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SOME BASIC PRINCIPLES IN THE COMPILATION OF NAUTICAL CHARTS

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INTRODUCTION

1. This article is based on a paper presented to the 8th United Nations Regional Cartographic Conference for Asia and the Far East in January 1977. It is partly derived from the experience of the UK Hydrographic Department, and partly from a study of the charts produced by other well-established hydrographic offices, and is intended for the guidance of nations establishing hydrographic facilities of their own for the first time.

2. The paper is in summary form, and seeks to give advice on the insertion or omission of the different types of detail of interest to mariners, according to the various functions and scales of nautical charts and the types of area which they depict. In the space here available, only depths and topographical information are considered — to select both of these much judgement is needed. Of the other categories of information shown on charts, the main one, navigational aids, lends itself more readily to rules of thumb. The ways in which information is conveyed — colours, symbols, typefaces, etc — are also outside the scope of the paper.

3. Of the factors leading to the diversification of nautical charts, the most obvious is the scale chosen. There is a broad classification into four groups :

a) Port plans on large scales ;
b) Charts of open harbours, anchorages, and port approaches, also on large scales ;
c) Coastal charts on medium scales ;
d) General charts on small scales.

In groups b), c) and d) there are charts which contain areas of different degrees of scale ; that is, a chart may be first-scale in one part, second-scale in another, and so on. In groups b) and c), at least, differences in treatment can arise from the varying complexity of different areas, and the rate of change of the information presented.

4. Each individual chart specification may be conditioned by the

nature of the source material, which can vary greatly in quality and density. To a certain extent, also, in areas where hydrographic offices are the original charting authority, particularly national waters, there will be a tendency to include additional information, as the charts will serve as multipurpose information documents.

5. Charts differ from maps in that standardized specifications cannot be applied indiscriminately to them. In fact, the attempted application of simple rules to govern chart content has been a principal cause of wasted effort in the past. For example, although topographical contours are undeniably valuable on charts of some areas, their addition to others causes an amount of work out of all proportion to its value. Moreover, the drafting of standard rules covering particular features may lead to an attempt to give a chart uniform treatment throughout its whole area, although the essential fact of successful chart compilation is that different considerations apply as a compiler works from inshore to offshore areas, or along an open coast towards a shoal-encumbered estuary, or inland from the coastline.

6. Ideally, there is, indeed, only one fundamental criterion which should be applied. Each detail should be assessed for its usefulness to some important class of chart user in the context of the surrounding details and the scale of the chart. No useless detail should be charted and any minor features whose insertion would tend to obscure more important features should be excluded. The recommendations which follow are largely in amplification of this rule, and they suggest ways in which features which are of little or no value to the user can be reduced in emphasis, or excluded altogether. In practice this is not easy to achieve but there is considerable scope for producing clear, easily-maintained charts without adversely affecting the chart user or eliminating the concept by which a chart which is not on the first (largest) scale can be used in an emergency.

HYDROGRAPHIC FEATURES

Depths

7. The water area to be covered by a chart should be divided into areas which fit one or other of the following four categories :

a) Satisfactory depiction requires detailed depths ;
b) Rigorous selection of detail desirable ;
c) Depth contours sufficient ;
d) No depth information needed.

8. In areas where detailed depth information is required (paragraph 7 (a) above), careful selection of soundings is necessary to allow correct interpolation between them, to reflect the adequacy of the survey, and to permit the use of the chart as a plotting-sheet. The following general principles are recommended, observing that their detailed application must be controlled by the various complicating factors described in paragraphs 3 to 6 above.

a) Least depths on shoals and in navigable channels should be inserted first. The assessment of navigability should take full account of the tidal range.

b) The specified range of depth contours should next be inserted. They should give a reasonably faithful representation of depths and should not be over-generalized.

c) Thirdly, soundings should be selected which show trends of bottom features not brought out by the depth contours, using enough to show clearly shoal areas and the channels between, and bearing in mind that vessels cannot, or do not, always give dangers a wide berth. Changes of slope should also be shown as far as the scale permits without crowding — in general, areas of rocky or uneven bottom will require more detailed and irregular depiction than areas where the bottom is composed of unconsolidated material and the relief is subdued.

d) On large-scale charts and on others where the submarine topography is simple, it may be necessary to complete a uniform pattern of soundings to avoid an impression of incomplete survey. However, even distribution is not an aim in itself.

e) The soundings selected should be complementary to the depth contours — information should not be duplicated by inserting numerous soundings entirely in accordance with expected depths in the vicinity of contours.

f) Enclosed deeps in shoal areas should not be ignored, as some indication of their presence will be helpful to vessels using echo-sounders to confirm position in poor visibility and when anchoring — charts should show depths realistically.

g) In narrow channels of limited depth, soundings should be shown along the line of maximum depth as well as along the sides. In harbour areas, particular attention should be paid to the insertion of least depths in the entrances to harbours and basins. Dredged areas should be shown, and depths alongside piers and wharves. Occasionally, a table of depths at numbered or named berths may be desirable.

h) The practice of deliberately thickening the pattern of soundings in shallower waters, formerly justified to some extent on single-colour charts, has outlived its usefulness. It confuses the information inserted in accordance with c), f) and g) above, and is antagonistic to clear depiction of bottom relief. The use of shallow-water tint, and the increase in the range of draught of surface vessels, call for adherence to the basic principles of selection throughout the water area.

i) The dotted danger-line symbol should be used to supplement depth contours where circumstances require it — for example, in the delimiting of rocky areas, particularly on smaller-scale charts, and also to mark shoal areas of unknown depth, isolated dangerous shoals, rocks and islets, wrecks and obstructions.

9. The areas where rigorous selection of depth information is desirable (paragraph 7 (b) above) fall into two types :

a) Areas subject to continuous and rapid change need special treatment. In extreme cases the whole water area of a large-scale chart may come into this category. Changes may be so frequent and of such an extent that a survey can become significantly out-of-date in a very short time, so that a chart can never be expected to give an accurate detailed portrayal of depths. The best results can be achieved by using a severely reduced selection of information designed to give indications of the positions of navigable channels and their depths. Shoal areas should be shown by depth contours and a few soundings and drying heights. Where the water areas, as well as being changeable, are also complex at the scale of the chart, selection and generalization should be particularly severe, especially in charts of some navigable rivers. In the areas of anchorages and ports, supplementary detail can be added as scale permits. In such cases, a suitably-worded caution is necessary. These types of charts are distinct from the type discussed in paragraph 10 below because they are the preferred charts for navigation in the areas under consideration, and are used for plotting the ship's position. Adoption of this treatment saves much wasted effort, freeing manpower to correct the charts more frequently, enhancing their usefulness, and encouraging confidence in them.

b) A chart of which a part is covered by a separate larger-scale chart should be carefully considered with a view to reducing depth information within the area of the larger-scale chart. It is not suggested that the whole area within such limits should be so treated, because some of it may be navigable at the smaller scale, in which case normal depth information is desirable. In inshore areas covered by larger-scale charts, however, quite drastic selection can be effected, provided that the possible use of the chart in an emergency is not ignored.

10. In some areas only depth contours (and appropriate tints for shallow water) should be shown (paragraph 7 (c) above). Such areas lie within, but do not coincide exactly with, the limits of larger-scale charts which cover complex, changeable areas. On such charts it is possible to determine a line inshore of which it is not practicable, due to the nature of the area and the unsuitability of the scale for portraying it, to show navigational aids and wrecks generally, though long-range aids may be shown. In the general absence of aids and wrecks, such parts of a chart are totally unsuitable for navigation inside these areas, even for emergency use, and it is clearly desirable that the portrayal of depths in them should be limited to generalized depth contours only. It is suggested that this treatment is particularly applicable to medium-scale charts of estuaries and coasts fringed by offshore bars. In these cases the transition from open sea to inshore navigation is relatively gradual and the abrupt omission of all detail would be cartographically undesirable.

11. Areas where all depth information should be omitted (paragraph 7 (d) above) may be indicated by the existence of a more or less well-defined line at which the nature of navigation changes abruptly because of a transition from open sea to largely enclosed or restricted waters. Examples are sea areas cut off from the main body of the water area by coastline and chart limits ; inland waters which cannot be reached by sea-going vessels ; restricted waters which cannot be navigated at the scale of the chart ; waters within a group of dangerous rocks or coral heads, within which navigation should be discouraged ; and terminal port and harbour areas covered by a larger-scale plan on the same sheet.

12. Application of the selection procedures described may not be possible if, in the area in question, the chart concerned represents the largest scale cover in the International chart series.

Drying areas

13. Drying heights should be selected according to the principles already stated for soundings. Many landings and some ports can only be reached near high water, so that drying heights can in some cases be more important than soundings. This point is stressed because it is found that inexperienced chart compilers may assume that drying areas are of little or no navigational interest.

Quality of the bottom

14. The aim should be to show all significant variations in bottom quality. Modern surveys are sometimes deficient in such information, and older documents should be consulted if necessary. Areas in which bottom qualities are particularly important are indicated by the following uses :

a) *Anchoring.* Sand and shingle hold better than soft mud ; rock will be avoided. Important locations are recognized anchorages, roadsteads, pilot boarding-stations and outermost fairway buoys, while any sheltered water is a potential anchorage.

b) *Navigating close to shoals.* Qualities should be shown liberally on shoals, banks and reefs, as a guide to their stability and as a clue to possible undetected pinnacles.

c) *Taking the ground at low water.* Coasters and small craft are often concerned, for this reason, with the nature of the bottom in shallow or drying areas, particularly near harbours.

d) *Fishing.* Bottom qualities, especially rock, are of importance to fishermen on the continental shelf.

TOPOGRAPHICAL FEATURES

15. It is highly desirable that the selection of topographical features should be based strictly on the fundamental criterion of usefulness to

navigators at the scale of the chart, to maximize the clarification of important features. Furthermore, largely because of restrictions on the number of colours available, it is obvious that no chart can be made to compete fully with modern topographical mapping in the portrayal of land features. The mariner has little interest in the land beyond his visual or radar horizon. Therefore, except where the appearance of a chart would suffer unduly from leaving blank the central portion of a large island or peninsula, no topographical detail beyond the horizon should normally be shown, unless it be the barest minimum of detail to maintain an appearance of continuity.

16. Four basic principles, which are particularly applicable to large-scale charts, should be observed :

a) The navigator's interest in land detail is at its greatest at the coastline and falls off rapidly for features some miles inland ;

b) It is the unusual or unique feature which the mariner needs for positive identification of the land area he is looking at ;

c) Generalization may be necessary for clarity but a realistic visual impression of the landscape, as likely to be seen from seaward, must be retained ;

d) A navigator in well-buoyed and lighted waters has rather less need for detailed topography than one who must locate off-lying unmarked dangers by reference to coastal features.

Coast

17. On larger-scale charts, generalization of coastline is normally neither necessary nor desirable, but as the scale of compilation gets less, and especially where the coastline is complex, increasing degrees of generalization are called for. The same degree of generalization should be applied to the depiction of complex archipelagos on smaller-scale charts, even to the extent of omitting minor islets from areas clearly unsuitable for navigation at the scale of the chart.

18. Attention should be paid to showing differences in type of coast by the appropriate symbols or legends where this information is clearly of use to the mariner, but the same principles of generalization should be applied where demanded by the scale of the chart. For example, on large-scale charts all cliff detail, including any remarkable variations in colour, should be shown ; in contrast, the symbol for a sandy coast would only rarely be useful on scales smaller than 1 : 100 000.

19. In general, on large-scale and medium-scale charts of low-lying coasts, conspicuous objects are very important, while even minor clues to position — like sand dunes, hillocks, and low bluffs — may be very useful. On steep coasts, where traffic may be concentrated off projecting points of land, the nature of each headland should be made clear — whether it has vertical cliffs, or a sloping, rounded or low profile. The heights of cliffs and islets, both high and low, are informative.

Relief

20. The simplest method of depicting on the same plate as other topographical detail a reasonably accurate three-dimensional impression of relief from any seaward view-point is the use of generalized contours where the relief is sufficiently varied and its depiction is of definite value to the mariner. To achieve simplicity, the contour interval should be chosen so that the relief can be indicated by a few lines, though it may be necessary to show greater detail in the coastal strip by the insertion of supplementary contours within the range chosen.

21. On some large-scale harbour plans, and on charts of coasts with abundant navigational aids and artificial land-marks and with a terrain lacking recognizable individual features or fronted by an archipelago, it may be assumed that the identification of relief features plays a small part in navigation and that the insertion of contours would be wasteful of time and effort. In contrast, along a sparsely-inhabited coast unmarked by navigational aids, detailed topography in the coastal belt will allow the inshore navigator to clear dangers with the aid of improvised transits of charted features.

22. On any contoured chart, because the contour interval may not enable the compiler to represent small but locally remarkable features, or emphasize the local range of elevations adequately, supplementary information should be inserted as necessary, in the form of spot-heights, descriptive terms, proper names, symbolic representation, and views. On charts, other than small-scale charts, where relief depiction by contours is considered undesirable, the latter devices should be used to show any essential details of individual relief features, while a general picture of elevations may be given by the use of spot-heights.

23. Where the source material does not provide contours which are accurate at the chart scale, it may be possible, if necessary, to show approximate contours or form-lines. In general, contours should not be inserted on charts of scale smaller than about 1 : 500 000.

Drainage

24. Much time has been spent unnecessarily in the past on depicting drainage patterns in great detail. In general, only major streams and those which make a significant contribution to relief depiction should be shown, with drastic selection as the horizon is approached. Coastal lagoons may be useful in stressing the low-lying nature of a coastal belt. Navigable rivers and canals should be shown to the head of navigation by sea-going vessels, irrespective of the distance inland, together with names of river ports.

Vegetation

25. General depiction of vegetation is unnecessary but vegetation features likely to be of assistance to the mariner should be charted. The

type of vegetation in the coastal fringe may be shown where it is the dominating feature in a low-lying area. Instead of charting extensive tracts by symbol, however, descriptive terms may be used, such as " wooded ", " marsh ", " mangrove ", " bushes ". Legends may be effectively combined with a delimiting fringe of symbols, if the exact outline is significant. On low-lying coasts, isolated clumps of trees may provide useful clues to a ship's position.

Settlements

26. On harbour plans, fairly full details of the town plan adjacent to the water will be useful to the mariner unfamiliar with the port in question, buildings of particular interest being named. On large-scale coastal sheets, the coastal fringe of built-up areas is sufficient, but all isolated buildings on the coastline should be shown, reducing one or two miles inland to larger groups of buildings only. On medium-scale and small-scale charts, only towns and villages within the visual or radar horizon should normally be shown, either by a generalized street pattern (but still fine-grained enough to give a realistic impression of a town) or by a conventional symbol (churches or mosques, if known to be prominent, sometimes being used in this role). On steep coasts, settlements may be well-separated, and therefore prominent, especially at night.

27. Isolated buildings of various kinds should be charted prominently if known to be conspicuous objets or good landmarks. Elevated features like radio masts and tall chimneys often choose themselves. But care may be needed in deducing, for instance, that a white hotel on a cliff-top should be shown, while the surrounding scatter of buildings may be generalized ; or that, in a town with many churches, a pair juxtaposing a spire and a tower are the ones to be highlighted.

Roads and tracks

28. Much simplification and economy can be achieved in the depiction of roads and tracks. On large-scale charts, all roads which lead to the coast should be shown, though a mile or two inland only larger roads are needed. On medium-scale coastal charts, in areas where aids and landmarks are plentiful, the roads shown should be only main roads and links to ports and coastal installations, although in the rare cases where minor roads and tracks are known to be prominent from seaward, and other landmarks are sparse, their insertion should be considered. Details of roads should generally be omitted from charts on scales smaller than about 1 : 500 000.

Railways

29. Similar selection principles should be applied. In areas where sidings and minor branches are numerous, depiction should be generalized as much as is reasonable on all scales. Embankments and cuttings should only be shown if they are likely to be visible to a mariner.

30. The topographical recommendations in this paper have been drawn largely from instructions designed for British charts, which use a limited range of colours. There are other ways of treating such detail : in particular, the practice of inserting extensive detail taken more or less directly from maps. This has advantages for inshore navigation and relieves the cartographer of some of the difficulty of deciding what should be included. The penalties are increased costs and liability for correction.

CONCLUSION

31. Charts must respond to the changing requirements of navigators and other specialist users. Major developments affecting their content include the new emphasis on ship routeing in congested waters, the deep draughts of large crude carriers crossing shallow seas, and the off-shore exploitation of mineral oil on continental shelves. The increased use of charts by cruise liners, yachts and other recreational craft is a lesser, but still important, consideration. Each of these factors presents the cartographer with problems which are not yet fully resolved. The common feature is the acceleration in the rate of change of charted information, which is straining up-dating procedures beyond their limits. This, indeed, is the stimulus for the increasing interest in international co-operation in nautical charting.

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