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Digitizing Ipiranga Museum: preserving Cultural Heritage through GIS and BIM

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Learning Objectives

- Learn about the application of digital tools, from reality capture to modeling of building and urban assets using a common data environment
- Discover how to benefit from the interoperability among macro/micro-scale tools through GIS and BIM workflows
- Learn about the challenges from a scan-to-BIM process associated with historical buildings and step-by-step approaches
- Learn more about the variety of model uses that can be applied to this real case, such as 3D printing and gamification

Description

In this class, you will learn more about preserving cultural heritage and memory within a scan-to-BIM process. We will go deep into the real practice used for digitizing Ipiranga Museum, located in São Paulo, Brazil - the 12th most populous city in the world. A Brazilian history museum, Ipiranga Museum is a symbol of eclectic architecture and contains a vast collection of furniture, documents, and historically relevant artwork. Discover how to explore reality capture to generate and detail accurate models, including, in this case, both the Museum's Monument Building and the Independency Park where it is situated. We will cover the many potential integrations among ReCap Pro, Revit, Civil 3D, InfraWorks, and BIM 360 and demonstrate the ongoing results of this project. These are the first steps toward developing a digital twin for an existing historical asset, with the conclusion planned for 2022.

Speaker(s)

Fernanda Machado assists organizations in the public and private sectors to align their business challenges and strategies with digital transformation technologies, processes, and policies. She is a Technical Specialist and Sustainability Leader at Autodesk, based in São Paulo, an architect, an expert in BIM Management, with an MSc degree in Architecture, Technology and City from the University of Campinas. She has experience in BIM Consulting, building's design and construction projects, and research for innovation in international and national institutions. Fernanda leads the technical cooperation agreement between Autodesk and the Ipiranga Museum. She has won several awards in her career, such as the Autodesk Technical Sales of the Year FY21, the ABRAFAC Academic Innovation Award 2019, and the honourable mention in the 3rd BIM Excellence Award from Sinduscon-SP in 2018. Her technical interests include BIM, ICTs, Reality Capture technologies, VR/AR technologies, and the Internet of Things (IoT).

Pedro Soethe provides technical leadership in the AEC (Architecture, Engineering, and Construction) market, focusing on digital transformation in the construction industry. Since 1998 he has worked in several companies promoting the best methodologies and technologies in executing work, bringing innovation, and transforming doing things. He successfully implemented several projects and construction in highways, urban projects, commercial and residential buildings, dams, and hydroelectric plants. Using and applying the BIM (Building Information Modeling) LEAN, IoT, Big Data methodology in a pioneering way in this area, using the best technologies in the market, to achieve the best result in all the companies he worked and works for. Pedro technically leads technical cooperation agreements with DNIT (https://bit.ly/3kDkZYQ), DER-PR (https://bit.ly/3jAcK0f) and the Ipiranga Museum (https://bit.ly/3kNDwBA).

Marcelo Laguna has an undergraduate degree in Interior Design at Senac and studies Architecture and Urbanism at FMU, with experience in interior design, construction supervision and specification of materials. He is passionate about Architecture, Archaeology and Design, especially parametric architecture, development of new materials and construction techniques, seeking in architecture the point of balance between human and nature generating sustainability and environmental comfort. He joined as an intern in the Brazilian Autodesk Technical Specialist's team to collaborate with the Technical Cooperation Agreement of Ipiranga Museum and develop the museum's 3D model.

Vinicius Almeida Barros has an undergraduate degree in Architecture and Urbanism at Paulista University – UNIP. He is passionate about Autodesk technology for the Architecture, Construction and industry and joined as an intern in the Brazilian Autodesk Technical Specialist's team. He supports value engineering processes and sales automation, documents success cases and engages in Technical Cooperation Agreements related to civil infrastructure and the digitization project of the Ipiranga Museum.

The Project

Autodesk and the Paulista Museum of the University of São Paulo, better known as the Ipiranga Museum, signed a Technical Cooperation Agreement to digitize the Monument Building and the Independence Park where it is sited. By laser-scanning and capturing 3D internal and external images of the Museum, in partnership with Faro, it is now possible to build a complete BIM model of the construction, contributing to preserving this important Brazilian historical and cultural heritage. The BIM model will also assist in the operation, expansion and modernization of the assets. The partnership also includes the digitization of 50 pieces of the institution's historical collection. Please, visit the article from Redshift by Autodesk for more details: https://redshift.autodesk.com/preserving-brazils-ipiranga-museum/.

This project aims at meeting the United Nations Sustainable Development Goal to promote more Sustainable Cities and Communities. It addresses the target to strengthen efforts to protect and safeguard the world's cultural and natural heritage – in this case, the valuable Ipiranga Museum (Figure 1).

Figure 1 – SDG Goal 11: Sustainable Cities and Communities.

1. Ipiranga Museum: the Monument Building and the Independence Park

Located in São Paulo, the 12th largest city globally by population and the biggest financial and corporate centre in South America, The Ipiranga Museum is a Brazilian history museum sited near where Emperor Pedro I proclaimed Brazilian independence. It contains a huge collection of furniture, documents and historically relevant artwork, especially the Brazilian Empire era.

Opened on September 7, 1895, as a Museum of Natural History and landmark of Brazil's Independence, the Ipiranga Museum is undergoing restoration, expansion and modernization. The Monument Building is an eclectic small palace (Figure 2) built with bricks by the Italian architect and engineer Tommaso Gaudenzio Bezzi. The collection has around 125k pieces, and the Museum receives 350k people per year. It expects to be reopened to the public on September 7 of 2022, when the city's bicentenary will be celebrated.

2. The Ipiranga Museum's Challenge

In 2013, the Museum closed due to natural damages and risk of collapse. Now, beyond the renovation efforts, the Museum' board sees the benefits of digitizing the Building and its surroundings to create a digital memory of the heritage. The digital Monument and Independence Park will provide an accessible inventory to improve operation and maintenance activities and support educational efforts such as gamification and 3d printing.

Figure 2 – Ipiranga Museum + Autodesk Partnership.

The Project Scope

The project scope defined for generating the Model Use mainly for Operation & Maintenance includes the following scan-to-BIM process:

a. Survey and modeling of the Independence Park and the Monument to Independence
b. Survey and modeling of the Monument Building (Ipiranga Museum)
c. Survey and modeling of the Art Collection

The whole area of intervention is calculated in more than 160,000m², embracing the Park and the Building (Figure 3) – plus the collection of 50 pieces.

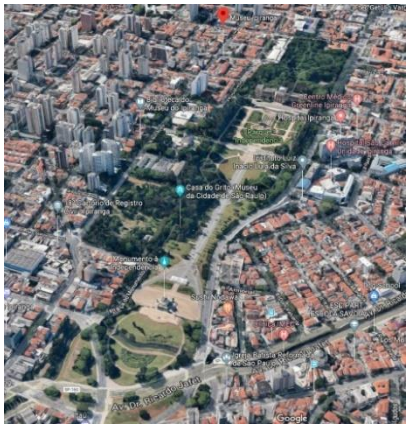

Figure 3 – Project Scope.

Macroflow & Solutions

We defined a macro strategy to develop a BIM execution plan for this project, considering the technologies, processes and policies to guarantee success.

a. Common Data Environment – CDE

The CDE is the single source of truth used to collect, manage and disseminate the project data and the digital assets for the whole team and stakeholders involved. BIM 360 was set to be this centralized platform and connects Autodesk, Faro and Ipiranga Museum teams (Figure 4). All the requests for information, issues, model review, and sharing documentation are managed and fulfil the BI dashboard. In addition, the complementary materials and references provided by the Ipiranga Museum's team are also offered using BIM 360.

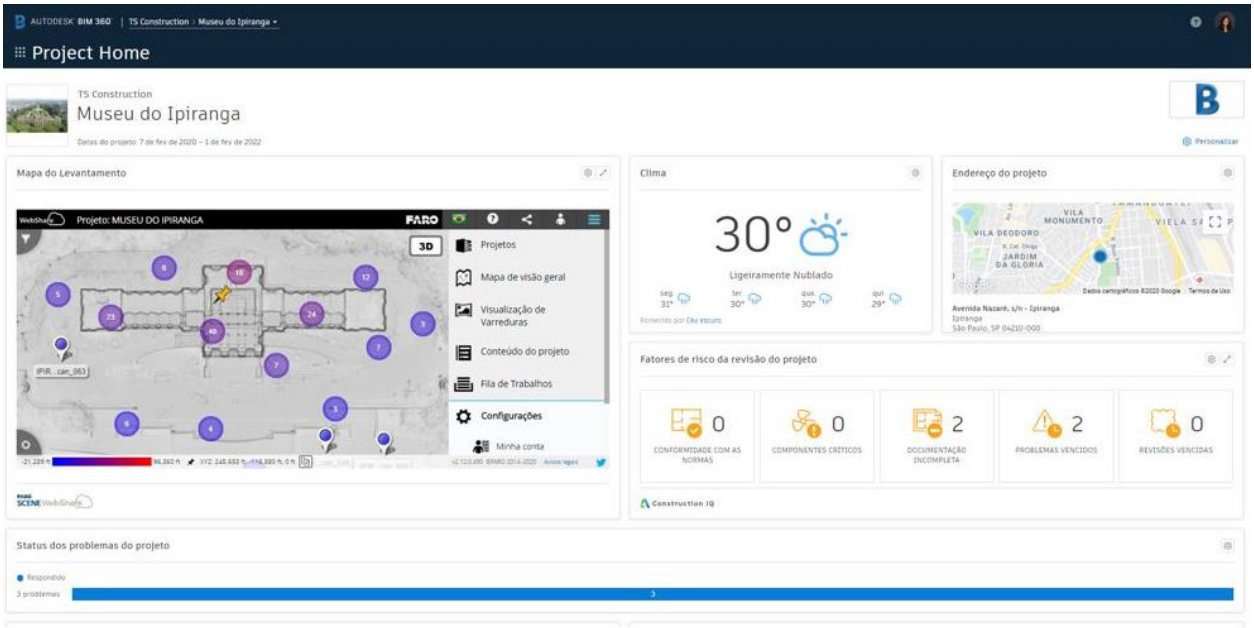

Figure 4 – BIM 360 Dashboard and Partner Cards.

b. Reality Capture

The Reality Capture process is accelerated by technologies such as Laser Scanning and Photogrammetry. We have adopted a hybrid strategy using both techniques (Figure 5). The Laser Scanning process covered the existing conditions of the Building's envelope and its internal areas:

- Field/Processing time: 2 days/8h
- Equipment used: FARO Focus S 350
- Solution: FARO Scene + Webshare Cloud
- Number of scenes: 166 positions
- Number of points captured: 2.3 billion points
- Accuracy: 3.7mm

Figure 5 – Equipment.

The Photogrammetry process covered the Building's envelope and the Independence Park. In this case, the equipment used was the DJI Multirotor Drone, Phantom Pro, NADIR position, 90°, 80% overlap. Then, we imported the results from both surveys (laser scans and photographs) in ReCap software to process and treat them and generate the point cloud files – transforming the physical into a digital asset (Figure 6).

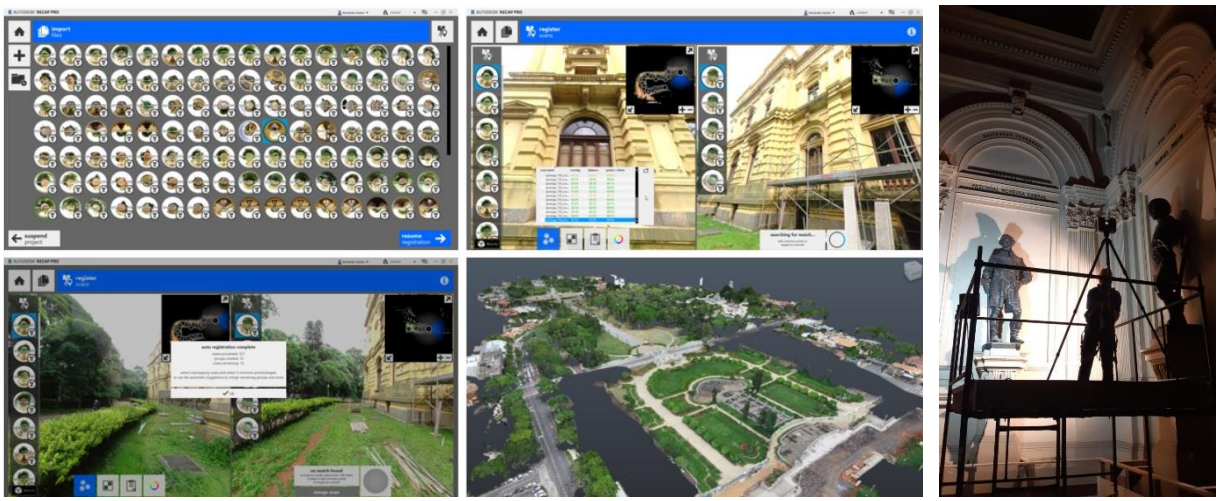

Figure 6 – Point Cloud generation: ReCap Pro and Photo.

Among the challenges from the Reality Capture process, due to the ongoing construction, we highlight the need for:

- Mobilization/demobilization of equipment and scaffolding
- Accessibility for detailed scanning of sculptures and architectural details
- Existing physical barriers at the site due to the works
- Natural lighting vs artificial lighting vs shading
- Georeferencing demands marking generated by the construction company's surveyors
- Drone visibility and wind issues

We have published the point cloud files in the cloud (BIM 360) to share with all stakeholders and facilitate navigation using the Real View images (Figure 7). One best practice to publish the point cloud from ReCap in BIM 360 is to upload the temporary files (.rch) and the RCP file (.rcp) in the same folder. It is important to highlight that the point cloud must be in the local drive for linking the file into Autodesk Revit. This workflow is enabled by ReCap 2022 and later versions.

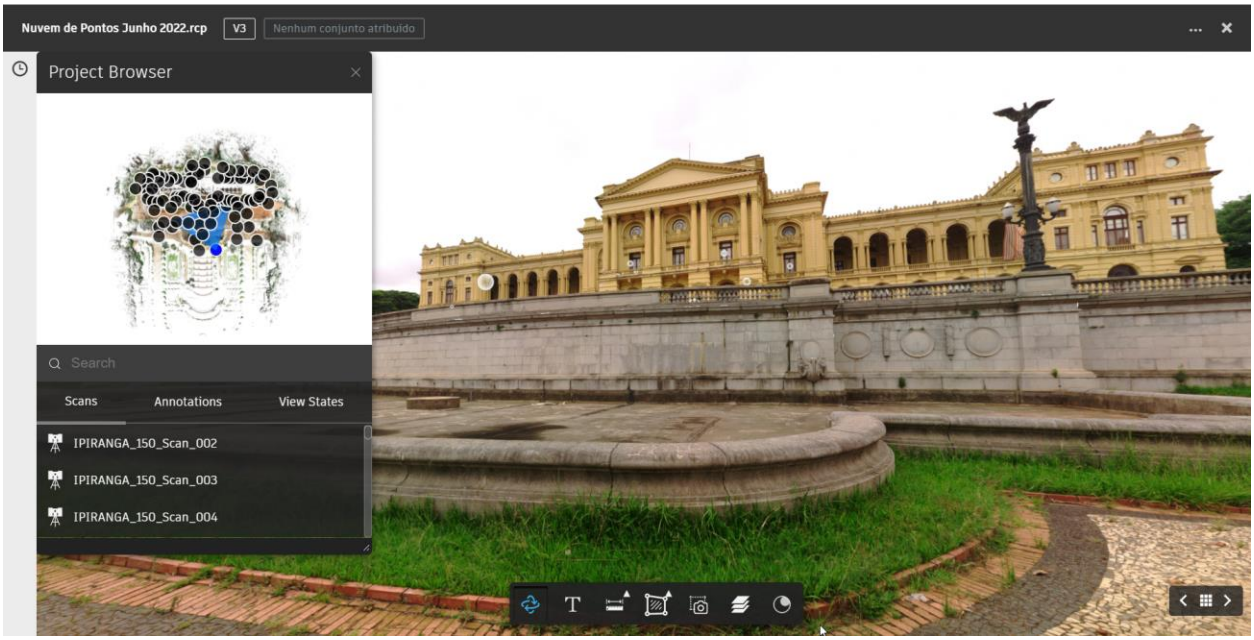

Figure 7 – Point Cloud file navigation (Real View images) in the cloud.

c. Implementation & Context

After the surveying, we divided the scan-to-BIM process into two separate workflows: (1) one dedicated to the implementation and understanding of the Ipiranga Museum in the real world and (2) another specifically for the Monument Building modeling.

Thus, we created the project environment directly in Model Builder from Infraworks, enriched by its interface with geospatial GIS data retrieved from GeoSampa (a public database platform from the Prefeitura de São Paulo). GIS/BIM overlapping data helped to the modeling purpose of surroundings. Also, using the point cloud as a reference, we created the terrain surface first in a ReCap to Civil 3D workflow and then imported the result to the central model in Infraworks. One highlight is Infraworks potential for interoperability and capability to read data from different sources. This potential allowed us to build, aggregate and sync from Revit elements and urban assets such as stairs, walls, and water mirrors – geolocated in this three different software: Revit, Civil 3D, and Infraworks. The whole process generates a real-world context model that can be used in conceptual and detailed design (Figure 8).

Some tips from the process mentioned above include:

- To convert polylines in polygons to assure cover areas management
- To use breaklines to define assets reference and create assets shapes
- To explore multiple supported files in Infraworks to build a content library, such as .3ds, .dae, .dxf, .fbx, .obj, .sff, .svf
- To import shapefiles (from GIS database) setting the Drape option in Infraworks to avoid that objects appear in level 0,00

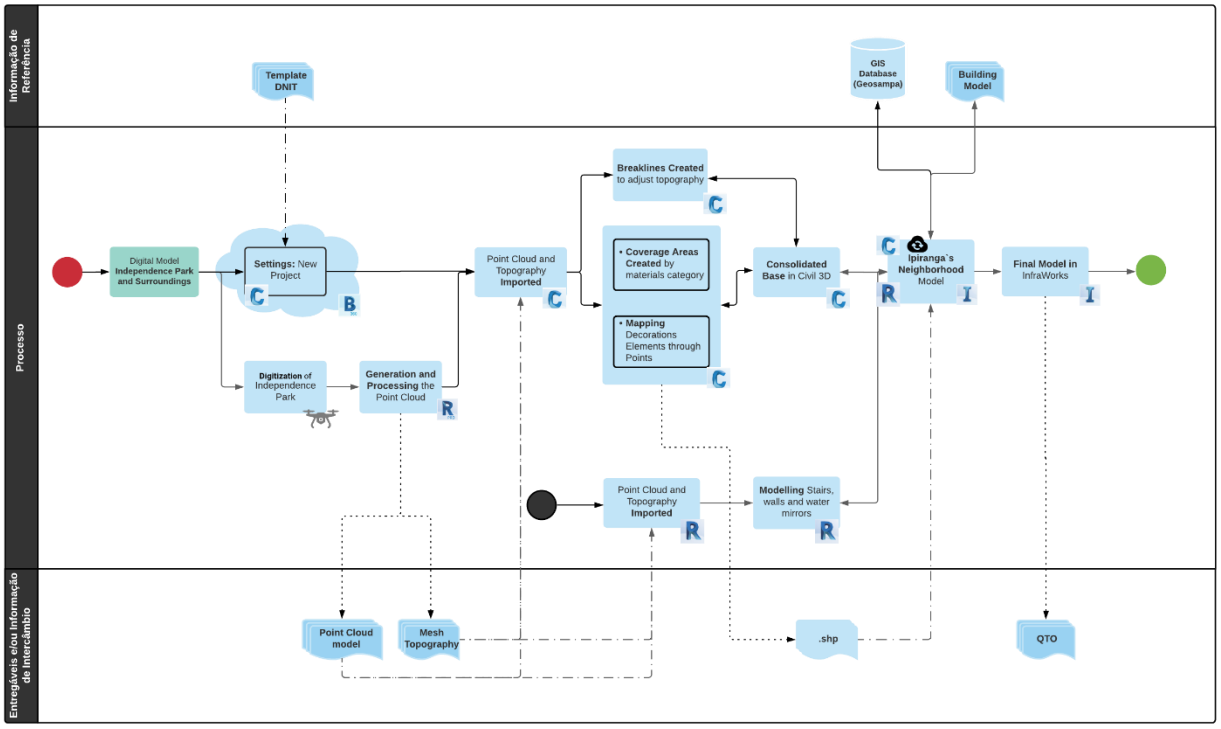

Figure 8 – Macro workflow for the Federated Model.

Beyond the technologies, we did retrospective research to understanding and modeling the historical urban assets with the information needed from the Museum's board and maximum detail to a model used for gamification. Also, we prepared the Independence Park model for data extraction and quantity takeoff – including grass areas, pavements, urban assets – to support the operation and maintenance of the park (Figure 9).

Figure 9 – Infraworks central model and data management.

d. Building Monument

The Building Monument modeling process guarantees the preservation of the asset and its accessibility to future generations. The point cloud reference was key to go deep into the logic of this historical architecture. We studied the Building, its history, and the sectors and floors –

starting to model in Revit from the base to the top, from the outside to the inside, including the main elements: walls, floors, columns, stairs, guardrails, roofs, and ceiling, sequentially. The eclectic architecture was challenging, with different dimensions and openings, details and decorations. This step by step allowed us to control the point cloud slices and explore the details and complexity of cornices, eaves, vent trims, and ceilings (Figure 9). The main elements have been linked to the survey images and historical standardized naming and descriptions to support model-based—navigation, operation and maintenance activities.

Figure 10 – Scan-to-BIM process in Revit.

The use of worksets for sectors and floors and links to enable the management of external data such as the point cloud file from ReCap and topography file from Civil 3D are well recommended in similar cases. This clean process is key in combination with a modeling strategy and planning concerning a BIM object library with elements and patterns (Figure 10). Finally, the shared coordinates settings leveraged the synchronization between Revit and Infraworks to build a landscape view of the whole project. The cloud was the glue to aggregate all the data in a single platform.

Some tips from the process mentioned above include:

- Understand the existing Building and elements before starting
- Prioritize settings for interoperability and georeferencing
- Standardize naming and main elements modeling strategies, create indexes and spreadsheets with images
- Define key parameters to identify historical objects and facilitate modeling activities
- Create worksets and links to manage external data and file size
- Avoid in-place families and develop loadable and embedded families for historical objects and detailing
- Synchronize and publish recurrently to the cloud for management purposes

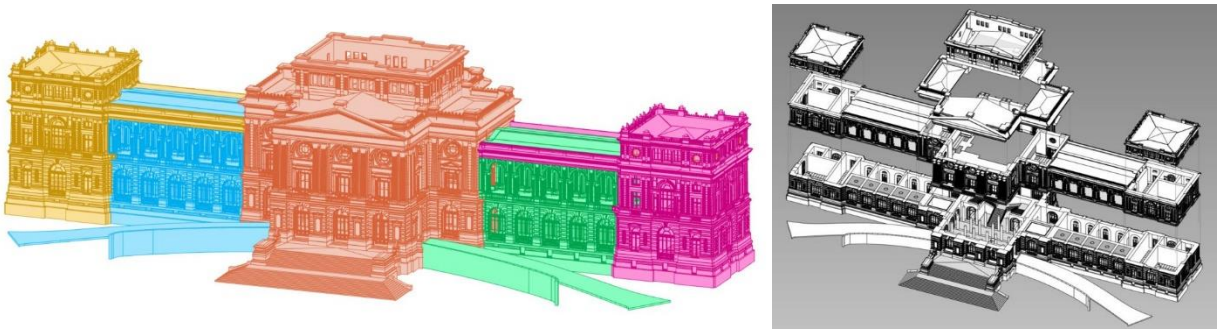

Figure 11 – Workset View/Check and modeling strategy.

Considerations

This ongoing project is intended to be delivered for the Ipiranga Museum reopening in 2022. Here we can reinforce the potential of the existing solutions and highlight processes and best practices to prove the value of BIM for Culture Heritage. Autodesk do Brasil will announce any updates about future deliverables on social media.