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Digitalizing the College of Architecture Museum: The University of the Philippines Experience

Karen Therese F. Lopez [1]
kflopez1@up.edu.ph

Abstract

Museums are an accessible means of exposing students to excellent architectural works. Such immersion is important to inspire and enhance the skills of architects and aspiring architects. One such museum is Haraya, an architecture museum that transformed from a physical exhibition to a fully digital one because of the pandemic.

This study explored how a university digital museum was created in a feasible manner, with the objective of making the experience similar to the physical museum. This required data gathering, exploring options, and creating a new digital museum for Haraya.

We created Haraya 2022 using a 3D model, rendered images, rendered videos, links, and navigational nodes. It was made available for online viewing to the public. A survey was also conducted to determine the viewers' satisfaction with the Haraya 2022 digital museum. The results showed positive feedback where most had an excellent or a very good experience. However, there were navigational issues that needs to be resolved for future digital museums.

The method used to make Haraya 2022 is a viable option for digital museums. If a physical museum is present, a digital counterpart can still be made for better accessibility.

Keywords: Digitalizing, Museum, Architecture, Virtual

Karen Therese F. Lopez is a licensed architect who co-founded Arkalo, an architectural firm. She took her Master of Architecture degree at UP Diliman, where she is currently an Assistant Professor. Ms. Lopez's expertise is in BIM and other architectural software.

I. Introduction

Architecture is a visual profession where immersive museums or galleries featuring interesting architectural works are greatly appreciated. This is one of the reasons why the University of the Philippines College of Architecture holds an annual event called Haraya which showcases the architecture students' outputs.

Haraya is a highly anticipated event held at the end of the academic year to celebrate the accomplishments of the college and its students. However, on-site visits were limited during the pandemic due to the possible health risks. Haraya thus shifted to a purely online and digital format. Unfortunately, the digital format is less satisfactory because looking through a screen is not as immersive as seeing the displayed works physically.

Exploring different strategies to make a digital museum immersive will improve the experience and increase the accessibility of the museum.

There are plenty of sophisticated methods to create a good digital museum, but many of these methods require expertise, equipment, and funding. The goal is to look for an effective method that is feasible for architecture schools or universities in the country.

II. Review of Related Literature

Museums are like the modern-day media since they intend to both inform and entertain viewers. They form stories and give rise to arguments and make the featured works accessible. (Silverstone, 1994).

A. History and Purpose of Virtual Museums

Museums and their relationship with people have evolved in different ways throughout history. Initially, museums were collections of items that were displayed privately in the wonder rooms or cabinets of the wealthy. The oldest known museum is the Ennigaldi-Nanna's Museum (dating back to 530 BC), while the oldest public museum was established much later, during the Renaissance period in

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Rome. Most of the notable museums were only founded in the 18th century (Cilasun, 2012).

Essentially, all museums are "virtual". Museums would take a piece or an artifact from its original setting that usually holds significance. This artifact would then be transferred to a different location: the museum, wherein the connection of the artifact to its original setting will simply be recreated (Giaccardi, 2006).

During the 1980s there was a move in the concept of museology wherein the context of an artifact was more essential than the artifact itself (Alsford, 1991). Museums that use virtual technologies were created, making the context of artifacts more available and appealing. This improved the museum experience.

Museums use technology to present their artifacts or collections in a more interesting way. There was also a trend to add interactive features to enhance the connection of the person or viewer to the artifact being exhibited (Yaneva et al., 2009). Interactivity became a key factor for the exposition technique of museums. One of the first known examples was a museum that allowed the viewers to activate models in Berlin. Using different technologies like simulation, video projections, sound shows, and light shows; viewers were given the choice to make decisions and promptly get feedback to discover different learnings (Keene, 1998). Technological advancements in digital image and graphic manipulation paved the way for varying displays that can preserve cultural artifacts and sites and give a deeper experience and appreciation for history, past cultures, places, and people (Bergstrom & Clark, 2007).

In 1947, Andre Malraux proposed the idea of an imaginary museum that had no location or space so that anyone can check the museum from anywhere in the world (Stylani et al., 2009). This idea is called a Virtual Museum. A Virtual Museum, also called an online or digital museum, is "a logically related collection of digital objects composed in a variety of media, and, because of its capacity to provide connectedness and various points of access, it lends itself to transcending traditional methods of communicating and interacting with the visitors being flexible toward their needs and interests; it has no real place or space, its objects and the related information can be disseminated all over the world" (Schweibenz, 1991). A virtual museum can have different forms- it can be a 3D model of an actual physical museum, or it can be an imaginary setting wherein there could be rooms where the artifacts will be placed.

The key features of good online interactive museums are the following: 1) the capability for the viewer to connect with the exhibit seamlessly, 2) a good instructional design, 3) proactive learning methods, 4) a balance between leisure and learning, and 5) avoidance of text-heavy pages that are likely to interfere with the experience (Hin et al., 2003).

One of the advantages of a virtual museum is that it can provide a database that can easily be retrieved and stored whenever necessary, providing curators with a convenient way to preserve their artifacts. It is also easy to experiment with exposition and presentation styles that could make the museum experience more engaging to virtual viewers, without having space limitations. Most important is how it gives better access to people around the globe. Nevertheless, there are also issues and drawbacks. A digital image or representation can have errors and lead to misinterpretation or even falsification. The technologies would also require a specific expertise or staff training. Viewers who are not technologically adept may have trouble viewing the virtual museum. Lastly, cost is a major limiting factor, as the creation of a virtual museum will require investment in equipment, time, and people.

Despite the difficulties and challenges, virtual museums provide an amazing opportunity for interactivity and improved learning. A historical virtual reality exhibit called "This Old Digital City" cost $300,000 to make but the museum had an increase in attendance of around 89% with a 100% increase in museum revenue (Cremer et al, 2001). Virtual museums also break away from the limitations of physical museums and the exhibits are much easier to update and improve.

B. Types of Virtual Museum

There are several types of methods or options to make a digital museum, including but not limited to Virtual Reality, Augmented Reality, Mixed Reality, Virtual Tour, 3D, Video Gallery, and Photo Gallery.

Video and photo galleries are both web-based where videos or photos are simply shared. This option is the easiest and cheapest, but it barely has any interactivity and would likely be ineffective.

3D models of artifacts can also be uploaded on the internet wherein a viewer may look at the object from all angles by panning and orbiting the object. The 3D model is usually created using 3D software which is then uploaded on the internet. This is possible using VRML or X3D with X3DOM.

VRML is a 3D interchange format that is used by most 3D software today, it is a simple multiplatform language used for publishing a 3D model on a web page with no licensing fees. X3D is an open standard XML-enabled 3D format which is a successor of the VRML. X3D has several upgrades over VRML like the inclusion of particle effects, multitexturing, rigid body physics, character rig-support, and layering (Bergstrom et al., 2007). X3DOM is used to view X3D files in a web browser.

A 3D format called COLLAborative Design Activity or COLLADA with a DAE file format is usually an available file format for conversion or export for the most popular 3D software today like SketchUp and 3ds Max. A DAE file can

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then be exported to X3D using other 3D tools like Blender or Meshlab. X3D can also be converted to common 3D formats like STL, 3DS, OBJ, X, STP, and PLY.

Virtual Tour shows an environment that exists by using panoramic image technology that allows people to move around and view the existing environment from many different angles using a computer or phone (Lifeng et al., 1999). This will require a physical museum to be set up and the use of 360-degree capable cameras to take multiple images from different points to create the Virtual Tour environment.

A Virtual Tour of the Forbidden City was available online for everyone to view for a time (Figure 1).

Figure 1. The screenshot of the virtual tour Interface.
Source: Li, et.al. (2022). Evaluation of Virtual Tour in an Online Museum.

For this sample, viewers can move to certain points within the Forbidden City Museum. From these points, the viewer can orbit and view the surroundings. The artifacts can be viewed and zoomed in or out with the mouse.

Augmented and Mixed Reality makes use of virtual objects that appear in the actual physical museum. This is possible using specialized software methods and sensor devices. For Augmented Reality, virtual objects are displayed over the real environment, giving viewers an opportunity to interact intuitively with the artifacts. Mixed Reality refers to an environment where both the existing and the virtual items coexist in the same environment.

Virtual Reality or VR immerses users in an artificial world. "Weak Virtual Reality can be characterized by the appearance of a 3D environment on a 2D screen" (Heim, 1993). A strong Virtual Reality usually makes use of a device like a head-mounted display or a 3D polarizing stereoscopic glasses which creates an immersive experience and a feeling of control albeit in an artificial world.

A good Virtual Reality world can be quite immersive and does not have the limitations of traditional museums. However, creating a fully artificial 3D world from scratch can be tedious and time-consuming. This would also require expensive capable hardware and software. Viewers will also need to be given equipment like headgear or to have their own, which could further increase the cost. Furthermore, VR does not have the complexity of the real

artifacts and it could lead to misinterpretation. The computer illiterate will also have difficulties when using the technologies required, thus ruining the experience.

Several commercial VR software like WorldUP and WorldToolKit can create fast and good virtual museum environments, but the licensing is costly for small to medium-sized museums (Styliani et al., 2009). Museum owners are hesitant to invest in VR exhibitions because of several issues: the lack of understanding, fear that the costs of development may be more than the benefits, and maintenance difficulties (Severson, 2001). To justify these challenges, the capabilities, benefits, and advantages of VR and other 3D methods must be demonstrated and understood.

With the difficulties in implementing VR, alternative options such as open standard methods like VRML and X3D may be more viable. A Virtual Tour is also a good option and would be easier to do than VR. Viewers will also see what can be seen in the actual museum site which would be more genuine. However, a Virtual Tour is limited to what is already in the physical museum. While it is possible to add objects, the use of panoramic photographs make it difficult to edit objects or the environment compared to VR. The need for a physical museum is also a disadvantage compared to VR, which has no space limitation.

III. Methodology

To review the available data regarding current practices in establishing digital museums, the phrases "digital museum" or "virtual museums" and the terms for the individual types of virtual museums were input in several search engines, like Google. Using the information obtained from the search, options for creating digital museums were listed and considered. These were then shortlisted based on important factors like budget and time constraints. This process is depicted in Figure 2 below.
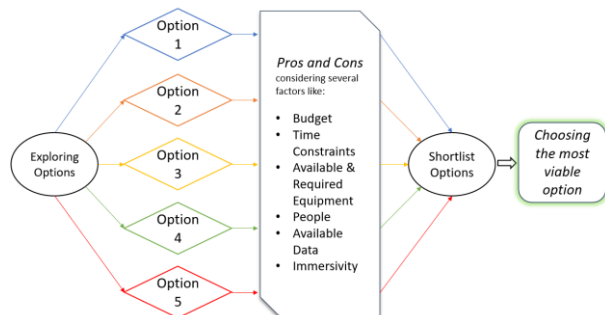

Figure 2. Choosing the type of Digital Museum for Haraya 2022.

After choosing the most viable option, the Haraya 2022 digital museum was then created. The process of how Haraya was produced was documented.

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After the Haraya 2022 digital museum was launched, participants were allowed to tour the museum online. Once they ended the Haraya tour, the participants were requested to answer a survey asking about their satisfaction with their experience.

The data gathered from the studies and surveys were evaluated to find out what aspects failed or succeeded and what possible improvements could be made.

IV. Results

The Haraya organizing committee was made up of three people including the researcher. We looked for different options to create an effective online digital museum. After ample research about digital museums, the researcher considered the pros and cons of the various methods as summarized in Table 1.

Table 1. Digital Museum Methods Pros and Cons.

|	Pros	Cons
Virtual Reality	• Flexible • No space limitation • Immersive	• Expensive • Needs a detailed 3D model which can be time-consuming to do • Requires headgears and/or other equipment • Requires specific software and expertise
Augmented Reality or Mixed Reality	• Flexible • Immersive	• Requires specific software and expertise • Needs a physical space
3D: Web-based	• Affordable	• Needs 3D models which can be time-consuming to do • Requires specific software and expertise
Virtual Tour	• Realistic • Immersive	• Expensive • Requires a 360-degree capable camera • Requires specific software and expertise • Needs a physical space
Photo and/or Video Gallery	• Affordable • Quick and easy to do	• Not immersive

The major limiting factors were the lack of a physical space, a limited budget, and the lack of the needed expertise for some of the methods. With these in mind, two feasible options were shortlisted. 3D: Web-based was considered but it had to be outsourced. Photo and Video Gallery was the backup option since it was the easiest to do.

Given the lack of time and the lack of response from the experts for creating the 3D: Web-based museum, the Haraya organizers decided to use images and videos in a creative manner. Simple links and navigational nodes or buttons were used to make the exhibits interactive.
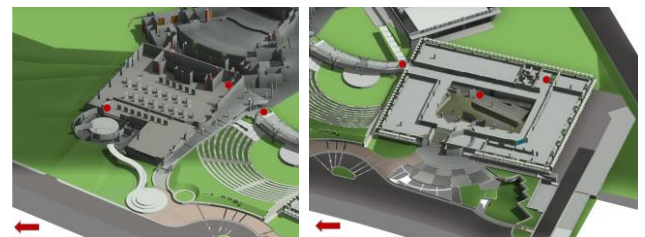
First Draft

The initial draft started with an aerial axonometric view of the University of the Philippines College of Architecture (UPCA) campus. This would have been the museum site had there been no pandemic. An existing 3D model of the campus was refined and used for the digital museum.

From the aerial axonometric view, the viewers can choose to go to "Building 1" or "Building 2" by clicking on a red dot which would have a link that will send the viewers directly to the axonometric plan of the building as seen in Figure 3 and Figure 4.
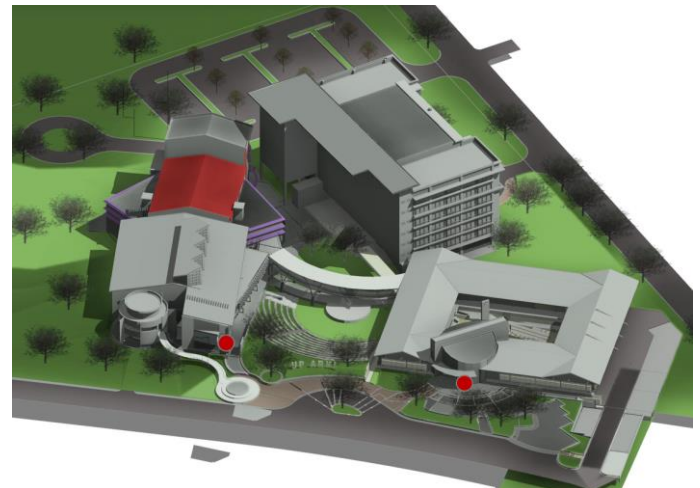
Figure 3. UPCA Aerial Axonometric View – Draft.

Figure 4. UPCA Building 1 and 2 Axonometric Plan: Level 1 – Draft.

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From the axonometric plan of either Building 1 or Building 2, viewers can go up or down the stairs by clicking on the red dot. They can also move to the other building by selecting the dot near the bridge (Figure 5).
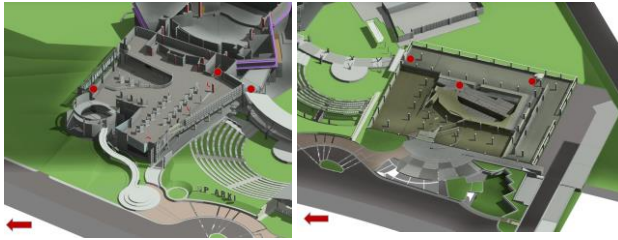

Figure 5. UPCA Building 1 and 2 Axonometric Plan: Level 2 – Draft.

The dots can also be used to magnify each room. Once in the room, clicking on available arrows would allow viewing from different perspectives (Figure 6).

Figure 6. UPCA Building 1 Sample Perspectives – Draft.

The perspectives would show the displays with the works that will be showcased. As seen in Figure 7, the works that were displayed had a red dot. Clicking on the red dot would lead the viewers to a high-quality image of the work that can be zoomed in or out (Figure 7).

Figure 7. UPCA Building 1 Sample Perspectives with Works – Draft.

Final Version

For the final output, several things were added and polished. Publication materials like logos, banners, and dividers were created. Some of the publication materials were added to the 3D model. 3D versions of the logos were modeled. Icons were added and redesigned to be less confusing as seen in the navigational legend (Figure 8).

Figure 8. Navigational Legend.

The UPCA aerial axonometric view was changed to a more realistic and rendered aerial perspective (Figure 9).

Figure 9. Aerial Perspective.

The viewers could choose to go to either building 1 or 2 by clicking on the red dot. Instead of leading the viewers directly to the cutaway axonometric plan, the viewers was led to a walkthrough video which would make them feel like they are walking through the building (Figure 10).

Figure 10. Building 1 and 2 Entry Video Screen Captures.

They could then proceed to the axonometric plan of the building (Figure 11).

Figure 11. Building 2 Level 1 Axonometric Plan.

From there, viewers could check the rooms or areas wherein the student works were displayed. They could also check the perspectives which would show a directory and a view of the 3D logo as seen in Figure 12.

Figure 12. Perspective views of Building 2 Level 1 Directories and 3D Logo.

Viewers could also opt to go down to level 2 by clicking on the stairs(down) icon or go to the bridge by clicking on the triangle icon (Figure 13).
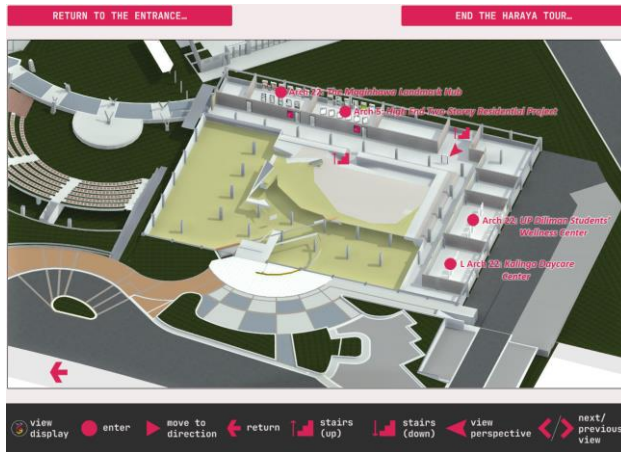
Figure 13. Building 2 Level 2 Axonometric Plan.

As seen in Figure 13, the rooms that had displays of student works contained a circular icon and the title of the course and featured project. Selecting a room led the viewers to an enlarged axonometric plan of that specific room (Figure 14).

Figure 14. Building 2 Level 2 Enlarged Axonometric Plans.

The rooms had arrows that when selected, automatically led to the corresponding perspective view of where the arrow is pointing. If the arrow with a glow was selected, the viewers would see the banner of the course and project featured for that specific room (Figure 15).
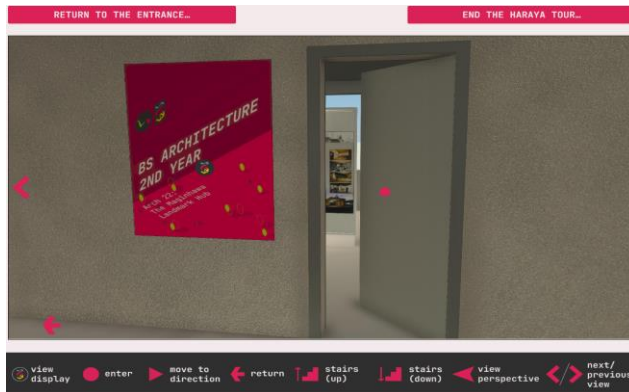

Figure 15. Course Banner Perspective Sample.

The banner could be viewed by selecting the Haraya 2022 logo icon which would open a new tab wherein the banner would be fully displayed.

While in a perspective (Figure 16), the viewer could select the return arrow which led them back to the enlarged axonometric plan (Figure 17).

Figure 16. Display Perspective Views.

Figure 17. Enlarged Axonometric Plan Sample.

Similar to the course banner, the works could be viewed in detail by selecting the Haraya 2022 logo icon which were placed in the middle of all the student works. The viewers could also select the arrows at the side which would make them see the other perspective views beside the current perspective view they were in (Figure 16). It will be like they were moving within the room and checking the different works displayed.

Viewers could return to the building axonometric plan by clicking on the return arrow from the enlarged plan (Figure 17) then they could choose to go back up to the 1st level by clicking on the stairs (up) icon. From there, they could go to the bridge by selecting the triangle icon.
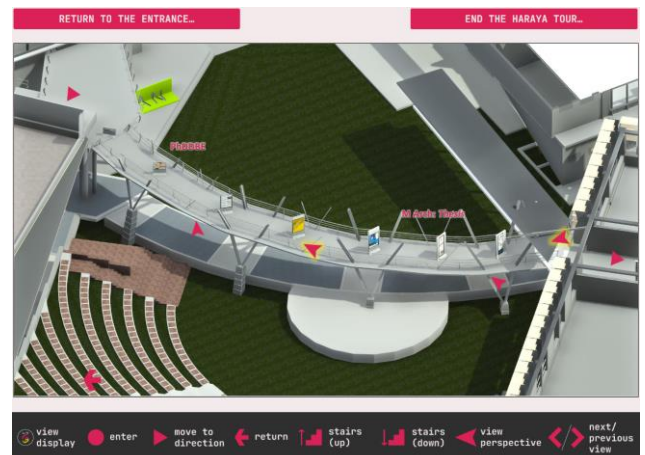

Figure 18. Bridge Axonometric Plan.

The axonometric plan of the bridge (Figure 18) had works which could be viewed by selecting the perspective arrows. The triangle icon on the right led the viewers back to Building 2 and the triangle icon on the left would let the

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viewers go to Building 1 (Figure 19) just like how it would be if the viewers were in the actual UPCA campus.

Figure 19. Building 1 Level 2 Axonometric Plan.

The set up of Building 1 was similar to Building 2, except that Building 1 had large areas instead of many rooms so the displays were spread out (Figure 19). Selecting the circle icon led to an enlarged plan of that area (Figure 20).
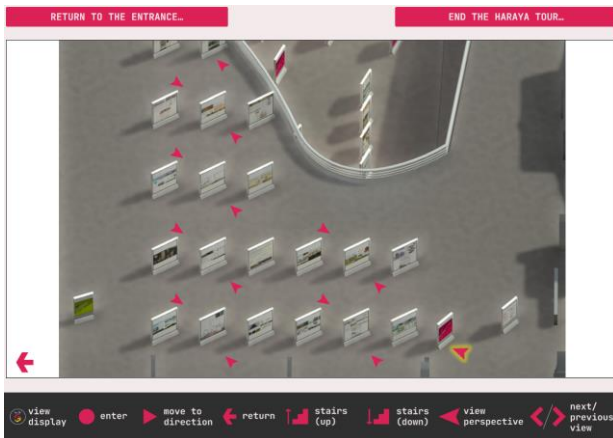

Figure 20. Enlarged Axonometric Plan Sample 2.

The viewers could easily return to the entrance by clicking on the "Return to the Entrance…" button at the upper left (Figure 20). This led them back to the aerial perspective.

Post-Tour Survey

The survey results showed mostly positive feedback with 66.7% saying they had an excellent experience, 22.2% had a

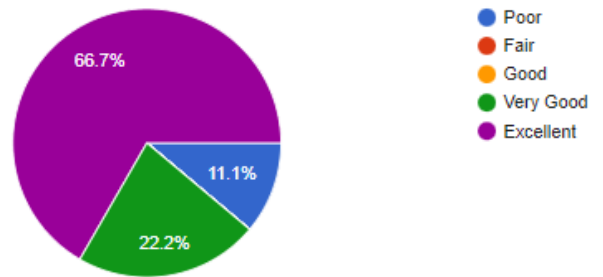very good experience, and just 11.1% saying that the experience was poor (Figure 21).

Figure 21. Survey Results – Haraya Experience Rating.

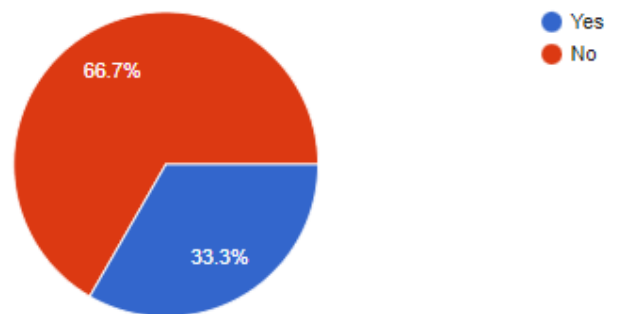When asked about the navigation of the site, 66.7% stated that they had navigation issues (Figure 22).

Figure 22. Survey Results – Navigation Issues.

The issues with navigation were identified as follows:

1.	There was no directory of exhibits per room/area;

2.	Viewing works opened a different tab in the browser;

3.	The website interface was incompatible with the mobile website;

4.	The introduction and exposition were too long.

Some participants also complained that some videos of student works were missing. These videos were submitted using incorrect format and thus could not be displayed.

Other comments and suggestions were mostly positive. Some recommended that a directory be included and that the number of introduction pages be decreased, while others suggested having a smoother walkthrough video and higher-resolution images for the digital museum.

The link below leads to the actual digital museum: https://haraya.upca.upd.edu.ph/experience-haraya-2022/.

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V. Analysis and Discussion

The Haraya digital museum made use of rendered images and videos instead of more advanced methods like Virtual Reality, Virtual Tour, or Augmented reality because of the lack of budget, time, physical space, and people. It was the most realistic approach, especially with an available model of the campus at hand. Other more advanced methods required specific equipment and expertise that were not available to the organizing committee.

Unfortunately, a simple photo and video gallery is not attractive to viewers. This method was used when Haraya shifted to the online format in the beginning of the pandemic in 2020 and 2021, but it was not immersive. The organizing committee had to be more creative and come up with a method in which the viewers can interact with the exhibits. The solution was to make use of rendered cutout axonometric plans, perspectives, and links (Figure 23).
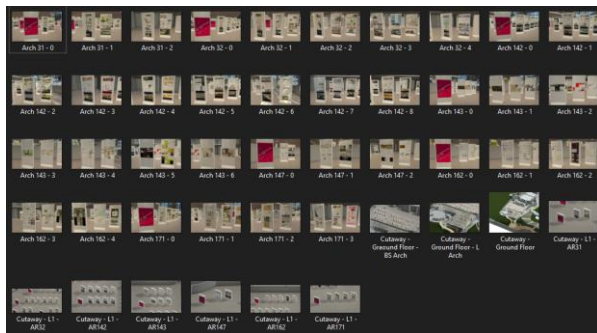

Figure 23. Rendered Images.

Creating a New Digital Museum

Planning, strategizing, and testing took less than three months. Afterwards, the digital museum had to be created in less than a month because the student works were only available three weeks before the launch of Haraya. The creation of the digital museum required the following processes:

1. Organizing the student works;
2. Reformatting student works;
3. Planning the display layout;
4. Adding the student works in the display areas;
5. Rendering the images;
6. Uploading everything on the website.

An aerial axonometric view of the UPCA campus was used to orient viewers, similar to a theme park map. The aerial axonometric view was changed to an aerial perspective view to make it look more realistic (Figure 24).

Figure 24. Aerial Axonometric and Aerial Perspective.

Cutaway axonometric plans were chosen over flat 2D plans for better visualization and viewer comprehension (Figure 25). A 2D plan is more technical and accurate but an axonometric plan is more intuitive and presentable.

Figure 25. Sample Axonometric Plan.

Entry arches were patterned after the logo and other publication materials. 3D logos were used in the digital museum to make the virtual model more interesting (Figure 26).

Figure 26. Building 1 and 2 Entry Arches and 3D Logos.

More specific and refined icons were created to avoid confusion while navigating the digital museum. These icons were added as a legend at the bottom of the screen (Figure 27).

Figure 27. Haraya 2022 Digital Museum Icons.

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The images used for the final output were enhanced by adding lighting, materials, and effects to be more aesthetically pleasing (Figure 28).

Figure 28. Draft Perspective and Final Perspective.

Building entry videos were added to make the experience more immersive. However, one comment from the survey mentioned that the walkthrough video could be smoother as the video had some lag issues.

For the axonometric plans, course, and project titles were added to the display areas so that the viewers were informed of the subject of the featured works (Figure 29).

Figure 29. Axonometric Plan with Course and Project Title.

Directories were added to help the viewers navigate the museum (Figure 30). These were placed on each level of all buildings.

Figure 30. Directories.

Enlarged axonometric plans of the areas were added for better viewing. All perspective views were accessible from the enlarged plan for ease of navigation (Figure 31).

Figure 31. Sample Enlarged Axonometric Plan.

The perspectives showed previews of the students' works. If a viewer wanted to see more, they could click on the Haraya 2022 icon to view more details and a high-resolution image of the work. This icon was present in all the student works. This setup is similar to the traditional museums where there are works a person would prefer to look at in more detail.

To avoid long loading times, the axonometric plans, enlarged plans, and perspectives were placed in one PDF file. Once accessed, it loaded only once. The only other step that required a loading time was when individual works were viewed in more detail by selecting the Haraya 2022 icon. This opened a new tab, which allowed a more seamless viewing of the digital museum. The viewers were able to return to the previous tab after checking a student's work in detail. The viewers could also choose to save the student work for viewing later by keeping the tab open. This is more convenient than making the student work appear in a pop-up window that needs to be closed before moving on.

In a traditional museum, there is an exit which signifies to the viewers that the museum tour is over. Contributors can also be posted and properly acknowledged at the exit. To provide a comparable experience in the digital museum, an "End the Haraya Tour…" button was added so that the viewers could leave the museum at any time. Ending the tour would bring them to a page where they would see the acknowledgments and the contributors and be able to answer the survey.

Survey Results

The survey showed positive results although some concerns were raised. First, the lack of a directory of student works was mentioned several times.

The second concern was that some respondents did not like having to click on a new tab when viewing the student works. They preferred to have it in the same tab. However,

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as mentioned above, there are advantages to using a new tab.

The third issue was the incompatibility of the website with the mobile interface. The website had a landscape orientation while most mobile gadgets have a portrait orientation. Thus, on mobile gadgets, the website appeared too small (Figure 32).
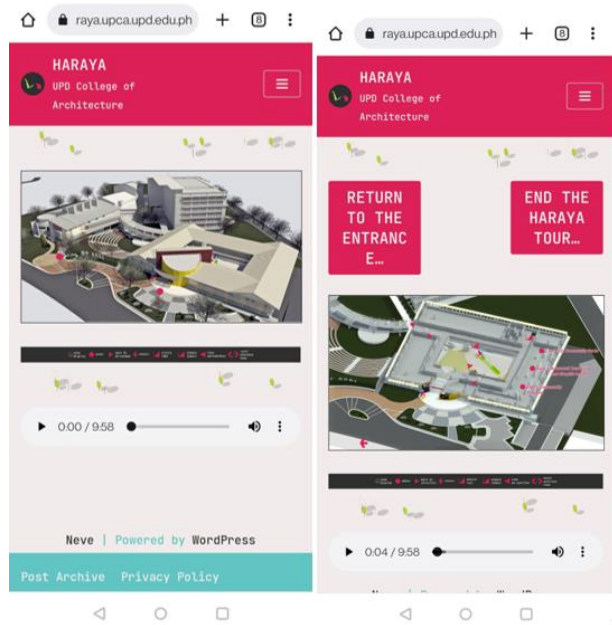

Figure 32. Haraya 2022 Viewing Using a Mobile Gadget.

Given the size, the nodes were hard to select. Zooming in was a viable option but the viewer would not be able to see the whole picture. Orienting the mobile gadget to a landscape orientation would work better, but for a 20:9 screen, either the buttons or the legend would be cut off from view (Figure 33).
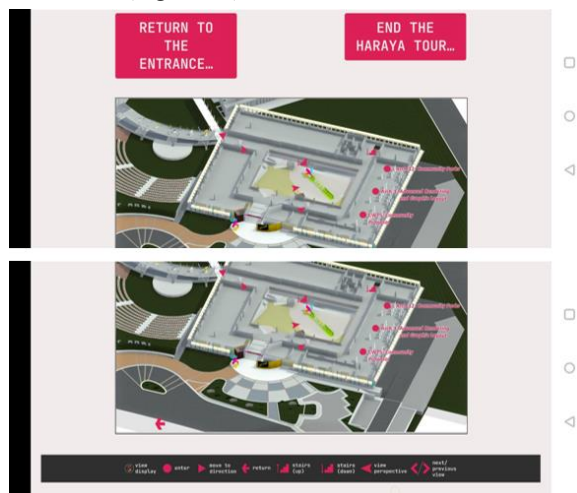

Figure 33. Haraya 2022 Viewing Using a Mobile Gadget in Landscape Orientation.

The fourth issue was the long introduction and exposition. Upon viewing the home page of the Haraya 2022 website, the viewer would need to go through five pages showing the theme, creators, logo, and message before finally arriving at the main page of the digital museum. This was made worse by the prolonged loading time because of the high resolution of the images and graphics used.

The fifth issue was the missing videos for some student works. Most videos were either more than the required time limit or had large file sizes which made it difficult to upload on the website. The file size of the videos could have been solved by converting them to a lower resolution but given the limited time, the organizers were no longer able to edit or fix the videos submitted.

VI. Conclusions and Recommendations

Creating a digital museum with a small team and a limited budget presented a number of challenges. Nevertheless, with the creative use of limited resources it is possible to construct a digital museum that provides an immersive experience. This is reflected in the positive feedback in the survey.

Issues with navigation and compatibility as identified in the survey can be improved upon in the future. One feature that could greatly improve the museum experience is the addition of a comprehensive directory with the corresponding links, location, and instructor and student names. The directory can be placed by the side of the screen so that the viewers are free to move from work to work.

Video and image renderings of the digital museum can be enhanced but loading time should be considered. Higher resolutions and larger file sizes will make the loading time longer.

The introduction pages should be reduced and be more concise. One introduction page instead of five would be adequate and the resolution of the images should be decreased to help the page load faster.

Compatibility of the website with mobile screen should be considered, especially with the abundance of mobile gadget users.

Student works should follow a strict format with maximum file size to avoid issues with uploading works. The images should be submitted with the correct format to facilitate uploading.

Future digital museums can be created using the methods described in the study. I recommend that the method not only be replicated but improved upon based on our experience. If a physical museum is present, a digital counterpart can still be considered to increase access for those who may have difficulties going on site. Digital museums are a way to promote globalization and interconnectivity.

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References

Alsford, S. (1991, October). Museums as hypermedia: Interacting on a museum-wide scale. In D. Bearman (Ed.), *Proceedings of the ICHIM '91 Conference, Pittsburgh, Pennsylvania, USA*, 7–16.

Bergstrom, A., & Clark, J. T. (2007). X3D-based virtual reality stereo-rendered human heritage exhibitions. *IEEE Virtual Reality*.

Cilasun, A. (2012). *Virtual museum and review of virtual museums in Turkey*. [Paper presentation]. 5T A New Affair: Design History and Digital Design Museum, At İzmir.

Cremer, J., et al. (2001). This old digital city - one year later: Experienced gained, lessons learned, and future plans. *Proc. Seventh International Conference on Virtual Systems and MultiMedia – Enhanced Realities: Augmented and Unplugged*, 49-56.

Giaccardi, E. (2006). Collective storytelling and social creativity in the Virtual Museum: A case study. *Design Issues*, 22(3), 29–41. https://doi.org/10.1162/desi.2006.22.3.29.

Heim M., 1993. *The metaphysics of virtual reality*. Oxford University Press.

Hin, L.T.W. (2003). Virtual science centers: A new genre of learning in web-based promotion of science education. *Proceedings of the 36th Annual HICSS'03 Conference, IEEE Computer Society*, 156–165.

Li, J., et al. (2022). Evaluation of virtual tour in an online museum: Exhibition of architecture of the Forbidden City. *PLOS ONE*, 17(1). https://doi.org/10.1371/journal.pone.0261607.

Lifeng S., et al. (1999). Real-time walkthrough in real image-based virtual space. *Journal of Image and Graphics*, 4(6), 507–513.

Schweibenz, W. (1991). The virtual museum: new perspectives for museums to present objects and information using the internet as a knowledge base and communication system. In H. Zimmermann, & H. Schramm (Eds.), *Proceedings of the 6th ISI Conference, Prague, November 1998, Konstanz, UKV* (pp. 185-200). http://www.informationswissenschaft.org/wp-content/uploads/isi/isi1998/14_isi-98-dv-schweibenz-saarbruecken.pdf.

Severson, J. (2001). Prospects and challenges for creating historic virtual environments for museum exhibition." *Proc. Seventh International Conference on Virtual Systems and MultiMedia – Enhanced Realities: Augmented and Unplugged*, 248-252.

Silverstone R. (1994). The medium is the museum In R. Miles & L. Zavala (Eds.), *Towards the museum of the future* (pp. 161-176). Routledge.

Styliani, S., et al. (2009). "Virtual museums, a survey and some issues for consideration." *Journal of Cultural Heritage*, 10(4), 520–528. https://doi.org/10.1016/j.culher.2009.03.003.

White, M., et al. (2004, June 19). Arco - an architecture for Digitization, management and presentation of virtual exhibitions. *Proceedings Computer Graphics International*. https://doi.org/10.1109/cgi.2004.1309277.

X3d file extension - what is it? how to open an x3d file? x3d file extension - what is it? how to open an x3d file? (n.d.). Retrieved March 9, 2022, from https://filext.com/file-extension/X3D.

Yaneva A., & Rabesandratana T.M. (2009). Staging scientific controversies: a gallery test on science museums' interactivity. *Public Understanding of Science*, 18(1), 79–90. https://doi.org/10.1177/0963662507077512 PMID: 19579536.

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