On the Orientation of Pyramids

by

OTTO NEUGEBAUER *

The remarkable accuracy of the orientation of the Great Pyramid has led to a number of suggestions concerning the methods on which the determination of the cardinal directions could have been achieved. All astronomically based theories, however, face serious difficulties, e.g. that there is no bright star exactly at the celestial pole, or that rising and setting amplitudes suffer from the poorly defined positions of the observer (as well as other practical difficulties). It is therefore perhaps permissible to suggest as a possible method a procedure which combines greatest simplicity with high accuracy, without astronomical theory whatsoever beyond the primitive experience of symmetry of shadows in the course of one day. In short, one can use the shadow of a pyramid as an excellent instrument for orientation.

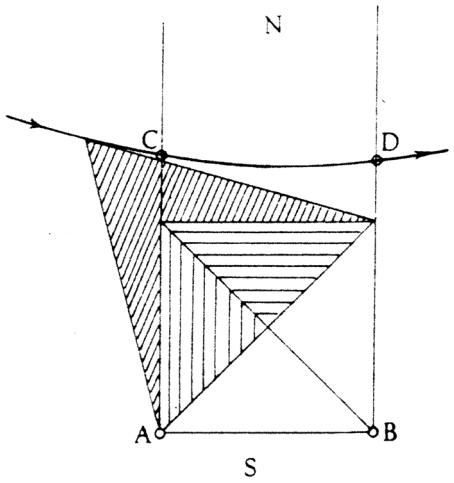

Fig. 1

* History of Mathematics Department, Brown University, Box 1900. Providence, Rhode Isl. 02912, U.S.A.

Centaurus 1980: Vol. 24: pp 1-3

All one has to do is to place an accurately shaped pyramidal block (e.g. the capstone of the pyramid under construction) on the accurately leveled ground which will eventually carry the monument. Let the square base be oriented according to a reasonably accurate estimate of the SN/EW directions.[1] Then one observes the path of the shadow cast by the apex of the pyramid from some time before noon to some time after noon. This path describes a curve (which we no know to be a branch of a hyperbola, concave toward North in the winter half of the year, concave toward South in the summer, a strait line at the equinoxes, which will intersect first the western, then the eastern base of the pyramid or a straight continuation in a northerly direction (cf. Fig. 1). If these points of intersection are at different distances from, e.g., the south corners (AC and BD respectively, then the orientation is not yet correct. A slight turn of the base and repeated observation on the next day will improve the situation.

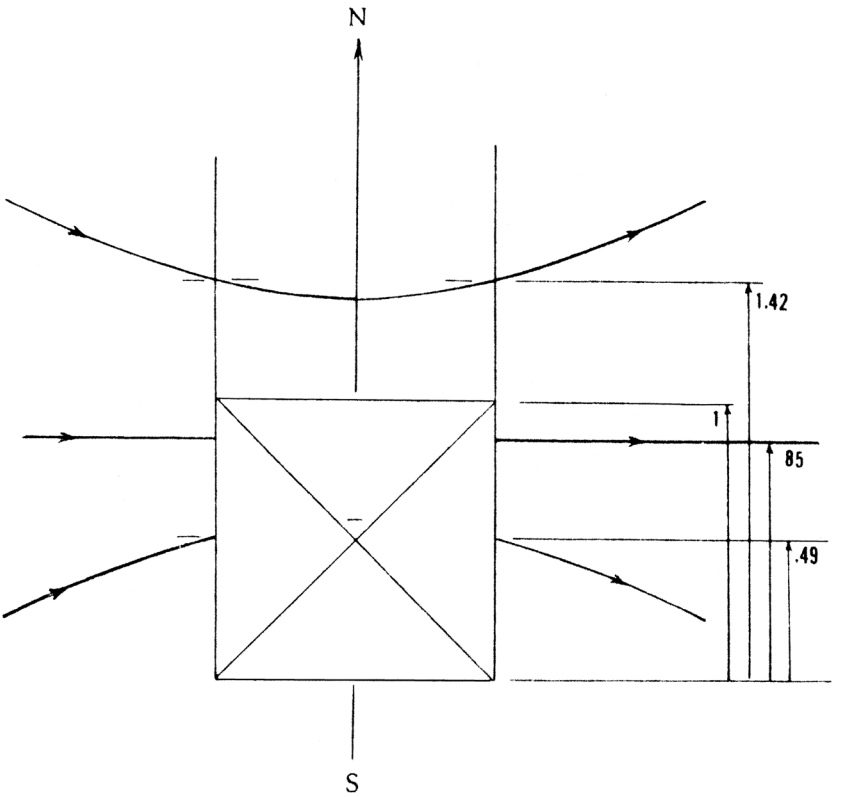

Fig. 2

Not only can these processes be repeated many times until high stability is reached but by waiting some weeks one utilizes different tracks and thus in effect averages small errors of individual observations. For example, observations scattered over half a year would lead to a neat set of mid-points between the two parallel base sides providing the desired SN direction, valid for any structure erected on the same ground. Figure 2 gives a scale drawing of the range of shadow curves available at Memphis, assuming a slope of 52° for the faces of the pyramid. But the method in no way depends on these specific data. For example, any accurately shaped pyramidal model can be used as "gnomon".

NOTE

1. This preliminary orientation toward north may well be carried out ceremoniously by the king, looking at the northern constellations. Such rituals imply nothing for the technicalities of the actual construction, not to mention that the accurate determination of the north celestial pole by means of naked eye observations of the Big Dipper is a problem at least as difficult as the orientation on the ground.