Redesign of a Cultural Heritage Digital Experience in a Lean Approach

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Project background brief

The Dunhuang Mogao grottoes are one of the world's most famous Buddhist heritage sites. Tsinghua University was one of the research institutions to participate in the Dunhuang Cultural Heritage Digitization Project since 2012. The Dunhuang Mogao Caves Virtual Reality Museum VR application created by Tsinghua researchers has been exhibited worldwide. The project was completed as a VR Mogao Grotto in 2016, then added more content and developed into a VR museum in 2017 & 2018. The previous version of Dunhuang VR Museum application (Ma and Lu, 2019) was developed based on the Unreal engine and required a high-performance computer and a head-mounted display for the experience.

In the context of the COVID-19 pandemic, the offline exhibitions could not be conducted, so the team recreated a lightweight WebXR[1] application and deployed it on the Internet, provided a browser-based experience without geographical restrictions. This redesign approach explores a lean way to create a digital experience of cultural heritage content.

Reasons and principles for the redesign

However, as an offline interactive experience exhibition of virtual reality, people inevitably have to share the same VR device, which in the present day poses the hidden danger of spreading the Corona-19 virus. To overcome this, the project team aimed to redesign the digital museum, reconstructed initially using a highly accurate photogrammetry model, into a more lightweight online WebXR gallery. It is a very promising way, retains support for high-end stand-alone VR glasses, and offers the possibility of providing an experienced approach for people who do not have VR equipment.

A WebXR experience is a particular form of a web page hosted on a web server. Therefore, its content can be modified, added, and extended at any time and delivered to the entire Internet almost without time delay. And it can be an all-in-one solution for multiple terminals so that it can be experienced in various ways, including 3D tours, VR viewing, and AR interaction on mobile phones, tablets, computers, and VR glasses(MacIntyre and Smith, 2018). When roaming in the virtual museum, the application will dynamically load the required assets according to the navigation route, improving

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[1] The WebXR Device API hopes to bring AR and VR capabilities to the web and allow these technologies to be added to new or existing web sites.

loading speed and saving the data traffic expense. Also, the 3D scene can be interactive with videos, audio, annotations, and 3D models, thus improving the efficiency of knowledge and information communication.

Because of work at home and the lack of the necessary hardware, the new design and development project was posed technical and design challenges for the creators. Therefore, the new WebXR project was launched with the principles and ideas of lean development established.

Redesign and development process

The high-precision models and textures used in Unreal Engine were not suitable for web apps. First, the team uses open-source software Blender to optimize it into a low surface model and as much as possible to ensure that the visual quality is not reduced too much.

Second, JavaScript was used to develop the interactions. In order to reduce the development effort, some of the interactions in the project scenario were done using *Verge3D*, a WebGL visual design tool based on *Three.js* library. Like Fig 1.
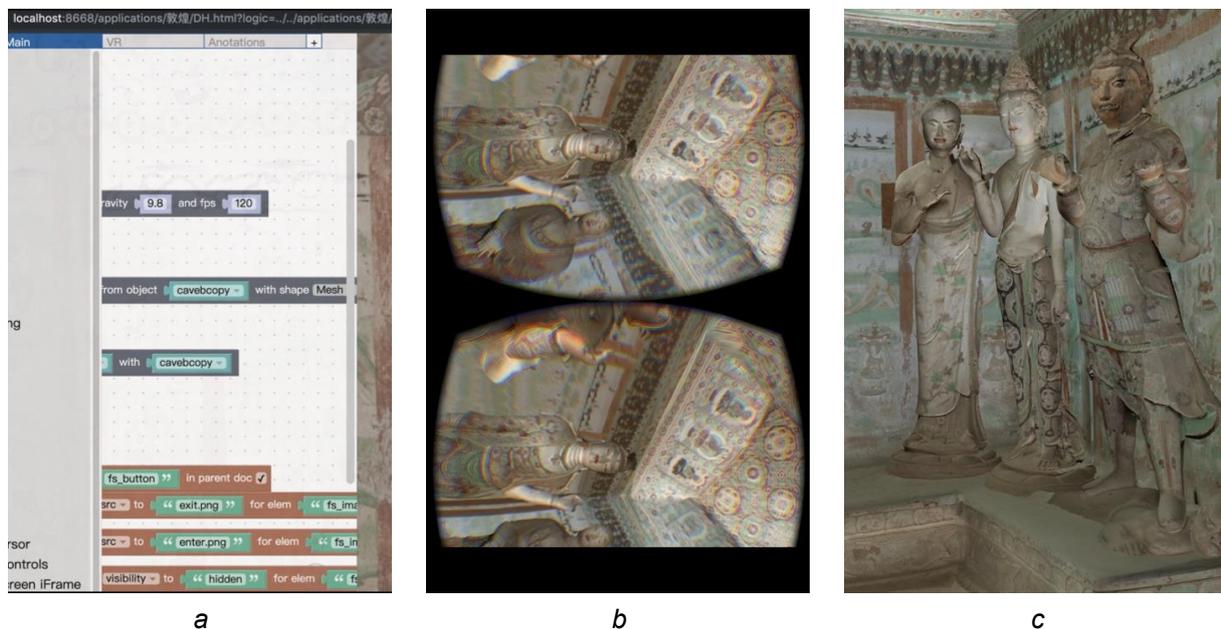

| a | b | c |

Fig. 1. Interaction design for Mogao No. 159 Grotto Web Experience
a) Visual interaction design with Verge3D puzzles; b) A screenshot of a WebVR scenario on a phone; c) A screenshot of Web3D scenario (© Lijun Ma).

Third, use the Chrome extension WebXR Simulator to simulate and debug the app in the browser, locating and fixing the bugs earlier.

Fourth, hosting and distributing the web app through the Github Page service is economical and stable. Meanwhile, hosting on the Github platform is adopting an open-source protocol to share the current stage of creation with the public, which allows more people to develop based on this approach.

Fifth, using the open-source tool Electron and Cordova to package the web app into executable files that can run on multiple devices like computers, tablets, and mobile phones.

Design thinking:

In today's highly globalized world, although technology can slow down the process of extinction, it cannot be preserved the material cultural heritage forever. The latest challenge comes from the unprecedented global pandemic of Covid-19 pneumonia, which has slowed down many conservation efforts for tangible cultural heritages and hinders the opportunity for ordinary people to understand and learn from the past. This is not only a challenge faced by designers but also the new social responsibilities.

In the process of transforming and disseminating cultural products from design content (cultural heritage content) to consumable cultural products (for experts, scholars, researchers, and society at large), it includes at least several stages of cultural discovery and extraction; visualization, graphic, abstract, metaphorical, and digitalization of cultural connotation; storytelling, interaction design; VR application design; multi-channel design integration and multimedia design and dissemination, etc. Functional, accessible, and expressive approaches to discovering the past starting from the present (or vice-versa) are generally a strong requirement (Fanini al., 2021). It embodies the consumer-friendly characteristics of immersion, experience, spatiotemporally, humanity, ritual, interaction, fun, communication, embodiment, etc. In the process of user research, we must also consider the user's role attributes and the possibility of non-fixed role changes, like Fig 2.
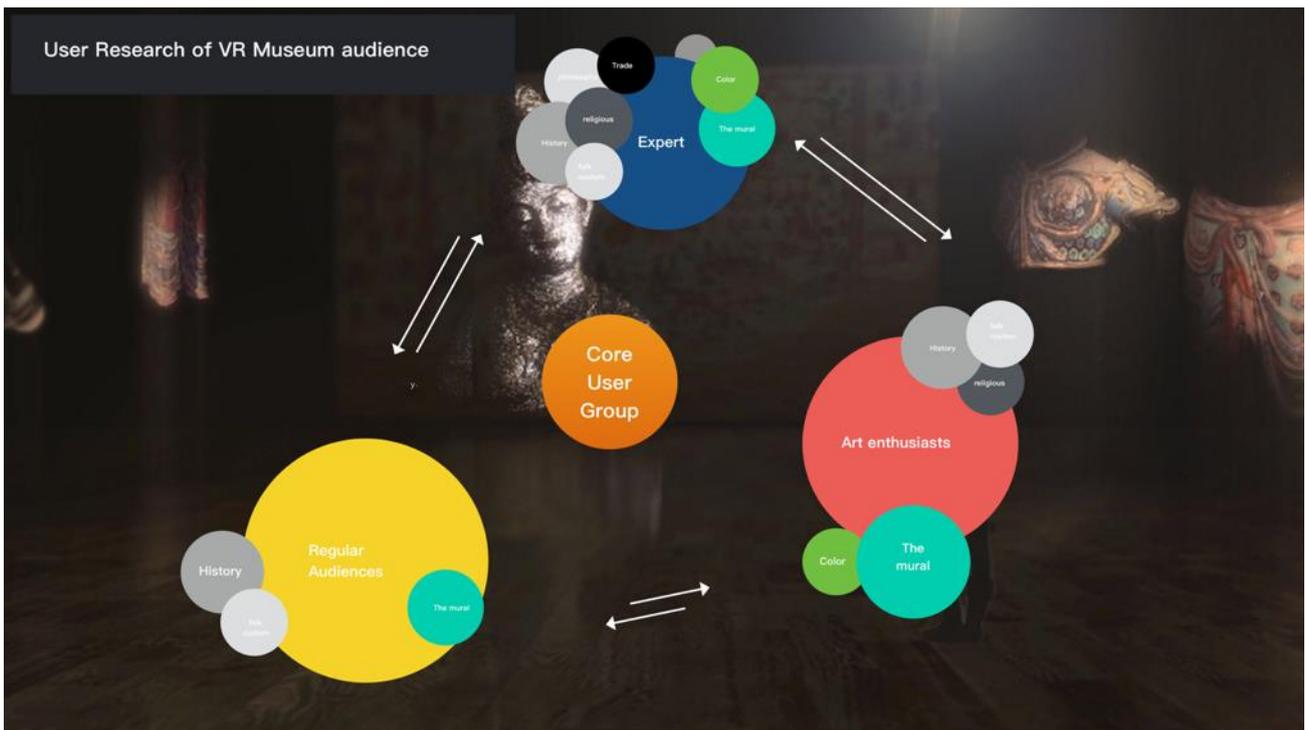

Fig. 2. User research: core user interest analysis (© Lijun Ma).

The increasingly complex process of producing digital experiences for cultural heritage and the increasing demands on the handling of digital assets can have a negative impact on the dissemination of cultural values. And one of the principles of agile software development is that continuous improvement is achieved through short-term iterations. Therefore, producing WebXR-based lean cultural heritage experience design and production is a design path worth continuing to explore.

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Author Contributions

Conceptualization: Lijun Ma
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Methodology: Xiaobo Lu
Software: Lijun Ma
Supervision: Xiaobo Lu
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