the library need to continue to allocate precious space and resources to providing this service in-house? As one XR service coordinator stated, "as a library, we are committed to doing cool interactive technology stuff, but we aren't tied to being the VR library forever." Another coordinator foresees the emergence of hologram displays that do not require headsets. He states "We can't stop buying stuff from Looking Glass. Everything they've released we're huge fans of. We're really interested in 3D displays, we're probably pretty bearish on head mounted displays."

Holographic Display from Looking Glass

At MSU, they are seeing more and deeper engagement with their 360 video display room than with their VR headsets. Says Terrance O'Neill, "The 360 immersive theatre, we are seeing classes plan their entire course around creating for that space. We are seeing capstone projects. We are seeing parts of people's dissertations. It's not that we are going to end VR, but we are looking at it in comparison to some of these areas where we are seeing diverse array of engagement with the technology"

360 Visualization room at MSU

XR for Research

One area that XR service coordinators are increasingly interesting in exploring is the use of VR technology for faculty and graduate student research. There are unique

benefits for using VR in research, specifically the ability to create an environment that is controlled and repeatable. The potential applications are nearly limitless, as any discipline could conceivably use VR as a research environment. Indeed, some libraries reported that they have already had graduate students and faculty using their equipment to conduct research, and one coordinator states that he has served on the tech advisory committee of multiple graduate students using XR for their thesis or dissertation research.

Mozilla Hubs and WebXR

Many XR coordinators were excited about the possibilities offered by Mozilla Hubs. Mozilla Hubs allows for the creation of virtual rooms where VR content can be shared and users can interact. Built on WebXR, which provides access to XR content through a web browser, Mozilla Hubs could provide a solution to some of the major limitations associated with VR use in education. First of all, multiple users from any location can access the virtual room at the same time, allowing for more of a classroom type atmosphere where teachers and students are able to interact with each other. Second, because Mozilla Hubs is built on WebXR, it supports headsets from different companies and doesn't require anything other than a web browser to be accessed. Users can even access the content without a VR headset. Finally, Mozilla Hubs provides a platform where educators can host, display, and interact with VR content, such as 3D models, but also more traditional multimedia content such as videos and web links. Many see the emergence of Mozilla Hubs as an important step for VR. As one XR service coordinator who creates VR content said, "I'm primarily a WebXR developer, I don't really see myself returning to game engines to make anything for public release." Harvard Library has a Mozilla Hubs demo that is open and can be viewed online, and shows some of the promise of this application.

Data Visualization

Several coordinators expressed great interest in VR for visualization purposes. Utilizing VR to examine and engage with large data sets could provide unique benefits

for researchers, as they could view data in 3D rather than on a flat screen. Virtualitics is one platform that offers VR data visualization capabilities.

Recommendations

Based on my interviews and reviewing best practices and innovative approaches being taken at libraries, the following are my recommendations for XR services at the Henry Madden Library:

1. If it hasn't already been done, conduct a thorough environmental scan of XR technology usage and services being offered at Fresno State, including what applications are currently being used or taught. As not duplicating XR services offered elsewhere on campus is a best practice for libraries, learn about the future plans of those using XR on campus, and look for gaps or areas where the library may be able to provide value.
2. Allowing students to access VR headsets outside of the library provides many benefits compared to only in-house use, and is the direction library XR programs are moving towards. Explore the feasibility of including high-quality VR headsets in the Tech Lending program to make the technology more accessible to students.
3. As previously discussed, the sharing and discoverability of XR content created in universities is a significant problem. Include any XR applications that the library has purchased in the catalog and website. Explore making XR content created by Fresno State students and faculty accessible to the wider community, either through Scholarworks or commercial platforms.
4. Clarify what XR services and assistance are available to students and faculty on the Innovation Space website.
5. Cost and access to XR technology may be a barrier to faculty on campus who are interested in using XR for their teaching and research. Consider a long-term loaning program of VR headsets and VR-capable laptops to faculty so they can explore XR without making a financial investment.

6. Libraries that have XR services geared specifically to students have reported great success utilizing a student-run service model. Explore the option of hiring student assistants with experience and expertise in content creation software that can be used for XR, who can then provide assistance to other students.
7. Consider offering regular workshops for software that can be used to create VR content, either in person or via Zoom.
8. To reach the campus community, best-practice outreach channels to consider are newsletters, social media, and/or regular open houses showcasing XR technology.
9. The literature suggests that users of XR in libraries are often male and in STEM disciplines, and this has also been mentioned in interviews. Make an extra effort to conduct outreach to diverse user groups. Targeting diverse student organizations and clubs is one best practice that has been reported as successful by many.
10. Subject liaisons already have relationships and developed communication channels with faculty in their departments. This can be leveraged for outreach purposes. Provide Research Services librarians with “talking points”, fact-sheets, and other literature that can be easily disseminated to faculty who might be interested in using XR in their classes or research.
11. When conducting outreach to specific faculty on campus regarding XR usage in curriculum, include the liaison librarian for that department, as they may already have a relationship with that faculty member and knowledge of their curricular and research areas.
12. Implement basic assessment best practices of collecting data on XR usage in Innovation Space. These could include user demographics, what software is being used, the purpose of user visits, and if students are using XR for a specific course. Consider more innovative assessments such as tracking learning outcomes for curricular use.
13. Consider creating a feedback form or survey for those who use XR in the library, asking for feedback and what services, technologies, or applications they would like to see added in the future.

14. Explore potential curricular uses of freely available 3D models from platforms such as Sketchfab. This would be an easy, no cost way to utilize VR in courses.
15. Explore whether there is a curricular need on campus for 3D scanning or photogrammetry services.
16. There is great promise for the use of XR in graduate research. Explore collaborative opportunities with the Division of Research & Graduate Studies to make students and faculty aware of this option.

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Appendix A.

List of Conducted Interviews

University	**Interviewee**
San Jose State	Jon Oakes
University of North Carolina	Lynn Eades
MIchigan State University	Terrance O'Neill
CSU San Bernardino	John Hernandez
Western Michigan University	Alex Teal
San Diego State University	Pam Lach (Digital Humanities Center) Jenny Wong-Welsh (build IT)
University of Utah	Tony Sams
Penn State	Elise Gowen
North Carolina State University	Colin Keenan
University of Oklahoma	Bobby Reed Carl Grant
Harvard University	Matt Cook

Appendix B.

Applications Commonly Reported in Interviews

Architecture and Interior Design	Revit
Art and Design	Tilt Brush
	SculptrVR
	Quill
Chemistry / Visualization	ChimeraX
History / Documentary	Traveling While Black
	I am a Man
	Apollo 11
	1943 Berlin Blitz
Geography	Google Earth VR
Medicine	3D Organon VR Anatomy
	Body VR: journey inside a cell
	Sharecare VR
	Medicalholodeck
	Visible Body
Math	Calcflow
Psychology / Social Work	Mindscape

Appendix C.

Original Sabbatical Proposal

Section 1. Proposal Objectives and Goals

I am requesting a sabbatical leave for the spring 2021 semester in order to conduct research on the use of virtual reality (VR) and augmented reality (AR) technology in universities. In recent years, VR/AR spaces and technology have become increasingly common in academic libraries, and the creation of a VR/AR space in the Henry Madden Library is planned in the imminent future. For my proposed sabbatical project, I would like to research the following questions:

- how are different academic disciplines utilizing VR/AR technology
- what are some of the different VR/AR software options that are available for students and faculty
- what role do library liaisons play in the use of VR/AR for students and faculty in their subject areas
- what kind of outreach techniques are liaison librarians using to increase the use of VR/AR by faculty and students in their subject areas

In my preliminary research, I've identified a number of university libraries that offer VR/AR technology in a lab setting, including Michigan State University, North Carolina State University, UNC-Chapel Hill, UM-Amherst, and Penn State. A sabbatical would give me the opportunity to make contact with the library staff and faculty who operate these VR/AR labs, as well as library liaisons who may be involved, in order to gather information on how their programs operate and how their faculty and students are using the technology. Given the busy schedules of library staff, and the time zone differences of libraries across the country, a sabbatical would allow me the flexibility to set up phone and Zoom meetings at their convenience. It would also afford me the time to compile my findings into a report that could be distributed to those working in the Henry Madden

Library. Depending on my findings, I may in the future look to publish an article on this topic.

Section 2. Benefits to the faculty member

As library liaison to the Lyle College of Engineering, History, Political Science, Armenian Studies, and Media, Communications and Journalism, I am responsible for instruction, research support, and outreach to the students and faculty in these departments. By having a thorough knowledge of the ways different academic disciplines are utilizing VR/AR, I will be better able to promote and support the use of these technologies to not only those in my liaison departments, but also the entire campus community. It would also allow me to better collaborate with faculty members on the use of VR/AR in their curriculum.

Section 3. Benefits to the university

My limited research into VR/AR in libraries has shown it has the potential to benefit students and faculty in a variety of different ways to support education. Indeed, it is already being used at Fresno State by Professor Wei Wu, faculty in the Construction Management department, to visualize construction projects for his students. This sabbatical research would allow me to increase my knowledge of VR/AR so that I can better assist faculty and students in making use of this technology, as well as inform fellow library liaisons. Given that the library will be making a sizable investment in this technology, I think it's imperative that library liaisons are well informed of VR/AR to better serve the campus community.

Section 4. Previous Leaves

No previous leaves taken.

Appendix D.

APM 360 Report Required Information

a) the accomplishments of the leave in relation to the goals of the original proposal

During my leave I was able to accomplish the objectives set out in my original proposal. Specifically, I conducted interviews of 13 people representing 11 different institutions who are involved in coordinating XR services. As a result of my interviews, I was able to collect data that allowed me to examine and address my research questions, and compile them into the preceding report.

b) modifications, if any, to the original proposal, and the circumstances that necessitated these modifications

At the request of the dean of the library, I added three additional areas of inquiry to my research:

1. “Given that your sabbatical is scheduled for Spring 2021, a year after the installation and implementation of the Library’s video studio lab and AR/VR lab, in order to be of benefit to the CSU, your sabbatical project will need to look beyond the current configurations into the implementation of our facilities. The process of purchasing equipment, daily operations, best practices, student engagement and faculty outreach have all been built on through consultation with librarians and staff managing these spaces and providing feedback and guidance as we built the labs, so next steps should look to evaluation of such spaces and how to ensure best use of our facilities”
2. “Your request to study the use and implementation of AR/VR labs in 2021 will result in outdated data (qualitative and quantitative) a year from now if it does not look to future uses and propose plans for continued development and

enhancement of services. Since we are currently implementing that technology and enlisting key faculty from several colleges who are interested in using the AR/VR lab and the video studios, it will be important that your sabbatical look at the future and not to descriptions of currently existing technology and programs"

3. "Since our labs are based on similar labs in several CSU libraries which have a growing number of immersive technology labs (San Francisco State, San Jose State, and Chico State, for example), please make sure that your research includes studying CSU libraries that offer immersive technologies that would seem most appropriate and useful to our faculty"

c) the objectives of the original proposal (if any) that were not accomplished

While I accomplished all the objectives of my original proposal, I encountered a few difficulties that affected my research, specifically:

1. I was unable to examine some of the libraries I had hoped to look at, due to non-response of potential interviewees. This included several CSU's (San Francisco State, Humboldt State, and Sonoma State). Instead I looked at their webpages for general information on their XR programs.
2. One of my main research questions was to examine subject librarian involvement in XR programs, and look for models or best practices in this area. The information I was able to collect on this research question was limited, as I found that in most libraries, subject librarians are mostly uninvolved in XR services, other than outreach.
3. Due to covid, the XR services at libraries had been mostly shut down for an entire year. Therefore, the data I collected during interviews regarding XR usage at their libraries was largely related to their pre-covid activities.

d) anticipated outcomes for the near future as a consequence of the leave's activities

Upon my return from sabbatical, my report will be shared with all library staff via email and the library's wiki. Additionally, I will present my findings at a future professional

development “brown bag” and Research Services meeting. It is my hope that the information and recommendations outlined in my report will help inform and shape the library’s XR services going forward.