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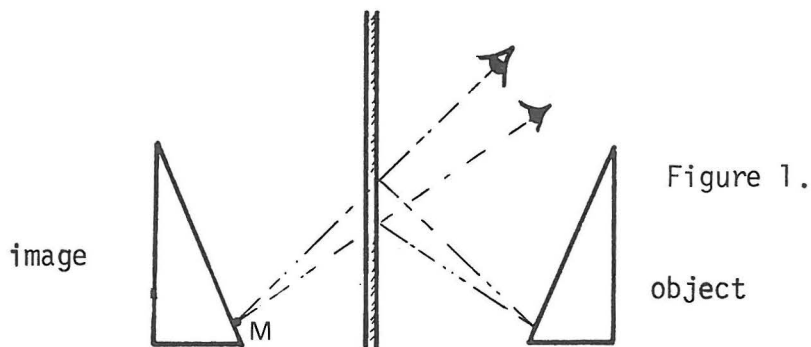
THE REFLEX PLOTTER: A PLOTTER WITHOUT PHOTOGRAPHS

Abstract

A plotter is described which is capable of plotting or taking measurements from a reflection of a small object, such as an archaeological find or an anatomical specimen. The plotter requires no photographs, it is relatively cheap and an unskilled operator requires only minutes to learn how to use it.

The principle of the Reflex Plotter

There is a growing need for three-dimensional measurement and shape determination in archaeology, orthodontics and anatomy. Most of the objects to be measured are less than 0.3 m in maximum dimension and the Reflex Plotter is able to plot using the reflection of the object in a semi-reflecting mirror. A measuring mark capable of three-dimensional movement can be seen through the mirror, and is brought into contact with the reflection using the observer's binocular vision. As seen in Figure 1, the image is situated behind the mirror, and is stationary in space. The measuring mark M can now be moved along outlines or contours, and its three-dimensional movement can be recorded digitally or it can be plotted as a plan with heights.



Some design details

The mirror is shown vertical in Figure 1, and in that position the rear of the object's reflection cannot be seen. The mirror mount allows the mirror to rotate about a horizontal axis through  $45^\circ$  as seen in Figure 2. In the  $45^\circ$  position, the observer's head is positioned over the image and a better view is obtained for contouring. The mirror's attitude can be set to give the most suitable view of the object.

The mirror itself is a semi-reflecting film on a sheet of glass. The glass must be fairly thick to remain flat, since any warping of the mirror deforms the image. An identical sheet of glass in front of the semi-reflecting surface is necessary, since without it the ray from the measuring mark

would be refracted through the glass and the reflected ray from the object would not be refracted at all. The operator would then see the mark appear to move off the object as he moved his head. The front glass ensures that both mark and object rays must traverse two thicknesses of glass to reach the observer's eye. Both are now refracted equally and remain coincident when the head is moved.

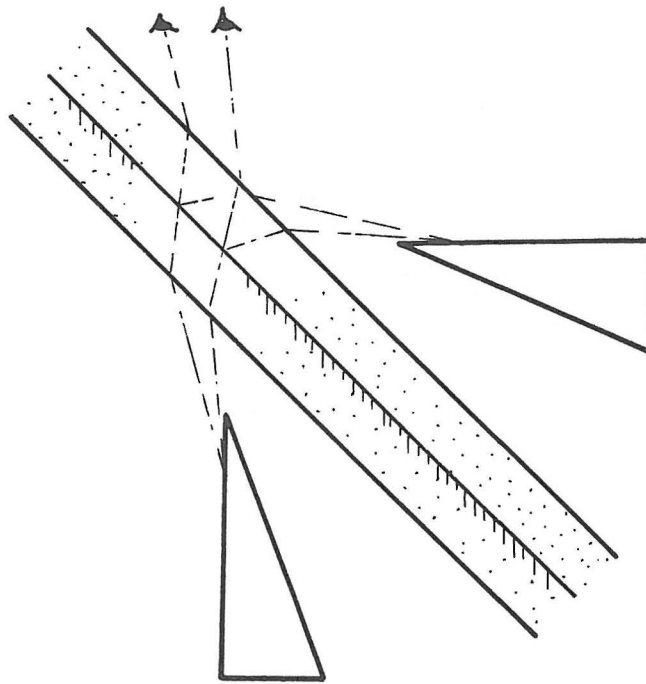


Figure 2.

The mirror mount is also capable of rotation about two fixed, orthogonal horizontal axes, shown in Figure 3. When the mount is rotated about one of these axes, the image will appear to rotate about the same axis (and through twice the angle). The image can thus be levelled with respect to the plotter's datum.

The accuracy of the instrument has been assessed by repeated readings onto a well-defined point in the image. When viewing from vertically above the image as in Figure 2, the height co-ordinate corresponds to stereoscopic depth. A typical set of readings indicates a spread of 0.3mm in height and less in plan. If necessary, the accuracy can be increased by using binocular magnifiers (worn as spectacles) which allow for viewing at 100 mm distance from the reflection. This gives a base: distance ratio of about 1:1,7 for the average viewer. Alternatively, periscope prisms could be used to enlarge the eye base.

### Conclusion

The plotter requires no photographs. There is no need for relative orientation, and the absolute scale of measurement is exactly 1:1. A plot can thus be produced in an extremely short time. Perhaps the greatest advantage is that an unskilled operator can learn to use the instrument in a few minutes, and this in turn means that he no longer relies on a photogrammetrist to interpret the detail to be plotted.

The instrument has been developed by H.F. Ross, Downton, Wiltshire, to whom all enquiries should be directed.

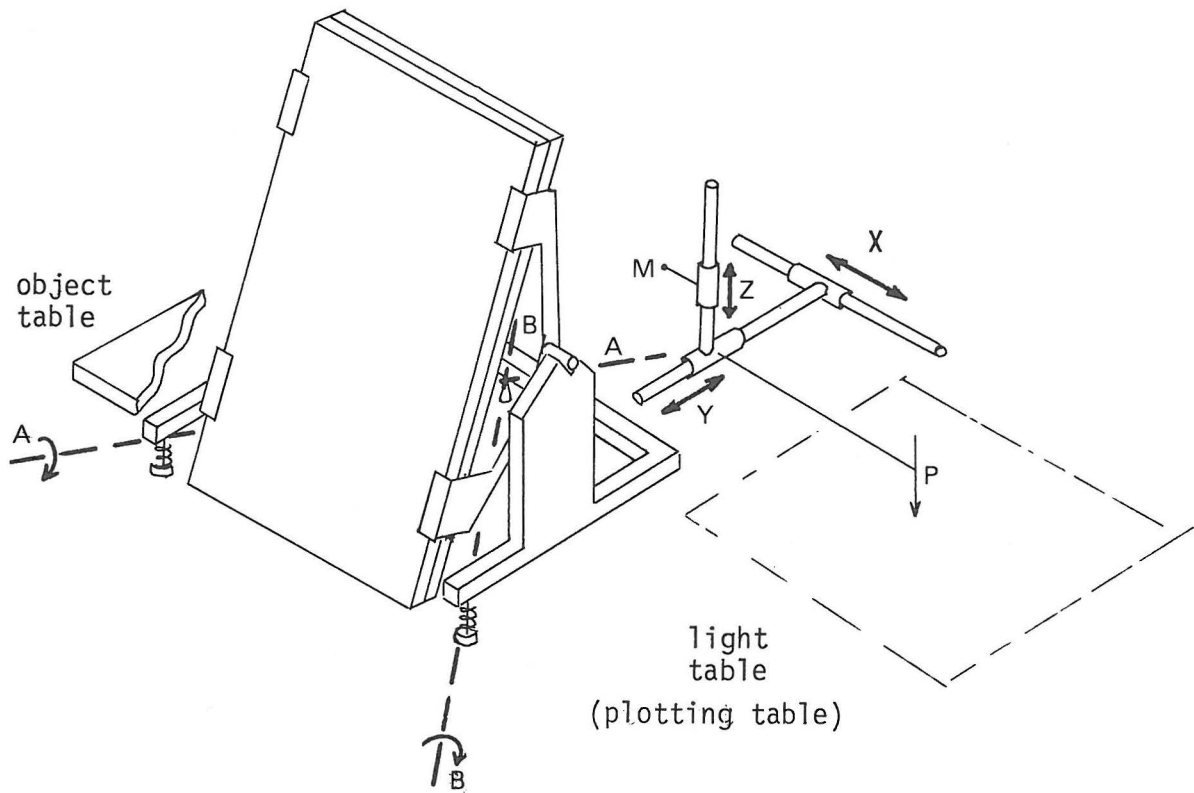


Figure 3. The mirror mount can be rotated about the two axes A-A and B-B. The measuring mark M is carried on a digitised X-Y-Z slide system. A plotting point P follows the X-Y movement of M, and can be used for direct plotting. Alternatively, a microscope can be inserted at P and the X-Y digitisers can be used to obtain two dimensional co-ordinates from a photograph or map laid on the plotting table.