Saving **San Sebastian Basilica**

FROM POINTS TO THE UNDERSTANDING OF THE BUILDING

A brief history

In the Philippines, a small group has begun taking steps towards saving cultural heritage sites. The conservator Tina Paterno and her team have taken on the project of restoring one of the most historic churches in the country, the San Sebastian Basilica. It's rich history and unique qualities have inspired these people to work hard in the hopes of saving the only all steel church in Asia before it succumbs to further decay.

San Sebastian Basilica was originally built in the 1600s. Made of wood, the church burned down in 1651 and the succeeding structures, which were built of brick, were destroyed by fire and earthquakes in 1859, 1863, and 1880. Distraught, the Parish Priest Estebán Martínez, sought help from a Spanish architect Genario Palacios to create a structure that would not fall victim to the disasters they so often faced. Palacios worked with the help of Belgian contractors to create a design of an all steel Neo-gothic style church that was both fire and earthquake resistant. Parts of the church were then manufactured in Belgium, and were later shipped to the Philippines. Although the parts were ordered from Europe, local artists added finishing touches to the basilica by adorning its whole interior with paintings.

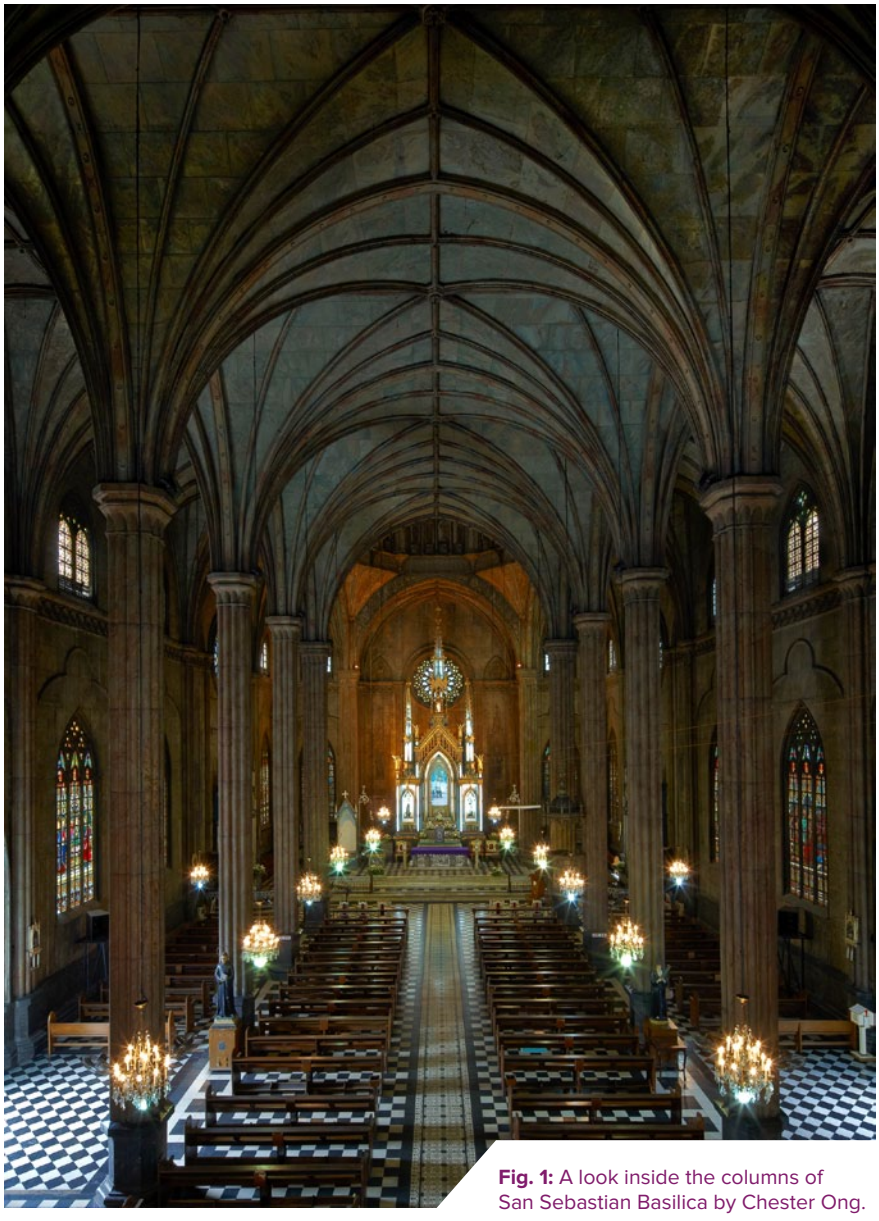

Fig. 1: A look inside the columns of San Sebastian Basilica by Chester Ong.

BY LOURDES G. **CEREZUELA**, DIGISCRIPT PHILIPPINES INC.

Today, it is a miracle that this church is still standing. According to Paterno, the church is suffering massive corrosion and rusting due to living conditions in Manila. Holes and flooding have been recently discovered in the steel columns that serve as the foundations of the whole structure. Further studies and extensive analysis are in process to ensure that all damage to the Basilica is recognized and may later be addressed. However, a major setback to this project is the lack of blueprints and records that can serve as a map towards restoring the Basilica (see Fig. 1).

Reconciling the modern world with our past

Given the delicate state of the steel church, data gathering is half the battle. Therefore, it is important that the group finds the right tools to aid them in their work. This is where technology steps in. Since manual labor would be extremely arduous, dangerous, and almost impossible, Paterno and her team have sought help from DigiScript Philippines for their laser scanning services.

As a leader in 3D building technology solutions, DigiScript volunteered its expertise in the field of laser scanning to the San Sebastian Church in order to help with their heritage documentation program. Working alongside other technical experts and consultants in this project, DigiScript laser scanning point cloud deliverables have proved to be invaluable to the project.

The data that DigiScript's services have provided has played an essential part in the restoration of the San Sebastian Basilica. Prior to meeting DigiScript, some surveys were already conducted but were found to be inaccurate and incomplete since many areas were not accessible and difficult to capture. DigiScript laser scanning helped in making these measurements more precise. The project team also identified critical areas to be scanned, such as areas with known misalignment or where major deterioration was visible.

Each scan location was methodically placed to make sure that inaccessible areas of the church were also captured. With strict control measures and the industry best practices workflow, DigiScript was able to complete the scanning and survey of the entire Basilica in 4 days with a total of 85 scans that were registered together to create one complete 3D point cloud model that is now the basis for all the further studies by the other professional consultants. The 3D point cloud serves as a guide for the team to identify numerous deficiencies in the building that would have otherwise not been visible without it (see Fig. 2).

DigiScript's laser scanning services have been a great help in the preservation project of San Sebastian Basilica and can be further utilized in numerous other fields and applications. It is a strong tool to have and may shape the way our society sets its standards with regards to infrastructure, agriculture, architecture, and much more. With this technological advancement readily available in the Philippines, and with the rich culture behind the country, it may be easier for us to continue in these efforts and move towards preserving our past now, and for the benefit of our future.

From points to alignments and movements

Lourdes G. Cerezuela also volunteered on the project to conserve San Sebastian Basilica. Her work at the church will help her to gain an understanding of the current state of the

Fig. 2: Leica C10 scanning the interior of San Sebastian Basilica.

church by utilizing the point cloud data obtained from the DigiScript efforts, and to share her knowledge with the rest of the team to help them in their future projects within the country. This will create a database of valuable and important information and drawings for both future studies of the building and restoration projects. She applied different techniques that she has acquired over recent years to help with understanding of the building.

Usually the scan data is used to create high accuracy CAD drawings of the building, but in this case the team already had architects who had made the survey in a traditional way. To take advantage of their work, they have been provided with high-quality orthoimages to superimpose over their drawings. This way the architects can see where errors or movement have occurred and provide any needed corrections.

In Europe there is a well-known and widely used method to create photoplans for preservation projects. However, in countries like the Philippines, among many others including the United States, this technique is still not put into practice, either due to unfamiliarity or lack of training. Photoplans are primarily for the building's internal and external facades. To create them it is necessary to superimpose the orthoimages from the point cloud data with the CAD drawings and the photograph parts like a puzzle.

All the pictures have been taken with a reflex camera and each shot provides an adequate overlap area with the contiguous one and were taken maintaining the angle of incidence as perpendicular as possible to the surface in order to minimize distortions of perspective. All the areas where it was not possible to take pictures and/or occupied by non-significant elements have been integrated with a neutral color. Estan Cabigas was the photographer who took the high quality pictures to help with this method.

Fig. 3: External photoplan of the main access to the church.

In order to create the photoplans, the orthoimages are extracted from Cyclone software in .tiff files with the same orientation as the facades. Simultaneously, CAD drawings are created also from

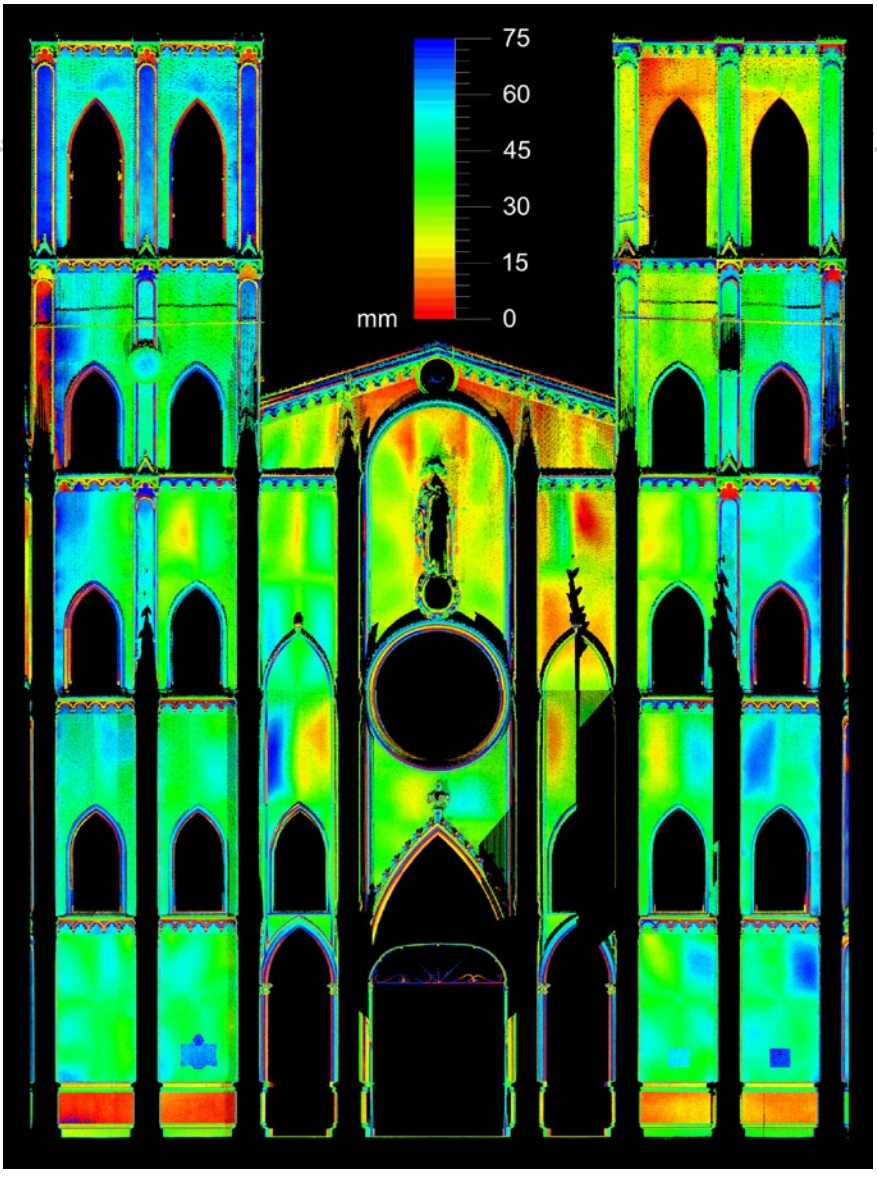

Fig. 4: Forensic mapping study of an internal façade surface.

the point cloud data with the plug-in Cloudworx in AutoCAD. Then each photograph was rectified using one of many computer software programs currently on the market, such as Photoshop, manipulating them to move the pixels to the accurate position.

Photoplans derived from high quality digital photographs will provide a record of color, materials, texture, degradation and the current state of conservation of a building or structure, a valuable tool when planning for restoration or providing a detailed record of a landmark. Fortunately, the cameras integrated into the scanners are improving and it will not be long until this meticulous, drawn-out and manual process will be done automatically and with high accuracy (see Fig. 3).

Bulging exterior columns are manifested in the misalignments of cornices. The alignments of a building are very difficult to measure properly. For this reason, the structural engineers have been provided with a misalignments plan that shows constant angles from the vertical to the columns and from the horizontal to the cornices. With these angles, generic height from the original design and basic trigonometric functions they will be able to calculate the exact displacements of the columns and cornices.

The main part of the project consists of the surface mapping. By leveraging information obtained from the dense 3D surface data of a laser scan, topographic maps can be created of linear surfaces. These forensic studies clearly illustrate deviations from horizontal and vertical planes. With this information we can quickly identify problem areas and the extent of surface movement that the wind loads or settlement have caused to the surfaces of the church. It is particularly important to this project because movement of component parts of the building has resulted in the deformation of wall, columns and ceiling panels. This method can reveal causal mechanisms for this condition and help the structural engineers to confirm if their suspicions about the warping of wall panels are due primarily to seismic tremors (see Fig. 4).

The last method of analysis consists of slicing the external and internal walls, floors, ceilings and external columns. Unfortunately, this method cannot be applied to nonlinear surfaces, such as curved, spherical or parabolic. The topographic maps are colored and each color is a slice of 3mm of thickness. The number of colors chosen has varied depending on the size of the area to study. For columns and small areas 16 colors have been chosen, whereas for the big areas it can be up to 32 colors. In the columns we found the presence of "oil canning", a waviness in flat metal areas of roofing and siding panels that usually originates from the steel mill. It is an

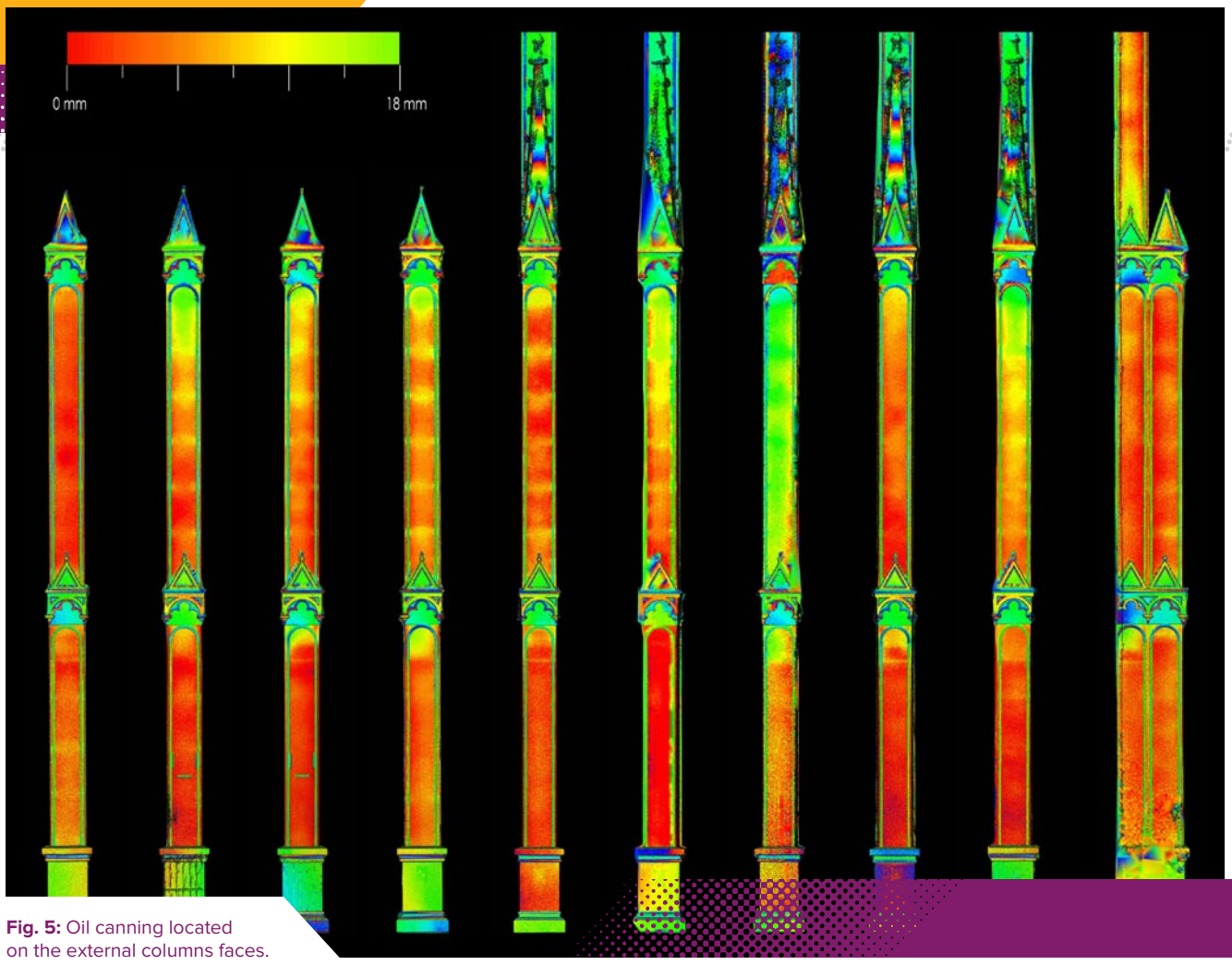

Fig. 5: Oil canning located on the external columns faces.

aesthetic problem and normally structural integrity is not affected. However, structural integrity must be reviewed if the distortion results from an extreme external influence. Waviness has been located in the second level of the front faces of 10 columns and also in the lateral faces of 2 columns (see Fig. 5).

Until recently, normal practice has been to use only this latter method as the way to extract relevant data from the point cloud for use in both architectural and preservation studies. However, as an architect herself, Lourdes G. Cerezuela believes that it is possible to gain more practical information from the point cloud, not just the usual high accuracy surveys and visualizations. For her Master's thesis she plans to create a simplified mesh of the Church's central dome that will allow her to generate a structural grid based on the scanned point cloud, enabling the current deformations of the building to be viewed.

Architects are usually at the forefront of building restoration work. For this reason it is important to develop new, more practical applications from the current tools and technology, allowing a deeper understanding of a building's behavior and ultimately leading to a more adept restoration.

Project data info:

Foundation: San Sebastian Basilica Conservation and Development Inc.
Architect: Lourdes G. Cerezuela
Scanning Services: DigiScript Philippines Inc.
Scanner: Leica C10

Lourdes G. Cerezuela is a young Spanish Architect specializing in Heritage Preservation using 3D laser scanning, studying and working around the world. After completing her education in Spain, she joined an archeological mission in Syria, and then continued on various projects in the UK, Italy, and Armenia. Following an internship in the first half of the year with a NYC based Architect and Laser Scan Company she traveled to the Philippines. Currently she is studying for two Master's Degrees related to her specialization in order to continue her research with this technology.

DigiScript Philippines Inc.
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