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XR Cone: Turning non-standard collections into a hall of inspiration

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Abstract:

The TU Delft (TUD) Library is embarking on an ambitious project to turn its iconic book wall into a collection wall that reveals and activates physical and digital collections in its main hall. Currently in the research and development phase of the project, we are testing our ideas through a series of prototypes. Our second prototype, XR Cone, is a proof-of-concept station to visualize and navigate our nonstandard format collections (videos, maps, 3D scans, and more). Conceptualized by library staff and coded in-house by a developer at the XR Zone learning space, this XR application turns the interior floors of the central cone into shelves of animated visualizations. Users can interactively browse collections that currently exist online in separate websites and have a limited physical presence. Using XR, the physical area right in the middle of the library can present a plethora of interactive multimedia, while keeping the space visually "quiet" for students studying. For feedback, we relied heavily on surveys and connections with education, holding structured user testing sections with related courses and student groups. We plan as well to incorporate XR Cone into an upcoming XR festival the library is co-facilitating—extending our connection and reach to the greater XR community. Content-wise, the 3D scans and models make the most of XR, but the TUD New Media Center was also keen on how it repackaged the videos from their lecture capture service. Video content from programming is also made available to visitors to browse for inspiration. This paper documents and overviews the development and functionality of the XR Cone application, provides some insights derived from its user testing (within the TU Delft Library), and offers preliminary assessments and reflections connecting to the larger theme of how XR multimedia can be in service of libraries as institutions and communities.

Keywords: extended reality (XR), interaction, digital collections, new media, developer

Introduction

Libraries may be most associated with their general and special collections, but libraries are increasingly becoming acknowledged for their role in cultural programming and content production, leading to a

situation where there are non-standard collections even beyond mainstay collections to be found. As these projects and initiatives arise, especially in a booming digital landscape, this creates a situation where websites full of content exist untethered to online public access catalogs. These collections-affiliated sites may be neglected or actively updated with fresh, regular content, but they usually lack audiences and reach beyond, but even within, their own communities. Library visitors and traffic are an obvious audience to target in the physical space of the library, areas where online collections often have little presence.

At the TU Delft Library, we are embarking on an ambitious project, turning our four-story suspended book wall into a collections wall to visualize and activate collections as well as address some of the issues just raised. This short article details the second of a series of prototypes in the collection wall project, XR Cone (Figure 1), which is a proof-of-concept station to visualize and interactively browse our non-standard format collections (e.g., videos, maps, 3D assets, and more) in extended reality (XR). Similar to other XR projects found in education, XR Cone "does not aim to provide significant knowledge transfer, but instead to create an ... association between education content and enjoyable experience, utilizing a new medium" (Boletsis, 2013). XR Cone also accounted for private (alone or two)...interactions...design[ed] for quiet reflection [which] can enhance learning"(Raybourn et al., 2019).

One of the main experience goals of these prototypes, especially XR Cone, is to offer something attractive in the physical space for patrons that could not be replicated online. Extended or augmented reality is especially promising in this regard because it incorporates virtual elements in combination with the physical location. Our Library's iconic architecture suggested an ideal site for an XR intervention: underneath the central cone, looking up into the four floors above (Figures 1-4). This is a space that many visitors come to admire for its own sake, so we wanted to see how extended reality could heighten the experience by turning the floor of the cone into a hall of inspiration for collections content as well as architecture.

XR Cone prototype development and documentation

The objective for XR Cone was simple, an interactive browsing experience, proof-of-concept, which enabled us to work in as many non-standard format collections as possible. Library staff co-designed the concept, which essentially turns the floors of the cone into shelves for collections items, which would be presented as a vast data visualization above (Figure 3). This data could be collected, curated, and animated to be even more visually appealing and dynamic for modern audiences. Two pop cultural influences for the concept consisted of Ariel's secret grotto from Disney's *The Little Mermaid* (1989) and the Hall of Faces scene from the fifth season of HBO's *Game of Thrones* (2015). Both memorable scenes present a hall of potential knowledge to inquisitive minds yearning for exploration beyond their experience.

While conducting concept and technical meetings with our developer to conceive what was feasible for a prototype, we discussed the desired file types and contextual information we wished to incorporate. We agreed to use a selection of 1) historic maps, 2) lecture videos from classes and cultural programming, 3) artifacts from recent exhibitions, 4) images, and 5) 3D scans.

Because reading even small amounts of text in pixel-noticeable XR is undesirable, we limited context to providing a title and one-sentence accompanying text (and if the process allowed, we wanted to explore adding audio to the context information in an update). These were achievable from our developer's perspective, so the next step was to streamline. All information was compiled using a simple collaborative spreadsheet where we specified name, sublocation, file type, and description for each file. For videos, we added year and speaker name. We had a team of three people, including the developer, to collect, curate, and edit the data that would be housed in this application. For aesthetics, we tried to be minimal (it was a prototype) and conform to the university's house styles for communications, instead focusing on functionality and trying to get the data populating and animated in the shelves. In

terms of interactivity, we hoped to have the data selectable and 3D assets scalable and movable around the virtual space.

XR Cone was developed using the Unity game engine for the Meta Quest 2 headset because this offered the best extended reality potential for the price point as well as the ability to use the headset without cables. A notable feature of the Meta Quest 2 is the passthrough capability. At the start of the project, The Quest headset was one of the few head-mounted displays (HMDs) that allows the developer to use the cameras on the Quest and show a video feed. Now other HMDs allow this.

Initially the idea was to also use the passthrough feed for object tracking or QR code-based tracking, but the feed proved to not be accessible for the developer. It can only be used as a window into the environment, not modified or used by the developer for image-processing. This limitation is done for privacy reasons, as this is a consumer-grade headset, but unfortunately this made some of our ideas impossible and others difficult.

We also originally intended to use hand tracking as this sounded like the viable choice for a standalone headset without someone helping every user. Using hands as input with gestures would mean no controller (which eliminates problems with power and teaching controls/buttons). However, during testing, we found out that not everyone is as comfortable with hand tracking yet. Plus, sometimes the hands would not be tracked at all. These reasons made us opt for controller-based input for the prototype.

This prototype was made as modular and extendable as possible within the time. The collection was divided into themes that give user guidance and allow the developer to add in a combined effort. Further, our collection spreadsheet could be imported as a .csv, which allowed us to achieve a prototype that could be adapted to new needs and ideas. This spreadsheet could then be loaded into the headset and would update the titles, summaries, video locations, etc. This method allowed for faster development times and makes it easier to update with more themes (and collections items). The videos were added to the headset into their respective folders corresponding to the location of the .csv. The application then loaded them locally. This allowed us to upload a large amount of content into the app circumventing the restrictions on Android app sizes.

Later in development, we made further determinations to prioritize functionality and variety of data in the prototype over some of our initial intents. The causes were technical challenges that just were not realistic to solve with a single developer. For example, we employed a menu structure for navigation. While not ideal in XR, this proved to be a much more efficient way for us to develop this proof of concept. One of the difficult features was aligning the menu to the physical floor. In the end, we solved the alignment by using a setup process every time the headset is put on. This process aligns the virtual world with the actual world, but it also creates an additional threshold for users not experienced with XR. Some of the interactivity with the 3D models was dropped as well. For example, scaling and placing the 3D model in space was not an important enough factor of the experience goals to justify the development time needed. Related to this, limitations on the Meta Quest 2's boundary and location tracking methods prevented as much free range as we imagined.

We had other unexpected problems in the physical space. The Meta Quest 2 headset uses infrared cameras as its eyes to see where it is in physical space—tracking elements to see where it is relative to that object as you move. However, in our case the experience was placed right underneath a window and on a highly reflective floor with little to no distinguishing features. The windows let in an abundance of light (also infrared) in such a way that tracking becomes difficult as cameras cannot see enough contrast in the environment. To solve this problem, we designed a rug with a distinguishable pattern (Figures 1 & 2) that would be made from a non-reflective material.

We incorporated some initial user testing during development, which revealed opportunities to improve how selected items were spawned and delivered (e.g., location and speed); maximizing and minimizing windows and their locations (to prevent overlapping); and limiting it to a one-button, one-controller

experience. We discovered an obvious oversight: that there needed to be a "clear" button to remove all the explored content from a user's field of view. Testing also revealed that it was just not feasible at this time to show more than one 3D asset in the space at a time. Even optimized assets as small as 2M were too heavy to show two at a time.

One fundamental question we kept waffling on was whether this was a sitting or standing experience. The variety of media was the root cause of this ambivalence. We knew no one was going to watch hour-long videos on our prototype, but we also knew people may be more inclined to check out videos longer if they are comfortable. Whereas the 3D assets promised a fuller experience standing as one could walk around them. The physical site and concept requiring users to look up also seemed in favor of seating. Eventually we decided to provide for both experience options and focus a question on our feedback survey to further inform this decision for a future iteration. We then integrated a 360-rotation player on the 3D assets to ensure seated users will have a 3D experience with the assets without having to stand.

In new media projects and prototypes, deadlines offer us a crucial moment to stop endless development and focus on presentation, use, documentation, and feedback. The authors are grateful to IFLA, for providing a venue in which we can document our prototype. So, here is what we managed to execute into this XR Cone prototype:

1. **Accumulate all intended varieties of data** (e.g., images, text, video, 3D scans/models) **into a single physical location presenting a digital container for interactive browsing.** Having one location, front and literally center of the library, that effectively highlights collections content currently distributed over no less than four websites cannot be underestimated from a patron point of view. We think a similar application would be valuable for other libraries dealing with the realities of diffused and informal non-standard format collections, especially because of the possibilities for incorporating standard collections items.

2. **Use extended reality to successfully map our libraries data in the physical environment.** Relying on XR technologies, the library can present interactive multimedia, while keeping the space visually 'quiet' for studying. While reducing the replication potential (certainly a tradeoff to be aware of), being site-specific makes the application more meaningful and inspirating for users because it reinterprets the quotidian, living up to the name of the technology by extending our lived reality of place. Current technology met our expectations in this department and we were very pleased with the results.

3. **Provide aesthetic animations and the feeling of vast amounts of data (**Figure 4). Using the digital language of RGB color for rectilinear, spine-like data visualization forms and integrating it with library collections data provided a visually pleasing experience. To make the shelf space even more visually interesting with a limited prototype dataset, we duplicated the data to fill the shelves more and innovated a "wink" animation that consisted of images getting larger and small, almost disappearing as they move. This addition helps maintain interest for longer. Items drop down from the center of the cone above, beamed out of the portal area at the top of the cone. This speed took adjustments. We did decide to put a brief, timed message triggered after clicking the menu bar to "look up" to help orient users as it takes a few seconds for items to arrive and be displayed in the eye-level panorama, where content items rotate around to fill the space. Lastly, fitting maximized items to take up the scale of a whole floor at eye level allowed a much closer examination of maps and a cinema-like experience for video.

4. **Hone down the primary interaction to interactive browsing.** It was a process to become comfortable that interactive browsing was enough. Functional actions like maximizing and closing windows; playing, stopping, and skipping video; and selecting (in the menu structure) were paramount. It is natural to want to pack new media to be as interactive as possible, but after being critical to the meaningfulness of these interactions, we realized the inspiring part of the experience is navigating so much information, not being able to move or rescale 3D items. Certainly, when

the technology allows, we are enamored with the idea of an application that allows patrons to curate, save, and share their own XR exhibitions using library collections.

5. **Explore alternative technology and format for curation of content.** XR Cone curates lectures organized by each of the eight university faculties (e.g., Aerospace Engineering, Architecture, etc.) and houses artifacts from past and current exhibitions [e.g., a curated sample of chairs that related to the *Redesign Rietveld* exhibition the library presented at the same time (https://www.tudelft.nl/evenementen/2023/library/redesign-rietveld-exhibition)]. We 3D scanned original Rietveld chairs from our Academic Heritage collection (https://collecties.bk.tudelft.nl/chairs) and included as 3D assets in XR Cone. Content-wise, the 3D scans and models make the most of XR, but TUD New Media Center was also keen on how it repackaged the videos from their classroom lecture capture service (https://collegeramavideoportal.tudelft.nl/catalogue). Video content from cultural programming was also repackaged and repurposed for library visitors to discover. Lastly, to also include more contemporary 3D assets than historic collections, we ran a student design competition for students to create virtual model homages to Rietveld's designs and we presented the winners in the XR Cone application (https://newmediacentre.tudelft.nl/rietveld/).

Assessment and reflection

Given the ongoing nature of this work, we would like to offer some preliminary assessment and reflections instead of "conclusions."

The XR Cone prototype was installed for user testing for the last five months (Feb 23 - July 5). For feedback, we created a short, online survey form consisting of eight content-related questions and three user demographic questions. We relied heavily on connections with education and held structured user testing sessions with related courses and student groups. Formal learnings, insights, and new ideas from these sessions are still being tabulated. We also ran coffee giveaways to encourage more of the library's general student population to participate and respond. Before disassembling we plan to incorporate XR Cone into an upcoming XR festival the library is co-facilitating—extending our connection and reach to the greater XR community.

The prototype and survey still have another month left to run, with hopefully an influx of responses from the XR festival, but preliminary results are encouraging. Reponses overwhelming indicated that people saw XR Cone as an important means to browse large overviews of data, watch videos of lectures/programming, and for thematic storytelling. Out of approximately 60 responses, 73% were students under 30, with over 80% of users being very or moderately satisfied and 60% saying they were likely or very likely to return to use XR Cone again. 67% preferred seated, Over 54% of users were attracted to it as a way to relax during their study break, 30% visiting the library for the first time, and over 15% were guided by staff, which also reveals that extended reality may need some human encouragement and support, but ultimately it provides another avenue for interaction between library staff and library patrons. Another statistic worth preliminarily reporting is less than 16% of people using the prototype interacted for more than 5 minutes. This could be due to the limited dataset, but we feel this number reflects the current attention span people are willing to offer these types of experiences, which is a highly relevant consideration for designers and developers to bear in mind.

Data preparation and the development workflow for XR Cone was a bit underestimated by the team, and this is an important factor to note for those interested in custom developing XR applications. One main developer worked on the project for a period of 130 hours, and the demands for edits, updates, and maintenance (especially considering the student design contest addition) have continued past the allocated time. We expect the effort commitment for a full-scale project more towards a product than a quick prototype to multiply. Bringing in outside developers would again multiply the budget, translating into an exponential increase in overall effort and expense for such a project and keeping it updated.

There were multiple suggestions and improvements we consider worthy of exploration. One fun one would be to orient maps on the ground floor, so that users could walk around the territory. But the most fundamental one known to the developers would be to allow users the ability to select items from animated shelves, instead of solely relying on the menu navigation.

Another implementation we think would improve the user experience would be to incorporate audio instead of text descriptions. Audio was planned for a second stage intervention to amplify data curation and context without relying on text. The reason for this postponement was audio entails an additional production process, writing, recording, and editing new files. We believe this is easily achievable, technically, although it would be nice to test the user experience of supplemental audio within this application as there may be surprises lurking there (like with the 3D assets). We also envisioned this container to be a gateway to other XR apps created by the XR Zone. Such an addition would further utilize the hardware format and broaden interactive browsing to a curated range of interactive experiences or trainings more reflective of the "3D/VR research ecosystem that supports the full research lifecycle of 3D creation, analysis, publication, and curation" (Lischer-Katz, 2022), which is particularly relevant given the educational context of university labs in STEM disciplines.

In terms of the presentation of XR Cone, a few things could be improved. For instance, relying on security and power cables was regrettable for the experience. If the situation and budget allow, it would be preferable to have a monitored station or checkout system that would enable a completely cordless experience. Also, XR is far from accessible, especially for the seeing-impaired, to the point of excluding some users with eyeglasses, reminding us of the importance of our colleagues' charge for "librarians...to take an active role in ensuring that VR can fully support users with different abilities" (Lischer-Katz & Cook, 2022).

That said, we still hope to see XR technology grow the extension of reality to larger spaces, offering larger boundary conditions as well as having the processing power to view many 3D assets at once. Our XR Cone was a "simple" prototype to test a promising concept and associated technology for application to a larger location. This paper shares development decisions and some of the preliminary ideas for improvement when facing the many challenges of 3D/VR that "can only be solved through systematic and concerted effort across multiple stakeholder groups and existing subfields of preservation research and practice"(Lischer-Katz et al., 2018). May it help GLAMA (DCDC 2022) colleagues interested in pursuing XR/AR "digital interventions...to transform, improve, correct, enliven; … emerging from a deep engagement with the collections and their history"(Geismar 2018).

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Figures

Figure 1: XR Cone physical setup (standing). Photo credit: Mischa Mannot.

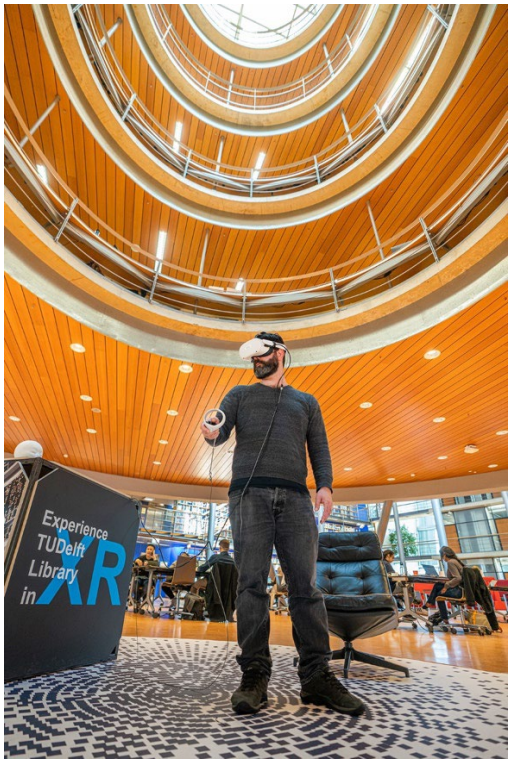

Figure 2: XR Cone physical setup (sitting). Photo credit: Mischa Mannot.

Figure 3: XR Cone concept sketch. Credit: Alice Bodanzky.

Figure 4: User experience video of XR Cone (https://www.youtube.com/watch?v=j-GwQmMN66Q). Credit: Jeroen Boots.