

# PHOTOGRAMMETRY AND THE PREPARATION OF MARINE CHARTS

by

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The task of locating the signals (natural or artificial) for the principal triangulation has been completed; but if these points could be joined up by an accurate photogrammetric survey of the stretch of coast between them and if, from the photographs themselves, we should be able to obtain suitable information to replace the innumerable artificial signals essential to those who take the soundings, the work of the hydrographer would be greatly facilitated.

A young and intelligent enthusiast for aerophotogrammetry, after the Conference in 1935 analyzed, in this connection, the cartographic problem of Somaliland, and expressed several ideas which seem to be opportune even to-day. He discarded the solution by photographs taken from airplanes, whether with vertical axis or of the panoramic type, and focussed his attention on the photographs with horizontal axis taken from the sea. These photographs should be taken from the ship, using the multiple-type chamber with a cardan suspension, and as high as possible above the ship although still below the true photographed horizon in such a manner that it forms part of the zero line represented by the line of breakers where the sea touches the coast. The positions from which the photographs are taken should be spaced along the track of the vessel at intervals equal to one-third of the distance between the ship's track and the shore.

By suitably superposing these groups of views, one should be able to solve the problem without recourse to the intervention of other known points than the fundamental positions to which reference has already been made, and which are separated from each other by 30 to 40 miles or 50 miles at the maximum.

For the orientation of the plates it is evident that there should be available sufficiently accurate compass bearings, azimuths of the sun, approximate length of the photographic base, and the approximate position of the ship at the moment the photograph is taken. With regard to the absolute orientation of the first pair of plates, that is, the need of having a more or less large number of trigonometric points joined up with one or more outstanding fundamental signals, I refer to the estimate of that investigator who fixed their number at five; a number which incessant study for the purpose of reducing the too great subjugation of photogrammetry to the ground, may result to-day in reducing, if not abolishing entirely.

I maintain, therefore, that in this problem of representation, for the needs of maritime cartography, of the coastal zone visible from the sea, there should not be insurmountable difficulties. The distance of the track of the ship off the coast, for the purpose of taking photographs should be between three and four miles (4,000 to 5,000 m.) or even less. This distance is always adequate for the safety of the vessel and for observation and reconnaissance of the shore.

However, for purposes of soundings along the coast..... it might be necessary to make another photographic survey parallel to the first at an even more reduced distance: and here I would desire that the real possibilities should be superior to those hoped for; to take soundings to a scale not less than 10 000, it should be absolutely necessary to eliminate the work of placing and locating the signals: a shrub, a rock or a reef, or any object which can be well identified and recognized without uncertainty, and which is well located in the successive sounding zones, should suffice.

It is necessary that the photogrammetric operators should be able to give us a survey of the coast, seen from the sea, to a scale which may vary between 25 000 or 50 000 to 100 000 for the preparation of general charts over the entire extent of the Somaliland; and other charts to a larger scale (about 10 000) for the various parts of

the coast which hold some special interest (in the vicinity of landfalls or near shoals which are dangers to navigation).

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For the rest, the use of aerophotogrammetry for the surveys of submarine depths has not progressed much since I last had occasion to speak here of this matter, that is, about two years ago. Up to the present it has always been limited to secondary indirect results; and the experiments made by the French in Morocco still remain examples to be cited. The hostility of the natives and the difficulties along the coast did not permit a careful reconnaissance of the terrain. The photographs taken from airplanes not only showed the various places where soundings needed to be denser, but also clearly indicated the localities where communications might be established with that inhospitable country, such as the places most sheltered from the sea and best adapted for landing. Certainly special precautions had to be taken. Practical experience showed that it was necessary to take the photographs not only with a calm sea but with a bright sun at an altitude between  $40^{\circ}$  and  $55^{\circ}$ . A light breeze, especially from the sea, suffices to create ripples on the surface which hinder the formation of good images of the bottom. The atmosphere also should be limpid, although it has been found that a slight mist, even visible, does not prevent the photographic plate from registering the submarine relief when taken from an altitude of 2,000 to 3,000 metres. When the water is clear, the various depths show on the plate as patches of variable opacity. With a single photograph it is not easy to recognize whether the different patches indicate a greater or a lesser depth of ocean. However, the stereoscopic examination of the parts common to two successive plates allows this point to be determined with less uncertainty.

But aerophotography has proven advantageous to hydrography for the study of the ocean bottom even where exceptional circumstances do not exist and where the water is not clear and limpid.

For the photographic study of the ocean bottom where an appreciable tide exists, it is necessary to distinguish between two cases depending upon whether the water is clear, or is turbid as a result of sand and mud held in suspension. If the water is muddy, and in any case if the lack of transparency hinders the direct photographing of the bottom, one can still hope to discover the shallows and the dangerous shoals by noting on the photographic record the characteristic streaks which the current produces over the uneven bottom at a certain stage of the tide. This stage corresponds to the beginning of the ebb tide or the end of the flood tide, depending on the shape and orientation of the shoals. At the instant of maximum current, the surface agitation is ordinarily too general to permit the deduction from the photographs of sufficiently clear indications of the shoals.

These streaks show their characteristic aspect during a short time only, and consequently an observer on a vessel cannot take in with a single glance of the eye this complex phenomenon which occurs in the zone to be studied, and must therefore repeat his observations during several successive tides. On the other hand, a single photographic apparatus located at an altitude of about 2,500 m. can fix on several consecutive plates the totality of the dangerous area within a few minutes.

In this manner dangerous shoals have been discovered in turbid waters in which the shores of the banks and the zone to be sounded were sharply outlined.

This, however, should not lead to the conclusion that we have already reached a stage of easy application and practical results. We should add to what has already been stated that it is almost impossible to distinguish on the aerial photographs the level attained by the sea with respect to the shore, and consequently rocks covered by one or two metres of water do not show any difference from rocks which are uncovered. Further, the aerial photographs show much more readily the coloration of the ocean bottom than the depths, and for this reason the study of the photographs has to be made by real specialists. We have not spoken either of the difficulties of locating on the chart, that is, in relation to the coast, those shoals shown on photographs taken at sea and distant from the shore. The assembly of various photographs may possibly be facilitated somewhat by the images of the streaks of current, and also somewhat by the eddies, or by the bottom patches existing in the zones common to two photographs. These are the same difficulties which are encountered with the ordinary system for similar assembly of views.

The problem of the application of aerial photography in the construction of nautical charts is therefore very real but, as I have indicated for the survey of a stretch of

coast, (by substituting for the planimetric survey a panoramic survey), we can also obtain a compromise for the bottom relief.

For surface navigation the dangerous shoals are those over which the depths are less than 10 metres. However, if by means of a stereoscopic examination of the ocean bottom from photographs taken from the air, we can outline the dangerous zones, usually contained in a strip of ocean more or less wide but close to the coast, and if we can outline the zones of water near the open sea where the broken ground of the bottom projects upwards to a depth of 10 m. and less, we shall have made great progress. Nevertheless, I should recall again the difficulties — apart from those of interpreting the photographs — in the orientation and assembly of the photographs of the sea and which are all the greater when the zone is far from the coast and does not show a section of the shore line.

To conclude, the application of new methods might lead to novel marine charts, that is, having a rather peculiar aspect to eyes accustomed to the old charts, viz :- many panoramic profiles and an incomplete planimetry, in which the incomplete portions will show which are the run-over zones, the depressions, the parts invisible from the ocean; and the surface of the sea, no longer covered with constellations of figures which represent the depths, but divided into various coloured zones according to the numerical scale, which might be fixed in each one of them.

