LEVERAGING EXISTING HERITAGE DOCUMENTATION FOR ANIMATIONS: SENATE VIRTUAL TOUR

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KEY WORDS: Valorization, Heritage Documentation, Animation, Point Cloud, BIM, Senate Virtual Tour

ABSTRACT:

The use of digital documentation techniques has led to an increase in opportunities for using documentation data for valorization purposes, in addition to technical purposes. Likewise, building information models (BIMs) made from these data sets hold valuable information that can be as effective for public education as it is for rehabilitation. A BIM can reveal the elements of a building, as well as the different stages of a building over time. Valorizing this information increases the possibility for public engagement and interest in a heritage place. Digital data sets were leveraged by the Carleton Immersive Media Studio (CIMS) for parts of a virtual tour of the Senate of Canada. For the tour, workflows involving four different programs were explored to determine an efficient and effective way to leverage the existing documentation data to create informative and visually enticing animations for public dissemination: Autodesk Revit, Enscape, Autodesk 3ds Max, and Bentley Pointools. The explored workflows involve animations of point clouds, BIMs, and a combination of the two.

1. INTRODUCTION

1.1 Background

Digital documentation of heritage places is important for technical applications. Techniques such as laser scanning and photogrammetry provide records of a building at a specific moment in time and are useful tools in the conservation and rehabilitation of these places. Building Information Models (BIMs) can be created from these data sets to provide more technical data for engineers, architects, and other heritage professionals about the specific elements of the building.

There is an opportunity to give the data a secondary purpose; to use it for valorization. The data can be used to create visual content for different digital storytelling applications. These applications can increase public engagement with a heritage place and make the place accessible to people around the world who cannot physically visit it. The valorization of cultural heritage through virtual tours and exhibits will likely lead to more visitors to that place (Ciurea and Filip, 2016). This can then contribute to the economic development of the site and local area.

1.2 Senate Virtual Tour

The Centre Block, Canada's main parliamentary building, is one of the most iconic buildings in the country. Ground was broken on the original building in 1859, eight years before the confederation of Canada. The current Centre Block opened in 1920, after a fire destroyed the original building in 1916 (History of the Hill). The building houses Canada's two parliamentary branches, the House of Commons, and the Senate. Each parliamentary branch houses legislative sessions in its chamber on opposite ends of the building: the Senate in the east wing, and the House of Commons in the west. Needless

to say, the heritage value of the building is closely tied to that of Canada. Starting in 2018, the building will be undergoing a 10 year rehabilitation. The Centre Block will be closed to parliamentarians – who will move to temporary chambers – and the public during the rehabilitation (Rehabilitating the Centre Block).

CIMS made a virtual tour for the launch of The Senate of Canada's new website on March 1st, 2017. The first iteration of the tour allows the user to navigate through the entrance of the Centre Block and to the main spaces occupied by the Senate: the Senate foyer, the Senate antechamber, and the Senate chamber. The tour will ensure virtual access to the Senate spaces that will be inaccessible during the rehabilitation, and lasting access for those who cannot physically visit the building. Users can orbit each of the 21 panoramic images in the tour, and click on pieces of artistic or architectural significance for more information. Most of these 'hotspots' were composed of some text, narration, and images. Animations were added to some of the 'hotspots' and to the beginning of the tour to make it more dynamic. Due to the short timeline of the project - less than five months from the beginning of site work to the full launch - and limited site access, the focus was on capturing the panoramas and still images needed to complete the tour. So, the question became, how can the existing data be leveraged to create animations for the tour?

The existing data consists of point clouds from laser scanning and photogrammetry (captured by CIMS and Heritage Conservation Services (HCS)), and was captured over several years. This data is not only and existing record of the building, but it was also used to create a BIM of the building. This BIM was created prior to the rehabilitation, and will be used by the consultants for technical design, and project management.

Brief, empirical tests were performed on four programs to determine which one was the most effective for creating animations of the point cloud and BIM data. Two animations were made from the existing data for the first release of the Senate Virtual Tour: the introductory animation that takes the user through a point cloud and inside the Centre Block, and an animation of the Senate chamber ceiling that combines a point cloud with the BIM. This paper will give an overview of each program, the workflows involved, and the situations that each one is best suited for.

1.3 Parameters

The four programs evaluated were chosen for their strengths and availability to the team creating the animations. 1) Autodesk Revit: a BIM program that was used to create the BIM of Centre Block. 2) Enscape: A plug-in for Revit that renders the model in real time. 3) Autodesk 3ds Max: a program for rendering and 3D modelling. 4) Bentley Pointools: a program for processing and visualizing point clouds. Each software was evaluated using six parameters to help determine how effective the program is at leveraging point cloud data, a BIM, and both together for public dissemination.

1.3.1 Import File Types: What types of files can the program import that are specifically related to BIMs and point clouds? The import file types determine if the native files can be used, or if a conversion step must be added to the workflow.

1.3.2 Complexity of the User Interface: How is easy is the program to learn and use? The ease of use of the program will help to determine if it is the right tool for people of different experience levels and under different time constraints. Each interface was evaluated empirically resulting in a label of simple, intermediate, or complex.

1.3.3 Camera Control: Which camera parameters can you control and customize? The ability to set or key frame various camera parameters over time is essential to control the feel of an animation: the camera's position and orientation (pitch, yaw, and roll), the field of view (FOV), the focus length, the distance of a clipping plane, and the interpolation between key frames.

1.3.4 Anti-aliasing: To what extent can the program eliminate aliasing effects? Aliasing is a common problem that occurs in renderings of still images and animations. It occurs when there isn't enough resolution to render certain objects. Shapes like polygons and lines can only be rendered up to a certain resolution, this leads to stairstepping (jaggies), moving artifacts (crawlies), and scintillation (flickering) (Molnar, 1991). Anti-aliasing commonly deals with this by supersampling – sampling the image at a higher resolution and then scaling down to the desired one (Architectural Rendering Glossary, 2016). Without this feature the aliasing effects are often distracting, especially in animations involving point clouds.

1.3.5 Real-time Updating: Can the program update the BIM in real time? Real-time updating saves a step in the overall workflow. In the case of the Senate tour with the Centre Block BIM, the model was being edited as the animation was being set up. It is also a useful feature, in case some changes need to be made to the model specifically for the animation.

1.3.6 Export File Types: What types of files can the animation be exported as? Animations can be exported as a sequence of images or as a compiled video file. Though they add an extra step to the workflow, image sequences are preferred. An image sequence allows for the rendering to be interrupted at any time without the loss of data because each frame is exported individually. An image sequence allows for easier manipulation of individual frames in post-production (Rendering Animations).

2. EVALUATION

Table 1 summarizes the results from the evaluation of each program. A more detailed analysis of specific parameters can be found in the following subsections.

2.1 Revit

Revit is a Building Information Modelling (BIM) software. It is commonly used by engineers and architects for the design of buildings. Revit was used to create the BIM of the Centre Block and has ability to create animations of point clouds and BIMs. Animations in Revit are known as walkthroughs.

The workflow with Revit is relatively straightforward. If Revit was used to create the BIM the point cloud is already converted to the right format and is aligned with the BIM. Other than point cloud and BIM files, Revit can link CAD files and decals – textures to be placed individually on a face of a model – into a project.

The ribbon-based user interface allows for a wide range of control within the program while making the core functions easy to find. Setting up a basic walkthrough is simple, but the interface for editing it is less so. For example, the orientation and position of the camera need to be changed from an elevation, plan, or external 3D view; it cannot be changed from first-person movements. This makes fine tuning camera movements a tedious process.

The interpolation between key frames in Revit is automatic and cannot be controlled – though the speed between key frames can be edited. The lack of a graph editor to manipulate the interpolation can lead to unwanted movements in some cases, and can be frustrating to fix.

There are two ways to render a walkthrough in Revit: through the viewport or through the renderer. Rendering through the viewport is a less realistic option that gives animation more of a model-like appearance. When rendering using the viewport using one of the different visual styles (wireframe, hidden line, shaded, consistent colors, realistic, or ray trace) the user has the options to smooth lines with anti-aliasing. Smoothing the lines eliminates most overt aliasing issues, but some flickering issues still remain, especially with point clouds. Using the renderer with the NVIDIA Mental Ray Engine (the Autodesk Raytracer was not tested) the anti-aliasing is scaled with the quality setting, but can also be edited separately from other quality settings. The highest rendering setting is successful at anti-aliasing, but rendering a single frame can be severely time consuming. In Revit, point clouds cannot be rendered with the Mental Ray engine, which limits the high quality animation possibilities of the program.

Program	Import File Types (Point Cloud)	Import File Types (BIM)	Complexity of the User Interface	Camera Control	Anti-aliasing Control	Real-time Updating (BIM)	Export File Types (Animation)
Revit	RCS or RCP	RVT or IFC	Intermediate	Location, orientation, FOV, far clipping plane	Yes: on/off (viewport rendering), slider (NVIDIA Mental Ray Engine)	Yes	Image sequence (JPEG, TIF, BMP, PNG) or video file (AVI)
Enscape	N/a	RVT or IFC	Simple	Location, orientation, FOV, depth of field	Yes: slider	Yes	Video file (MP4)
3ds Max	RCS or RCP	RVT, SKP, or geometric formats (FBX, OBJ, etc.)	Complex	Location, orientation, FOV, near or far clipping plane, depth of field, focus distance, key frame interpolation	Yes: slider	Yes	Image sequence (JPEG, TIF, BMP, PNG, Kodak Cineon, Encapsulated Postscript, Open EXR, Radiance, SGI, RLA, RPF, DDS, Targa image file) or video file (AVI, MOV)
Pointools	POD	Geometric formats (3DS, OBJ, LWO)	Intermediate	Location, orientation, FOV, far clipping plane, key frame interpolation	Yes: on/off	No	Image sequence (JPEG, TIF, BMP, PNG, Targa image file) or video file (AVI, MOV)

Program

Table 1. Summary of the evaluation of the programs for leveraging BIMs and point clouds for animations

2.2 Enscape

Enscape is a third party plug-in for Revit that provides real-time rendering of 3D scenes. The real-time rendering makes it very quick to create renderings of a BIM using the plug-in. It also a powerful tool for model review and to show work to clients.

No files can be directly imported into Enscape, because it is a plug-in for Revit. The plug-in is limited to the file types that Revit can handle. Of these, Enscape supports decals and BIM files, but it does not support point clouds or CAD files.

The Enscape user interface is simple and intuitive. It can be learned within a matter of minutes. Setting up the animation is simple. You orbit the model in first-person, as the camera, and set key frames. The visual settings (contrast, cloud level, etc.) and export settings can all be accessed in the settings panel.

Enscape only allows for very simple animations. At this time, only two-point animations can be created with Enscape; the user navigates in 3D space to set the first key frame, then the second. The plug-in interpolates between the two using linear, smooth, or handy cam interpolation; the user cannot manually control it with a graph editor.

The anti-aliasing in Enscape is built into the quality setting. When you increase the quality (low, medium, high, and ultra) the anti-aliasing quality, along with the shadow, motion blur, and depth of field quality increases (Version 1.7 Released,

2016). Even on the highest quality settings, some visible aliasing elements remain.

2.3 3ds Max

3ds Max is a 3D modelling and rendering software. It has a wide variety of uses from architectural renderings to video game applications.

When a BIM is linked from Revit into 3ds Max the point cloud is not imported along with it. And when a point cloud is imported into 3ds Max it is imported at the click point and not in its registered location. This adds an extra alignment step to the workflow when using both data sets in 3ds Max.

The 3ds Max user interface is the most complex of the four programs. Because of the versatile applications of 3ds Max, the program can be intimidating to use, and some time is required to become familiar with the workings of the program.

However, the complexity does provide the user with full camera control. The user has the ability to control all parameters discussed in 1.3.

Rendering tests were performed with the NVIDIA Mental Ray rendering engine in 3ds Max. Other engines were not tested. In 3ds Max, the renderer has the capability to render a point cloud, unlike in Revit. The level of anti-aliasing can be controlled in the rendering options, and ranges from draft to very high. At the

higher settings, virtually no aliasing issues are visible, but similar to Revit, the render time per frame becomes long.

2.4 Pointools

Pointools is a program that is designed to edit and visualize point clouds.

All of the main point cloud formats (TXT, LAS, PTS, etc.) need to be converted to the POD format, using Bentley's PODcreator, to be used in Pointools. A BIM cannot be exported directly from Revit into Pointools, but if the model is imported into 3ds Max, it can then be exported to a format that is compatible with the program. This two-step process can lead to workflow problems in the translation of material textures between programs. There is also the possibility to import and export camera paths between 3ds Max and Pointools. This could make it possible to render the BIM in 3ds Max and the point cloud in Pointools. However, several tests could not get the feature to work properly.

The Pointools user interface is of intermediate complexity. The ribbon setup is similar to that of Revit's, but with an additional toolbar at the bottom for editing animations. It can be difficult at first to edit the camera parameters, but for an easier workflow they can all be key framed together instead of edited individually.

Key frames are set in a first perspective and interpolation can be set to stepped, linear, Catmull Rom, or TCB Spline and finessed from there using a graph editor.

The program eliminates most visible aliasing when rendering an animation of a point cloud containing millions of points, and has a faster rendering time than the NVIDIA Mental Ray engine. BIMs rendered in Pointools have the model-like quality of viewport renders in Revit instead of the realistic quality of renders created with the NVIDIA Mental Ray engine.

3D models imported into Pointools cannot be updated, a new model would have to be imported if any changes were made. It is a two-step process, which makes the workflow less than ideal.

3. RESULTS

For users familiar with Revit, the integration and familiarity with the program make it an obvious first consideration. However, the lack of complex camera controls, and the inability to produce high quality renders of the point cloud using the NVIDIA Mental Ray engine make Revit less appealing when compared to 3ds Max. The animations in the Senate tour required high quality renderings of the BIM and point clouds, which eliminated it as a possible option. The program is not recommended for point cloud or BIM animations.

Enscape is as easy to use as a program can be. The real-time rendering makes it simple to edit environmental settings, such as time of day, cloud cover, contrast, and bloom. It is significantly easier to create a final product in Enscape compared to 3ds Max or Revit because the user can see the output in real time; you do not have to render test frames, adjust settings, and repeat the process to create visuals. However, the inability of the program to handle point clouds, and create complex animations prevented it from being used as the sole program for the Senate tour. Enscape is recommended for creating quick, high quality rendered videos of BIMs.

3ds Max is complex and can be time consuming to use, but with complexity comes versatility. The program has detailed lighting and material selection options that can produce animations of the highest quality. Its direct integration with Revit, and its ability to handle point clouds make it useful when creating animations of the two data sets together. However, a lot of computing power is required to view a point cloud in full density in 3ds Max when compared to Pointools. For example, a test on a laptop computer rendered a point cloud of around 30 million points with no issues in Pointools, but had to be reduced to less than 200,000 points in 3ds Max so that it would not crash. Despite this, the program does produce high quality visuals on a powerful computer, and was considered for the Senate chamber ceiling animation that combines the point cloud and BIM. 3ds Max is recommended for complex animations of BIMs and animations that combine both data sets.

Pointools can handle larger point clouds, with shorter render times, when compared to 3ds Max. The BIM import is a two-step process and materials and textures do not always get transferred properly in the process. Though anti-aliased well, the BIMs are of model quality, like the viewport renders in Revit, and not at the high level of quality produced by the NVIDIA Mental Ray engine. Due to this, Pointools was only considered for point cloud animations in the Senate tour. Pointools is recommended for animations of point clouds.

In the end, Pointools was used for the introductory animation of the Senate tour, which was made using point clouds of the Centre Block (Figure 1). Pointools was used because of its ability to handle large point clouds with high visual quality, and relatively low rendering times. A combination of Pointools and Enscape was used for the animation of the Senate chamber ceiling, which combines point cloud and BIM data (Figure 2). The animations from the two programs were aligned by eye, which was possible due to the simplicity of the camera movements, but this process is less applicable for more complex applications. This workflow was chosen over 3ds Max due to time constraints. The complex interface and long rendering times of 3ds Max made Enscape and Pointools more time efficient options. Additionally, there was little time advantage to using 3ds Max, and its ability to render both data sets in the same program. A manual alignment would be needed between the point cloud and BIM when imported.

4. CONCLUSION

There is a lot of potential for using technical documentation data to help increase public engagement in heritage places. Animations used in this context can help to create more dynamic virtual exhibitions. The point cloud and BIM data gathered for the rehabilitation of the Centre Block were successfully animated and added for the launch of the Senate tour using workflows that balanced quality and efficiency.

At this time, there is no best solution that balances ease of use with the ability to animate both data sets well, and render in a timely manner. The method chosen is dependent on the skills of the user, and the requirements of the project.

As time passes the programs will evolve, getting better and making valorization more accessible to heritage professionals. Future work includes other programs and plug-ins that were not evaluated: the inclusion of mesh objects in the valorization workflow, and the examination of future versions of each program.

Figure 1. Screenshots from the introductory point cloud animation of the Senate Virtual Tour made with Pointools
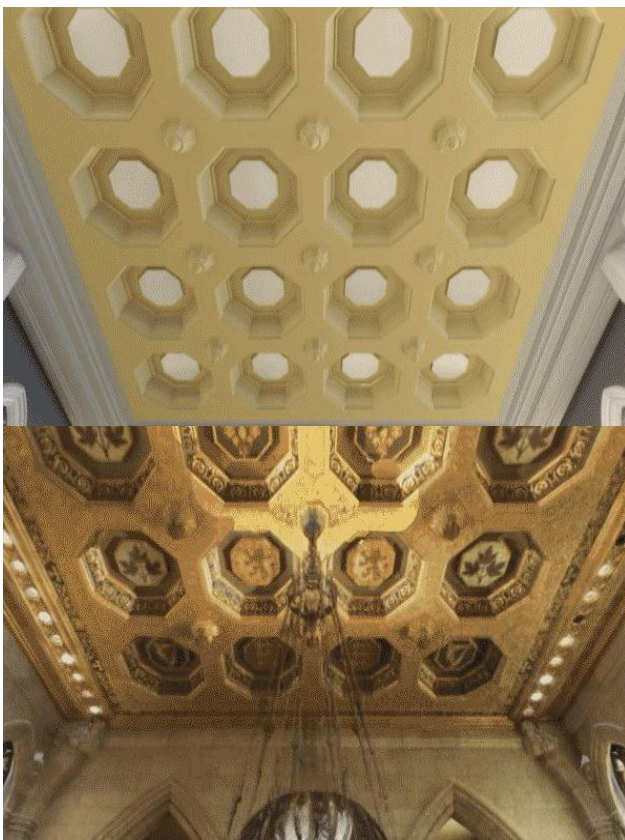

Figure 2. Screenshots from the Senate chamber ceiling animation: the BIM animation made with Enscape (top), and the point cloud animation made with Pointools (bottom)

ACKNOWLEDGEMENTS

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