Charleston Photogrammetry

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On September 23, 1989, the residents of Charleston, SC, were faced with the aftermath of Hurricane Hugo. The damage to buildings as a result of Hugo was severe. None of the historic structures around the Battery was totally destroyed, as was the case with other structures in the city. However, if a building had been lost, those without adequate documentation could not have been accurately reconstructed. Although the recovery from the storm is now almost complete, many believe that there is much more work to be done. Connie Wyrick, the director of programs and development of the Historic Charleston Foundation, defines total recovery from Hurricane Hugo as "adequate preparation for a similar occurrence." In order to be adequately prepared, the members of the Historic Charleston Foundation believed that baseline documentation was necessary for the buildings that were most susceptible to catastrophic loss. HABS has been operating by the principle of "preservation through documentation" since its inception in 1933. Given the needs of the Historic Charleston Foundation and the services that HABS and HAER provide, a natural partnership was formed.

HABS, in cooperation with the Historic Charleston Foundation, undertook a documentation project of the Battery. The project was initiated in the summer of 1992 to produce a photogrammetric and photographic record of the streetscapes along the South and East Battery in Charleston. These homes are considered the most vulnerable of the city's historic resources. This documentation is intended to provide a baseline documentation for catastrophic replacement.

Photogrammetric documentation was chosen because it is the most cost effective way of rapidly collecting data for a large number of structures, enabling the recording team to photographically document 26 houses in 8 days, working an average of 8 to 10 hours per day. The photographic images will be archived until scaled drawings are needed, at which time the graphic information can be digitized into CAD drawings using AutoCAD and PhotoCAD software and a digitizing table.

The photogrammetric camera system consists of the Linhof Metrika 45 with two lenses, a 90mm and a 150mm. It is a specialized camera that was manufactured in Germany and is the first of its kind to be used in the United States. The 90mm lens is a wide angle; the 150mm, a normal focal length. Because of the project requirements, only the 90mm lens was used for the Charleston photogrammetry project. The Metrika is a semi-metric camera that produces 4"x 5" negatives on 5" roll film. A glass plate with a reseau grid (a pattern of cross hairs) is pressed against the film by a vacuum at the moment of exposure so that the grid is superimposed on the negative. The optical characteristics of the lenses and reseau grids are measured and entered into the program data so that the optical distortions in the camera do not compromise the accuracy of measurements taken from the photographs.

No. 34 South Battery, Charleston, SC. The photos illustrated give an example of the two different types of houses photographed 1) #34 South Battery represents a simple facade with a minimum amount of foliage compared to 2) #29 East Battery which was complex and foliage was a major factor that had to be considered when photographing. Please note the reseau grid (a pattern of cross hairs) superimposed on the photo image, the black and white Xerox targets placed randomly on the structure, and the different camera stations used. Photo by Jet Lowe, 1992, HABS.

The digitizing software used by HABS is

No. 29 East Battery, Charleston, SC. Photo by Jet Lowe, 1992, HABS.

published by Desktop Photogrammetry and is used in conjunction with our AutoCAD Release 11 software package. It is important to note that there are two photogrammetry programs published by Desktop Photogrammetry, PhotoCAD-Single and PhotoCAD-Multi. PhotoCAD-Multi is used for three-dimensional measurements and was, therefore, used to aid in the Charleston Photogrammetry project. Four main components are critical to the process and must be considered: (1) camera specifications such as camera calibrated focal length; (2) known horizontal node points and a dimension which must be visible in all of the photographic shots; (3) a minimum of three camera stations, usually left of center, center, and right of center; and (4) the angle of view between the camera stations must be greater than 10 degrees in order for the program to orient the images properly. The software takes at least one known dimension which must be visible in common among all photographic views, in conjunction with other common points, and uses mathematical algorithm to locate the known points in three-dimensional space. Once the three-dimensional model is established and verified other points can be digitized and measured from the photographs and a CAD drawing can be produced. To establish common points, targets can be placed on the structure in random locations prior to photography which reduces the chance of inaccuracy. The targets we use are Xerox black and white targets with a bulls eye located in the center which enhances digitizing capabilities.

The modus operandi for field work was to establish two datum points at a known horizontal distance and place random targets on the remainder of the house or in the field of view as common reference points to aid in the digitizing process. The datum points that were placed on each facade had to be carefully measured, as this was the most critical component within our survey control data. The survey control data (field notes), used as reference information, includes datum point locations, measurements, and different camera stations. One of the initial challenges that we were presented with was accessibility to the structures to place targets that were necessary for the digitizing phase of the photogrammetric process. The targets were placed either by the use of a ladder when safely accessible or by entering the houses to place targets on balconies and windows. Although placing the targets was a relatively simple process, access to the structures presented some scheduling problems, as many of the homeowners, for various reasons, were unavailable and we were unable to proceed with photographing their homes. However, throughout the eight days most accessibility problems were resolved without causing much delay.

Although the facades can usually be photographed from a minimum of 3 camera stations, the complexity of some of the facades required that we photograph them from 4-10 stations in order to ensure adequate coverage. In photographing a structure, many natural and man-made obstacles present limitations on obtaining the clear, clean images needed for the photogrammetry process. Those obstacles, combined with the relative complexity of the architecture, dictated the number of view station points and angles needed to adequately document a facade. Foliage and automobiles were the two major obstacles with which we had to contend. In these instances it was common that the amount of angles and view points would double or triple in order to ensure adequate coverage. One of the most beneficial techniques we employed was to use a “cherry picker” to shoot aerial views of the facades, which removed most of the foliage and showed the roof and upper portion of the facades in greater detail. Sun location and the weather also dictated

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our progress. We were very fortunate that we were able to photograph during all eight days we were in Charleston; only one day was partially interrupted due to rain. We did have to develop a strategy to take advantage of the different lighting conditions during the day. We had to shoot the facades along East Battery in the morning to take advantage of the rising sun, and we shot the facades along South Battery later to take advantage of the afternoon and evening sun.

Photogrammetry does have some inherent limitations when it is applied to architectural documentation. First, unlike a "typical" HABS / HAER project in which a complete structure is hand-measured, creating extensive field notes which can be used to verify accuracy, photogrammetry has minimal amounts of field notes in which to verify accuracy. Second, during the film developing and digitizing processes there is a potential for inaccuracies and distortions to occur. Third, you are only documenting what the camera sees. This could result in incomplete documentation, and makes documenting floor plans and structural systems difficult or impractical.

Although there are some limitations inherent in photogrammetry, there are many benefits in using this method of documentation. First, it has the ability to record a large complex of buildings in a relatively short period of time. Second, it can postpone the cost of developing scaled drawings until funding becomes available or drawings become necessary. Third, at the very minimum, it provides photographic records in a uniform format.

When considering photogrammetry as a possible method of documentation, a judgment has to be made as to whether the benefits of saving time and money outweigh the potential inaccuracies of plotting a photographic image. In the case of the Charleston Battery project, because of its scope, it was easily determined that photogrammetry was the most efficient method of documentation. If HABS / HAER had hand-measured all 26 facades, which is the "traditional" method of gathering field data, it might have taken a team of 10 members more than 3 months to collect the necessary data. Using the photogrammetric process, a team of four members, including the photographer, took eight days to gather the data necessary for photogrammetry.

The appropriateness of the photogrammetric process must be evaluated on a case-by-case basis. In addition to cost, the possible dangers of hand-measuring in a given case should be a factor in deciding whether to use photogrammetry. With developments of technology and computer software rapidly improving, applications of photogrammetry will probably increase until it becomes the preferred method of documentation.

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