HOW MOBILE MAPPING EMPOWERS HERITAGE SCANNING OF FUNCTIONAL INFRASTRUCTURE

Innovative reality capture technology helps surveyors offer advanced laser scanning and BIM services for heritage scanning.

by Bulent Yusuf

3D BIM model of Gumpendorfer Straße Metro Station in Vienna, Austria

NavVis mapping partners Vermessung Schubert and LevelS3D completed projects on subway stations in two European capitals that double as historical landmarks.

Sites of important historical value can represent more than just pretty monuments for tourists to visit and take pictures. They can also play an integral part in the built environment – heritage sites which also serve a functional purpose.

An excellent example of this principle is metropolitan transportation, the subway systems that ferry hundreds of thousands of people around a city each day. Many of the subway stations and tunnels in Europe were first built in the late 19th century, designed by the leading architects and engineers of their time, and they're still in continuous operation more than a century later.

The beauty of a heritage subway station is that they belong to a different architectural era, proudly representing styles of design and decoration which are very different from the modern day. But their elegance and sophistication aren't impervious to the ravages of time. Changing social and environmental conditions can accelerate decay and damage at these historical sites, so

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much so that they require ongoing conservation and restoration.

Using traditional methods, attempts at restoration and conservation at a subway station can be especially challenging. Incomplete documentation or paper floorplans which do not comply with modern standards is just one obstacle. Another problem is access: these subway stations function as the beating heart of the commuter journey. Projects require precise planning to carry out all necessary work without causing delays and disruption.

Modern technology in the form of 3D laser scanning is the solution. Not only can these mapping systems speed up the process, but they can also raise the quality of documentation and, by extension, the quality of restoration by helping create intelligent models for the purposes of building information modeling (BIM). This specific stage of the process is called scan-to-BIM, whereby a high-quality point cloud of the site is generated by a 3D laser scanner and fed into the BIM model.

Point clouds are great for documenting existing conditions, because the data takes the form of billions of points of light generated within a three-dimensional frame. When registering these points with the correct reference, they can provide a detailed, precise, and accurate representation of the as-built condition of a site.

In the sections below, we'll cover two projects completed in this manner at historical subway stations by NavVis Mapping Partners Vermessung Schubert in Austria and LevelS3D in France.

Case Study: Gumpendorfer Straße Station in Vienna, Austria

Gumpendorfer Straße station in Vienna, Austria, dates back to 1898. Famous for its curved platforms and structure, passengers and even tourists often stop to admire the historic landmark designed by the famed architect, Otto Wagner.

But while historical buildings often become local attractions, archaic floor plans tend to lose their charm over time. In the case of Gumpendorfer Straße station, the original plans were the paper drawings from 1898. There have been many changes in the intervening century, including a major renovation that took place from 2006-07 to increase station accessibility.

Gumpendorfer Straße is the first of 109 public transport stations across Vienna where floor plans are undergoing extensive updates to introduce a BIM workflow. In the summer of 2018, NavVis Mapping Partner Vermessung Schubert, a surveying company based in Austria, was chosen to pitch to station owner Wiener Linien GmbH & Co KG why they should provide the scanning and BIM services.

To give themselves a competitive edge, they showed the prospective client that they can offer them the next generation of technology for the built environment: reality capture. And when they showed them that the end product would include the NavVis IndoorViewer visualization software, they won the pitch.

How Reality Capture Software Applies to Heritage Scanning

Since adding the NavVis Indoor Mobile Mapping System (IMMS) to its arsenal of surveying tools, the team at Vermessung Schubert has been able to scan large indoor spaces much faster. The IMMS makes it much more efficient to update BIM models for existing buildings.

But the real selling point is that captured building data and creating 3D models are no longer just for BIM users. Potential customers – and custodians of historic buildings – are always delighted to find out that they will get browser-based, virtual access to their premises. They can "walk through" the site from their desktop and use this virtual representation to verify measurements remotely.

For surveyors, reality capture software makes it easier to capture more data without additional effort. The NavVis IMMS is on wheels and automatically captures point clouds, dense imagery, and sensor data as the operator pushes the device through indoor environments.

A Laser Scanning Process That's Fast and Accurate

Of course, there are now multiple reality capture software and hardware solutions on the market. But very few are suitable for being deployed in large indoor environments – that's what sets the NavVis IMMS apart.

A major metropolitan transport hub, for example, is notoriously tricky to capture, with large, open spaces, and long winding tunnels and

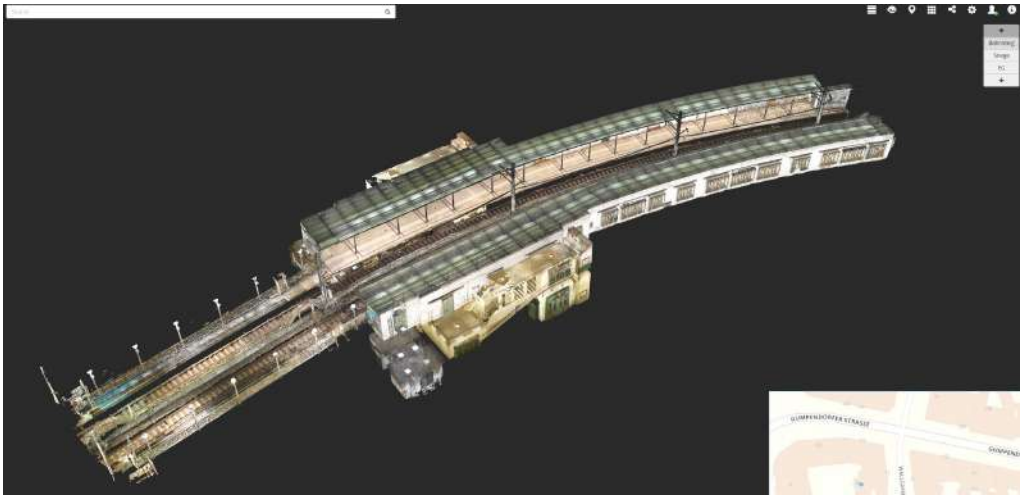

Figure 1: Colored point cloud of the Gumpendorfer Straße Metro Station in Vienna, Austria, captured by NavVis IMMS and displayed in NavVis IndoorViewer.

corridors. And then there's the rush of daily commuters and travelers scurrying to and fro at peak times.

Gumpendorfer Straße Station is a perfect example of this type of complex indoor environment. The team at Vermessung Schubert had to capture open spaces, long platforms, and even the small technical rooms that have kept trains running day after day, week after week, year after year since 1898.

More about the site: Gumpendorfer Straße Station encompasses over 2,000 square meters. Capturing this space with the NavVis IMMS took a little under six hours – half the time it would take using static laser scanners.

At the same time, 46 ground control points (GCPs) were captured by a total station. While this step is not necessary for every situation, GCPs are often used in the surveying industry to increase the accuracy of laser scans. With NavVis technology, these ground control points can accurately position the scan in relation to the real world around it, and to automate dataset alignment.

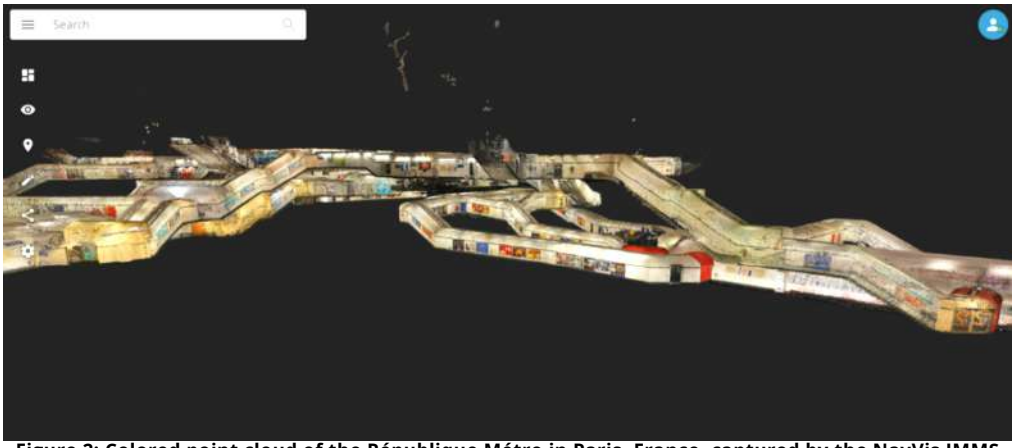

Figure 2: Colored point cloud of the République Métro in Paris, France, captured by the NavVis IMMS and displayed in NavVis IndoorViewer.

Figure 3: Panoramic image of the Gumpendorfer Straße Metro Station in Vienna, Austria, captured by the NavVis IMMS and displayed in NavVis IndoorViewer.

Granular BIM Models with Browser-Based Access

NavVis technology made it possible to quickly capture the data needed to bring a historical European structure to BIM. The client especially approved of the approach to minimize disruption to the passengers and being able to turnaround large indoor spaces much faster. But in the end, it was the addition of the NavVis IndoorViewer that won the pitch for Vermessung Schubert.

In short, BIM serves many useful purposes but is limited to those users who have access to advanced reality capture software and the knowledge of how to use it. The NavVis IndoorViewer democratizes building data by offering access to every stakeholder, making it a valuable addition to every surveyor offering.

Case Study: République Métro in Paris, France

LevelS3D is a French surveying company and NavVis Mapping Partner who took on a unique project with the Régie Autonome des Transports Parisiens (RATP) Group, the state-owned operator of public transport in the city of Paris.

RATP had an issue with water seepage in the République Métro in Paris. To address the problem, they contracted LevelS3D in early 2018 to map the entire station so that maintenance teams could identify sources of water seepage from any location using high-definition 360° imagery and assess its status. The project is the first-ever digitization of a major metro station in the bustling capital.

As Dario Gaudart, Project Manager and BIM Expert at Wiener Linien GmbH & Co KG, explains:

" Having experienced the benefits of designing new construction projects in BIM, we decided to test it in our existing buildings. The NavVis mobile mapping system captured the data needed to create BIM models and provided added value with the browser-based IndoorViewer. With the NavVis IndoorViewer, our building data will no longer be restricted to those team members who know how to use BIM software, which is an excellent starting point for increasing the use cases of digital building technology. "

In short, the goals of the project were to map the République Métro in Paris in its entirety, create an inventory of 360° panoramic images to help identify and assess water seepages, and provide remote access for barrier-free site inspections.

The Bigger the Project, The Bigger the Challenge

The République Métro is not just a site of historical value; it's one of the largest and busiest stations on the RATP network, where five separate subway lines converge beneath the Place de la République. The complex character of such a heavily trafficked venue creates a few challenges for indoor scanning.

Firstly, it's a large, complex area. The République Métro has 12,000 square meters spread out across an extensive system of corridors of varying sizes and shapes, connecting the whole station on multiple levels.

Secondly, the team at LevelS3D had a very narrow time frame for capturing the data. Closing the station for the scanning project wasn't an option; the disruption of services and cost for RATP would have been immense.

Thirdly, there was the matter of safety and security, with multiple security and access constraints for managing the stream of people in and out of the station daily.

Versatile 3D Scanning Equipment for A Complex Environment

LevelS3D was undaunted by the scale of the scanning project, however, because they had a decisive advantage – the NavVis IMMS, capable of fulfilling all the customer requirements regarding data quantity, quality, and time needed.

In preparation for executing the indoor scanning, RATP provided 2D floor plans and guidance so that LevelS3D could cover the whole area in the shortest time possible. The team also conducted a single on-site inspection before commencing work.

Figure 4: The République Métro in Paris, France captured by the NavVis IMMS and presented as an immersive 360° walkthrough in NavVis IndoorViewer.

The On-Site Scanning Process with The NavVis IMMS

On the first day, the mobility and versatility of the NavVis IMMS allowed for a smooth scanning process throughout the whole station. Thanks to the ability to adjust the device's height and width, features like uneven ramps and narrow spaces weren't an obstacle to cause any delays.

The scanning process took place over two nights, while the station was closed, between the hours of 1 am and 5 am. That's a tiny window of four hours per night. The allotted time proved to be more than enough, however, since the NavVis IMMS can scan up to 30,000 square meters per day.

How is this possible? Every NavVis IMMS has four laser scanners which gather point cloud data, plus six cameras that simultaneously capture high-resolution images of the surroundings. In effect, LevelS3D was able to quickly and reliably capture all the data from the République Métro without incurring any expensive setbacks.

Delivering One Project, Enabling Multiple Use Cases

From RATP's perspective, the project upgraded its ongoing maintenance responsibilities at République Métro. Using the NavVis IndoorViewer, they can assess the condition of the tunnels quickly and more efficiently, and make faster decisions, all while having access to a single source of information on which they can collaborate and share insights.

According to Véronique Harroch, RATP Project Manager: "As a project manager, this tool allows me to have a 3D picture of the station from the beginning of the project. It has the advantage of being searchable anywhere, any time, by all project stakeholders."

Moreover, the project is already enabling other use cases for various departments of the RATP Group, including maintenance activity monitoring and the possibility of BIM modeling for other stations.

According to LevelS3D, the project counts as a significant success for the company. Their value proposition – powered by NavVis technology – secured a cornerstone project with a client operating multiple public transport stations and associated facilities throughout France. And most importantly, it's paved the way towards more large-scale scanning projects on a nationwide basis.

Wrapping Up

What these two case studies make abundantly clear is that scan-to-BIM is an incredibly valuable technique to create as-built documentation, which forms the most accurate basis from which to carry out renovation, maintenance, or restoration works of a heritage site. And once the initial project is complete, this data can be stored and retrieved for future use or fed into subsequent BIM models. As further advancements in mobile mapping technology come to market, the scan-to-BIM workflow will become faster, more accurate, and more reliable while overcoming the specific and unique challenges posed by a historical site. Not every heritage site is going to be a static monument; preserving their use as functional infrastructure in the present day is a tremendous and perhaps even noble application for 3D laser scanning.

About

NavVis was founded in 2013 to bridge the gap between outdoor and indoor digital maps. NavVis has developed 3D scanning hardware , the NavVis Indoor Mobile Mapping System, and 3D visualization software, NavVis IndoorViewer, which serve as the core technologies for seamlessly implementing and operating digital twins. Headquartered in Munich with offices in New York and Shanghai, NavVis currently employs 200 people around the world.

Vermessung Schubert offers surveying, 3D mapping, 3D laser scanning, BIM 3D modelling based on Revit or ARCHICAD, 2D floorplans, 2D intersections, 2D building faces, all together combined as basic input of general planning and facility management tools over the building life cycle.

LevelS3D is a start-up founded in September 2012 by Yannick Folliard, with a focus on 3D digitization applications and augmented reality. LevelS3D is developing a scan3D application for next-generation tablets and smartphones, equipped with a sensor depth (compatible equipment). This application is designed for building stakeholders and more particularly design offices, architects, general contractors and space fitters.

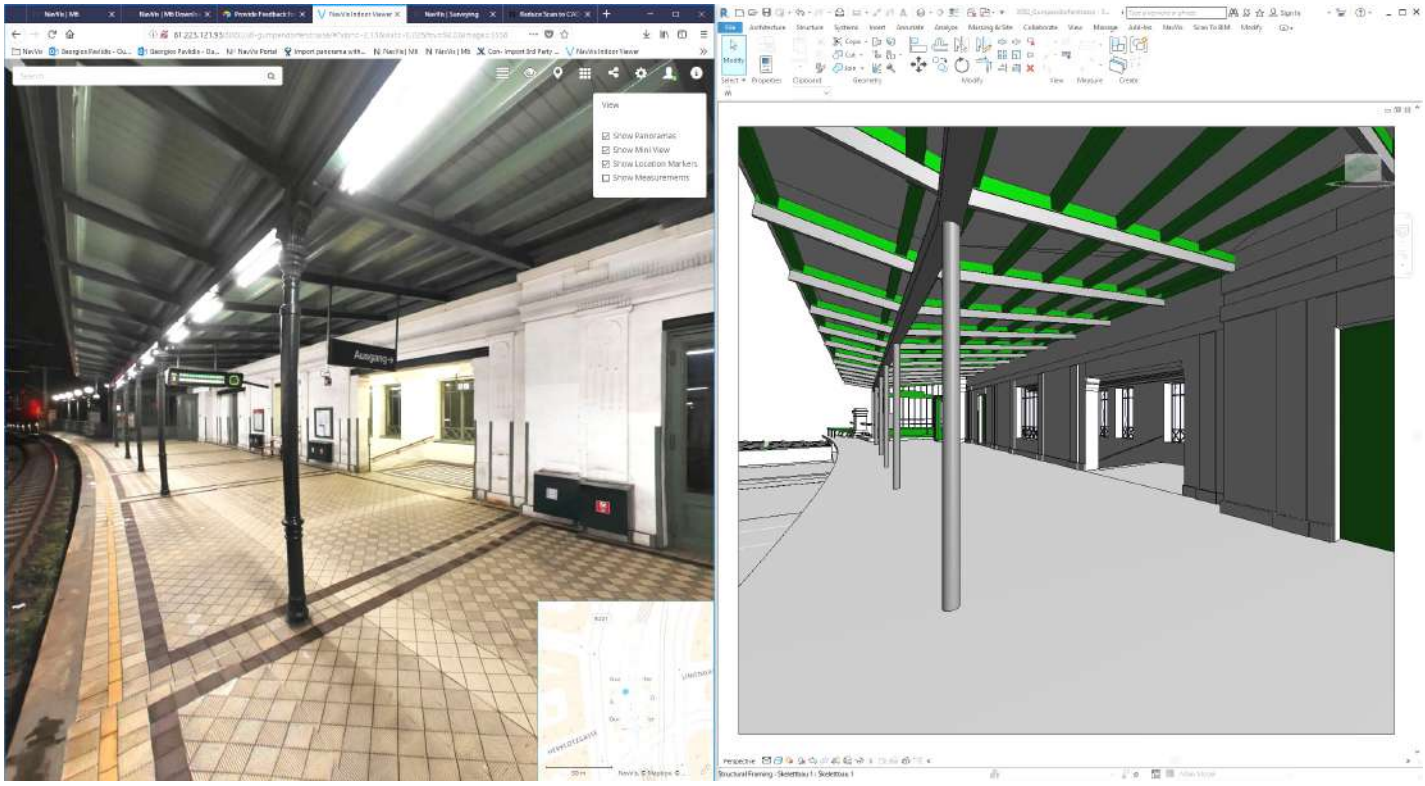

Figure 5: The République Métro in Paris, France captured by the NavVis IMMS and presented as an immersive 360° walkthrough in NavVis IndoorViewer.