MAP MAKERS ARE HUMAN
COMMENTS ON THE SUBJECTIVE IN MAPS

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LIKE bombers and submarines, maps are indispensable instruments of war. In the light of the information they provide, momentous strategic decisions are being made today: ships and planes, men and munitions, are being moved. Maps help to form public opinion and build public morale. When the war is over, they will contribute to shaping the thought and action of those responsible for the reconstruction of a shattered world. Hence it is important in these times that the nature of the information they set forth should be well understood.

Certain implications of an obvious fact will be discussed in this paper—the fact that maps are drawn by men and not turned out automatically by machines, and consequently are influenced by human shortcomings. Although this fact itself is self-evident, some of its implications are often overlooked. The trim, precise, and clean-cut appearance that a well-drawn map presents lends it an air of scientific authenticity that may or may not be deserved. A map may be like a person who talks clearly and convincingly on a subject of which his knowledge is imperfect. We tend to assume too readily that the depiction of the arrangement of things on the earth’s surface on a map is equivalent to a photograph—which, of course, is by no means the case. The object before the camera draws its own image through the operation of optical and chemical processes. The image on a map is drawn by human hands, controlled by operations in a human mind.

Every map is thus a reflection partly of objective realities and partly of subjective elements.¹ No map can be wholly objective. Even a photograph

¹ This topic is dealt with implicitly in all works on the art of cartography, but it has seldom been considered explicitly as a subject in itself. See, however, Max Eckert: On the Nature of Maps and Map Logic, Bull. Amer. Geogr. Soc., Vol. 40, 1908, pp. 344-351, especially p. 347.

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taken vertically downward (not a map but akin to one if the terrain imaged is flat) is subjective, in the sense that the photographer’s choice determined the tract of country shown in it and also the time of day when the film was exposed and thus the aspect of the shadows appearing in the picture. Likewise, no map is wholly “nonobjective,” as some forms of painting and sculpture are said to be. Even a map of an imaginary country is objective, in the sense that the mountains, roads, towns, and so on that it pictures were suggested by corresponding objective things in the real world.

The maps produced by governmental surveys or made in the field by explorers are more or less directly copied from nature. As in the case of the memoirs and letters written by those who have participated in historic events, their quality is influenced by the experience and powers of observation of their makers. A topographic map drawn by a man familiar with geology and physiography is likely to be far more expressive of relief and drainage than one drawn by an untrained observer, just as the memoirs of an experienced statesman are likely to present a more truthful record of an international conference than those of some inexperienced journalist. Many maps, however, are not drawn from nature but are compiled from such documentary sources as other maps, surveyors’ notes and sketches, photographs, travelers’ reports, statistics, and the like. As these sources are themselves man-made, the subjective elements they contain are carried over into the maps based on them. In the following paragraphs maps will be considered in the light of the effects on their sources and their compilation of certain mental and moral qualities: scientific integrity, judgment, consistency, progressiveness, and their opposites.

**Scientific Integrity**

Fundamental among these qualities is scientific integrity: devotion to the truth and a will to record it as accurately as possible. The strength of this devotion varies with the individual. Not all cartographers are above attempting to make their maps seem more accurate than they actually are by drawing rivers, coasts, form lines, and so on with an intricacy of detail derived largely from the imagination. This may be done to cover up the use of inadequate source materials or, what is worse, to mask carelessness in the use of adequate sources. Indifference to the truth may also show itself in failure to counteract, where it would be feasible and desirable to do so, the exaggerated impression of accuracy often due to the clean-cut appearance of a map. Admittedly this is not always easy of accomplishment.
A map is not like a printed text, in which statements can be qualified with fine shades of meaning. One cannot, on the face of a map, cite the evidence used and discuss its validity. A town or a mountain must be shown in one place, even though three sources of apparently equal validity may locate it at three different places. Nevertheless, there are certain ways in which the map maker can, within limits, modify the definiteness of his commitment. If he is not sure of the courses of rivers or if contours are approximate form lines only and are not based on actual field surveys, he can at least show them by broken lines. He can introduce question marks or, as on marine charts, such challenging letters as P.D. (position doubtful) or E.D. (existence doubtful) alongside islands and shoals. Another device is to include in the margin of the map a small diagram of the region showing the character of the surveys and other sources on which the map is based—a "relative reliability" diagram. This accomplishes to some extent what the careful historian or economist does with qualifying phrases in his text and appended critiques of his sources. Although this device is not often used at present, it may someday become a standard practice in cartographical scholarship where maps, especially maps covering considerable tracts of territory, are based on different source materials of varying validity.

Beware of maps prepared to substantiate a pet theory! There is a well known type of reasoning that begins with a theory, gathers statistics and other data that seem to support it, makes a map on the basis of the statistics, and finally "proves" the theory by reference to the map. The dishonesty in such a procedure may be unconscious, but there is a large use of maps in propaganda with a view to conscious and deliberate deception in the service of special interests. The relative areas of different regions as disclosed on maps in railroad timetables are usually deliberately distorted so as to show particular railroad systems to best advantage. More subtle and dangerous is the type of deception found on maps designed for propaganda purposes—maps on which facts are played up or played down, omitted or invented, for nationalistic ends. Hans Speier has recently dealt with this subject in a paper entitled "Magic Geography."

Today, maps are distributed on posters and slides, in books as propaganda atlases, on postcards, in magazines, newspapers and leaflets, in moving pictures and on postage stamps.

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2 Such diagrams appear on the sheets of the American Geographical Society's Map of Hispanic America, 1:1,000,000, and have now been accepted as standard for the International Map of the World, 1:1,000,000.

3 Social Research, Vol. 8, 1941, pp. 310-350; references on pp. 310-311 and 316.
Maps are not confined to the representation of a given state of affairs. They can be drawn to symbolize changes, or as blueprints of the future. They may make certain traits and properties of the world they depict more intelligible—or may distort or deny them. Instead of unknown relationships of facts they may reveal policies or illustrate doctrines. They may give information, but they may also plead. Maps can be symbols of conquest or tokens of revenge, instruments for airing grievances or expressions of pride.

Speier analyzes the ingenious manipulations of design and color to be found on some of the “geopolitical” maps issued in the interests of totalitarian propaganda. For example:

On a map to illustrate the repatriation of Germans who had been living in Latvia, the German minority about to return to the fatherland is represented by a row of thirteen identical symbols, each standing for five thousand men. The symbols extend over the whole area of Latvia where it is widest, from Libau in the west to the eastern border. The size of the symbol is so chosen that the country seems to be populated by Germans, whereas, in point of fact, the German minority amounts to 3.7 percent of the total Latvian population.

Speier exposes the more blatant forms of propagandistic maps intended to influence the masses. Nationalistic bias may also reveal itself in detailed maps published in serious books and learned periodicals. Superficially these may seem to have been prepared according to sound scientific principles. They may accurately record accurate statistics, but with a symbolism devised to overemphasize the distribution of one people or language or religion or set of institutions. Assume, for example, that the frontier province of Pomeria, which formerly belonged to Sudia, was annexed by Nordia in the last war and that a recent census has shown that half of the population of Pomeria are Nordians and half Sudians. The Nordians are concentrated in the towns, the Sudians form the bulk of the rural population. On a detailed map of Pomeria in the Bulletin of the Sudian Geographical Society the areas where less than 10 per cent of the total population is Sudian are left white and those where more than 90 per cent is Sudian are shown in dark red, with intermediate gradations of lighter red to bring out intermediate percentages. Clearly most of the map would be red, giving an impression of a preponderant Sudian population. In 1925, in his great work on cartography, Max Eckert4 discussed this particular type of deception, which he asserted had “recently been propagated on certain non-German maps,” notably “maps showing the languages and the plebiscitary vote in Upper Silesia, which were drawn neither by German hands nor in the German scientific spirit.”

JUDGMENT

Fully as important as scientific integrity in the making of maps—indeed, largely a function of scientific integrity—is judgment. This embraces critical acumen in the selection of source materials, discrimination in the use of techniques, taste in choice and arrangement of colors, symbols, lettering, etc., and, throughout, a feeling for consistency.

As maps are only rarely accompanied by relative-reliability diagrams, critiques of their sources, and explanations of the graphic techniques by which information is disclosed on them, it is not always possible to test the quality of the judgment that has gone into their construction. The essential accuracy of certain types of map, however, can be taken on faith. One hardly needs to question the basic reliability of the charts and topographic sheets issued by governmental institutions such as the United States Coast and Geodetic Survey and the United States Geological Survey, whose high standards are well known. On the other hand, it is not safe to take on faith the reliability of the average reference map, atlas map, or statistical map. A general reference map can usually be spot-checked by comparison with good maps of the same region on larger scales, and a statistical map spot-checked against the sources if these can be identified and found. Whether or not such tests need to be carried out depends, of course, on the uses to which a map is to be put. A map exact enough for measuring the air-line distance from Boston to New York may be quite unsuitable for measuring the total length of the Maine coast line. In general, unless one has solid ground for confidence in the integrity and judgment of the makers, detailed information derived from maps should not be incorporated in other maps or used as a basis for conclusions and decisions of importance. The fallacy of overrefined inferences from maps should be carefully avoided. One can with good reason accept the general over-all picture that a map presents, but this does not mean that the map in its every particular presents the gospel truth.

SIMPLIFICATION AND AMPLIFICATION

Although a map's reliability is no higher than that of its sources, it may be considerably lower unless good judgment is exercised in its compilation. In this process the "raw" information provided by the sources is transformed by the cartographer. Two operations may be carried out. If the "raw" information is too intricate or abundant to be fully reproduced to

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*See R. S. Patton: The Physiographic Interpretation of the Nautical Chart, Geogr. Rev., Vol. 17, 1927, pp. 115-127, on the "limitations to which all charts are subject."
the scale of the map as it stands, it may be simplified and generalized. If it is too scanty, it may be amplified and elaborated. Similar operations are performed in all fields of investigation. For example, where the records yield scanty details, as for ancient times, the historian seeks to fill in the gaps on the basis of inference and conjecture. Where the information is superabundant, as for modern times, he selects. In both cases he does not copy the sources but gives a partly subjective interpretation. Frequently he must both amplify and simplify in the same study. So, too, one part of a map may be the result of amplification of the sources, another part the result of simplification.

For most general reference maps the sources are simplified and generalized to some extent by the removal of minor irregularities in coast lines, railroads, slopes, etc., as well as by the omission of many features—towns, hills, mountains, lakes, etc. If the process of simplification and generalization is not carried out consistently, the results may be misleading. Sometimes one category of information is simplified to excess in relation to another. For instance, the omission of stream lines where form lines or contours are reproduced in detail may give an erroneous impression of dry watercourses. This is an inconsistency found even on standard atlas maps. There is also inconsistency where specific information is more radically simplified on one part of a map than on another. Such inconsistency is sometimes necessary on even the best of general reference maps to avoid overcrowding; for example, where, in the more densely settled regions, towns much larger than those shown in the sparsely settled regions are omitted because there is no room for them. In such cases the map maker must use his discrimination in deciding what to omit, and his map, although it may gain in legibility and beauty, will lose in reliability, at least with regard to the specific distributions that are inconsistently shown.6

Amplification of the information provided by the source materials is the addition of details regarding the exact location of which the sources fail to provide precise evidence. Amplification is, of course, wholly unjustifiable where there is no sound evidence of the existence of the details added, as where an unsurveyed river is shown with sinuosities in the sincere belief that they are more "natural" than a straighter course would be. If,

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6 On its new Map of the Americas, 1:5,000,000, the American Geographical Society has attempted to reduce such inconsistency by showing all towns of more than a certain population selected on the basis of what it was possible to show on a map of that scale in the most congested areas and then adding elsewhere such places of smaller population as are important, as road and rail centers and ports.
however, reliable observers report having crossed the river at several points, the careful cartographer need not omit it from his map because he has little to guide him in drawing its exact course. It is usually preferable to plot the river by conjecture, in the light of whatever evidence there may be. On maps designed for certain specific uses, such as air navigation charts, too much of the conjectural may be seriously confusing; but, in general, amplification of the sources, when done critically, is misleading only when the users of maps draw overprecise inferences from the features that have been amplified, and such danger is obviated if these features are represented by broken lines (Fig. 1).

**Quantitative Information on Maps**

Quantitative information shown on maps is peculiarly affected by the operations of amplification and simplification. By quantitative information I mean here information regarding the distribution of quantities of varying intensity. Contour lines, of course, provide such information. Statistical maps, or maps the purpose of which is to provide quantitative data, are essential tools in geography, climatology, oceanography, demography, and other branches of the natural and social sciences. They are also frequently consulted by the general public in atlases, magazines, and popular books. They are so widely used that it might be well if their comparatively high degree of subjectivity were more generally recognized than it is.

Certain terms must first be defined. One way of setting forth quantitative data on a map is simply to copy from the sources numbers giving heights, depths, populations, etc. As this gives no visual impression of relative magnitudes, the more usual method is to show quantities by means of symbols. Three kinds of symbols may be used: point symbols, isopleths, or spatial symbols. A point symbol is a dot, disk, cube, sphere, or other geometrical figure of conventional form that represents a specified quantity; an isopleth is a line that represents a uniform quantity; and a spatial symbol is a color, shading, ruling, geometrical pattern, or the like that represents either a single specified quantity or a range of quantities between two specified limits.

Now it is obvious that the quantities the symbols represent—the "mapped

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Fig. 1—These maps illustrate the processes of simplification and amplification of cartographic source materials (see text). The upper map, which shows a part of the Andean region of southern Peru, is reproduced from the Lima sheet (South D-18) of the American Geographical Society’s Map of Hispanic America on the Scale of 1:1,000,000. The lower map is from one of the unpublished field sheets of the topographical survey made by the Peruvian Expedition of 1912 (scale 1:56,360; contour interval, 200 feet) used in the compilation of the area marked “1” on the upper map: this particular section lies to the northwest of the figure “1”. Area 2 on the upper map was compiled from various large-scale topographical surveys made for the study of railway routes, including a survey on the scale of 1:48,000 carried out by the International Railway Commission in 1893. Area 3 was filled in from various compiled maps on which no contours appear.

As suggested by comparison with the lower map, the data appearing in the original sources for Areas 1 and 2 has been simplified; drainage patterns appropriate to the scale of the Millionth Map were selected; only the contours prescribed by the scheme of the Millionth Map are shown, the other contours being eliminated.

For Area 3 the details from the cartographic sources were adjusted to the adjoining topographical surveys covering areas 1 and 2, which also furnished guidance for the pattern of the formlines shown by broken lines. The relief as represented thus reflects amplification of the sources.
Fig. 2—These "maps" show how differently the same quantitative distribution may be mapped. The numbers in A are "control quantities" (see text). Each number might represent either a "locational control quantity," such as an altitude, or a "spatial control quantity," such as the density of units in the square in which the number stands. In B and C isopleths have been drawn with reference to the numbers by interpolation and spatial symbols ("choropleths") have been placed on the spaces between the isopleths. In C the class intervals between the isopleths are equal, whereas in C they are narrower at the lower end of the scale, widening toward the upper end. Thus B presents less information with regard to the areas of lesser intensity and C less with regard to those of greater intensity. On E and F, where the densities are shown by "choropleths" or spatial symbols plotted with reference to the squares, the same difference appears. (D is merely an aid to comparison of E and F; for the areas shown in solid black on D, E provides more information than F, and for the areas ruled on D the reverse is the case.) The densities in each of ten larger spaces (bounded by heavy lines in A) are plotted by choropleths on G (which, of course, gives a far less adequate picture than either of the other maps). On H the distribution of units is shown by dots placed by an assumed "amplification" of the statistical information so as to bring out something of an assumed character of the distribution within the squares. I is a density map similarly constructed.

The following incorrect assumptions, which might easily be based on examination of the symbols on these maps, illustrate the "fallacy of overrefined inferences from statistical maps": (1) that the actual density in square a on E is more nearly like the density in b than like that in c; (2) that the densities in the spaces a on F and G are less than those in the spaces b.
quantities," that is—seldom correspond precisely to the quantities as given in the sources. As the latter guide or control the map maker in selecting the appropriate symbols and in placing them on his map, they may be called "control quantities." The mapped quantities are almost invariably simplifications or generalizations of the control quantities. For example, a point symbol may show that a city has a population between 500,000 and 600,000, whereas the population according to the census—a control quantity—may be 578,341. From isopleths one might determine that a given point was between 20 and 40 feet above sea level, whereas a bench mark at that point would show its altitude to be 32.5 feet.

A distinction must also be made between "locational quantities" and "spatial quantities." A locational control quantity is one that indicates the intensity of some condition at a "control point," such as the altitude of the point or the temperature or barometric pressure recorded there. Locational control quantities are usually determined by instruments and may be shown by point symbols of graded sizes, though more frequently isopleths (for example, contour lines, isotherms, or isobars) are used. A spatial control quantity is one that applies to the whole of a given space, the "control space" (usually a political division); for example, the population of a county. Spatial control quantities are usually determined by census or other enumerations rather than by instruments. Point symbols are properly employed (as on "dot maps") for showing total quantities; spatial symbols are more appropriate for showing spatial ratios. A spatial ratio may be the ratio of a certain quantity in a space either to the area of the space (for example, density of population) or to some other quantity in the same space (for example, income per capita, birth rate per 1000 persons).

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8 In dealing with matters of this sort confusion may be avoided by calling any given part of the earth's surface a "space" rather than an "area" and using the latter term with reference to size only. In this way one avoids having to refer to the "area of an area."

9 Spatial symbols may be bounded either by the limits of control spaces or by isopleths. Symbols of the former type, which represent quantities as actually determined for subdivisions of the region mapped, have been called "choropleths" (Wright, op. cit., p. 14; see also Erwin Raisz, General Cartography, New York and London, 1938, pp. 246 and 247); those of the latter might be called "chorisopleths" (for example, hypsometric tints, shadings bounded by isotherms).

10 On statistical maps one occasionally finds "isopleths" that indicate roughly the distribution of spatial ratios. Spatial ratios, however, cannot be determined with respect to points, but only with respect to spaces. Hence a line that purports to pass through points at which spatial ratios are equal actually represents "quantities" that do not exist. For "iso-" lines of this type the term "isochore" is suggested; and for true isopleths (for example, contour lines, isotherms) drawn with reference to control points, the term "isometric line." "Isopleth" seems to be fairly well accepted by American geographers as a generic term covering "iso-" lines of all kinds when used for plotting geographical distributions (see Geogr. Rev., Vol. 20, 1930, p. 341).
RESULTS OF GENERALIZATION OF QUANTITATIVE DATA

In deciding what quantities his symbols are to designate, the cartographer must first study carefully the general character of the distribution he intends to map. Unless he does this, he may find, for example, that he has assigned too few people to each “dot” and consequently has to crowd so many dots into the more densely settled regions as to produce a solid black mass. Thus his map is inconsistent, since it fails to give any picture at all of the way in which the people are distributed within the black mass. Similarly, if he makes each dot represent too many people, he will meet with difficulties in placing the dots in the sparsely settled regions, where one dot may have to represent a population scattered over a very large tract. Much the same problem is encountered when spatial symbols are used. Many phenomena have a tendency toward extreme concentration in relatively small spaces; population is a notable example. If the class intervals of the densities of population represented by the spatial symbols are uniform (e.g. 0–10, 10–20, 20–30, etc. to a square mile), there may be too few classes to show adequately the differences in density in the regions of sparse distribution and more classes than can be legibly differentiated for those of greater concentration. Hence it is customary in mapping distributions of this type to make the class intervals narrow at the lower end of the density scale and increase the width as the upper end is approached (Fig. 2, r, t).

Much the same principle also applies to the representation of relief on maps covering large tracts of country. As lowlands and plains are on the whole far more extensive than mountains, it is usual on such maps when relief is shown by contours and hypsometric tints to employ narrower contour intervals for the lower elevations than for the higher (Fig. 2, c). In this way more topographic detail can be shown for the lowlands, and there is less crowding on the highlands, than would be the case if the contour intervals were uniform. This, of course, has unfortunate effects when applied on maps that include extensive high plateaus such as those of the central Andes and Tibet, since the contour intervals are too wide to bring out adequately the often varied relief of the uplands.\footnote{An instance of too wide an interval in submarine contour mapping is cited by Paul A. Smith elsewhere in this number of the Geographical Review.}

Thus the pattern and with it the adequacy of maps showing quantities are much affected by the discrimination with which the cartographer ad-
justs the classification of the mapped quantities shown by the symbols to the control quantities.

As the control quantities for a density map are functions of the areas of control spaces, the information provided by them will necessarily be less detailed for the parts of the map where the control spaces are relatively large. For this reason the pattern of symbols based on this information will be inconsistent within itself, unless all the control spaces are of approximately equal size, which is seldom or never the case. Furthermore, and for the same reason, it is obvious that two statistical maps of the same territory showing the same distribution will present quite different patterns if based on control data for different systems of control spaces (Fig. 2, compare e and c); for example, a population map of the United States based on county statistics and one based on statistics by minor civil divisions. Likewise, two statistical maps of different regions are not comparable except in a very general way if one is based on figures for control spaces with areas that are on the average larger than those of the other.

**Amplification of Quantitative Data**

Some of the inconsistencies due to lack of uniformity in the areas of the control spaces can be partly eliminated by amplifying the control quantities in the light of other evidence. Where point symbols are employed to show distributions, they can be arranged within each of the control spaces so as to conform to the probable character of the distribution therein. In placing them, other maps are consulted that make this probable character reasonably clear; for example, maps showing houses, villages, woodlands, mountains, and so on. A similar procedure can be followed where spatial symbols are used, by breaking down the control spaces into subdivisions, to each of which an estimated density is assigned with the aid of nonstatistical evidence, care being taken that the estimated densities are made to conform to the known total control quantity of each space. Such estimated densities might be called “secondary control quantities,” since it is they that actually govern the placing of the spatial symbols.

Isopleths are drawn on a map with reference to control points. Other things being equal, the smaller the interval between the mapped quantities represented by the isopleths (for example, the contour interval), the larger the amount of detail shown. The reliability of this detail, however, depends

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not only on the accuracy of the control quantities but also on the geographical density of the distribution of the control points. If the control quantities are of uniform accuracy and the isopleths are located with reference to the control points merely by interpolation, the probable reliability of the information furnished by the isopleths will vary in proportion to the density of the control points.

When the isopleths are drawn by interpolation, there is a minimum of amplification. As in the case of point symbols and spatial symbols, however, the isopleths may be drawn in such a way as further to amplify the information provided by the control quantities. Thus the surveyor further amplifies his map when he "sketches in" contours by observing the terrain in the field (or from the study of photographs) and shaping the lines accordingly. Formerly contours were nearly always "sketched in," and much margin was thus left for the exercise of judgment. Today the use of photogrammetrical plotting instruments is largely eliminating this subjective factor so far as contour mapping is concerned, though it still influences the plotting of isopleths of other types—isotherms, isobars, etc. The map maker must first decide whether to interpolate arbitrarily or to try to draw the lines more realistically on the basis of guided conjecture. In either case the user of the map has no way of distinguishing the parts that are probably more reliable from those that are probably less so, unless the positions of the control points are shown on the map itself or on an accompanying diagram. Unfortunately this is seldom done on the isopleth maps in most common use, though it has been frequently recommended by climatologists and others. An interesting illustration of control on isopleth maps is given on Veatch and Smith's 1:120,000 charts of the submarine topography off the northeastern United States. No need to ask of these, "What is interpretation and what is fact?"

Although some maps present no quantitative information of the types that have just been discussed, every map is quantitative in the sense that it provides information regarding distances, areas, and directions. Such quan-

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13 "The original method [of contouring] used by the Ordnance Survey was to send a levelling party to fix each of the contours on the ground, and put in lines of pegs as they levelled round each slope. The pegs were afterwards surveyed by traverse by another party."

14 "This excellent but very expensive way is now rarely followed, and the rigorous use of the word 'contour-line' has largely disappeared, for the majority of maps showing contours depend on nothing more accurate than interpolation between spot heights or some such method" (Frank Debenham: Map Making, London and Glasgow, 1936, p. 98).

tities can be accurately determined by direct measurements on maps covering small spaces if the maps themselves are reliable. The larger the space covered, however, the less can reliance be placed on direct measurements, on account of distortions introduced by the projection. The Yankee saying “What you make on your mackerel, you lose on your codfish” applies here. If some of your distances are in correct proportion, others will be misleading; if your relative areas are consistent, your shapes and distances will be badly out; and so forth. The plotting of a map on a particular projection is a mechanical operation with little that is subjective about it, but the selection of the most suitable projection for any given purpose is highly subjective, requiring good judgment guided by technical knowledge.

These remarks should have made it clear that the quantitative information furnished by maps is much affected by subjective influences. The most marked effects of all, perhaps, are felt on maps showing densities and other ratios. Because of the different practices employed by their makers, with different degrees of skill and judgment, such maps are seldom strictly comparable with one another or even consistent within themselves.

SYNTHETIC INFORMATION AND GENERALIZATION

Up to this point we have been dealing primarily with subjective influences on the mapping of the distribution of individual phenomena, such as coast lines, populations, and temperatures. One of the most important purposes that maps accomplish, however, is to show relationships of different phenomena to one another. Such relationships may be brought out by the use of different symbols on the same map to show different kinds of things: blue lines for rivers, red lines for roads, dots for cities, etc.—“mixtures” of information, in other words. Many maps present “compounds” rather than mere mixtures—that is, the symbols themselves indicate either quantitative relationships between two phenomena or more or the coexistence of two phenomena or more at particular locations or within particular regions. Such “synthetic information” may be the result of the compounding of only two or three elements, as on a map showing a relationship between rainfall and temperature, or between the distribution of malaria and that of Anopheles mosquitoes, or between the number of doctors and the total population. Or a much larger number of elements may be compounded, as on maps showing various types of “region”—climatic regions, soil regions, economic regions, land-use regions, “natural regions,” “cultural regions,” and so on.
The influence of subjective factors—judgment, discrimination, critical acumen—is of paramount importance in mapping of this type. Whether a particular relationship between two wholly objective elements is of significance or not depends on the quality of the map maker's judgment. He may, for example, show areas where, during the growing season, a rainfall between 40 and 60 inches is correlated with mean temperatures between 60° and 70°. He picks out this relationship because he believes it has meaning in relation to soils, vegetation, crops, erosion, or something else. If he is mistaken in his belief, his map may mean little more than a map would that shows by counties the ratio of illiteracy to cocktail lounges, even though the objective statistical facts of this relationship might be mapped with meticulous precision.

It is usually difficult if not impossible for the purposes of mapping to combine in the form of ratios, coefficients, and the like more than a limited number of statistical quantities. Consequently, the more general natural and human regions that geographers have marked out on many maps either are based on the assumption that the presence of certain individual phenomena or simple combinations of phenomena within a region is a fairly reliable indication that more complex combinations exist there, or else are arbitrarily marked out on the basis of the map maker's general fund of information. Frequently such regions are delimited to provide a framework for teaching or for the arrangement of material in textbooks—for convenience, that is, rather than to reflect absolute realities on the earth's surface. Maps of this type may be useful as pedagogical devices. They give the student at least a rough idea of how the parts of the world differ from one another in certain large respects, but next to maps of imaginary countries they represent almost the ultimate in subjective cartography. The regions they show are the equivalent of the well defined "periods" into which history teachers divide the course of human events, and they have both as much and as little reality as such periods.

Harmony and Taste

We have seen how judgment and other subjective factors affect the reliability of the information presented by the symbols on a map. A symbol may, however, present a given phenomenon correctly as regards its distribution, character, and quality and yet be altogether unsuitable. Whether

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15 For a wide variety of illustrations of symbolism see Raisz, op. cit.
or not it is suitable depends on the map maker's taste and sense of harmony.

Where quantities such as altitude and density of population are shown by means of gradations of color or shading, the symbolism will not be suitable unless there is some harmonious relationship between the variations in the tonal intensities of the symbols and the varying intensities of the quantities indicated by them. Although experiments have been made with a view to grading tonal intensities so that they may bear a definite mathematical relationship to the mapped quantities, for the vast majority of maps the tonal grades are established by rule of thumb, just as are the gradations in the quantities that the symbols represent. In matters of color and tone the rule of thumb must be applied with the skill of the artist if the results are to be good.

Medieval maps are adorned with castles, towers, sea monsters, ships, and such things, and the employment of pictorial symbols is coming back today. It has certain advantages, especially on maps for popular use. By employing as point symbols conventionalized pictures of men, locomotives, bunches of wheat, insane asylums, whales, and the like, one can crowd a good deal of miscellaneous "mixed" information into a small space, but for any single distribution one cannot present as much precise and detailed distributional information as by the use of dots or other point symbols, since each little picture is likely to occupy more space than a single point symbol. Experiments have been made in the use of pictorial patterns as spatial symbols—for example, patterns made up of tiny men, or ears of corn, or cows—but such patterns tend to look "fuzzy" around the edges and do not lend themselves to the representation of gradations in quantity. Although in a sense they may be in better "harmony" with the things that 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.

The quality of a map is also in part an esthetic matter. Maps should have harmony within themselves. An ugly map, with crude colors, careless line work, and disagreeable, poorly arranged lettering may be intrinsically as accurate as a beautiful map, but it is less likely to inspire confidence.

**Progressiveness and Conservatism**

Whether a maker of maps is ever seeking and finding new things to map and developing new ways of mapping them or is a blind follower of tradition and precedent is of course partly a matter of individual character,
but it is also a result of outside influences. Advances in cartography are
due largely to the stimuli and opportunities that social needs give to the
inventiveness of cartographers. Where a need arises, as for automobile road
maps or air navigation maps, cartographers respond. War provides a power-
ful stimulus, as the feverish mapping activities in and out of the government
today bear witness.

Conservatism in cartography is not inherently an evil when it means
adherence to conventions and standards that have been tested by time and
found good. The users of maps have become used to certain conventions
in symbolism, and too radical departures from these may be needlessly con-
fusing. Many of the conventions have their origin in attempts to make
symbolisms conform at least roughly to certain aspects of the things mapped;
for example, that of showing water in blue instead of, say, pink (on medie-
val maps the Red Sea was shown in red), that of showing the relative im-
portance of places by point symbols and lettering of graded sizes or of
showing railroads by crosshatched lines. The convention of grading hypso-
metric tints more or less according to the spectrum, from greens for the
lower altitudes, through yellows for intermediate levels, to reds and violets
for mountain ridges, has been found by experiment and experience to give
a graphic visual impression of relative altitudes. That there are different
techniques altogether for representing the character of the surface configu-
ration of the land is hardly a sufficient reason for abandoning a well estab-
lished and, on the whole, satisfactory method of representing relief.

Conservatism is an evil when it means failure to keep abreast of chang-
ing social needs and technical improvements. There is a certain danger of
this in peacetime, especially in large map-making establishments where
maps are produced in immense quantities according to uniform specifi-
cations. Under such conditions changes are costly and difficult, involving the
training of personnel in new methods and the purchase of new equipment.
This is why so many maps in atlases as well as in series follow traditional
patterns or even repeat old errors long after the need for something better
has made itself felt.

**Map Users Are Human**

If map makers are human, so too are map users. The qualities of integrity,
judgment, critical acumen, and the like are as much required in the interpr-
etation of maps as in the preparation of them. Like carpenters' tools, maps
should not be misused. More should not be expected of them than they
can perform. Sometimes when a critic damning a compiled map because he has found errors on it in regions that he has visited, his condemnation may reveal ignorance of the nature of cartography on his part rather than carelessness on the part of the map maker. Not all maps can be based on new surveys. Errors that originated in the sources of a compiled map frequently could have been avoided only by not making the map.

It is a misuse of maps, also, to draw unwarranted conclusions from them. To compare the area of Greenland with that of New Guinea on a map drawn on the Mercator projection is like trying to cut down an oak tree with a jig saw—it simply cannot be done; and we have seen that statistical maps are liable to similar if less obvious misinterpretation. Particularly dangerous are unwarranted conclusions as to the meaning of the facts that maps actually do disclose. Bring together all the maps there are showing languages, religions, densities of population, resources, economic regions, and the like; add to them twice as many more; compare and correlate them with all the ingenuity of which you are capable—and you will not, from such study alone, get very far toward the solution of vital international and national problems. Conditions and motives that no man can map must also be considered. As was pointed out at the beginning of this paper, maps are indispensable tools in human affairs. That you cannot navigate a ship without charts, however, does not mean that you can navigate it by charts alone. Rudders and helmsmen are also necessary.