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The cartographic technique

THE story of the development of cartography from its beginnings is essentially a composite of the chronicles of exploration and survey, together with such abstruse material as the mathematics of map projections. Until recently the use of maps was largely limited to specialists such as navigators, surveyors, military planners and the like, and the preparation of their maps constituted a problem only with respect to the accuracy of the things mapped. Except for the commercialized atlas trade, presentation media and techniques have been of relatively little concern throughout the development of cartography.

Only in the past few centuries have really major advances occurred in cartographic technique. The majority of these advances, such as the isoline, the graduated circle, and the hachure, have come about because of the ever-present and fundamental problem of presenting quantitative facts. Accuracy is obviously the first objective of any scientific activity; but when presentations of factual materials

become widely used, the manner of presentation becomes of primary significance. This is of extraordinary importance in the field of cartography and approaches critical consequence with respect to the special purpose map, the map which treats but a few categories of data. The navigator and engineer are primarily concerned with spatial data of a precise and numerical nature. For these data various kinds of charts, topographic maps, and the language of mathematics are reasonably adequate means for their display, but the same cannot be said for the social scientist who is commonly concerned with less precisely definable data, relationships, or concepts.

Maps in social science as well as its written terminology deal more with the qualitative and interpretive aspects of investigation and knowledge. The vehicles for presenting such materials should be capable of recreating in the mind of the reader, so far as possible, precisely the intended intellectual meanings and interpretations of the author. It is relatively easy to accomplish this when language is the medium, since there are generally accepted standards and definitions for its use. Words are merely intellectual ideas graphically presented; but, unlike most other visual symbol forms, they pass through the eye to the brain without occasioning major visual stimuli. There are, to be sure, significant variations in the readability of typefaces, point sizes, and page layouts, but long usage has tended to submerge these to such an extent that it is doubtful if any significant erroneous intellectual reactions could be ascribed to them. In cartography, on the other hand, the graphic techniques and media are legion, and the possibilities of arrangement are so tremendous that the inexpert map reader, when viewing qualitative, and even some quantitative data, cannot help but unconsciously receive from the unfamiliar visual forms many sensory impressions in addition to, or in place of, the intellectual concepts intended by the cartographer.

Every map is a complex stimulus, for all its shapes have both visual and intellectual relationships to one another. Anything existing within the neat or trim lines may be described as a series of related intellectual concepts represented by visual media. In some

cases the visual symbolism is so characteristic or well known that one is able, unconsciously, to disregard the visual stimuli and see and recognize clearly the intellectual concept. In other cases the medium acts more like a cleverly constructed mask and so obscures the intellectual thought that the only way to determine its identity is through reference to a legend or a key. It is only natural that the eye and the mind frequently make guesses concerning the nature of the things thus visually represented, regardless of the earnest intention on the part of the viewer to accept only known facts. This must happen with remarkable frequency, since it is well known that the mind and the untrained eye do not ordinarily distinguish between intellectual and visual stimuli. Indeed, for many people it is next to impossible, for the major part of knowledge comes to all of us through our eyes, and it is only natural to confuse visual and intellectual factors. "Seeing is believing!"

In the recent stages of cartography there seems to have evolved a well developed and unusually tenacious habit of substituting convention for technical quality. It appears somewhat anomalous for conventions to have a strong hold over a field which prides itself on its creative artistry. Nevertheless, from colors to boundary lines, and from lettering to projections, the field of cartography leans, or rather reclines, on its conventions. The habit is insidious for it tends to stifle investigation toward greater technical competence, because the innovator is reluctant to depart from the rut of convention. Even standardization among small-scale maps has its proponents! Many of the standards suggested will no doubt turn out to be ill-conceived conventions. As one distinguished observer, O. M. Miller, has put it, "once a map convention has been established it is difficult not to feel prejudiced in its favor."¹ Until the past century or so, this powerful influence was sufficient, considering the technical limitations of the field, to maintain the profession in good standing with the other arts. As the technical horizon widened, however, convention only gradually relinquished its hold on cartography. Notwithstanding, there were many changes (the cartography of 1910 is very different from that of 1810) yet the power of convention had not greatly decreased. The force simply

transferred itself to other technical phases. The advances of the past one hundred years have been enormous but, generally speaking, convention has merely replaced convention.

Examples are many. Perhaps the most widely publicized in recent years is the general use of the Mercator projection. This projection, designed for a specific purpose, navigation, has been regularly and indiscriminately used although many other projections more suitable for general purposes have long been known. Only because of our recent so-called "entrance into the air age," and the vituperation against the Mercator accompanying the move, has this projection declined in popularity. It is interesting to note that, as in the past, the conventionalism, rather than disappearing, seems to be in the process of being transferred, this time to the polar aspects of the azimuthal projections.

Many conventions are logical or stand functional analysis. In this category may be placed many of the techniques of symbolism such as dots, circles, or squares for cities; the pictorial kinds of symbols such as hatched lines for railroads; dot-dash lines for political boundaries; and the innumerable *conventional signs* on topographic maps. They constitute a kind of cartographic shorthand and, so long as they are employed with proper regard for their effect on the overall design of the map, they are adequate for indicating character and location. The importance of the visual functional evaluation of spatial symbols is well illustrated by J. K. Wright who points out that although "tiny men, or ears of corn, or cows . . . may be in better 'harmony' with the things they represent than flat colors or shading would be, they may also be out of harmony with the purpose of the map if that purpose is to give a clear and clean-cut concept."²

Some conventions are justified on the grounds that they have been tested by time and found good. All too often, however, they have been tested only by their makers, and the quality of parental pride is not always objective. Basic analysis of their visual effects and logic is conspicuous by its absence. The prime example of such a convention in cartography is the practice of presenting hypsometric layers somewhat according to the spectrum, that is, with

green for the lower altitudes ranging upward through the yellows and reds. This system of progression has even been given a kind of international approval, for it was chosen as the basis of the system of representing hypsometric data on the international map. Its champions point to the fact that most people are familiar with the system and thus it "has been found by experiment and experience to give a graphic visual impression of relative altitudes." Similar conservative rationalization opposes most proposals of change. When analyzed, the only justification for this convention is its conventionalism. The spectrum bears not the slightest relation to altitude. The ocean is only occasionally blue; lowlands are not universally green; and mountains are not red. Even more important is the visual fact that the progressive colors of the spectrum bear little relation to one another as far as the eye is concerned. Actually their lack of relation is much more significant in vision. The wide variation in brightness and visibility of the spectral colors when applied to hypsometry contributes more to cartographic confusion than to clarity. To discard this convention in favor of a more rational approach is probably impossible. It would require a generation of education.

Cartographers are not entirely to blame for their general conservatism and adherence to convention particularly with respect to lettering, color use, and map design. Private cartography, unlike some of the fields in the fine arts, has little popular support, whereas commercial cartography dominates the broad market. In highly competitive fields, and in fields catering to the well informed, improvement and change function as tangible assets. Not so in cartography. Those who buy maps or cause them to be made (school boards, teachers in various subjects, publishers, and editors), are generally quite uninformed about cartography, and as a consequence they buy what is already familiar. Since new plates, expert consultants, and new techniques are neither cheap nor do they guarantee income, the commercial map producer is naturally only too happy to peddle the older wares and reap an ever increasing rate of profit as long as possible.

The undue dependence upon convention and custom has been accompanied in many instances by absurd rationalization. Logical foundations for many of these conventions are commonly lacking. For example, Max Eckert-Greifendorff asserts that brown is the best color for terrain, contours, and land representation since "the fundamental color of the soil is brown as is especially evident in freshly tilled soil in the spring."³ This is the kind of "logic" which has tied cartography to convention. If his "logic" be analyzed he is actually claiming that the color for landforms and isohypses should be based solely on the B horizon of middle latitude humid forest and steppe-land soils. In any case it is difficult to see why contour color should have anything to do with soil color. Contours lie on the ground and the surface of most soils is either (a) black or nearly so (and covered with green vegetation), or (b) red (and covered with green vegetation), or (c) if visible, as in arid regions, a color ranging from grays through degraded yellows. Large areas of the earth have no soil cover. How much better it would be to determine contour color on the basis of (a) maximum transparency with solid body, (b) preciseness of definition, (c) degree of continuous tone produced by lines in juxtaposition, (d) lack of disharmony with other contemplated color use, and so on. Objective investigation may point to brown as the best color, but not because it is the color of "freshly tilled soil in the spring."

Tradition and familiarity maintain a strong hold. On the other hand, it is reasonable to expect that the developments in the science of vision and the spreading appreciation of the importance of design may combine with the marked increase of interest in cartography in recent years to promote more critical examination of many of the long standing conventions.

Considering the wide use of maps and their importance as media for portraying scientific fact it is indeed surprising that there has been relatively so little written on the cartographic technique. W. M. Davis complained that "maps are . . . indispensable . . . but they are inarticulate, and their silence seems to have affected their makers. . . . It is as if their expertness in the graphic expression of facts were accompanied by an atrophy of the faculty of

verbal expression following its disuse.”⁴ The reference to expertness may be open to question, but there can be no argument about the lack of critical written material on a large proportion of the technical aspects of cartography. Since small-scale maps are generally prepared with specific objectives in mind, it could be reasonably expected that, like any other practical creative field, such as architecture or even advertising, there would exist a body of principles and laws based on experience, experimental research, or logic which would govern the employment of the various structural materials. By reference to these principles one could, within the bounds of controversial interpretation, arrive at fairly accurate evaluations of the effectiveness with which the techniques and media accomplish their purpose.

The drawing of a parallel between cartography and architecture is instructive. Each lies in the field of the practical arts; each is older than history; and each, since its beginnings, has been more or less under the control of its consumers. The procedures of architectural and cartographic creation have been based on convention or artistic whim, and in many cases on well meant but ill-founded judgment. In general, functional inadequacies have been concealed beneath the guise of artistry, a standard form of refuge among many intellectual pursuits.

It is interesting and informative to draw such a parallel for we are witnessing what amounts to a revolution in the field of architecture. Modern building design, within the limits of conservative opposition, has become functional. It is now accepted that a structure will be planned and built according to the needs of its future users. It is not expected that the inhabitants or the weather will conform to the structure. Function provides the basis for the design. A similar revolution appears long overdue in cartography. The development of design principles based on objective visual tests, experience, and logic; the pursuit of research in the physiological and psychological effects of color; and investigations in perceptibility and readability in typography are being carried on in other fields. The more widespread use of maps, and the appearance of critical dissatisfaction lead to the conclusion that cartography cannot continue to

ignore these developments, and that such a movement in cartography cannot fail to materialize.

There are indications in the literature that such a functional approach is already receiving attention. Even as far back as 1933 the National Society for the Study of Education devoted its yearbook to geography and one chapter to map standards.⁵ This relatively unpretentious statement may well be the first American appeal for a truly functional approach to cartographic methodology. It specifically asks for investigations of the visual standards of maps and suggests as worthy subjects for research such topics as legibility, psychological effects of color, and clarity. Throughout the entire chapter the need for simplicity and the wider use of the special purpose map is stressed. Ten years later, during the war, a large number of cartographers in government service realized the visual inadequacies of conventional small-scale cartography, and devoted considerable thought to the subject of functionalism. A Committee on Cartography of the American Society for Professional Geographers, in drawing on that recent experience for the benefit of the academic aspects of the subject, summarized its conclusions in 1946 by pointing out that: "Greatest emphasis in a course on cartography should be placed on map design and planning as related to the purpose of the map."⁶

Although geographers and cartographers are prone to judge maps, the major portion of such functional evaluation is made, not in terms of the visual aspects, but in terms of the geographic content. It may be presumed as self evident that content is an obvious functional aspect of a map, and that neither its determination nor its evaluation is a matter of strictly cartographic method. One of the cartographer's greatest problems is the selection and generalization of the data with which he is working. How many contour lines to draw, how much to smooth them, what selection of rivers or towns to make, how to simplify a coastline, and many others, are perennial problems to the cartographer. Considerable importance has been attached to these functions in cartographic writing, and the very frequency of their appearance and concern to the cartographer (especially generalization) has fostered a tendency to

think of them as cartographic. All scientific endeavor is constantly faced with the task of evaluation and generalization, and cartography, rather than being an exception, merely follows the rule.

If we then make the obvious assumption that the content of a map is appropriate to its purpose, there yet remains the equally significant evaluation of the visual methods employed to convey that content. These graphic methods, together with the logic which binds them to their function and sets the limits of their utilization, constitute the cartographic technique.

NOTES

1. O. M. Miller, "An Experimental Air Navigation Map," *Geog. Rev.* XXIII (1933), 48-49.
2. John K. Wright, "Map Makers Are Human. Comments on the Subjective in Maps," *Geog. Rev.*, XXXII (1942), 542.
3. Max Eckert-Greifendorff, *Kartographie* (Berlin, 1939), p. 41.
4. W. M. Davis, "The Progress of Geography in the United States," *Annals Assn. of Amer. Geog.*, XIV (1924), 194.
5. A. G. Eldredge, A. W. Abrams, W. Jansen, and C. M. Shyrock, "Maps and Map Standards," *The Teaching of Geography*, 32nd Yearbook of the Nat. Soc. for the Study of Education. (Bloomington, Ill., 1933), Chap. 25.
6. American Society for Professional Geographers. Committee on Cartography. "Cartography for Geographers," *The Professional Geographer*, IV (1946), 10-12.