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Using Computer-Generated Images at Fort Davis National Historic Site

Fort Davis National Historic Site contains a number of adobe wall ruins that are slowly eroding back to the earth. This is true despite past preservation techniques, such as epoxy spraying and the addition of soil cement adobe caps and veneers. The National Park Service identified this widespread problem in the Vanishing Treasures Initiative. This initiative seeks to secure federal funds to implement a 10-year program to improve the preservation of prehistoric and historic ruins in 41 national parks located in six states.

The current method of identifying erosion occurring to adobe walls at Fort Davis is by annual inspections carried out by the park's maintenance staff. This inspection method relies on the qualitative assessment of the individual inspector. Quantitative information is not provided; therefore, accurate comparisons cannot be made on the condition of the wall from year to year. In order to analyze the condition of an adobe wall ruin effectively on a consistent basis, the amount of erosion occurring to the adobe over time has to be measured and quantified. The issues addressed in this paper are a methodology for measuring the amount of erosion and the representation of the erosion using computer-generated images.

The Measuring Technique

In June 1993 and August 1997, the North wall of the Forage House (HB39) was measured to obtain the Cartesian X, Y, and Z coordinates for points on the adobe surface of the wall. Depth measurements were taken at six-inch vertical and horizontal centers to produce a six-inch square grid representing the surface of each side of the wall. Notes were made if the measurement was to bare adobe, stabilized block or veneer, or to cement mortar patching. Simple measurement equipment and techniques were used such as horizontal level lines, vertical plumb lines, and rulers for the measurement of depth offsets.

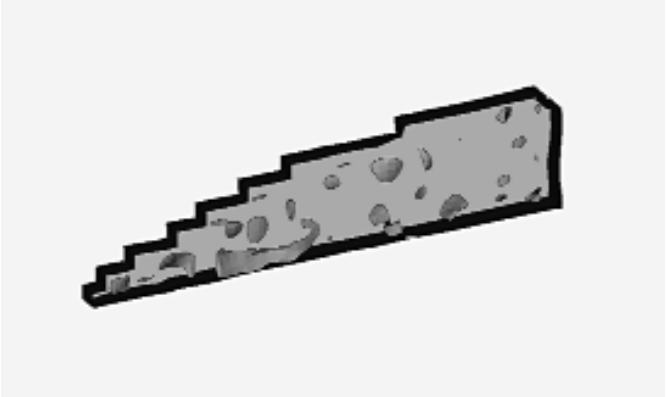
The initial intention was to use the measurements to quantify and represent the total volumetric loss for the whole wall over a four-year period and the amount of erosion occurring to each side of the wall on a point-by-point basis over a four-year period. There is, however, a problem with the calculation of the erosion on a point-by-point basis: the measurement method relies on the use of temporary datum lines established from points on the wall. The depth measurements relied on a datum line established from points on the top of the wall. An apparent outward lean to the wall was noted and this caused a difference between the position of the 1993 and 1997 datum lines. This anomaly caused the depth measurements to be erroneous. This finding meant that the amount of erosion occurring on each side of the wall on a point-by-point basis is not capable of quantification. The total volumetric loss of the wall is not, however, affected by this finding. A point-by-point comparison is made to illustrate a method to model erosion, even though there is concern about the reliability of the depth measurements.

Three-dimensional Images

A three-dimensional image of the adobe core of the wall is produced using AutoCAD® Release 13 by linking together several 3D meshes, with each mesh representing part of the surface of the wall. Each mesh is created using the Cartesian

Left, three-dimensional model of erosion greater than one-inch.

Right, three-dimensional solid model of the wall.



Forage House, Fort Davis National Historic Site (north elevation, north wall).

Images by the author.

coordinates for points on the surface of the wall. To avoid having to enter each point individually, script files are created for each mesh based on the coordinate data from Excel® spreadsheets. This method reduces both drawing time and the risk of incorrectly entered coordinates. The 3D meshes, when placed together, produce a wire frame of the adobe core of the wall. This wire frame is then rendered to produce a 3D image of the wall. AutoCAD® does not identify this set of meshes as a solid model from which mass properties can be obtained; data about the volume of the wall could not be obtained by using AutoCAD® alone.

Three-dimensional Solid Modeling

In order to obtain data about the volume of the wall, computer-generated three-dimensional solid models of the wall measured in 1993 and 1997 are constructed. These models are produced using AutoCAD's Mechanical Desktop®. The process for creating the models occurs in the following stages: (1) create lofted surfaces for the internal and external surfaces of a section of the wall using the X, Y, and Z Coordinates; (2) use the lofted surfaces for the internal and external surfaces to cut an AutoCAD® solid box to produce a solid model of part of the wall; and, (3) join all the solid sections of the wall together to produce a three-dimensional solid model.

A similar process is used to create a three-dimensional solid model of the erosion occurring to various depths. This is done by substituting the internal and external surfaces in the second stage of the process, for the external surfaces measured in 1993 and 1997 or the internal surfaces measured in 1997. By moving the 1993 surfaces by the depth of erosion required in the Z direction and repeating the process above, 3D solid models of the erosion occurring over a four-year period are obtained. The computer image shows erosion of greater than one inch to the external side; the top, bottom, and ends of the wall have been included for identification purposes. It is important to remember that some of the depth measurements are erroneous and are used to show how erosion can be three-dimensionally modeled.

Mass Properties of the Wall

AutoCAD® now recognizes the model as being solid. The mass properties command is used to obtain data about the volume of the wall. This is a summary of the results of this analysis: volume of 1993 wall equals 62,876 cubic inches; volume of 1997 wall equals 58,444 cubic inches; volumetric loss equals 4,432 cubic inches; and volumetric loss equals 7.05%. The two exposed surfaces equal 14,256 square inches. Average loss of width equals 0.62 inches over the 4-year period.

Condusion

By obtaining the Cartesian coordinates of the surface of an eroded adobe wall, various three-dimensional graphical representations of the wall are produced using AutoCAD®. By using the AutoCAD® extension, a desktop computer produces solid models of the wall. These models are analyzed to provide data about the volume of the wall. By comparing models of the wall measured at different time intervals, the quantity and percentage of erosion are calculated. This data provides those charged with preserving these ruins with valuable information on which to make decisions about future preservation strategies. The problem of measurement still remains. Ongoing research at Texas A&M University's Historic Resources Imaging Laboratory is aimed at finding an economic and non-intrusive method for measuring adobe wall ruins in order to quantify the amount of erosion occurring over specific time periods using total station surveying together with computer-rectified photogrammetry.

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