*The Validity of Stereophotogrammetry in Volume Determination**

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ABSTRACT: *In order to ascertain the validity of the photogrammetric technique for volume determination, calculations of a basketball were made photogrammetrically, geometrically, and by water displacement. The photogrammetric results were within three per cent of those obtained by other methods.*

THE volume determination of such items as coal, ore, and pulpwood piles is frequently accomplished through photogrammetry, and some work has been done in measuring the amounts removed, as in gravel pits and open pit mines. Although aerial survey organizations engaged in this type of activity will admit to errors of less than four per cent, little information concerning the validity of the technique is available. Young has demonstrated that for sections of pulpwood piles, photogrammetry is more reliable than ground transit methods, and Hallert and Fagerholm have reported errors of 0.5 to 1.0 per cent to total volume in coal pile inventories at the Vienna Gas Works in Austria (8, 2).

Validity is the extent to which a device measures what it purports to measure, and is determined by the correlation of the test measurement and the "true" criterion measurement (1, 5). In ascertaining the validity of photogrammetry for volume determination, the test object should be one for which the volume could be computed by a number of methods. A closer approximation of "true" volume can be made from multiple criteria. In the present study a basketball[1] was selected as the most practical test object and the devices selected for volume measurement were photogrammetry, geometry, and water displacement.

As a test object, a basketball is subject to the following limitations: (1) it is not a perfect sphere; (2) the surface is not smooth; and (3) its exact diameter is not easily determined. Because of the previously mentioned accuracy claims, it was assumed that the sum of the errors would amount to no more than four per cent of the total volume. Errors of less than four per cent between the photogrammetric calculation and geometric or water displacement calculations would justify acceptance of the technique employed.

The ball was so placed that it projected half-way through a panel. Horizontal control was effected by drawing ten-inch lines on the panel near the ball; wooden pegs projecting one-quarter, one-half, and one inch from the surface of the board served as vertical-control. Maximum image-size could be achieved only with a two-model procedure because of the "drop" at the sides of the ball. A photo image of 1.9 inches (Figure 1) was compiled at a scale of 1:1, resulting in a finished "map" with a mean diameter of 9.406 inches (Figure 2). When measured with calipers at three different points, the mean diameter of the ball itself was 9.44 inches—a difference of less than one-half of one per cent from the map diameter. Contour intervals of one, one-half, one-quarter, and one-eighth inch were compiled on the Stereocartograph Model IV, and the mean of five planimeter readings for each contour was used in the computations. The decreasing size of the interval was felt to be necessary because of the "slope" of the ball.

The method described by Wild was used to calculate the volume of the contoured hemisphere. (7) This value was then doubled to obtain total volume. This volume of the basketball, as photogrammetrically determined, was 430.10 cubic inches, Geometric

[1] Courtesy of Michigan State University Athletic Department.

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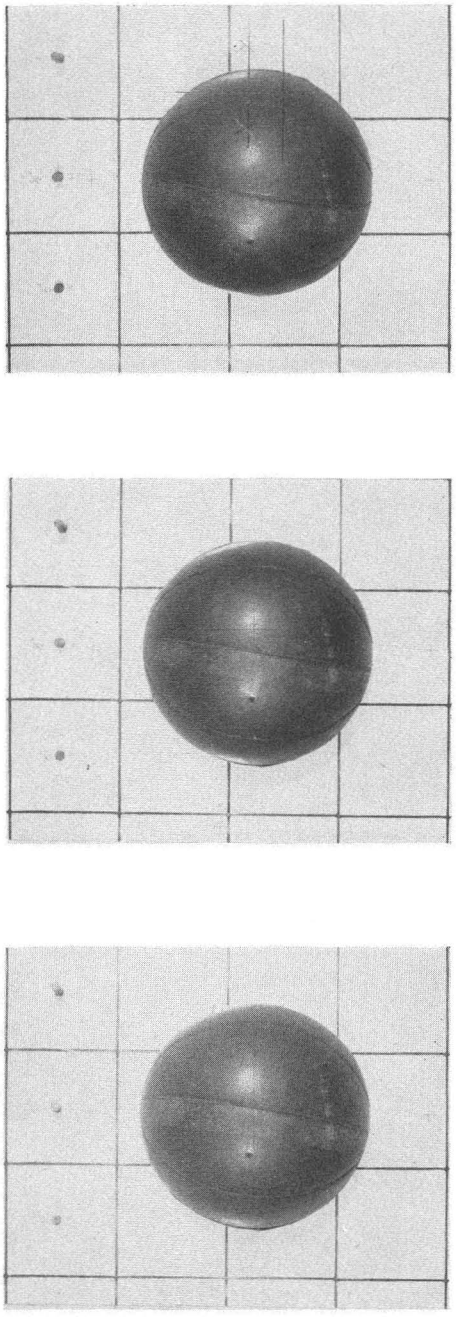

FIG. 1. Stereo triplet horizontal and vertical control.

calculations were based on the mean di ameter of the ball itself and the mean diameter of the contoured representation. These calculations, of 440.49 and 435.75 cubic inches respectively, resulted in errors of 2.35 and 1.29 per cent when compared with total volume as calculated photogrammetrically. When compared with the volume computed by water displacement (435 cubic inches), the photogrammetric method yielded an error of 1.2 per cent.

The contours of the basketball were not circumscribed with compasses, and it is logical to assume that an experienced operator will maintain accuracy regardless of the shape of the feature to be compiled. The results of the present study indicate that photogrammetry is a valid technique for volume determination, and that errors of considerably less than three per cent can be anticipated.

The possibilities of using photogrammetry to calculate human body volume have been mentioned by Pierson and Hertzberg et. al. (6), (3). This technique would circumvent many of the disadvantages of the water immersion method (e.g. fear of water on the part of the subject and length of time under water required for accurate readings). It has the further advantage that the volume for segments of the body can be determined, making possible more accurate physiological and nutritional studies.

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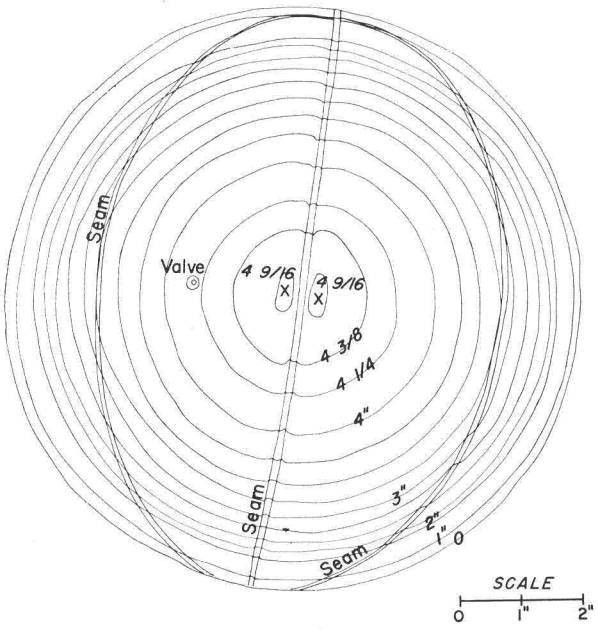

FIG. 2. Photogrammetric "map" of a basketball.

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*Airphoto Analysis of Terrain for Highway Location Studies in Maine**

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INTRODUCTION

THE Airphoto Interpretation Project at the University of Maine is financed jointly by the Maine State Highway Commission and the U. S. Bureau of Public Roads. The function of this project is to provide information on soils, drainage and other natural and cultural features which might be useful in all phases of highway engineering from preliminary planning to construction operations.

Engineering soils, drainage and materials maps have been prepared for an area of approximately 3,500 square miles. These maps were prepared by quadrangles, an area of approximately 200 square miles, at a scale of 2 inches equals 1 mile. Precedence was given to the areas where the most construction was anticipated. These maps are especially useful in the preliminary planning phases of location studies and the preparation of cost estimates.

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