PHOTOGRAMMETRY

BY A BEGINNER

BY

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The word Photogrammetry does not yet appear in standard dictionaries, although the technique has been practised in the survey field for more than a hundred years. The following are some notes on a layman's investigation into the use of this practice for the preparation of geometric drawings for ship-building within the MOD(N).

Terrestial (geometric) Photogrammetry is the technique of producing three-dimensional drawings from stereoscopic photographs. In the survey world it has long been recognized as a method of accurately plotting survey maps from aerial photographs and for years, it seems, contour lines have been added

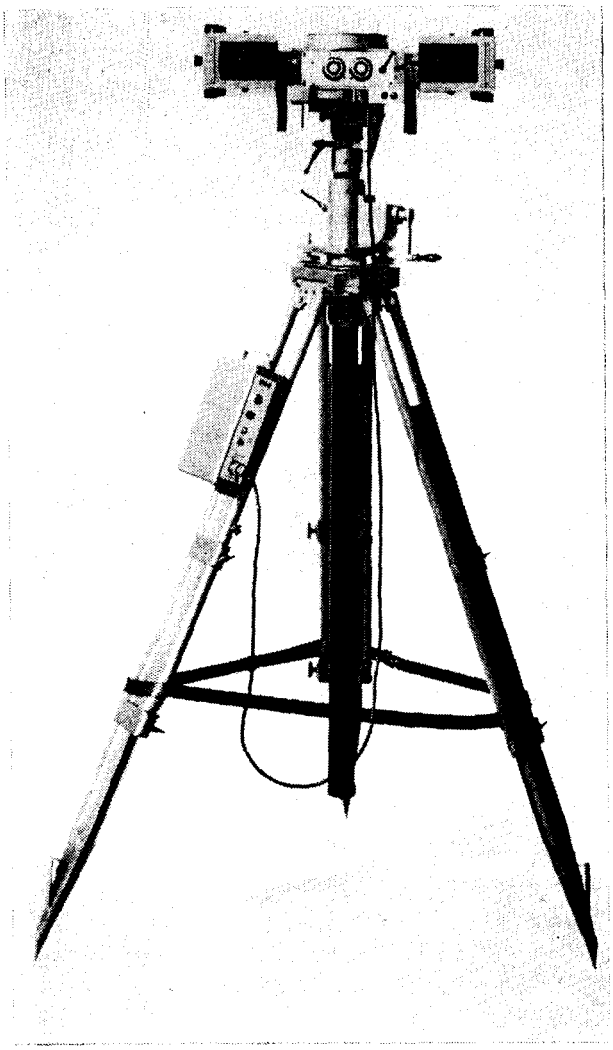


FIG. 1—WIDE ANGLE STEREOSCOPIC CAMERA

without full realization that this was the third dimension similar to X, Y and Z planes in geometric drawing. It also appears that there is so much scope in the survey world that the incentive to branch out into the geometric field has not attracted much attention.

Terrestial photogrammetric machinery is only produced seriously by a few firms, the main ones being German, Swiss and Italian. Although there are firms in Britain offering a photogrammetric service, no equipment is produced in this country; there is, however, some news of the impending appearance of a 'Japanese copy'. The possibility of using this technique for naval application is being evaluated by Portsmouth Dockyard with, to date, extremely encouraging results.

The equipment consists of two basic items: the cameras and the plotters. The cameras are precision instruments and are used to take stereoscopic pictures of the subject to be drawn. Very generally the types of camera fall into three categories:

(*i*) Stereoscopic cameras in fixed mountings 400 mm apart with range of 1·5 – 10 metres

(*ii*) Similar to (*i*) but in fixed mountings 1200 mm apart with range of 5 – 30 metres

(*iii*) Single camera used stereoscopically in two positions to suit the subject with range of 3·6 metres to infinity.

The plotter is, in fact, a computer which solves the optical formulae for measurements within stereoscopic pictures and converts the results to a drawn picture in plans and elevations on a plotting table. The stereoscopic pictures have to be set up in the plotter to the camera particulars and fixed data so that they can be viewed through binoculars, usual magnification 6 to 1, as an enlarged three-dimensional picture. Selection of the scale for the drawing is an automatic procedure. The drawing is made by following the 3-D picture with a measuring mark (a micro-light or black spot) in the normal geometric planes X, Y and Z. Travel control of the light or dot in each plane is by two handwheels and one foot-wheel. Following the three-dimensional image in the plotter results in plans and elevations, as selected, being drawn on the plotting table. Refinements can be added to these plotters to give digital plots of the subjects in numerical

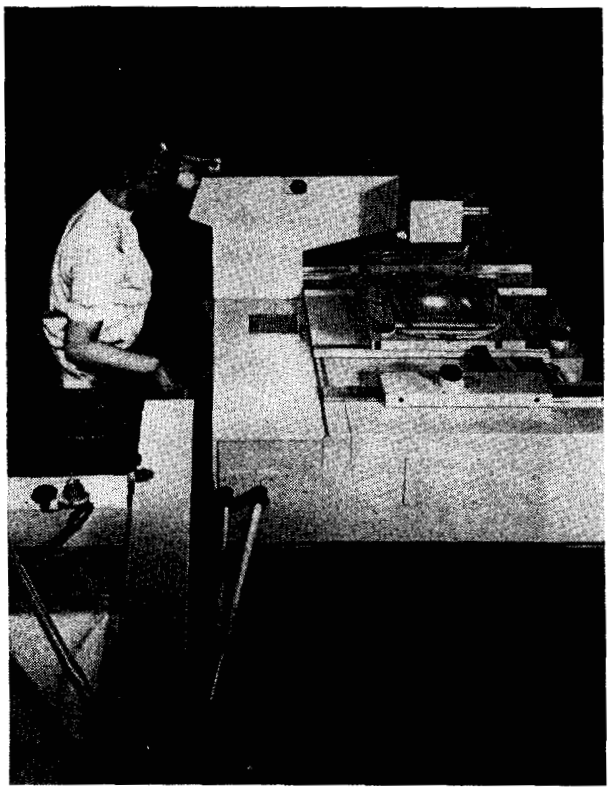


FIG. 2—PLOTTER

form, either on punched tape, punched cards or magnetic tape.

Investigations at Portsmouth have been kept as simple as possible while giving attention to photogrammetry of congested or confined areas. So far demonstrations have been made with the following:

(*a*) Habitability Mock-up
(*b*) 'B' Lock Caisson
(*c*) Stern and after quarters of H.M.S. *Victory*.

Habitability Mock-up

Two firms used the habitability mock-up for demonstration. The part of the mock-up used is a 12-bunk space with a mirror, electrical switch and a folding table fixed to the bulkhead; the space between bunks is 2 ft 6 in. and access for the camera is at the end of a bunk space in the small passage-way. Photographs were taken by both firms in 20 to 30

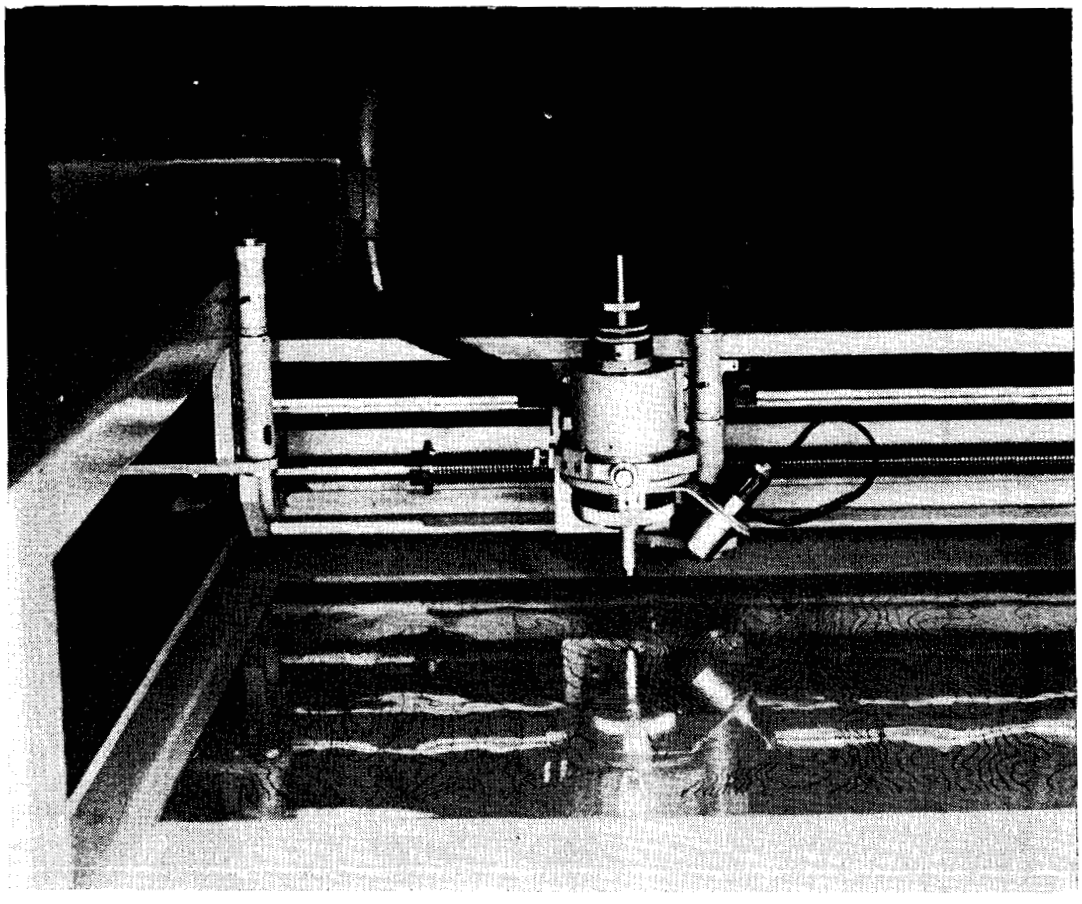


FIG. 3—PLOTTING HEAD

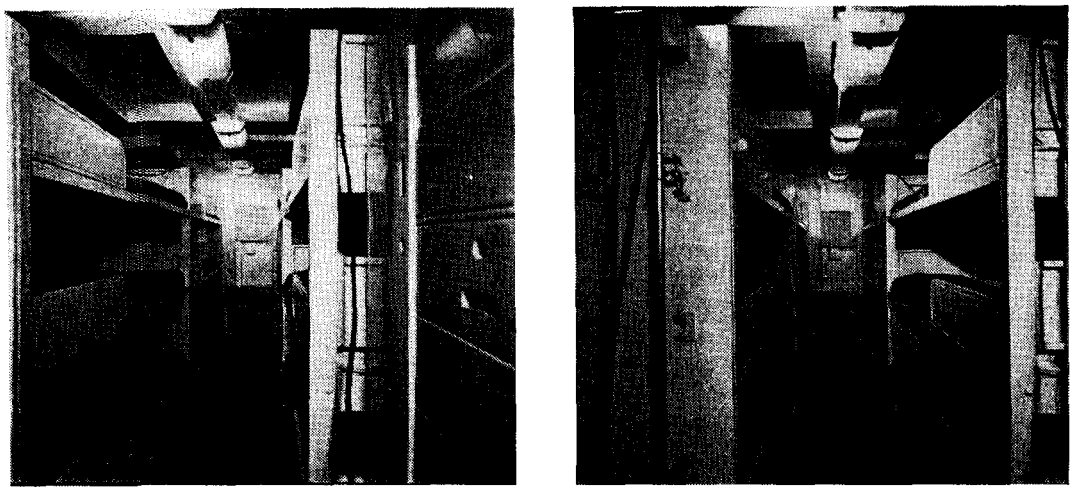
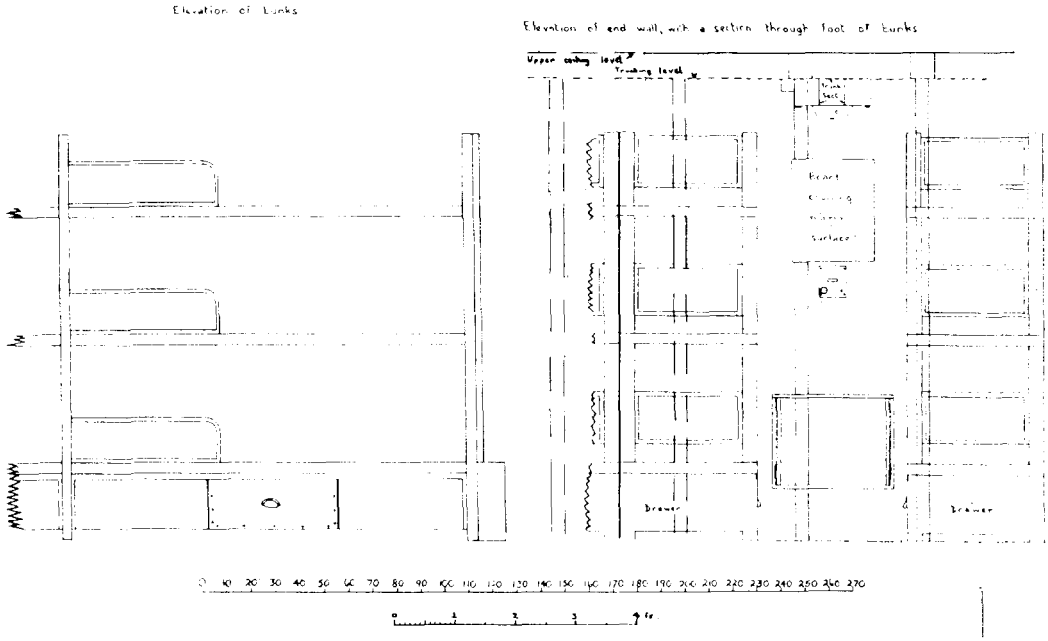


FIG. 4—HABITABILITY MOCK-UP—STEREOSCOPIC PHOTOGRAPHS



Dimensions from wall to face of:			
Mirror	6·00 in.		
Electricity box	3·38 in.	Bunk section (right)	6·44 in.
Upper section of mirror	4·89 in.	Table edge	24·93 in.
Bunk section (left)	7·46 in.	Table base edge	6·67 in.

FIG. 5—HABITABILITY MOCK-UP—DRAWINGS

minutes and from these were produced elevations of the bunks and bulkheads and plans of the ceiling lights and ventilation ducting and of the floor. The drawings were produced in one day by survey draughtsmen who had little knowledge of geometric drawing and had not seen the subject. On one firm's drawings, accuracies were such that the face of the switch from the bulkhead was quoted as 3·38 in. (actual $3\frac{3}{8}$ in.), the rivets on drawers were shown not to be equally pitched ($\frac{1}{8}$ in. difference) and tiles were shown correctly as $11\frac{7}{8}$ in. square and not 12 in. as often loosely quoted. The other firm's drawings had a few operator faults but, in general, dimensions were within the same sort of tolerances. The 400 mm spaced stereoscopic camera was used by both firms.

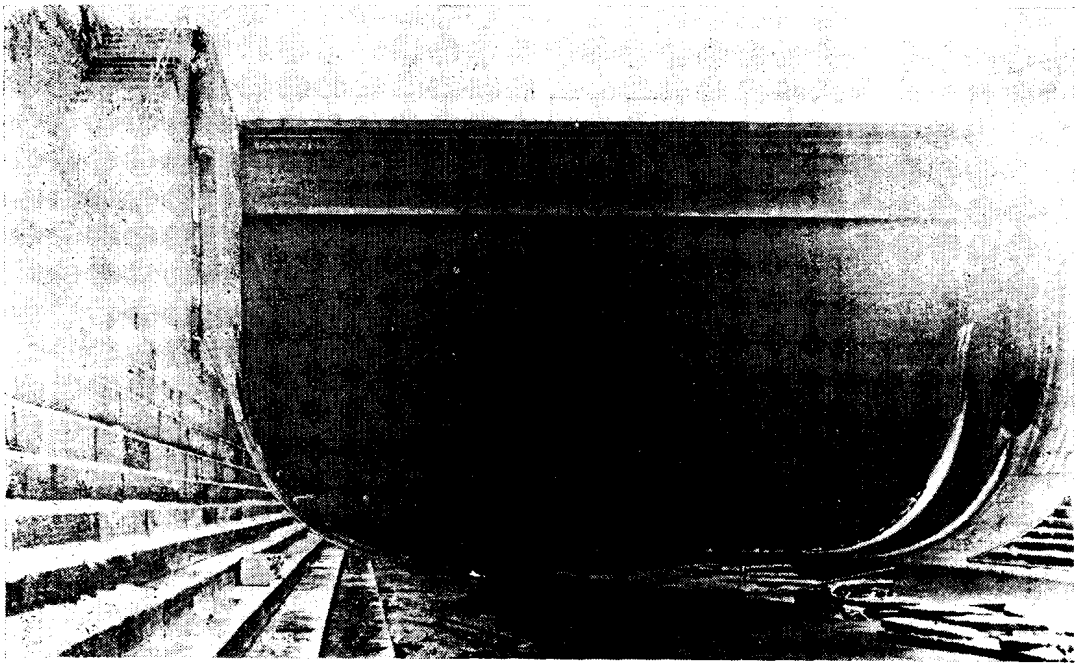


FIG 6—LOCK CAISSON—PHOTOGRAPH

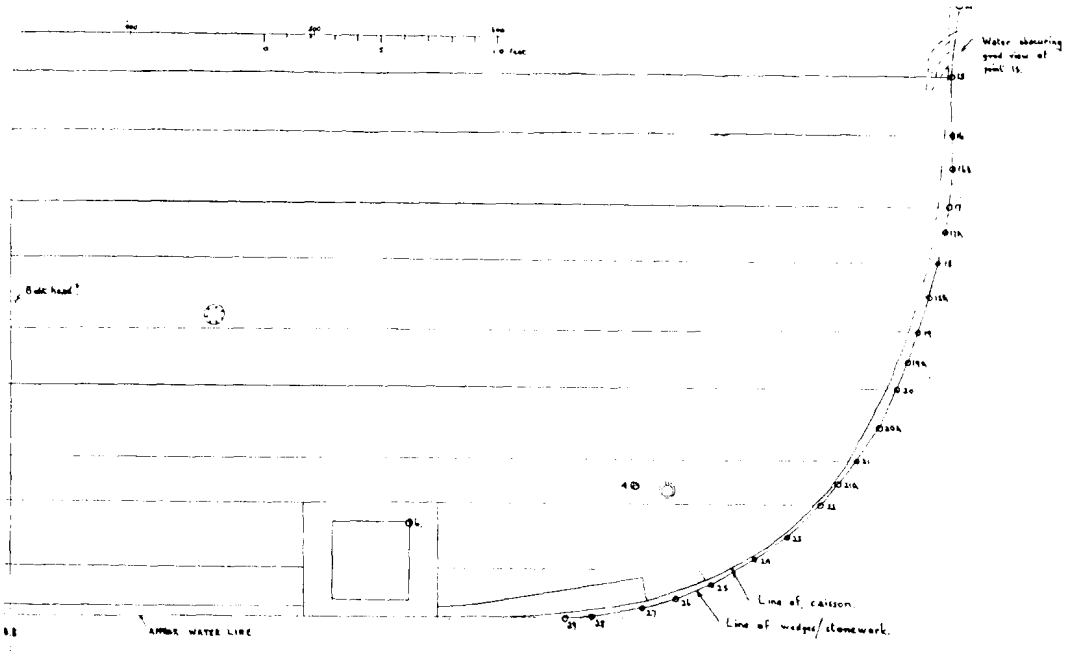


FIG. 7—LOCK CAISSON—DRAWING

'B' Lock Caisson

The 'B' Lock Caisson demonstration was used for a twofold purpose:

(*i*) To demonstrate a longer range camera

(*ii*) The 'B' Lock Caisson is scheduled for eventual renewal and the true shape of the invert is required.

Setting up of the camera (one camera used in two positions) and the photography took one hour; plotting of the invert also took one hour. In addition the invert was rolled by draughtsmen in the usual manner employed for measuring such jobs and the two drawings were superimposed. The photogrammetric drawing exactly matched the rolled drawing except where the line was obscured by a large water leak. Again, the operator did not see the subject and plotted only from photographs, and, when the correct line (under water) was pointed out, he plotted the corrected shape with no trouble at all. The rolling and plotting by draughtsmen took ten days.

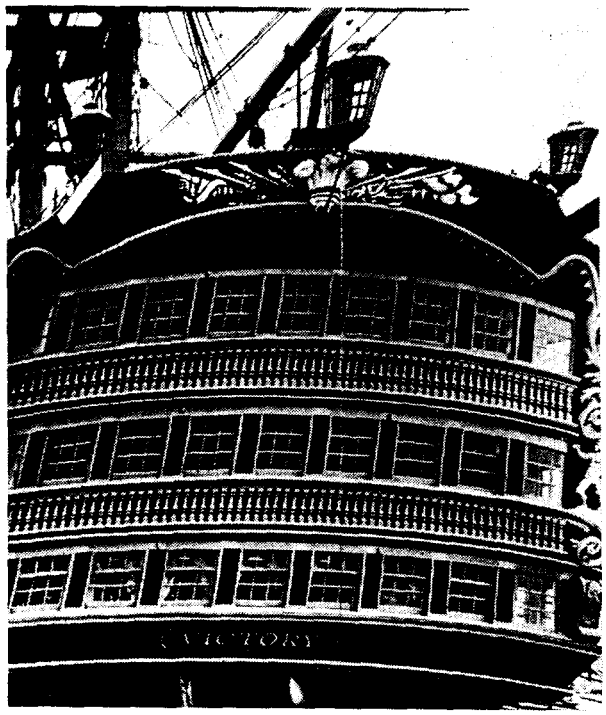


FIG. 8—STERN OF H.M.S. VICTORY—PHOTOGRAPH

Stern and After Quarters of H.M.S. Victory

The *Victory* plot was extremely interesting. Records of the highly decorated stern and quarters are required to overcome difficulties in preservation work. The firm undertook this as a costed demonstration. The first photographs were taken from the platform of the Simmons truck in a howling gale and, understandably, were not good enough to use. The second set was taken from the deck of the basin caisson in another gale; the results were completely usable and a set of measurable drawings to scale were made. These included a set of corrective curves for true measurement of the port and starboard quarters which were slightly bowed in the horizontal direction. These are overall views, but it is noteworthy that full details of any part of the stern can be obtained by plotting from the photographs.

FIG. 9—STERN OF H.M.S. VICTORY—DRAWING

Conclusions

From these examples the following conclusions can be drawn:

(*a*) With a skilled operator, drawing from the plotter is extremely quick and accurate

(*b*) The tedious task of complete measurement is eliminated. It must always be remembered, however, that what is not in the photograph cannot be measured

(c) Once equipment is installed, production of drawings is ridiculously cheap. For example, the measuring to produce equivalent drawings for the *Victory* project would probably take two draughtsmen a year (including the erection of scaffolding), and the total drawing time is estimated at three draughtsmen for six months; whereas photogrammetry produced the photographs and drawings in six weeks at a cost of £450.

The estimates for training photogrammetists do not vary much between firms; starting with completely untrained staff, male or female, it is estimated that reliable work can be produced after three months and operators become experienced after a year. These times would be halved for training draughtsmen for terrestial photogrammetry only. Draughtsmen, having a knowledge of trigonometry, are obviously ideal material for training as photogrammetists. The existing MOD(N) organization can meet the photographic requirements. An ideal team for this equipment to meet naval requirements is, therefore, one draughtsman and one photographer.

With this technique it is difficult not to become over enthusiastic. It must always be borne in mind that what is not in the photograph cannot be drawn,

but if photographs are planned to be taken both before and during stripping or as each system or equipment is installed, such photographs can cover every required dimension. It is then unnecessary to plot from these photographs until drawings are required.

The evaluation of this equipment carried out at Portsmouth was with only one use in mind, that of 'as fitted' drawings and pre-refit information. Numerous other applications for the equipment can be appreciated with a little thought. Suggested other uses for the equipment are:

Exact measurements for arcs of fire and cam drawings

Deflection of equipments under normal and abnormal loading

Accurate plotting of awkward shapes

Scale plotting from mock-ups

Propeller shapes; erosion and corrosion details.

Obviously savings can be made by the use of this equipment in the Drawing Office field alone, although, at this stage, it is difficult to assess how much. It is certainly evident that, with this technique, drawing times are much reduced when compared with normal methods. The cost of the cameras plus a suitable plotter is approximately £15,000.

At present the drawings demonstrated by the firms are being compared: the best method of evaluation, however, is the purchase and practical use of the equipment. The author will not be around to see the final results oft hee valuation, but as a photogrammetric beginner this looks like the nearest thing to practical computer drawing since computers became fashionable.

Note: Except for the habitability mock-up, single photographs only of the stereoscopic pairs are shown for space considerations