Close-range Photogrammetry Project - Architectural Restoration of an Ontario Hydro Building

A Project report by Frank Artés

Close-range photogrammetry has for a long time, been recognized by most European countries as a standard tool when undertaking architectural restoration projects. Centuries of architectural history have left a wealth of buildings and various structures that are now a valuable resource in understanding a nation's heritage. Structural and cosmetic maintenance is an on-going process for many government organizations, and the use of photogrammetry is a given in this type of work.

The accuracy of photogrammetry is the key, and when combined with a digital data set and a photographic record, is found to be a remarkable source of information.

Marshall Macklin Monaghan Limited recently undertook such a project to supply accurate digital information to the architectural community. An extensive restoration process was planned for a 98 year old building located in Niagara Falls. It was to be refurbished as a gaming casino, a far cry from its days as part of the great power generating company that was to become Ontario Hydro.

The Building

The building is a four-storey structure located in Niagara Falls, Ontario, and one of many owned by Ontario Hydro as part of their hydro-electric operation.

Erected in 1904, it was built in the Georgian Revival style made popular during the early 20th century, and follows a symmetrical design of a large central entrance, with a window-over-window pattern on successive floors.

It is located on an eight-acre parcel of land that was once owned by the Michigan Central Railway. As the former Niagara District and Regional Office, it is constructed primarily of brick and stone, and affords a fine view of both the Canadian and American Falls. It houses office space and machine shops, with underground communication and electric cables to the Niagara transformer station.

Fine detailing is restricted to the moulding around the large portico windows, which flank the central structure, the segmented transom above the main doors, and the parapet, all of which are constructed using carved stone. A copper monitor on the roof is composed of lattice-work panels and cornice moulding on the crown. Ornate metal railings over selected windows are also evident.

Client Requirements

The Client had requested a three-dimensional digital record of the front face of the building to a 5mm XYZ positional accuracy.

Specific data requirements included the identification of all building materials used, the location of all past repair work and major surface deterioration.

An orthophoto of the building with a vector data overlay was also required.

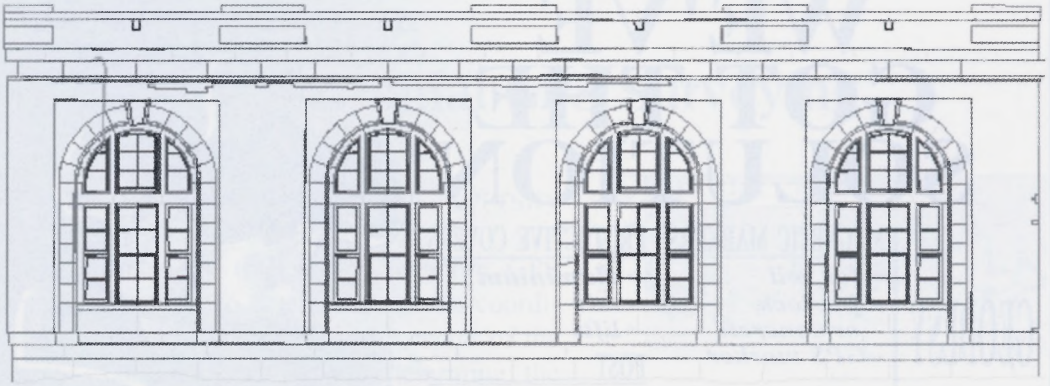
Planning the Project

In order to meet the client's requirements a detailed plan was set in place to maximize equipment use and in-house expertise in the time available to complete the project. Other factors taken into consideration were weather conditions and the time of day that the photography would be taken, bearing in mind shadows and obscured areas on the building itself.

It was decided to use targeted, full model control, using total station survey methodology. It would provide redundant control stations in a detailed analysis of the photogrammetric accuracy. The targets would be attached to the face of the building. Photography would be taken with a tripod-mounted medium-format metric camera.

The building is approximately 20 metres high and would require two lines of stereo photography to ensure complete coverage. To meet the 5mm accuracy requirement, a photo scale of 1:200 was chosen for the first line of

photography. This would take in the foundation level to the top of the parapet wall. The second line of photography would be at a scale of 1:100, and cover the top floor and monitor, which are set back five plus metres from the face of the building.



It was decided to use a cherry picker as the camera platform, elevated 10 metres above ground level, to take the first line of photography. By positioning the camera at this location relief displacement in the images would be minimized. The second line of photography would be taken from the parapet level, as close to the parapet edge as possible.

The mean base/height ratio for the camera stations was determined and approximate number of exposures calculated. It was decided to use a diapositive-type film (Kodak Professional Ektachrome E100S), to aid in data collection using an analytical stereoplotter, and to satisfy the orthophoto requirement to be carried out on a softcopy photogrammetric system.

On site

The first task undertaken on site was to position the control network on the face of the building, which consisted of approximately 200 plus targets. Once the target placement was completed the Total Station locations were determined and the control network data was recorded. It had been estimated that approximately 320 images would be required to obtain complete coverage of the front face and side panels of the building. Some close-up photographs were necessary to capture the fine detail of the window moulding and decoration around the main doors.

Adopting a simulated flight line approach, the camera stations were run parallel to the face of the building, using the cherry picker at two-thirds its maximum height. A 40mm camera lens allowed an optimum field of view to ensure that the required number of targets-per-model was achieved.

The second line of photography was a little more challenging, being taken from the roof level. However, careful positioning of the camera to avoid roof vents, cabling and drainage-gutters was key in obtaining the required coverage.

When dealing with multiple lines of photography, multiple exposures, and camera locations that might have to be revisited, on-site record keeping could not be over emphasized, and proved an important factor in the overall success of the project.

Data Capture

With the on-site photography and control portions of the project completed, the final stage called for a detailed photographic analysis of the building to identify the client's requirement of damage and repair location, structural material used, and specific architectural detail recorded. This was carried out on a Wild BC-2 analytical photogrammetric stereoplotter, to generate a three-dimensional vector data set.

The orthorectified photographic image was produced using an ISM softcopy photogrammetric system, using digital image files scanned at 25 microns, which offered the best resolution-to-file-size ratio.

Summary

Close-range photogrammetry proved to be the most accurate and cost-effective approach in supplying the client with the required digital information. Other methods were considered by the client, such as reflectorless total station technology, but were found to be too costly and time consuming for this particular project.

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