

MAP DESIGN

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INTRODUCTION

The basic philosophy toward map design derives from the fact that designing is a decision making process. The cartographer is essentially an engineer attempting to construct a visual device which will effectively communicate geographical information to a percipient. The perception of a graphic display is a total reaction quite unlike sequential oral and written language. The construction materials for a map are the visual variables and he must know the perceptual consequences of their variation. The cartographer must analyse the purpose and the audience of a map with care, make his presentation as simple or possible, and be entirely concerned with the percipient.

MAP DESIGN

I shall begin by reminiscing, and I have a reason for being personal. Last spring, when I was asked to talk to you on the subject of map design, the combination of autumn in Washington, D.C. and a paper on map design seemed vaguely familiar. Long after I had prepared my remarks for this morning, I dug around in some old files, and what had lurked in the back of my mind turned out to be a paper delivered to the then newly formed Washington Geographers Club 33 years ago next Monday night. The title of that paper was "Design as a Technical Problem in Map Making."¹ Some of it is rather apt even now. Quoting from one's self is usually an indication of an inflexible attitude, an unhealthy state for a scholar, but on this subject I have not changed my opinion.

"The designing of maps has received little or no ordered examination, yet I know of no phase of cartography which is in greater need of study. In this emergency of wartime many directives are being presented pleading for

EDITOR'S NOTE: Professor Robinson served as honorary co-chairman of the Auto-Carto II Symposium. Currently president of the International Cartographic Association, the author received the Ph.D. from Ohio State University in 1947. During World War II he directed the Map Division, OSS. At the University of Wisconsin since 1946, he is past director of the Cartographic Laboratory and is Lawrence Martin Professor of Cartography. He is the author of The Look of Maps, co-author of Elements of Cartography, and has published numerous scholarly papers. A former president of the Association of American Geographers, he is a life member of ACSM. Former chairman, Cartography Division, he is currently editor of The American Cartographer.

brief, clear, concise reports. Speed is of vital importance. Unfortunately, in the field of cartography speed has been analyzed primarily from the production viewpoint. However, speed of consumption is just as important in the presentation of intelligence data. No busy intelligence officer, strategic adviser, or economic analyst appreciates a product requiring more consumption time than is warranted in relation to the value of the information. The depiction of economic-geographic data becomes therefore a problem of visual design. Speed of consumption is dependent upon good design, and when the final word is said concerning any map, it has served its purpose only if it has been well presented and well designed. The cartographer should think of himself as a kind of salesman of a visual product, the virtues of which should be quickly comprehended and easily retained."

Now let me jump ahead 33 years. Just a week ago I attended an International Symposium on Communication in Cartography held in London to which a variety of specialists contributed. Sometimes it helps to see ourselves as others see us. (When one does, -- and I can't resist the pun, sometimes one gets Burned!) The following is a case in point. A psychologist opened his paper on the legibility of relief maps with some observations on the competence of cartographers in communication.^{2/} He began with an analogy.

He asked his listeners to picture a man who had the job of designing an automobile, but for some reason he had no technical data available to him. The designer knew what an automobile was, of course, but he had no data on how the car worked with particular engines, or the adaptability of the car, its aerodynamics, etc. The psychologist further observed that the unhappy engineer had no idea who might purchase the car or the kind of individual who would drive the car or on what kinds of roads the car would be driven. He suggested that, although this might seem to be a "ludicrous picture," it seemed to him to be almost the norm for designing a map. He asserted that most cartographers seem to design their maps without any understanding of who the users will be, where, when and how the users will read the map and without much technical information about the way the map design may affect the users efficiency.

My reaction was that the psychologist was overly harsh. We cartographers have learned a good deal in the past 30 years, but perhaps we haven't spread the gospel as well as we could. It might help if we had among us a kind of cartographic Billy Graham, or if we were to open each technical meeting with a rousing rendition of some cartographic spiritual. Two appropriate titles come to mind!

"Nobody Knows the Trouble We've Got with Double Color Coding"
"From Out of the Ground the Figure will Rise"

There is no way, of course, that we can cover completely the complex subject of map design in the short time available this morning. Instead, I propose to present what appear to me to be the basic elements of an essential philosophy toward map design. Some 20 minutes ordinarily would not be enough to develop and justify a philosophical point of view. Fortunately, however, there is, I think, general agreement on a good many matters having to do with map design, which in itself is a mark of progress, and I need not waste much space on them. It is also necessary to narrow the scope since the general term 'design' is very broad and 'map' now seems to include everything from the tactile maps of John Sherman to the perspective views of a statistical surface available through a plotter or a CRT. Although my general remarks will refer to all kinds of design activity, I will stress the graphic component. Furthermore, I will focus primarily on design in thematic cartography.

Because it will help to emphasize an important point about map design I would like to face the question of what it is about a map that makes it a thematic map. Thematic maps are usually contrasted with general maps, and there is no question that general maps, such as topographic and atlas reference maps, are quite different things than thematic maps. Barbara Petchenik and I have considered the theoretical foundations of this at some length, and we are prepared to argue the position that fundamentally, a general map attempts to present simultaneously a set of diverse phenomena about some area, while a thematic map tries to portray the structural characteristics of some particular geographical distribution, such as population density, freight rates, or bedrock geology.^{3/} These are fundamentally very different objectives. Because a map is concerned primarily with one topic, such as soils or vegetation, does not make it a thematic map. There are a great many such maps which fall in the general class. The pure general map and the pure thematic map lie at the ends of a theoretical continuum. Of course, many maps combine some of the characteristics of each class. Often this is intentional and appropriate. But very often it happens because the cartographer was fuzzy about his objective and was designing intuitively. Map design is fundamentally a decision making process, and decisions are more likely to be good if they are rational rather than intuitive.

Since I am already sounding like a preacher it is appropriate that I have a text. Since the subject is map design, it is also appropriate that the text be cartographic. As a text, then, I would like to show you three maps, partly because they illustrate a basic theme in my remarks and partly because I think this audience will find them intrinsically interesting.

The first map, so far as we now know, is the first printed choropleth map. It was made by Baron Charles Dupin and appeared in 1827.^{4/} He employed a manuscript version in an address to the Conservatoire des arts et metiers in Paris in November 1826 on the general subject of popular education and its relation to the prosperity of France. The map has many points of historic and cartographic interest; although that is not our concern here, let me point out a few. The statistic in each departement is masculine chauvinistic and curious. It is derived by dividing the total population of the departement by the number of male children in school. The smaller the figure presumably the more enlightened the population and the lighter the tone. The tones, which were obtained by lithographic engraving, were intended to correspond exactly with the statistics, that is, they were not grouped or classed. As you can readily see, the cartographer made a poor choice of technique because the engraver did not have control of this medium. Today, choropleth maps without class intervals can be produced by automation, as Waldo Tobler has shown.^{5/} Whether it is a good thing to do is an appropriate question.

The second map is one on the very same subject published in 1832 by Adolph Quetelet, the great Belgian statistician.^{6/} Quetelet specifically did not like the choropleth technique Dupin had used (devised?), and he conceived this alternative method which he hoped would more effectively show the structure of the distribution. Although it has the appearance of being a shaded relief map of a statistical surface, it is not that at all. The best way to characterize it in terms of present techniques is that it is a sort of continuous tone dot map. Again, the lithographer did not have control over his medium, crayon shading, and the map came out much too dark. A more successful attempt using the same technique on another subject, incidence of crimes against persons, is another of Quetelet's maps published a year earlier in 1831.^{7/} These are just two of many possible ways of mapping these kinds of data.

The cartographic text to be derived from these early statistical thematic maps may be summarized in two assertions:

1. The map designer is in charge and he must control his media. If a map is a disaster it is not the technician's fault; it is the designer's.
2. In most instances the designer has a great variety of options, not only on the symbolic system to use but on a whole host of subsidiary graphic elements.

Now that we have put the responsibility for all the decision making squarely on the cartographer, let us look more in detail at the various aspects of map design.

It is helpful to define design, and I like the definition by J.F. Blumrich.^{8/} Shortened and paraphrased a bit it is:

"Design develops solutions to and structures for problems not solved before or new solutions to problems which have previously been solved a different way."

There are two key elements in that definition. One is the implication that it is likely that there is more than one solution. It is imperative that a designer keep his imagination active. The second, and the most important point, is that the designer, in the sense we are using the term, is faced with solving a problem. In that sense the cartographer is clearly an engineer. Just as no engineer can erect a proper structure or solve any other problem unless he knows what the function of the structure or the nature of the problem is, the map designer cannot possibly solve his design problem unless he has carefully settled on the purpose of the map he is going to design. Careful attention to the communicative aspects of the map, including an assessment of its audience, and appraisal of all the technical capabilities available for its production are primary components of the cartographic problem. When these are clearly defined, only then can the cartographer make decisions rationally.

It is difficult to focus specifically on some of the more general aspects of map design because they are all interwoven. To consider objective without considering the audience is to leave out an important element, but in order to examine the process we must stand off and look at various parts. Let us look at a number of these components in a little more detail, and in the manner of a good preacher I will offer a few comments and perhaps a few precepts.

Settling on a purpose requires considerable analysis of the functional context of the map. Is the map to be studied in a textbook for various reasons or is it simply to make clear to a selected audience the basic structural character of a geographical distribution that would not be apparent if the data were only made available in tabular form? Is the map to show the detailed complexities of the configuration of a distribution (thematic) or is it to provide only a suggestion of form along with geographically located numerical information (general)? All the pros and cons of all the possibilities must be assembled; it is not easy, but it is absolutely essential to good design. If one doesn't know exactly what one is trying to do, it will only be by chance that a particular purpose will be accomplished.

The primary objective of any map is, of course, to communicate. To be sure, even today there are maps which are mainly aesthetic in that their decorative character is a paramount. This aspect of cartography was more important in past time than today, but in any case, things aesthetic lie largely in the domain of intuition and in most instances cannot be approached rationally. Since most cartographers have had little familiarity with the graphic arts, I think it is safe to say that most map-makers are better advised to approach map design rationally rather than intuitively.

The main idea behind the communication objective is to evoke in the mind of the percipient or map viewer an understanding of the geographical relationships attending the distribution being mapped.^{9/} Just how this can be done is a very complex question to which we are just beginning to learn the answers. Even though we do not know in detail the nature of the perceptual processes involved in communicating about the geographical milieu, some things are clear.

The perception of a graphic display in two or three dimensions is entirely different from the communication accomplished verbally or by the written word. Unlike oral or written communications which come to us in a given sequence, a graphic display appears to us as a unified structure with a total meaning rather than as a summation of its different parts. This means the cartographer must go about much of his graphic designing in a way that is likely to be rather foreign to him. Some aspects are not unfamiliar. For example, there is a good deal of analytical thinking involved in settling on the purpose of a map and in choosing the particular symbolic system to be used. Most cartographers are comfortable with this aspect because they come to mapmaking from scholarly backgrounds where systematic analysis and synthesis are normal patterns of thinking. On the other hand; in the graphic arts the totality of impression is the primary objective, and most cartographers have not been trained to cogitate in this manner. Perhaps, this is why some of the maps made by artists in slick magazines look so different and are often so much more interesting than many of ours.

For communication to occur we need to be able to predict the perceptual consequences of the way we use the marks we put on a map. I refer to the "visual variables," a term introduced by Jacques Bertin. Basically, the mapmaker has available to him a set of marks which can be varied in graphically distinct fashion. Bertin lists six in addition to the two dimensions of the map space: shape, size, value (tone), pattern, color, direction, location.^{10/} Psychologists for a long time, and cartographers more recently, have been investigating the psychophysical dimensions of these visual variables. In some instances we can come quite close to predicting responses to the varying stimuli, as for example, in the tones of equal value scale, the equating of some symbol shapes, responses to circle size, and so on. There are a great many more, especially in the area of color, which are less well known. We do know a surprising amount, however, and as more studies in perception are made, in other fields as well as cartography, we will be more and more able to manipulate skillfully the visual variables in order to attain the communication objective.

One problem in settling on the purpose and audience is the question of how much variation in use to allow for. Some mapmakers appear to be overly concerned that someone may use a map in ways other than for the specific purpose it was made. In consequence a variety of things are often added to provide for the possible desires of what we can call a secondary audience. I refer to such things as geographical detail, additional place names, boundaries, transportation routes, graticule, etc. Generally speaking I think this is a mistake; a thematic map is best when it is straightforward and to the point. Singleness of purpose in thematic cartography seems to correspond to simplicity in art. As pointed out by Arnheim ^{11/} simplicity seems generally to be a virtue in artistic design, and Blumrich assumes it to be desirable in engineering.

It is fitting to bring these remarks on map design to a close with an observation which at first seems not at all creative. In his esthetic analysis of works of art, Helmholtz pointed out that although beauty is subject to laws and rules, the laws and rules are not consciously present either in the mind of the artist or the observer.^{12/} He goes on to say that a work of art ought to have the appearance of being undesigned. Similarly, if a percipient looks at a map and exclaims on its

graphic design, it is obvious that he is straying from the geographical objective of the mapmaker.

It is not normally good practice to conclude on a negative note, either pedagogically--or spiritually. But it is not really negative to assert that the design of a map should not be apparent. What that really means is that the map designer should be like a truly humble samaritan. He should make his decisions, and do his designing, not to please himself; instead he should give all his attention to the other guy.

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