

Modern Virtual Environments and Museums

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Abstract

Today, many places and environments are replicated digitally for several different reasons. Some of these popular use-cases include video-games, virtual travel, remote learning, and virtual museums. In some cases, they are purely for entertainment, and in others they are purely for convenience or reaching a wider audience. Digital museums, virtual tours, and even modern video games replicate actual and historical places into “Virtual Worlds” in order to overcome barriers like distance, travel, cost, availability, and even existence. Through studying various literature, case studies, and deployed applications, this project will attempt to understand the history and development of virtual worlds and how we use them today. Using the popular example of Virtual Museums, this paper and the associated project attempt to explore and analyze the value and quality of learning and process involved in the deployment of a virtual world.

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1. Introduction to virtual museums

A traditional definition of a Virtual Museum is “a collection of digitally recorded images, sound files, text documents, and other data of historical, scientific, or cultural interest that are accessed through electronic media.” (Encyclopedia Britannica, 2017). A “Virtual World” is defined as:

A complete representation of a physical realm. Most likely this world is populated by avatars representing players, as well as virtual representations of virtual world characters (bots). Virtual worlds can mimic environments we are familiar with, or populate worlds with completely different inhabitants and rules of nature (e.g. people can fly). (Murugesan, 2010)

Both of these ideas are the basis for what we now would consider a Modern Virtual Museum. Traditional reasons for the advent of virtual museums include overcoming logistical problems or budget restraints, marketing for attracting visitors to actual museums, or simply for the accompaniment or enhancement of actual physical exhibits. As far as the marketing aspect goes, this just works by itself based on the common gamification method of attracting attention or recruiting by use of a game or something fun. The idea is also that users will become interested in the actual contents and then visit the actual museum.

One of the biggest reasons virtual environments are so useful however, is overcoming logistical problems for large groups or not having the time or money for transportation to places or museums around the world. Due to a variety of different reasons, access to various locations throughout the world with high cultural and scientific learning value can be very restricted. Educators are restricted in the methods they can use to teach, especially when it involves taking students to actual places such as museums or historical locations. Problems with traveling with a class of students can include lack of faculty or chaperons, cost restraints, organization, and even safety issues depending on the area being traveled to. Digital replication allows for even whole classrooms to experience various historical and culturally valuable places like museums where they would not otherwise.

Digital technology today affords new and more convenient ways to learn and share information, and things like virtual museums and tours are becoming more popular than ever. One of the biggest advantages of this technology is that it allows us to actually visit another place virtually, whether

intended as an addition to actual visitation or to substitute the visit entirely, which can be extremely valuable in cases where actual visitation is difficult or impossible.

2. History and types of Virtual Museums

Most sources seem to agree that Virtual Museums of both types began somewhere around the birth of what is commonly referred to as “The Web 1.0”. This was of course the name given to the first era of the World Wide Web from about 1993 to 2000, characterized mainly by static websites that users would visit for information.

Widely regarded as the first major example of modern virtual museums, Apple’s appropriately named “Virtual Museum” was released on CD-ROM in 1992 making its creation only coincidental with the start of the World Wide Web. It was freely distributed to museums and schools around the world for free and can be accredited with kickstarting the “Virtual Environment” type of virtual museum. Virtual Museum consisted of a 3D virtual environment in which users could “walk around” and select different items and exhibits to learn about them. Upon selection of an exhibit or object, a piece of UI would appear providing information about it for the user to read.

Since Apple Computer’s Virtual Museum, there have been many different takes on creating virtual museums, but they mainly developed into two main archetypes. Wikipedia defines a “Museum” as “an institution that cares for (conserves) a collection of artifacts and other objects of artistic, cultural, historical, or scientific importance. Many public museums make these items available for public viewing through exhibits that may be permanent or temporary”. (Wikipedia, 2009). There can be a lot of

interpretation to what can actually be called a virtual museum, but there are mainly 2 different types today.

The first type of virtual museum has less to do with being virtually immersed and more concerned with the actual artwork and exhibits contained in a museum. These types of virtual museums are often simply web pages that serve as an archive for works you would see in a physical museum. The early pioneers of online virtual museums started during the Web 1.0 era, or before 2000 and continue today. Popular examples of virtual museums of this style include websites "www.webexhibits.org" or Nicholas Pioch's "WebMuseum". Webmuseum is a website in which users can navigate through the typical website interface and see various works that have simply been collected as images and then uploaded to the site. WebExhibits takes a similar approach with the addition of written content about all types of "exhibits" it contains. Some more modern versions of this type of virtual museum employ new and interesting ways to navigate through the works like the British Museum's "Museum of the World". This take on a web based virtual museum introduces a very interesting User Interface (UI) consisting of an animated timeline linking related works that users can browse through. And while these and other virtual museums of this type fundamentally serve the same purpose of physical museums by making available artifacts and items of cultural, historic, and scientific importance, they don't really include the experience of being in an environment, and therefore really only exist as either an archive, or an addition to the real museum they represent.

The second type of virtual museum involves the addition of simulating a virtual environment. Apple Computer's "The Virtual Museum" was an example of this type, and tends to be what we actually think of when we hear the term "Virtual Museum". These types of virtual museums are not only concerned with the work and exhibitions contained therein, but also seek to replicate the experience of being in the actual location through employment of current virtual reality technology. For that reason, these virtual museums not only have roots in traditional museums, but also in virtual environments or

Virtual Reality. "Virtual Environments or Virtual Reality is the immersion of a user in an artificial computer-simulated environment that is designed to emulate the look and feel of being in a real environment." (Wolfe & Cedillos, 2015). Since as far back as computer games themselves, the idea of recreating a believable virtual world has been swimming in the minds of programmers and inventors. Tricking the mind has been around since the beginning of time, and people were seeking new and more believable ways to do it. In 1968, A scientist by the name of Ivan Sutherland developed what is considered to be the first Virtual Reality headset. Even though it wasn't polished and the technology wasn't quite ready, it was understood that there was a certain level of potential for future technology to benefit from it. Being an early pioneer of this type of technology, it never really made it out of the lab, and up until technology of late, Virtual Reality was a distant thought. Over the years the technology was revisited and we got things like Nintendo's "Virtual Boy", but in the end the technology still wasn't ready. And the next big push for VR wasn't until advent of what we now call the "Head-Mounted Display" (HMD) with the release of the "Oculus Rift" in 2016.

3. The New Age of VR

Smaller processors, tinier transistors, and overall better computer hardware finally got to the point in the mid-2010s where it was time to take another look at VR. This is true for both the technology we use to create Virtual Environments as well as the technology we use to deploy it.

New technologies have afforded better ways to not only create, but also to capture and recreate virtual environments. Modern game engines, 3D scanners, and photogrammetry suites are some of the hardware and software tools used to create virtual museums that include a virtual environment. Within

the last 20 years, Laser or “Lidar” 3D scanner technology mainly used in surveying and engineering laid the early foundations of digitally capturing environmental data for the purpose of recreation. Lidar and 3D scanning technology were of course borrowed by the gaming industry in order to recreate virtual worlds including those of Ubisoft’s Assassin’s Creed series. This helped the games artists to recreate various iconic places such as Rome and Paris in their games, introducing a new level of realism and cultural heritage to people who may have not otherwise experienced it. Now with the advent of “Photogrammetry”, a user can take a series of photos and feed it into a software package in order to create a digitally replicated environment. These new capture technologies coupled with new hardware platforms brought us to where we are today.

With the introduction to modern-day Head-Mounted Displays (HMDs), we have been able to deploy these recreated worlds and immerse users to a degree we never could before. The simple action of looking around and having the scene move fast enough with your head to give the illusion of actually being in another environment was the key to this next wave of VR. And while this is not absolutely necessary, and many applications can successfully be deployed to desktop or even mobile platforms, we definitely have an obsession with VR. And while HMDs and VR have their place, Mobile and desktop ones do as well. Applications meant to be immersive available on mobile or desktop platforms require different controls from a VR HMD, which of course adds another layer of abstraction. This in turn gives a less immersive experience, but allows deployment to different platforms increasing usability. There’s a balance between these two things, deployability and immersion. There are a number of methods in which we try to immerse users in a virtual environment, and we are not only limited to what we commonly consider “virtual reality” today by use of an HMD like Oculus Rift or Gear VR. However, the fewer layers of abstraction there are within a simulation, the more intuitive and immersive the whole experience is. This of course provides a closer experience to what the user would actually experience as if they were actually visiting the location, thereby creating a higher quality of learning experience.

“...immersive environments allow people to become totally immersed in a self-contained artificial or simulated environment while experiencing it as real.” (Burns, 2011). So the more real the simulation feels, the more engaged the user is and the better learning experience we have overall. Unfortunately, as far as technology has come since early HMD prototypes in the 1960s, it apparently still has a way to go. Technology is still having trouble overcoming issues like walking or the feeling of touch and resistance in a virtual space. There’s no good solution to allow users to believably walk in place without incredibly expensive hardware, and while there are a few leads in what we call “Haptics”, there’s no real solution to making touch and resistance believable either. Coupled with the fact that none of this is exactly cheap or convenient, it seems that maybe VR technology still needs a few more years until it really takes off.

4. Virtual Museums today and the near future

Since the split between website and immersive environment based virtual museums, there have been relatively few variations. It seems the virtual environment type is still limited by technology, and many website-based virtual museums just aren’t very “virtual”. Also, as it turns out, the technology used to produce the elaborate digital environments isn’t all that cheap or easy as well. So, here we are in a sort of lull coming out of this last virtual reality craze or just waiting for it to take off. So, it seems like what we have today is a mix of the two aforementioned types of museums, constantly in a trade-off between convenience, usability, and believability. So what we have now are slightly more immersive versions of web-based virtual museums like Google’s “Arts and Culture” or different ways to interact

and see the art, like the British Museum's "[Museum of the World](#)". Google's Arts and Culture more or less leans toward the traditional type of web museum but with refined organization, attempting to replicate real-life museums like MOMA as well as making its own "collections". The Museum of the World takes on a whole new look based on an interface design, including sounds and animation. The most interesting part about it is the way its art is organized and linked by time and influence. It allows the user to take a journey if you will through time, "surfing" through timelines of related artifacts. It also during this era that many websites and applications came about that allow users to create their own virtual museums. Over the past decade there have been several attempts to create systems to allow users to create and deploy their own virtual museums as well, such as "Google's Art Project" or Facebook/Intel's "Museum of me". These allowed users to create a "conglomerate" type of virtual museum based on either 3D object or images they collected or just personal photos and videos. And while they weren't too popular, their archetype did seem to pave the way for the latest applications we can now in the way of virtual museums. Now, after the advent of early personal virtual museum creation tools we come to things like Google's "VR tour Creator" and [Artsteps.com](#).

Google's VR Tour Creator draws from several Google web applications like Google Slides, Image searches, and Google maps. This is a conglomerate-style web- based virtual museum creator that allows users to create a virtual tour of anywhere that exists simply by adding photos and defining navigation and interest points in Google Maps. Unlike traditional Google maps, creators can also actually go inside many buildings in popular areas such as travel centers, stores, and of course; museums! Creators can then select things in the Google Maps panoramas and attach things like hover text to allow explanations or descriptions. Once published, the user is given a link to share which can be used in web browsers or even VR HMDs like Google Cardboard. This example allows users to create their own virtual tours fairly effortlessly, and really seems to understand that multiple-deployability is key seeing that VR HMDs haven't become as commonplace as many previously thought.

Artsteps has decided on a similar approach in allowing users to make conglomerate-style virtual museums while at the same time leaning more towards the full virtual experience side of things. Not having the affordances of Google's already-existing web applications like Maps and Slides, Artsteps has employed the use of the Unity 3D game engine and its back-end infrastructure allowing it to be deployed to both web and VR platforms as well. The difference here, however, is that instead of having flat, 2-D panoramas from Google Maps, it instead allows users to create virtual environments and use 3D objects in order to make their virtual conglomerate museum more immersive. Provided 3D objects are simple but adding custom 3D models is also supported, allowing users of different experience levels to use 3D models they have found or even create their own. Users can also upload photos and videos and place them on objects or canvases throughout the room as well. And now we have an example of a virtual museum evolving out of the affordances of the technology it uses. Not only can we place pictures and objects like you would see in a real museum, we are now taking advantage of video technology being applied to say; a wall. Similar things have been done of course in real life like video installations, but you can see where the affordance of the technology used really allows for new ways of experiencing things.

Similar to this, another affordance from virtual environment technology like modern game engines is the ability to create or recreate worlds that either no longer exist, or never did in order to show something that is either hard to visualize or has been lost to time. A good example of this is "Rome Reborn", a virtual reality project that recreates ancient Rome in order to allow users to experience what it was like during the Roman Empire. Another good example of taking advantage of this technology in order to visualize digitally is the replication of the solar system used in ["NinePlanets.org"](http://NinePlanets.org) or ["SolarSystemScope.com"](http://SolarSystemScope.com). These examples go a step further and make use of a fly-around navigation system, allowing the user to "travel" between planets allowing a type of virtual museum that can't easily be replicated physically. In these, users can experience now-typical norms of

virtual museums like informational UI popups and explanations in a new type of learning environment. These examples may not be considered as cultural heritage like a museum, but it shows the direction we are now headed thanks to the affordances of employed technology. And now we really have a coming-together of VR, environmental surveying and video game technologies being used in a cultural learning environment unlike any other.

5. Methodology

Intentions for this project were to better understand the value, usage, and creation of virtual worlds, as well as to gain knowledge of the process to create a functioning prototype. To better understand the value and quality of benefits from virtual worlds, this study looked at several works including papers, case studies and actual deployed applications. Research involved learning the uses and affordances of virtual worlds and environments from a learning perspective and analyzing design decisions from existing projects. The project involved the research of several theoretical and practical-based works, case studies, and actual working applications related to the subjects of digital replication and virtual worlds, mainly virtual museums. In analyzing and categorizing different types of virtual museums and their creation, the research provided insight into which museums were better suited for what purposes as well as an understanding of common creation methods. Types of museums studies ranging from online-archive types to immersive virtual reality environments. Through exploring this wide range of available material, this project gathers and summarizes the general use of digital environments, explains

the theories behind each intended use, and analyzes the outcomes. The study of content regarding the theory behind the use of digital replication was used to understand what types of problems it is intended to overcome as well as the methods used in doing so. Researching actual case studies helped to identify what problems digital replication was used to overcome, how these methods were carried out and how successful they were in accomplishing their goals. These case studies also provided insight into the potential problems, caveats, and limitations that come along with the creation of virtual environment-based solutions. Studying actual finished works and applications employing digital replication also helped with this, as well as gave insight to available creation methods and the actual creation process. Along with the creation and assessment of the prototype, the end result is an overall understanding of the different uses of digital replication, methods for their creation, and a qualitative analysis of the success and effectiveness of each intended use.

6. Project

Link to Web-deployed Project: [Fighter Museum](#)

The accompanying project is a conglomerate-style, virtual-world based virtual museum on the subject of fighter aircraft. The chosen method of creation for the accompanying virtual museum project is based on a first-person traditional computer game platform and employed the use of the Unity 3D game engine. The game engine was chosen because it lends itself well to the classic first-person style and also allows for later upgradability, as functionality for the project was intended to be increased in later builds. Some new skills were learned, mostly in the Unity engine itself, such as Unity's User

Interface (UI) system and some minor scripting. The models were acquired through online collections but needed a lot of work in 3D to get them ready, and still more work could be done. Most of the time went into fixing up models and assets. By employing various concepts and methods used by modern virtual museums today, this project attempts to create a virtual museum of aircraft not normally seen together and provide some cultural and learning value to them. The subject in this case is a collection of the most popular American fighter aircraft still in use today. Descriptions and facts about each aircraft were added through the UI system, allowing users to read about each type of aircraft upon approach, using a non-diegetic (or “Heads-Up Display” style interface). Entitled “Virtual Aircraft Museum”, this several-phased project begins with a virtual hangar in which a number of fighter aircraft will be displayed. In the first phase, the user is allowed to traverse the environment in a first-person video game style and look at the various aircraft (Below).



The application in this phase is deployed simply to a desktop application. The second phase was the addition of the UI containing facts about the aircraft as shown below:



The project was then exported to an HTML5 WebGL format, and can be seen deployed [here](#) and navigated using the common “WASD” keyboard and mouse movement scheme. Subsequent phases may include the use of other modern virtual museum ideas such as the employment of things that could not normally be seen in a traditional museum like the aircraft functioning or being interactive. These additions may include further employment of game technology in the Unity3D engine like particle systems and special effects in order to show the aircraft engines operating. Other things that wouldn't normally be seen may be them flying in place, or various things working on them.

7. Conclusion

Virtual Environments for use in learning such as museums have ultimately proved to be a very useful tool. Studies seem to agree that the real thing is always better than a virtual environment, but this is of course mostly due to technology limitations, and virtual environments offer experiences that would otherwise not be feasible. By overcoming problems like limited budgets, distance, and other concerns, virtual environments and museums allow users to visit someplace and experience it like they were really there. Virtual worlds and museums spawn from a variety of influences including the traditional museums, learning methodologies, environment replication technology, and motivational aspects of video games. And it is through this evolution and employment of these that modern-day virtual environments still thrive. Some technologies like VR may still not be ready in order to fully immerse users without question, but there will still be a place for virtual worlds and museums until there is, and can continue to provide quality and worthwhile learning applications either way. The true potential of virtual worlds may really be the ability to show users things that traditional museums cannot, such as the experience of walking through a living cell or watching a star form through a time lapse. We are only limited by technology, and as that progresses, so shall the potential for sharing knowledge and culture through virtual worlds.

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