Now and Then:

Comparisons of Ordinary Americans' Symbol Conventions With Those of Past Cartographers

DENIS WOOD

The dime novel revolutionized storytelling in America by inventing endless ways of grabbing the reader's immediate and complete attention with a handful of words: "I dropped to one knee and fired twice," or "The girl was crazy as hell—or, if she wasn't, she thought I was." Suggesting that ordinary Americans repeat or recapitulate the entire history of cartography as they go through the process of developing images of the world is not as exciting as "I just lifted my foot and let the door have it," but it will have to do. It is the subject of what follows.

Although the history of cartography may comprise an ethnogenetic developmental sequence rather than a random collection of events serially ordered in time, it is a fact that historians of cartography tended to ignore it and its implications. Such a view of the history of cartography brings the promise of a structuring principle other than that of the ever passing years, and with it the possibility that anything known of similar patterns in other developmental modes—phylogenetic, ontogenetic, even pathogenetic—can be applied to the history of cartography and vice versa. In other words, "The map is a cultural concretization of man's geographic, environmental thought process, and the history of cartography preserves the developmental stages of that process. In this sense the map is a resolution of a chain of events that began long ago with the impulse to explore, the exploration itself, the return, and the remembrance and reproduction of the experience." [1]

But it is one thing to suggest a general parallelism between the mapmaking activities of the species as a whole and that of its individual members, and another thing altogether to demonstrate that this is in fact so. Until recently, two circumstances have mitigated against such a demonstration. First, until very recently practically nothing was systematically known about the ways in which individuals "map" the worlds of their experience. Second, our ignorance has been accompanied by a peculiar resistance to any admission of the actual complexity of the cultural artifact that the map is. However, the maturation of such disciplines as geosophy, psychogeography, and environmental psychology has done much to mitigate these circumstances. Since the publication of J. K. Wright's *Geographical Lore in the Time of the Crusades,* research in these areas has gradually accelerated to the point that each year now sees the publication of a substantial mono-

The author is assistant professor at the School of Design, North Carolina State University at Raleigh.

[1] Robert Beck and Denis Wood, "Cognitive Transformations of Information From Urban Geographic Fields to Mental Maps," *Environment and Behavior* (June 1976):203.

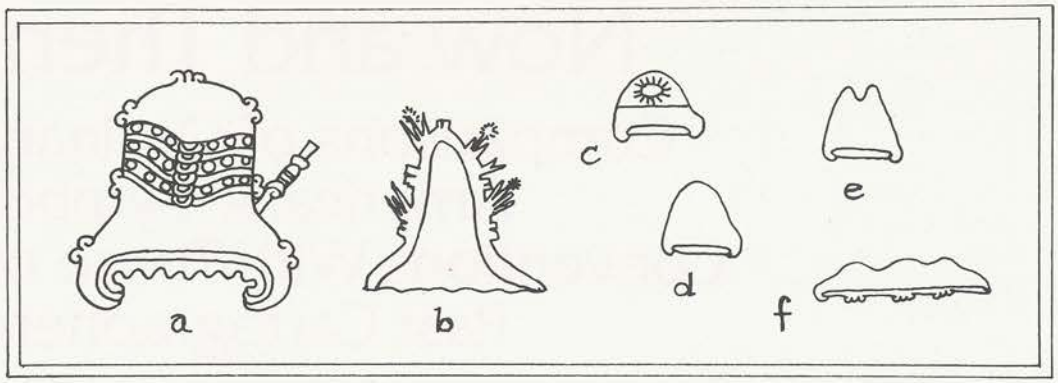


Figure 1. Mixtec and Nahuatl hill signs. (a) Codex Nuttal (b) Lienzo of Zacatepec 1 (c-f) Codex Tepetlaoxtoc.

graph and numerous papers on the topic.[2] The product of this sustained effort is an elementary knowledge of environmental cognition capable of acting as a foundation for the comparison of the ontogenetic development of mapping abilities with the ethnogenetic bases of cartography.

Cartographers can now acknowledge the roiled complexity of the map and deal with its subsystems incrementally. The map's history can be explored as a function of changes in the world view of various cultures or as a function of changes in the ecology of the map, as a function of changes in metaphysical systems or as a function of genetic principles with respect to any of these subsystems, and as a complex function of some or all of these and others not here mentioned. But in any case the fundamental rule is simple: if one map is treated as a manifestation of a world view, then all the maps covered must be so treated; if one map is treated as a manifestation of a concept of space, then all must be looked at in this light. We propose to take advantage of these possibilities and examine representations of landform relief (essentially hills and mountains) made by very different peoples at very different times. Comparisons will be made among maps in the record of the history of cartography and among several thousand experimental sketch maps and drawings collected from cartographically naive individuals between the ages of three and seventy over the past nine years. Other comparisons will be made between these two sets of images. Our hope is to show that there exists an inherent connection between the two groups which supports the contention that human beings possess a "mapping faculty" that transcends the limits of culture and the dimensions of time and space.

It is widely acknowledged by cartographic commentators that the representation of landform relief is one of the most difficult aspects of mapmaking. Of such difficulties Edward Lynam has commented, "The representation of mountains has always been the map-maker's hardest problem, for mountains have length and breadth as well as height, and they hide something round every corner which must nevertheless be shown on the map." [3] Insofar as it is developed, the historic record would seem to support these observations. Such is the case in modern times, and we may safely suppose that it was so for the cartographers of early or primitive cultures, though extant maps from periods before the European middle ages are rare from any part of the globe, and few enough have come down to us from all but the end of the middle ages. Furthermore, the attempt to extrapolate about early mapping activity from the mapping behavior of contemporary primitives is freighted with a potentially disastrous cargo. Nonetheless, it is here that the record begins and here we must begin in order to get at our comparative samples.

[2] J. K. Wright, *Geographical Lore in the Time of the Crusades* (New York, 1925; reprinted 1965). The most recent important monographs are Roger Downs and David Stea, *Maps in Minds* (New York, 1977); Gary Moore and Reginald Golledge, eds., *Environmental Knowing* (Stroudsburg, Pa., 1976); Thomas Saarinen, *Environmental Planning: Perception and Behavior* (Boston, 1976); Peter Gould and Rodney White, *Mental Maps* (Baltimore, 1974); Roger Downs and David Stea, eds., *Image and Environment* (Chicago, 1973); and this just scratches the surface of what is available.

[3] Edward Lynam, *The Map Maker's Art* (London, 1953), p. 38.

The earliest representation of landform relief may be found in the "Pre-Conquest" cartography of Mesoamericans, such as the Mixtec, although these people cannot be termed primitive in the usual sense of that word. Norman Thrower's mention of early Mexican cartography in the same breath with that of early Egyptian mapmaking is much more to the point and in keeping with the position adopted here.[4] The early cartography of all the ancient civilizations (China, India, the Near East, Mesoamerica)—to the extent ascertained—would seem very much to be of a type, and while the point is too complex to argue here, the cartographic efforts of all these cultures can probably be regarded as essentially similar.

One reason for focusing on the cartography of southern Mexico is that relative to the cartography of early Mesopotamia, Egypt, or China, a fair amount is extant; and if this extant corpus actually includes excessively few examples that are genuinely pre-conquest, then much of it is pre-conquest in all but very few details. In the Mixtec case in particular it is possible to demonstrate the remarkable extent to which maps like the *Lienzo of Zacatepec 1* observe the conventions employed in noncartographic codices predating the conquest by as many as two hundred years.[5] Among these conventions is a partial system of logographic writing in which certain forms "are not merely pictures, but logograms—signs which represent one or more words in the Mixtec language."[6] One of these logograms means hill. Smith describes it as follows:

> The sign for the Mixtec word *yucu* or "hill" is essentially a conventionalized "picture" of a hill. It is usually a green or brown bell-shaped form on a base that consists of a narrow red or blue band below which there is often a yellow scalloped border. At times the lower corners of the hill sign curl inward, forming volutes on either side. Often the outline of the hill shape is broken by small curvilinear or rectilinear projections which indicate the roughness or "bumpiness" of the hill. The hill sign has many variant shapes. For example, one side of the hill may be extended in a manner that suggests a slope, and at times this extended slope functions as a platform for human figures.[7]

Logograms like this for yucu were used in two readily differentiated fashions. On the one hand they were used much as we use words, to name a place, and it is in this fashion that they appear in the historical narratives of the codices. On the other hand they were used much as we use a combination of words and symbols on a map, to identify and locate a place, and it is largely in this fashion that they appear on the Mixtec maps. Smith describes their nonhistorical-genealogical uses on the *Lienzo of Zacatepec 1:* "the large rectangle formed by the boundaries contains three types of place signs: (1) 'non-cartographic signs'—that is, signs of towns which are actually located outside of Zacatepec's boundaries but which are placed *within* the rectangle of boundaries in the Lienzo, (2) the signs of Zacatepec's *estancias* or subjects, and (3) signs of uninhabited geographical features such as hills and rivers."[8]

The most interesting feature of this representational system is the flux it indicates in intentions: linguistic and pictorial, narrative and cartographic. At this early stage in the development of landform relief symbols, signs originally developed as names to be used in narratives are being adapted as "pictures" to be used on maps. And yet in these early Mixtec maps the transition was not complete and, in Smith's words, "the place sign is not a generalized portrait of a hill based on perception; it is a pictorial sign that reflects language rather than landscape."[9] However, a hill form did, in this manner, find its way onto a map, and this probably represents the earliest sort of hill symbol.

It is unknown how the Mixtec, and the Nahuatl, would have continued this development toward cartography, for it was at precisely this stage in the process that the conquest occurred. It is, however, possible to see how this hill sign

---

[4] Leo Bagrow, *History of Cartography* (Cambridge, 1966), p. 27, notes that the ancient cultures of Mexico "were highly developed," but this is just after having remarked that "many savage peoples have shown some skill in drawing maps." The linkage, however unforgivable, was more typical of the times than of Bagrow. Thrower's remark is in his *Maps and Man* (Englewood Cliffs, 1972), p. 10.

[5] Mary Elizabeth Smith, *Picture Writing From Ancient Southern Mexico: Mixtec Place Signs and Maps* (Norman, Okla., 1973); Donald Robertson, *Mexican Manuscript Painting of the Early Colonial Period: The Metropolitan Schools* (New Haven, 1959); Donald Robertson, "The Mixtec Religious Manuscripts," Howard Cline, "Colonial Mazatec Lienzos and Communities," and Alfonso Caso, "The Lords of Yanhuitlan," all in John Paddock, ed., *Ancient Oaxaca* (Stanford, 1966). The Codex Nuttall has been recently published, in color, as *The Codex Nuttall* (New York, 1975).

[6] Smith, *Picture Writing*, p. 21.

[7] Ibid., p. 39.

[8] Ibid., p. 92.

[9] Ibid., p. 94.

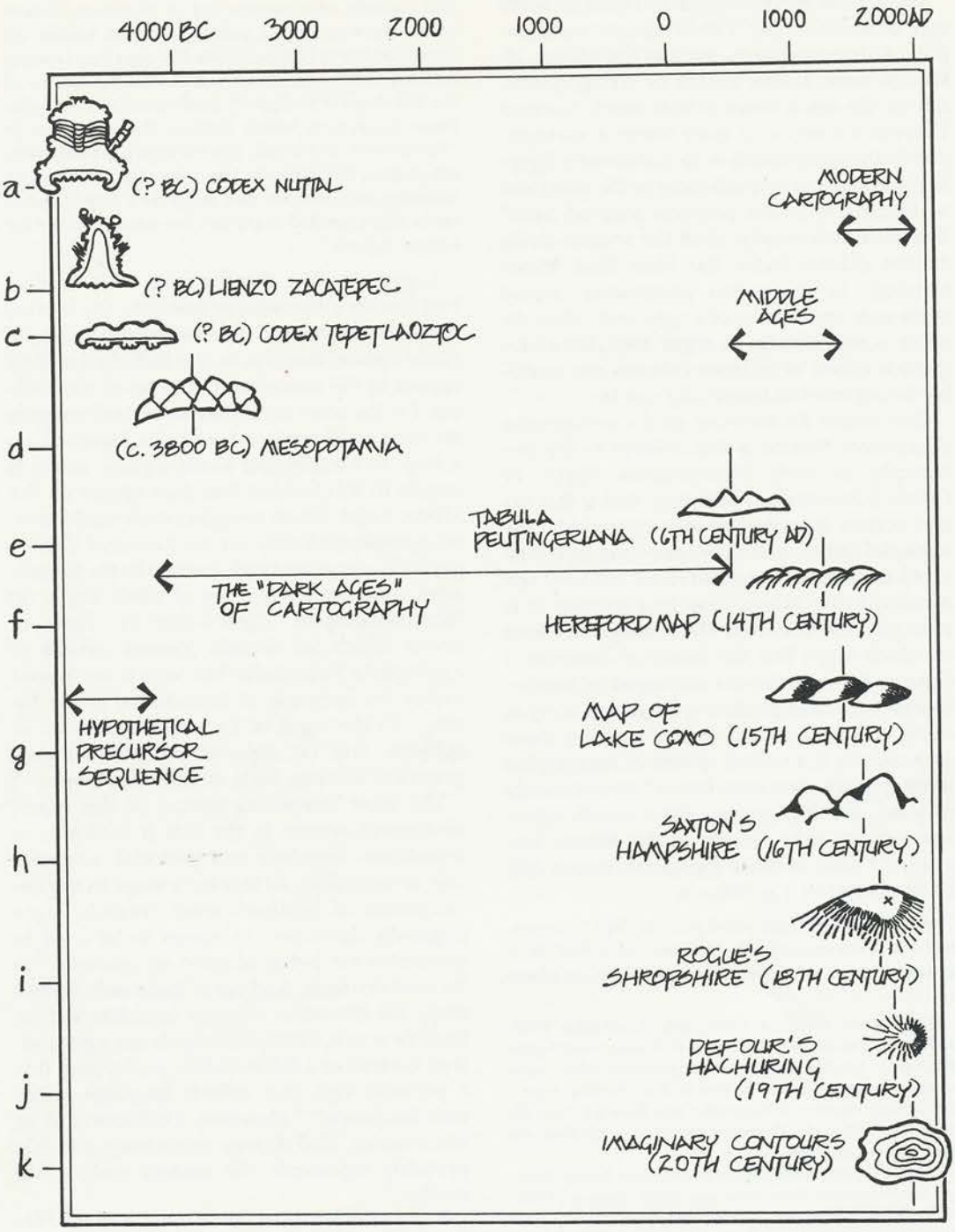


Figure 2. The ethnogenesis of hill signs. The hypothesized precursor sequence is that illustrated in figure 1.

was generalized under European influence, as in the *Lienzo Zacatepec 2* which was produced only two generations after the earlier version; or in that part of the Codex Tepetlaoztoc reproduced in Bagrow.[10] In the latter it is very obvious that the hill place sign was simply generalized into a generic hill sign, and it appears in four variants: as a place sign (with the additional logographic signs needed to spell out the proper name), in identical form but as a generic hill, modified to indicate peculiarities of shapes in hills and multiplied into a range of hills, or perhaps mountains.

The similarity of this latter multiplied form of the hill sign to that on the clay map of northern Mesopotamia (the Nuzi, ca. 3800 B.C.[11]) is sufficiently striking to suggest that a similar process of cartographic signmaking might have transpired in Mesopotamia via the early Sumerian ideograms and perhaps in all mapmaking civilizations in which landform relief is represented. That is, early cartographic signmaking probably developed concurrently with early linguistic signmaking; writing and mapping both grow together at first, sometimes difficult to separate completely, but subsequently following increasingly distinctive routes. This fusion is clear in the Mixtec and Nahuatl cases, and the proximity of the dates assigned the Nuzi map (ca. 3800 B.C.) and the development of Sumerian ideograms (ca. 3500 B.C.) is similarly suggestive. Weaker cases along the same lines can be made for Egypt and China.

Whatever the early origins of landform relief signs, in the West their character was little changed in the approximately four thousand years following their appearance on the Nuzi map. Those that show up on the *Tabula Peutingeriana* (ca. A.D. 500) are rather more than kissing cousins, and no really notable changes occur until the later middle ages when the portrayal of physical objects became more or less standardized as the use of profile figures came into vogue.[12] From this period forward, the history of landform relief representation has been frequently summarized. In the period from about 1250 to 1800, the essential changes involved a gradual shift from an elevation or profile view ("rather like cock's combs") through an oblique or bird's-eye view ("little rows of shady sugar-loaves") to the use of the plan view (leading in the eighteenth century to the hairy caterpillars "found crawling across maps of Asia and America until the end of the 19th century"). This shift in perspective was paralleled by the development of conventionalized shading, from the arbitrary medieval practice of shading profile views through the "obliquely" and usually eastern shading of later bird's-eye views to veritable vertical shading of plan views.[13] This led, in Skelton's view, to the development of hachuring: "Early in the eighteenth century, cartographers began to draw their hill-hatching as if vertically shaded or illuminated from a source above the object. From this method, which facilitated the representation of relief features in plan, developed hachuring by parallel lines drawn in the direction of the slope, the steepness being indicated by the thickness of the hachuring and the interval between them. This convention was used with plastic effect in 1757 in the physical maps of Philippe Buache." [14]

But Buache had already used contours on maps twenty years earlier (1737), and by the time hachuring became adequately refined (in the 1799 work of Lehmann), it was already being supplanted by the use of this still more abstract convention, although it took most of the nineteenth century to establish the contour's supremacy.[15] On small-scale maps, use of contours resulted in layer-tinted relief representation, both with and without shading. A number of other techniques have since been developed, but as Robinson and Sale point out, "Most of them are relatively complex and intellectually involved. Their use is limited to the professional geographer and geomorphologist, whose knowledge of landforms is sufficient to interpret them." [16] Of course this was once said of layer tinting, contours, and hachuring—probably of all innovations in relief representation—but Robinson and Sale do not imply that the history of the development of relief representation has come to an end. In fact, as they look into the future, they suggest the opposite, that it has a long way to go: "For many years

[10] Ibid., pp. 93-96; Bagrow, *History of Cartography*, plate 3.

[11] Bagrow, *History of Cartography*, plate 5.

[12] Wright, *Geographical Lore*, pp. 252-253.

[13] This is a summary of Lynam, *Map Maker's Art*, pp. 38-41. There was a third parallel development from hand-drawn manuscript maps through woodcuts to copper engraving.

[14] R. A. Skelton, "Cartography," in C. Singer et al., *A History of Technology*, 5 vols. (New York, 1954-58), vol. 4, p. 611.

[15] D. H. Fryer, "Cartography and Aids to Navigation," ibid., vol. 5, p. 439.

[16] Arthur Robinson and Randall Sale, *Elements of Cartography* (3d ed., New York, 1965), p. 177.

to come the representation of land form on maps will be an interesting and challenging problem, since it is unlikely that convention, tradition or the paralysis of standardization will take any great hold on this aspect of cartographic symbolization." [17] This seems especially likely in view of the fact that the full panoply of historically developed types is currently in wide use. If the plan view and the contour have taken over the large-scale topographic survey, the bird's-eye view and hachuring are very much in evidence in physiographic diagrams and landform and perspective maps. Despite Erwin Raisz's caution that his tachographic symbols "not be placed so regularly as to look like fish scales," they still look like they were nurtured on a small-scale map of the sixteenth century.[18] An even more primitive hill sign can be seen on a recently produced map of Los Angeles designed for Japanese tourists. Though clearly derived from the tradition of the Japanese woodcut, this sign rustles back through late medieval woodcuts (with their "mountains portrayed as enormous overlapping slabs of rock," in Lynam's words) to the very earliest attempts at portraying relief.[19] These and other historic forms thrive among us.

If professional cartographers regard relief representation as a challenge, the average American regards it as something more—or less. In a sample of 2,050 experimental sketch maps pulled from my collection to represent a diversity of mappers, terrains, and scales, only 157 (less than 8 percent) included any relief, although a number of others had the words hills or mountains written in appropriate locations. When shown, the relief by and large consisted of highly schematic, oblique views of mountain ranges. (See fig. 4.)

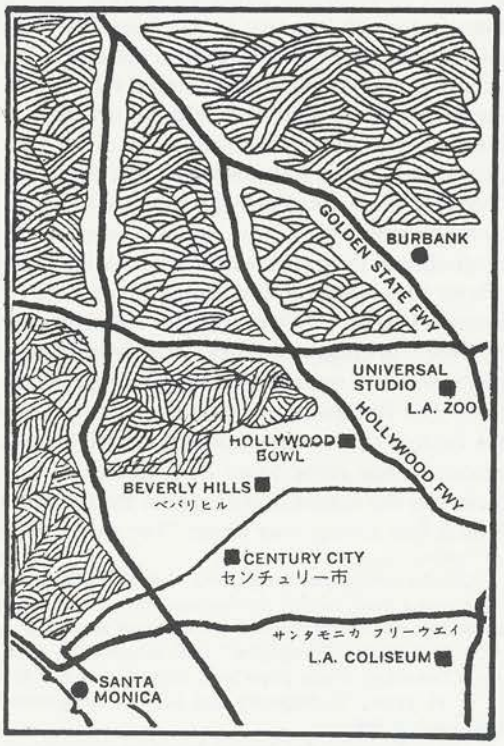
The failure to draw relief can be directly attributed to the sorts of difficulties faced by professional cartographers. Landform relief representation is not simple, and, given the level of accuracy revealed by such experimental sketch mapping, this is especially true at larger scales.

For the professional, however, it has been advances in color printing that have enabled "the cartographer to reach a relatively effective combination of techniques, without undue sacrifice of either desirable end." [20] This merely underscores the magnitude of the task facing the naive sketch mapper: it is a lot to ask of him that he show an urban street system and at the same time adequately portray relief. The naive mapper makes a choice of what to show and nine times out of ten he opts for culture. The same case—that the naive mapper faces the very problems of the cartographer—can be made for small-scale maps. Robinson and Sale argue that one thing that historically retarded the representation of relief over large areas was a paucity of knowledge about landforms. Needless to say, this is the situation facing a cartographically naive resident of San Juan trying to map the Cordillera Central of Puerto Rico. The most that might accurately be known is the generalized extent of the major aggregate feature (e.g., mountain range), and this is as adequately represented by its name inside a line embracing the region occupied as it is by a row

[17] Ibid., p. 173.

[18] Erwin Raisz, *Principles of Cartography* (New York, 1962), pp. 88-89.

Figure 3. Portion of a map of Los Angeles intended for the use of Japanese tourists.



[19] A portion of this map is illustrated in figure 3.

[20] Robinson and Sale, *Elements of Cartography*, pp. 172-174.

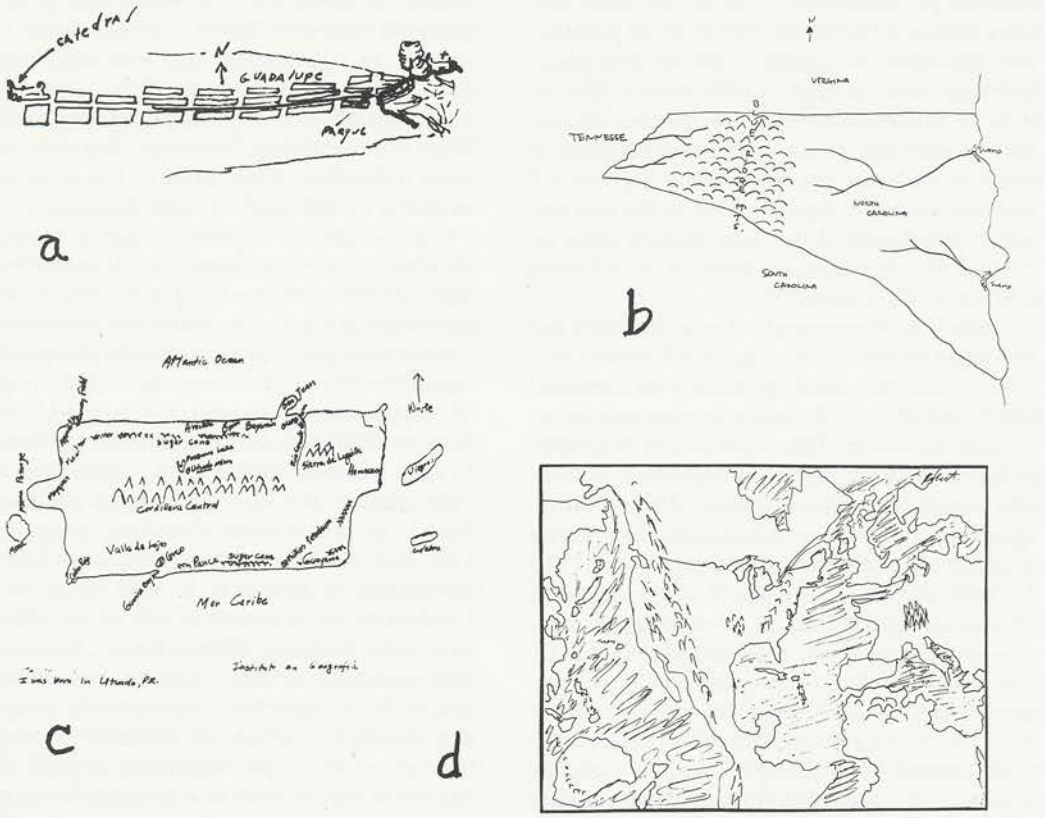


Figure 4. Some hill signs from sketch maps. (a) an oblique "picture" on a large-scale sketch of a barrio in San Cristobal las Casas (b) North Carolina as drawn by a Kansas college student (c) Puerto Rico from the pen of a native secondary-school teacher (d) the world by an adult resident of Connecticut.

of teeth or fish scales. When anything more elaborate is attempted, the same problems arise in the small-scale as in the large-scale case.

Thus, the failure to represent landform relief on 92 percent of 2,050 sketch maps probably not only does not reflect a lack of interest or awareness of such relief, it also does not reflect any peculiar difficulty not historically faced by the mapmaking profession itself. In fact, it likely does not reflect on the cartographically naive mappers' abilities to represent landform relief at all but simply on the fact that they have not spent their lives consumed with the attempt to solve this particular cartographic problem; namely, the representation of landform relief conjunctively with other landscape attributes. How, then, would such mappers go about representing relief if this were the only task set?

To address this question, a set of five hundred drawings of hills was collected from three hundred individuals between the ages of three and thirty. North Carolina residents all, they lived in each of the state's three distinctive physiographic regions: the coast, the Piedmont, and the mountains. The youngest were simply asked to draw a picture of a hill, although the stories they told about each drawing were recorded, along with other pertinent data. The older children and the adults were subjected to more elaborate tasks and inquiries. Important here is the fact that the four oldest groups were asked either to draw profiles, obliques, and plans in that order, or to draw a hill and then to draw it from the other perspectives. The difference is that some of the individuals in the four oldest groups were told from what perspective to prepare their first drawing, whereas others were free to choose this initial

perspective themselves. All of the drawings were examined from the viewpoint of perspective (elevation or profile, oblique and plan), hill form, and number of hills shown. The results of this examination, the number of persons in each age group, and the percentage of those in each age group drawing a given hill type are shown in figure 5. Due to the fact that about two-thirds of the respondents drew an average of two hills each, none of the columns adds up to 100 percent.[21]

There is a pronounced relation between age and point of view and range of hill types used. That is, with increased age there is an increased likelihood of representation in plan and an increased repertoire. This repertoire is illustrated in figure 5 which has been organized to indicate something of the diversity of types within age groups, as well as to highlight the salience of those types running across age groups like the brilliant colored threads in a hempen rope. Of special significance is the montiform complex embracing types 7, 9, and 10 (see fig. 5).

A small number of respondents of all age groups emphasized slope as the essence of relief by drawing things like roller coasters and roofs instead of geomorphic hills. A smaller number of the youngest children drew animate hills such as those seen in figure 6. (Those circles with rays on one of the hills in the figure are "the eyes of the hill.") When these young children were asked to draw hills as seen from above, drawings identical to those otherwise made were produced.[22] When those at the four upper levels were given the opportunity to draw their first hill without prior suggestion as to point of view, they did so in relative consonance with the ratios shown for the data as a whole; that is, there was a strong relation between their abilities and their preferences. It should be noted that the college and graduate students attended North Carolina State University, an agricultural and technical institution. Their inclination to draw plan views might not reflect that of the population at large. With this exception, however, the data are a good indication of the range of hill-form types available to and used by most Americans.

Comparison of figures 3 and 5 reveals a striking parallel between the development—latitudinally construed—of hill-form types in contemporary Americans with the development—construed partially latitudinally and partially longitudinally—of hill-form types in the history of mapmaking as a whole. The parallel is more than an artifact of similarly constructed figures. In each instance the hill form is initially a concrete picture of a hill, medially an abstraction based on the shadow-throwing property of hills, and finally an abstraction founded on the abstraction of elevation. In both cases the hill form starts out as a generic hill, as any hill and as all hills, becomes differentiated into types of hills—isolated, rolling, foothills, mountains—and ends up capable of representing uniquely any instance of whatever character or magnitude of relief. In the beginning in both cases the hill is represented as seen from the egocentric perspective of a typical human, frontally, in elevation; later it is represented as seen from the perspective of a bird's-eye, and finally is shown as seen directly overhead, as if from an airplane. In both cases the pool of potentially useful hill forms, initially extremely small and thoroughly unorganized, gradually broadens until it embraces nearly the totality of developed forms in an organization of hierarchic integration. In this progression each developed hill form is retained, having been—as it were—brought forward, but its use is subject to superordinate consideration of the mapper's intentions to communicate, record, or analyze. It is not merely that the same sort of hill forms show up in both situations but rather that nearly identical forms materialize in the identical order moving from the same beginning point to the same conclusion. The sequences are, in fact, parallel.

Thus there are two problems: first, why the sequences are parallel; and second, why the sequences observe the particular order they do.

The solution to the first problem takes as its starting point a consideration of the parallelism of the recent ends of the two sequences. Teach-

[21] Nearly half of these drawings were collected by Betty Murrell and her colleagues Greg Wall, Scott Stone, and Jeff Schoelkopf, undergraduate students in the School of Design at North Carolina State University, Raleigh. Others were collected by Dick Henry, Nann Boggs, Aileen Kennedy, and others, also undergraduates at the same school.

[22] For the ability of children to produce such drawings, see Roger Hart, *Aerial Geography: An Experiment in Elementary Education* (Master's thesis, Clark University, 1971); J. M. Blaut, *Studies in Developmental Geography*, Place Perception Research Report no. 1 (Worcester, Mass., 1969); J. M. Blaut and David Stea, *Place Learning*, Place Perception Research Report no. 4 (Worcester, Mass., 1970); J. M. Blaut, G. F. McCleary, and A. S. Blaut, "Environmental Mapping in Young Children," *Environment and Behavior* (June 1970); and the bibliography in Ronald Carswell, *Cartographica Monograph* 2 (1971).

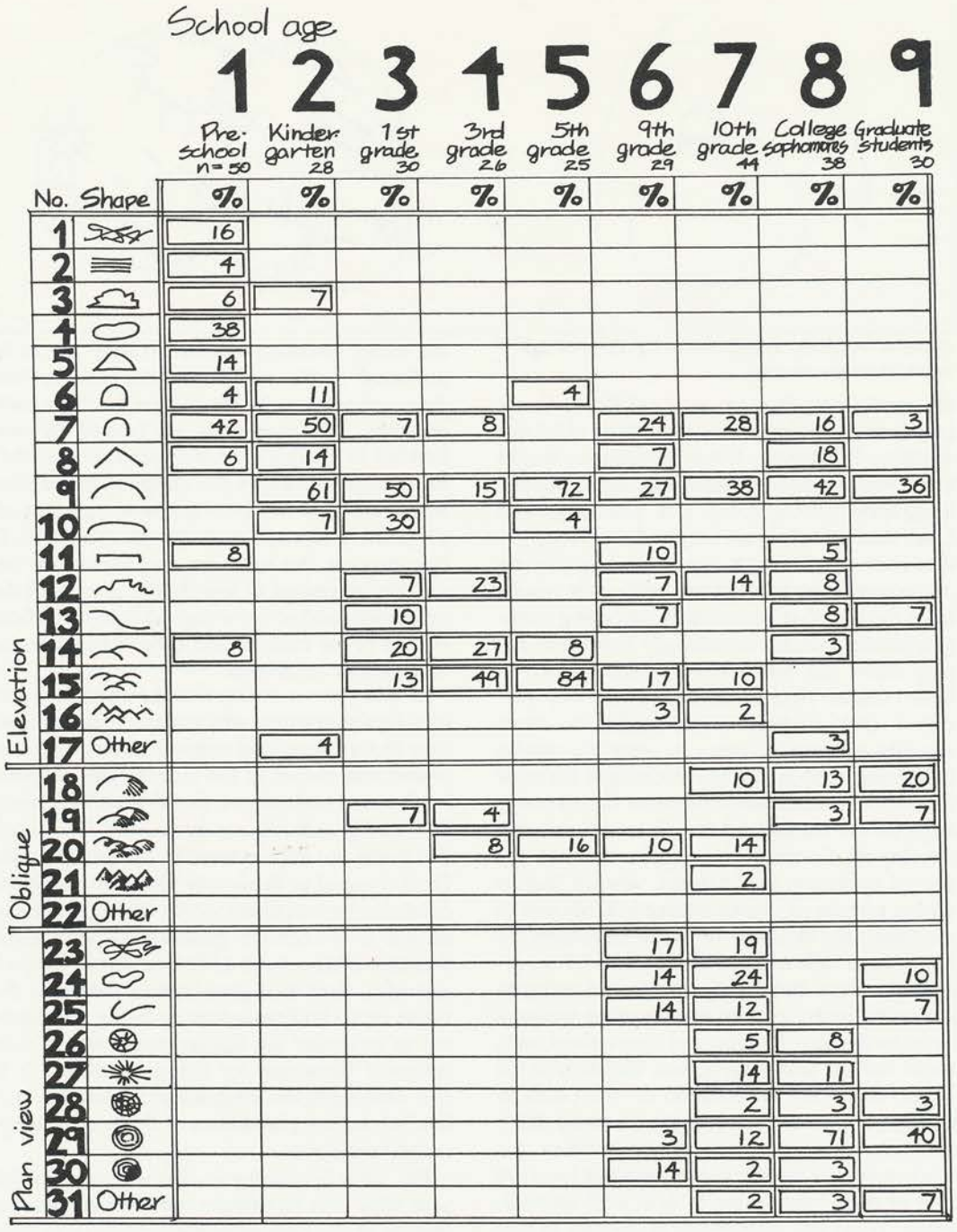


Figure 5. The ontogenesis of hill signs. School age is shown on the horizontal axis; hill-sign type, on the vertical.

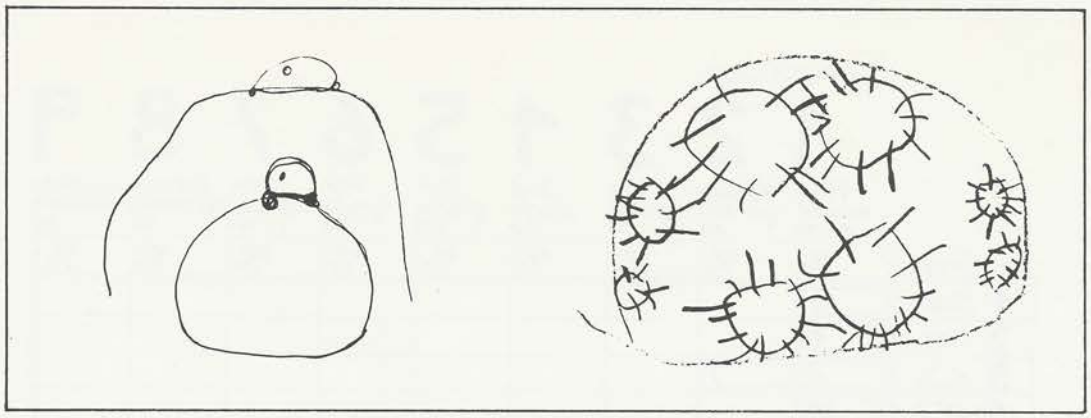


Figure 6. "Animate" hills drawn by a preschool-age and a kindergarten child.

ers, even when they are aware of them, do not induct their students into the habits of Mixtec or Roman hillsigning. When students are taught to represent landform relief—in social studies, geography, cartography, site planning, and other courses—they are taught the most up-to-date methods. This is to say that the parallelism of the recents ends of the two sequences results from the fact that individuals becoming cartographically mature increasingly learn and deploy those hill forms most recently given in their culture. And it has been ever thus: medieval cartographers were taught the most recently elaborated forms as were, no doubt, the Mixtec scribes. But the teaching of the most recent forms invariably depends on a knowledge on the student's part of forms previously developed. Contemporary instruction in the use of contours, for instance, always begins with a picture of planes slicing hills shown in elevation or oblique; or with elevations or obliques of hills marked by the lines left by receding waters. But the elevations and obliques are useful in this context only because students have long since familiarized themselves with these simpler and older forms. Children at the lowest levels are encouraged to draw hills in elevation and are usually discouraged from showing them in plan, either because the teacher fails to recognize the drawing for what it is or feels inadequate to deal with its challenge. What has happened, of course, is that the earlier forms have been pushed down the pedagogic ladder, with the earliest forms at the bottom. What was once fashionable in Rome is now the fashion in the first grade, and so on up the ladder. There is, indeed, a certain usefulness in preserving these earlier forms, for there are many situations in which they are to be preferred to the newest techniques, but this does not seem to be the reason for their preservation. The sequences are frequently embedded in curricula on the grounds that children must be taught the simplest forms first, where simplest has been unknowingly but appropriately equated with the most ancient. In this process the most ancient forms are frequently relegated to the child's preschool development and so are sloughed from the official corpus of the culture, and other forms become distorted or combined.

In this view individual maturation is measured by the extent to which mastery is acquired over the accumulated activity-potentials elaborated and stored in the culture group's past. But beyond maturation, individuals in actively developing cultures are frequently faced with situations not encountered in the group's past. They respond to these new situations with the creation of novel forms which in turn are transmitted to successive generations who must then also master these additional forms to reach maturity. And so it goes, culture acting as the rungs on an endless ladder enabling the climbers to construct yet higher rungs which then becomes platforms for future climbers. It is this ethnogenetic-ontogenetic interaction that lies behind the parallelism of the two developmental sequences.

But there is nothing in this explanation that says why it is elevations rather than contours that lie at the bottom of the ladder. To explain the order in which the hill forms occur recourse must be made to the structural principles of development described by Cassier, Werner, Kaplan, Piaget, and others.[23] They argue that

[23] The work of this school of structural developmentalists is summarized in Roger Hart and Gary Moore, *The Develop-*

development is an adaptive process which operates to ensure organismic stability through an increase in organismic flexibility, where organism is meant to embrace any coherent organization from individuals to cultures and species. Simplistically put, their argument is that as an organism increases the number of responsive options available to it (increased flexibility), it increases the likelihood of its surviving more or less intact (increased stability).[24] As the organism becomes more flexible it moves from orientations toward the environment that are concrete to those that are abstract, from orientations that are fused or global to those that are differentiated, and from orientations that are egocentric to those from which a number of perspectives can be held. At the same time these orientations become increasingly hierarchically integrated subordinations of the system as a whole.

This developmental process completely describes both sequences of hillsigning. The earliest hill signs in both cases are distinctly the most concrete. They encode nothing but the concrete facts of the hill's slope. On the other hand the most recent hill signs are extremely abstract, encoding the position of imaginary lines of equal elevation above an entirely imaginary datum. Similarly, the earliest hill signs are the most global; that is, they represent only global characteristics of hills and are thus incapable of distinguishing one hill from another. On the other hand contours were developed in great part to facilitate the most minute differentiation of relief forms as unique entities. At the same time, the early hill forms were the most egocentric. They only reveal the hill as seen from the perspective of people standing on the ground. Subsequent hill forms adopt other perspectives, the oblique parading this fact in its alternate name of "bird's-eye view." Finally, the entire system of hill signs has been hierarchically integrated and subordinated to the whole; in this case, the broad collection of cartographic purposes and intentions. In this system each hill sign fulfills a particular purpose for which it is uniquely qualified on maps ranging from the depiction of basal topography through block diagrams of relief features to sketches given friends of the route to one's house. When it is recognized that this identical developmental sequence materializes in untold numbers of processes it can be seen that the history of cartography, at least with respect to hill forms, requires no ad hoc explanatory mechanisms whatsoever and is, at least in its broad sweep, entirely independent of the particular political histories of its patrons or the idiosyncratic biographies of its practitioners.

But if developmental theories have a great deal to offer the history of cartography, the history of cartography has potentially much to offer what is in reality the nascent science of developmental processes. It has the most to offer with respect to the creation of novel forms (which is the engine driving cultural development[25]) and in the interaction of ethnogenesis and ontogenesis. The "functional shift" and the "form-function interrelationship" invoked by Werner and Kaplan to explain the evolution of novel forms for novel functions are not well understood; and while they seem to describe adequately the transferral of cognitive skills from realm to realm in the child they cannot deal with the kind of creative activity involved in the shift from hachures to contours.[26] Here biographies of the creative, generative behavior of cartographers could contribute data and insights. The same holds for the relation of the individual to his culture, especially in light of Bruner's insistence "that cognitive growth in all its manifestations occurs as much from the outside in as from the inside out" and his observation that "one finds no internal push to growth without a corresponding external pull, for, given the nature of man as a species, growth is as dependent upon a link with external amplifiers of man's powers as it is upon those powers themselves."[27] Here the serious examination of cartographic innovation in relation to culture and civilization in its broadest and most particular patterning could shed a brilliant light, of which this tentative essay—ever mindful that the path to knowledge is littered with the wreckage of premature generalization—is the merest premonitory glimmer. □

ment of Spatial Cognition: A Review, Place Perception Research Report no. 7 (Worcester, Mass., 1971). A shorter version is included in Downs and Stea, *Image and Environment.*

[24] Humberto Maturana, "Neurophysiology of Cognition," in Paul Garvin, ed., *Cognition: A Multiple View* (New York, 1970), provides the neurophysiologic foundation for the organismic arguments of Werner and others.

[25] Jerome Bruner et al., *Studies in Cognitive Growth* (New York, 1966). Especially relevant are the first two chapters by Bruner and the final three by Maccoby and Modiano; Greenfield, Reich, and Olver; and Bruner.

[26] Heinz Werner and Bernard Kaplan, *Symbol Formation* (New York, 1963).

[27] Bruner, *Cognitive Growth,* pp. 2, 6.