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THEMATIC-MAP GENERALIZATION*

O. M. MILLER AND ROBERT J. VOSKUIL

It is a truism that a theme requires a vehicle to carry it. Love and hatred mean nothing unless associated with people and objects. A map theme has no significance whatever until superimposed on, or embedded in, a geographical background. But here the question is, How much background? At a conference concerned with the kinds of information that should go on maps showing population distribution, a well-known geographer presented a long, carefully prepared list. When he had finished reading the list, someone asked him how he proposed to get all this information on one map. He replied, “That is none of my business; I’ll leave that to the cartographers.” So be it!

In compiling a small-scale map from a large-scale map, or a thematic or special-purpose map from raw statistics, most cartographers consider generalization to mean simplification or the elimination of unessential detail. More positively, generalization is a process of evaluation, selection, and emphasis. From these definitions there would seem to be two main types of individuals who practice this art. The first is timid and meticulous; the second, bold and intrepid. The first, influenced largely by his fear of leaving things out, is never good at generalization. Only the second can be truly successful, and only if he proceeds with the restraint of experience and preparatory thinking. The question arises, therefore, whether by rules and precepts the timid can

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* The authors of this paper offer no apology but, rather, a confession. Neither of us is expert at drawing a straight line or a complex curve. Although we are aware of the dangers of accepting spatial correlations at their face value, neither of us is a professional statistician. If left alone in a room with a two-color offset printing press and told to operate it, we should be terrified. Nevertheless, both of us, though working in different organizations, have for many years been closely associated with problems concerning the compilation, design, editing, and production of maps. Recently we had the opportunity to exchange our general ideas on these subjects, especially as they relate to generalization of information on small-scale thematic maps. We agreed so heartily that it seemed worthwhile to get our agreement down on paper.

Edit. Note. The present article is a slightly revised version of a paper presented by the authors at a meeting of the International Cartographic Association in Frankfurt am Main, West Germany, in September, 1962. In its original form it has been published under the same title in *Sonderdruck aus Nachrichten aus dem Karten- und Vermessungswesen*, Series 5, Number 4, 1963 (pp. 113–117), which is also Bulletin No. 3 of the International Cartographic Association. A German translation will be published in the *Nachrichten aus dem Karten- und Vermessungswesen*, Series 1, at some future date. Because of the broad interest and general applicability of the views expressed by the authors, it has seemed desirable to include the article in a journal of somewhat wider circulation—especially among geographers.

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be trained to be less timid, and the unreasonably venturesome can be made to contain their temerity.

Precept, Purpose, and Function

We make a distinction here between a rule and a precept. Semantically this may not be correct, but it is convenient. Rules are often desirable for compilers and cartographic draftsmen to ensure consistency of presentation in a uniform series of maps, but they are not necessarily good. As Thoreau has said: "Any fool can make a rule, And every fool will mind it." Precepts, on the other hand, should be regarded as general guidelines based on sound principles. The Ten Commandments are good examples of precepts. Because there are innumerable kinds of maps, there may be innumerable possibilities in the formulation of rules about the generalization of information. Perhaps the distinction between a rule and a precept in the practice of generalization is contained in the following precept: Do not make rules about the generalization of data except for maps whose scale and size have been stipulated and whose specific purposes have been clearly conceived.

Purpose, of course, is the factor of predominant importance. However, before we can discuss this intelligently, we must clarify some of our ideas concerning the functions of maps. No matter how hard we strive, no map can be made to simulate a landscape or an environment precisely. Therefore maps that achieve the purpose of presenting a theme cannot function as pictures, as, by contrast, aerial photographs do. Rather, and this is the critical point, maps are essentially means of communication in graphic form between intelligent human beings. Thematic maps present not only facts but ideas, hypotheses, and the results of analysis and synthesis. Often maps are the only means of communicating such information. Furthermore, maps may help to prove or disprove hypotheses, such as whether or not a spatial correlation between two distributions actually exists. Maps also may, and frequently do, point the way to further research.

The codification of information on maps by the use of symbols is not the result of our frustration in failing to achieve pictorial representation. On the contrary, it is the preferred method of transmitting information, because in cartography, as in mathematics, symbols can express relationships and convey information precisely and with the utmost economy of space. For the purposes of this discussion we assume that a map should be produced only when it is the best means of transmitting specific information; and we also assume that a thematic map on a small scale is devised with the principal
purpose of communicating special information in summary or abstract form. Such a map must be tailor-made.

We are all aware that to produce a successful thematic map the summarizing or generalizing process rightly starts at the planning stage and continues on through the steps of design, compilation, and drafting. But before planning can even begin, the source material must be sought out and appraised for its reliability and significance. This is an important branch of cartography in its own right. Here, however, we confine our attention to the graphic medium—the map itself. With this limitation, a precept born of experience is that in each of the steps of planning, design, compilation, and drafting, standards of accuracy, emphasis, conciseness, and truthfulness must be carefully maintained. But what are these standards? May they not conflict with one another, and do they not vary from map to map? Yes, they may, and they do. For this reason, and because a thematic map should be made intelligible and attractive to the particular groups it is directed toward, generalization is the most difficult skill in the art of map compilation, and, therefore, the most stimulating.

**Accuracy and Emphasis**

In the planning stage of a thematic map concepts of accuracy are not simple. Accuracy is controlled not only by the scale of the map to be made but also by the scales of the maps used as source materials, by the reliability of the basic information available, and by the relevancy of what is selected. A map is not necessarily more accurate because all the available data are used. In some cases positional accuracy may be of secondary importance. To take a familiar illustration, the main requirement of a road map is that the shortest or quickest or best routes between pairs of places be shown without error. On very small-scale road maps that show only important places many roads may be omitted without impairing the accuracy of what is shown. The important point here is that in planning it is necessary to determine first the kind of accuracy required and then the degree of accuracy necessary and sufficient to transmit the particular message that is the purpose of the map.

Even though a map is accurate, without the proper emphasis the transmission of information is not likely to be clear. The message will not be seen in sharp focus; even the basic accuracy may seem distorted. Cartographic emphasis can be divided into two main categories, statistical and graphical. Statisticians will probably object to the phrase “statistical emphasis,” because its use demands decisions concerning class intervals and group-
ings. However, the phrase serves a purpose here by pointing out that the development of proper emphasis must start during planning, though decisions made at this stage may have to be modified later by the requirements of the design. Poor emphasis usually is underemphasis—the essential information may be obscured through lack of sufficient generalization of the basic data or through lack of sufficient contrast between classes and groups. Or the essential information may be smothered by too much background detail, which creates clutter or, as communication engineers like to call it, “noise.”

Occasionally one comes across cases of overemphasis. A striking example was a gaudily colored map of the United States based on the 1930 census that showed, county by county, the degree of illiteracy. Solid black indicated greatest illiteracy. The southern part of the country was with few exceptions shown in solid black; so also were most of Connecticut and Rhode Island and all of New York City. The least illiterate areas were the Middle West and the Northwest. A first glance at this map left one aghast. However, when the fine print in the legend was read, the reader discovered that the black merely indicated areas with more than average illiteracy and that 95.7 per cent of the population was literate in 1930. Here was a clear-cut case of improper emphasis. A wrong impression was given with the utmost legibility.

Conciseness and Truthfulness

The conciseness with which data are presented contributes to the economy of a map. The map generalizer strives to communicate the essential information or knowledge in the briefest and most compact form, not only because this will cut costs, but because brevity is in itself a virtue. The probability that a business letter will be read is said to be increased if it is confined to a single page. Similarly, with reference to communication by means of a map, it can be contended that provided accuracy and emphasis are sufficient the smaller the scale of the map, the more likely it is to be read and understood. This may be a somewhat dangerous statement, because by decreasing scale we communicate less and less about more and more until finally we communicate nothing about everything. But for every planned thematic map there is probably an optimum scale. It is the task of the generalizer, by selecting, smoothing, and symbolizing, to make this optimum scale as small as possible. Unfortunately, as every experienced cartographer knows, overconciseness is often forced on him by economic, publication, or other considerations over which he has little control. But fortunately, he has many ways of indicating the shortcomings of the map, either on the map itself or in its legend or accompanying text.
We have introduced the word "truthfulness," as distinct from "accuracy," as an attribute of a map. What, then, do we mean by the term? Truthfulness implies more than an indication of the reliability of the source material. It involves a measure of responsibility and integrity in the compiler himself. It is, alas, only too true that statistics can be manipulated to serve a purpose and that facts can be juggled. The conscientious compiler and designer of a thematic map must constantly remind himself that there are many sins, both of commission and of omission, which he may be tempted to commit, either through laziness or through conscious or unconscious prejudice. Truthfulness in a map, therefore, reflects the dedication of the map compiler to the task of communicating results or conclusions without bias. A truthful map may have moderate accuracy, and a highly accurate map may fail completely to convey its intended message truthfully. As Joseph Glanvill observed several hundred years ago: "Truth, like a point or line, requires an acuteness and intention to its discovery."

**The Problem of Manuscript Maps**

Many published thematic maps are based on sketch maps provided by the authors of articles and books. These sketch maps differ enormously in quality of concept and execution, and it is necessary for map editors to adopt a highly critical attitude toward them. Some are excellent, requiring little but redrawing; others require the whole process of planning, designing, and drafting before the authors' intended messages are communicated satisfactorily. At times, even the messages themselves must be questioned with respect to purpose and validity. Map editors must therefore acquire a certain ruthlessness. Often they must be willing to offend the pride of authorship. For example, many authors think that their sketch maps cannot justifiably be reduced in scale and that the intended messages cannot be communicated without the extensive use of color. They are surprised—and usually pleased—to find that their objectives have been realized even when, as frequently happens, the reproduction scale is one-sixth or even one-eighth of the manuscript scale and the map is printed in black and white. A recent example is interesting. For a paper describing two different concepts of an areal distribution each author submitted a manuscript map with zonal classifications in several colors; the equatorial scale was approximately 1:15,000,000. Eventually the two maps were published on one sheet at the equatorial scale of 1:60,000,000 and in two colors only.

The American Geographical Society has recently embarked on an ambitious project known as the *Serial Atlas of the Marine Environment*. Each issue
consists of a folio in which maps accompanied by text and figures present an analysis of observed data concerning a particular aspect of the marine environment. The primary purpose of the program is to provide a medium for the cross-fertilization of ideas by intercommunication between scientists in various physical and biological disciplines working in the field of oceanography. At present, coverage is limited to the North Atlantic and the Arctic Basin. One example is sufficient to indicate the kind of problem that is being encountered in the planning of the series and to illustrate the caution a cartographer must employ in order not to oversell the map form as the best method of communicating all types of data for all purposes. A folio has been prepared to show the temperature regime at the 200-meter depth. This is a critical depth because, for the most part, it is the boundary between waters having large seasonal variation in temperature and those having little variation. Although isotherm maps for this depth had been prepared before, the recent rapid and vast accumulation of observations made the interpolation of isotherms more reasonably accurate. The data were presented in three series of manuscript maps. On the first, three numbers were shown in each degree of latitude and longitude; these indicated average, maximum, and minimum temperatures. In addition, isotherms of average temperature had been interpolated. On the second series of manuscript maps the temperature ranges were shown by means of isolines. On the third the number of observations, the number of months during which they were made, and the seasons of the year in which they were made were given for each degree area. The first and third series of maps presented an intolerably cluttered appearance. Although it was considered important that the supporting numerical information be published, it was decided that most of it should be taken off the maps and put into simple tabular form in an appendix. Here is a case where the map form was not entirely the best medium of communication.

In circumstances such as these, an author who intends to present thematic maps for publication should be urged to consult with the publisher's editorial and cartographic staff before, rather than after, the preparation of his manuscript. Although the author may have a clear conception of the nature of the message he wishes to communicate, and adequate knowledge of the availability of raw data and their relevancy, he may lack the cartographic sophistication to appreciate the problems incurred in the generalization of his theme into mappable form with the appropriate statistical and cartographic emphasis.

Training and Application

We now return to the question facetiously posed at the beginning of this paper concerning the training by rule and precept of the timid and the in-
trepid in the art of generalizing. More seriously, can training in generalization be furthered by classroom lectures or textbooks? We believe it can be, and should. There are a considerable number of competent professional map generalizers in the United States, among them a corps of free-lance individuals who supply generalized maps to newspapers and other publications. Many of these are self-trained. Moreover, there are excellent map generalizers who were indoctrinated into the art by meeting the particular and diversified needs of governmental and private mapping establishments. But there is undoubtedly a need in this country for greater emphasis, in introductory courses in cartography, on the principles and precepts of generalization. These courses should be not only for budding geographers and cartographers but also for all those whose work will lie in the physical, biological, and social sciences. Practitioners in these fields should have an understanding of the principles of generalization and should be able to prepare adequate sketch maps to illustrate their technical papers.

We conclude, then, that thematic-map generalization does require the application of “precept upon precept; line upon line . . . ; here a little, and there a little.” But every thematic map presents a special problem. Although the objective of the map must be kept constantly in view, freedom of expression must be permitted. Because practical experience combined with common sense and a flair for the subject is the essential requirement for successful generalization of information, perhaps in this paper we have overemphasized the importance of precept. We must remind ourselves of Samuel Johnson’s dictum, “Example is always more efficacious than precept.”