GENERALIZATION OF MERCATOR PROJECTION

An article by Mr. L. Strohl entitled "Le Vrai Visage de la Terre" (The True Face of the Earth) has been published in "La Nature, Revue des Sciences et de leurs Applications", No. 3187, Paris, November 1950, pages 321-340, with an introduction by Mr. André Siegfried.

Referring to the use made of Mercator's projection in representing the planisphere, the latter lays particular stress on the dangerous distortions involved as regards land-masses nearest the pole. Actually, the world as it really is appears only upon examination of a terrestrial globe, and cartographic technicians have applied their ingenuity to the discovery of plane representations that would as faithfully as possible portray certain parts of the world, or a continent, ocean or sea. The development of commercial and strategic aviation has increased the tendency towards "de-mercatorization" of general world maps.

Mr. Strohl's paper first reviews the various solutions arrived at in representing the terrestrial sphere, uniformly designated as *projections*, although in a large number of cases, points on the map bear no relation to points on the terrestrial globe corresponding to the geometric definition of the word. With the help of numerous diagrams, he briefly deals with the framework of meridians and parallels in polar and equatorial projections, meridian and transverse projections, and zenithal and oblique projections. He then examines the characteristic features of various projection groups such as conformal, equivalent, and equidistant projections, and perspective projections of the gnomonic, stereographic and orthographic types.

He recalls, and illustrates with figures, the characteristic features of the main projections that can be used in representing a hemisphere, such as orthographic and stereographic projections, Mollweide's and Lambert's equal-area projections, and others in which none of the elements (lengths, angles, or areas) are exactly retained, but where a minimum is sought for by balancing errors, as in Guillaume Postel's and Airy's projections, etc. The author then endeavours to retain the components required in the construction of a single map. He mentions the solutions that consist in making sections of maps incompletely joined together, such as Professor Goode's interrupted projection, Bartholomew's and Petermann's star-like projections, and polyconic projections resulting in only slightly distorted yet unconnected sheets, as the International Map of the World on the scale of 1: 1 000 000. He also refers to the double periodic projections of Pierce, Guyou and M. O. Adams.

In order to obtain projections extending outside the hemisphere, the author examines various systems of extrapolation beyond the limits of the hemisphere, as extrapolation to the Southern hemisphere of the polar stereographic projection, extrapolation of Postel's polar projection with equidistant parallels, and various 360° extensions of the equator in meridional projections, as in Mollweide's and Lambert's equal-area projections, Postel's projection, M. O. Adams' conformal projection and the Sanson-Flamsteed equal-area projection.

The common defect of all these latter types is of course the excessively exaggerated length of the meridians as one proceeds from the centre outwards, as the outer meridian is generally two and one-half times as large as the central meridian.

Cylindrical projections remedy this failing, as in equal-spaced projections, modified equal-spaced projections upon a selected parallel, or as in perspective projections upon a tangent or secant cylinder. The author then finally comes to the projection that seems to him as being the least unsatisfactory of all those yet devised for representing the earth in its entirety, and which in spite of its detractors and actual shortcomings still holds the leading position in any atlas : Mercator's conformal cylindrical projection.

Only beyond the 70th parallel of latitude does the Mercator projection really make atlas scale increases excessive, and for this reason atlas planispheres are almost invariably supplemented by two polar sections in order that the immediate vicinity of the poles may faithfully be represented.

Lambert and Gauss long ago made a detailed investigation of the transverse cylindrical projection, which is obtained by wrapping Mercator's cylinder around a meridian. This is a system that makes it possible to show a wide strip along the meridian selected, including the polar areas, without any undue distortion.

Professor Camille Vallaux likewise used this method in the construction of ocean charts. Ingénieur Louis Kahn applied the Mercator projection in order to show the principal air routes on strips along either side of a great circle.

Mr. Strohl's formula for a satisfactory solution is expressed in the following terms :

"Make Mercator projections that wind around oblique great circles, the latter being so selected that the extreme lateral portions of the "subject" of each chart be the shortest possible distance away from the axis."

He also suggests the use, in conjunction with Mercator's standard planisphere, of five charts or maps faithfully depicting the earth's entire surface. These consist of the following :

1. *Atlantic :* The circle of contact affording the minimum distance between the axis and the lateral sections of the ocean is the one bisecting the equator on the meridian 30° W. and passing 20° away from the poles.

2. *Pacific :* The major axis in the vicinity of the line drawn from Sakhalin to Tierra del Fuego and bisecting the equator on the meridian 160° W. and passing 40° away from the poles.

3. *America :* Great circle bisecting the equator on the meridian 70° W. and tangent to both 65° parallels.

4. *Indian Ocean :* Circle of contact bisecting the equator on the meridian 70° E. and tangent to both 50° parallels.

5. *Ancient Continent :* Great circle bisecting the equator on the 0° - 180° meridians and tangent to the 45° parallels.

Used with Mercator's standard planisphere, an accurate and complete representation of the earth is obtained by means of these five maps. They can be referred to with greater ease than a globe and larger areas can be taken in at a glance.

Mr. Strohl ends with an explanation of the method used in the immediate determination of the shortest distance between any two points on these maps or charts, and its direct measurement at sight by means of Hydrographic Engineer Favé's diagram. (1) The latter consists of a fan-shaped set of great circles passing through the same diameter in the plane of the equator, and at equal angles to one another — say 10°. All that is needed is to slide a tracing of the projection of this fan-shaped set along the axis of the map until the points of arrival and departure are on the same great circle or between two consecutive circles. Interpolation at sight will supply the shortest route between the points as well as the actual distance of the route found, as the great circle image on the tracing-paper is graduated for, say, every 1000 kilometres.

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(1) See Chart No. 5603 and tracing diagrams No. 5603 *bis* published by French Navy Hydrographic Office, Paris