

COMMISSION V  
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PRESENTED PAPER

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LINES DRAWING OF A BOATS HULL  
USING CLOSE-RANGE PHOTOGRAMMETRY

ABSTRACT

There are old hulls which were constructed without having a line-drawing made. To record the lines for the future and also to be able to compare new hulls with line-drawings, this paper describes a method for making a line-drawing of a hull using close-range photogrammetry. Tapes were mounted vertically on the hull at an interval of 0.15-0.20 m. Normal case stereo-photography was performed with a camera Wild P32 and a ZeissTMK. The edge of the hull and the tapes were measured in the instrument autograph Wild A7. In the numerical absolute orientation the co-ordinates were transformed to the co-ordinate system of the boat.

The measured tapes were approximated with spline functions and the points for the waterlines, verticals, diagonals and frames to be plotted in the line-drawing, were obtained by interpolation. The points were assorted to their line and plotted in a Calcomp plotter. The fairness of the lines is not perfect and the measured points have to be filtered or the interpolation method to be changed to get full fairness of the lines.

## BACKGROUND

The purpose of this work was to develop a fast and easy photogrammetric method to make a line-drawing of an existing boat-hull.

With such a method it is possible to compare a manufactured hull with its original line-drawing. Furthermore, one can document old hulls which were built without a line-drawing.

## METHOD

The method consists of three different parts:

- The photogrammetric part, which produces a co-ordinate file with all the measured points given in the co-ordinate system of the boat
- The interpolation part, where a set of routines calculates the desired lines (waterlines, verticals, diagonals and frames) from the measured points
- The plotting part, where the desired lines are plotted in different projections.

## PHOTOGRAPHY - MEASURING

A lot of targets were mounted in the model to improve the photogrammetric orientation process.

To obtain points for the relative orientation in the upper corners of the model, two 9 m-masts were set up, one fore and one aft of the hull.

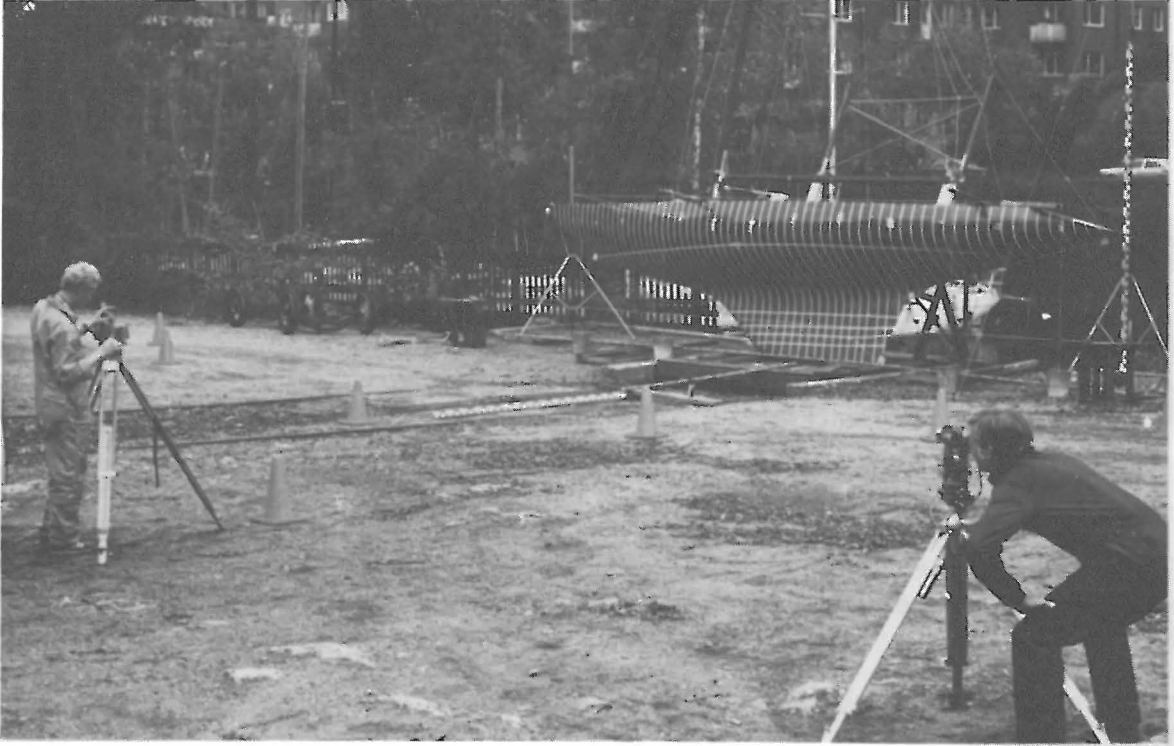
To be able to check and correct the relative orientation (mostly  $\phi$ ) a set of vertical and horizontal cords were set up and stretched, parallel to the camera base. These cords then described a straight line through the model. In the instrument the cords were checked for straightness, and the relative orientation was adjusted, when the cords were not straight.

For the absolute orientation the centre plane was defined by ten circle targets, and three scales were mounted parallel to the co-ordinate axis for scale control. To obtain a good contrast to the surface of the hull, tapes (10-15 mm wide; named "measured frames") were mounted vertically at a distant of 0.5-0.20 m.

Two boats have been photographed. The first one was a Lady Helmsman (12 x 2.7 m), photographed with a Wild camera P32 (camera base 3.1 m). The second one was a R5.5 m (9.6 x 2.0 m) photographed with a Zeiss camera TMK (camera base 9.1 m). See photograph.

On both occasions of photography, a horizontal normal case was used, with the camera base parallel to the centreline of the boat.

The relative orientation and point measuring were done in a Wild autograph A7.



The absolute orientation, transformation to the co-ordinate system of the boat (defined by the centreplane, the designed waterline and the point most aft of the hull), was done in a computer.

#### INTERPOLATION

In order to calculate the desired lines from the measured co-ordinates, a set of routines was written for a computer. For the interpolation, one-dimensional spline functions have been used.

If there was an intersection between a "measured frame" and the desired line-co-ordinate, points were calculated with splines out of that "measured frame" to get the desired diagonals, verticals and waterlines.

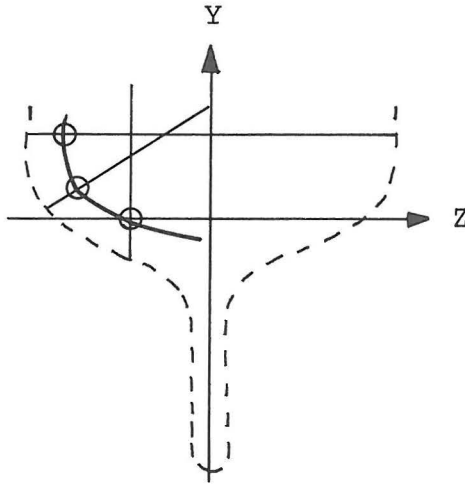


Figure 1 Calculation of points out of a "measured" frame

After having gone through every "measured frame", points were chosen from the pointfile in order to complete the lines.

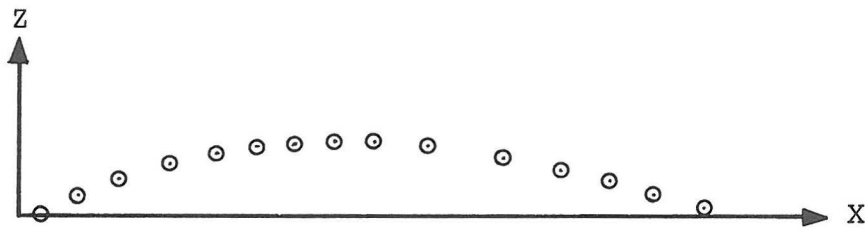


Figure 2 Complete waterline

The desired frames were obtained in the same way from the waterlines, just completed. All the completed lines were stored as vectors in separate files.

## PLOTTING

The lines consisted of only a few points before plotting and more points were calculated with spline functions between these points. The distance between consecutive points were 10 mm when plotting and the points were connected with straight lines.

Different scale, projection, colour, etc is optional in plotting.

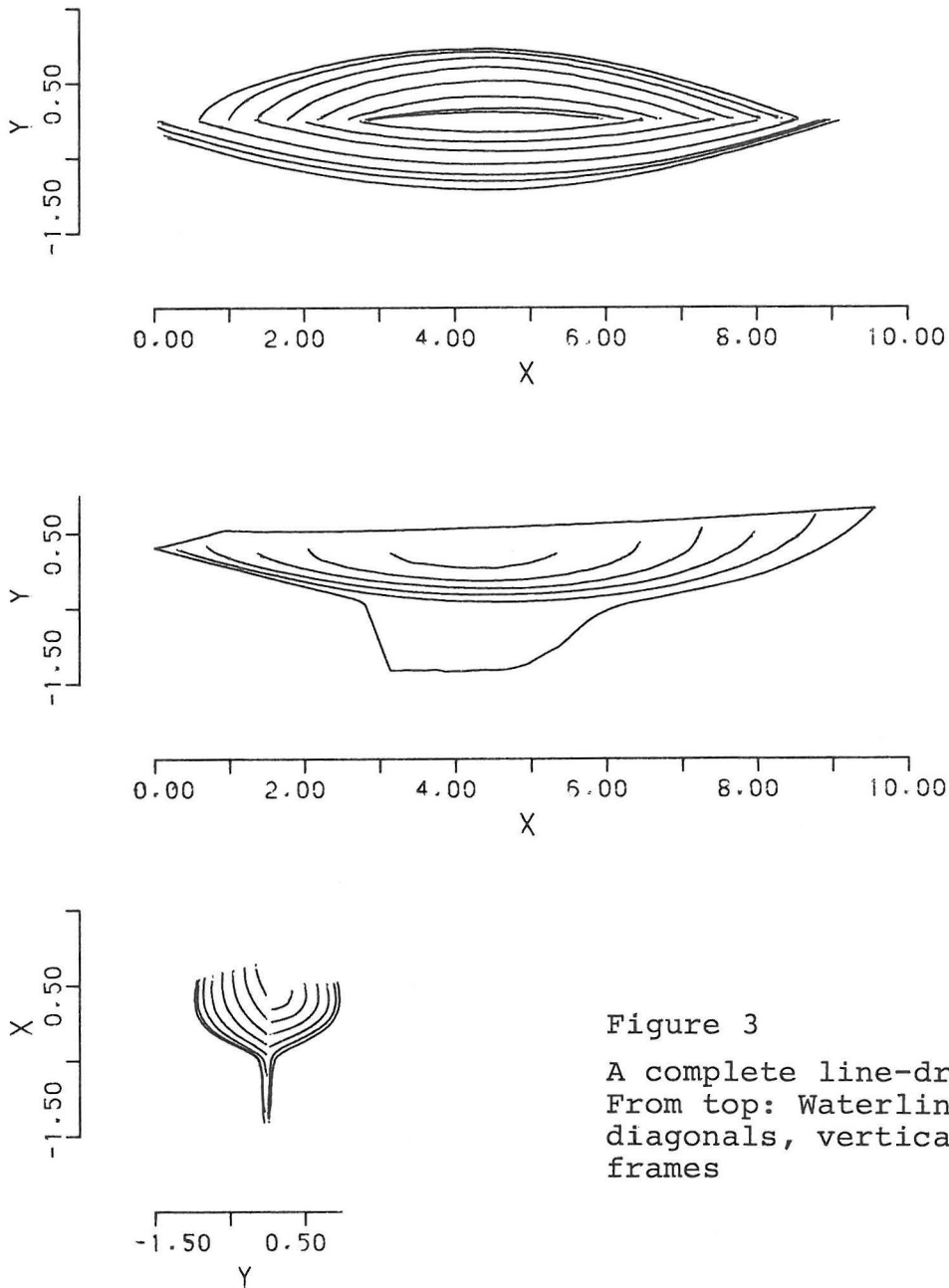


Figure 3

A complete line-drawing.  
From top: Waterlines,  
diagonals, verticals and  
frames

## COMMENTS

The precision of the measured points is estimated to 2-4 mm and can be improved if using a tape with a better design.

The complete documentation of a single boat takes about three days and this time can be reduced, if using analytical relative orientation and if several boats are photographed at each occasion. The fairness of the lines is not perfect because the spline function passes through each measured point, which means that each error can be seen in the result.

To improve the interpolation another interpolation function with better qualities of "fairness" has to be used or the measured points have to be filtered.