THE CONSTRUCTION AND UTILITY OF THREE NEW MAP TYPES

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Science is a subset of scholarship.
– John Fraser Hart

ABSTRACT

This paper proposes that cartographers consider three new map types: inventory maps, analytical maps, and synthesis maps. This paper demonstrates the cognitive and epistemological foundations of these three map types, and links them to models of not only cartographic representation and communication, but of how humans create, modify, reject and communicate spatial meanings.

In order to construct these three map types and to treat them as an integrated framework, I begin with a historical review of attempts in modern cartography to coin and use different map types. From this history I draw the conclusion that the many kinds of map types that cartographers have created, most notably the terms *thematic* and *general reference* maps and their affiliated synonyms, offer cartography little conceptual, pedagogical, or methodological rigor with regard to how and why we make and use maps.

This paper then excavates several ideas from twentieth-century cartography that are relevant to the new framework, especially ideas which appeared during the 1970s and early 1980s, a research period known as cartographic communication or cognitive cartography. Specifically, I examine *inventory* and *synthesis* maps, terms used by Bertin, Salichtchev and Petchenik. I also introduce a third term, *analytical* maps. I demonstrate how these terms enable us to construct a more rigorous theoretical framework for maps and map meanings by linking the terms to the cognitive and semantic practices of description, analysis and synthesis as used to create, revise and reject spatial meaning. I also consider briefly the possible linkages among these modes of meaning making, representation and communication with the semantic practice of question asking, a fundamental way in which humans seek, derive, convey, modify or reject meaning.

Finally, this paper presents several examples of these three kinds of maps in order to discuss how the framework is relevant to several important contexts of utility in cartography. This paper closes by cautioning against attempts to treat these maps as a taxonomic framework of mutually exclusive categories into which we should place maps. The strength of the framework ultimately lies in how it mimics certain fundamental stages in how we create, modify, represent and communicate spatial and geographical meanings, especially through cartographic representation and communication.

AUTHOR'S NOTE:
The paper appears in draft form. Readers are free to quote and cite the work with this in mind. Graphics were not available at the time of submission. Limited copies of the complete paper, with graphics, will be available at the conference. The graphics alone will be available to all as an addendum, in hard copy and on disk. The conference presentation is an abridged version of this paper, and will focus more on the framework than on the historical dimensions of the ideas that constitute the paper's thesis.

BACKGROUND of the PROBLEM

One of the continuing research questions of modern[1] cartographic theory concerns how to categorize the kinds of maps that humans make. The most common approach to this issue has been through the construction of map categories and taxonomies intended to be both mutually exclusive and comprehensive (Fisher, 1979). A second though less-structured approach has taken place through the pedagogical concerns of cartographic instruction and the delineation of different kinds of thematic maps (See Robinson *et al*, 1995, Dent, 1996 and Slocum, 1999 for typical examples). Other approaches have attempted to identify map types through the construction of models of the mapmaker and the map user (Board, 1967 and Ratajski, 1973) and through map functions and map reading tasks (Board, 1975, Morrison, 1978, Petchenik, 1975). Researchers have also attempted to elaborate map types through an articulation of different user groups and user environments, especially since the rise and diffusion of contexts of GIS use (Carter, 2001). In each case, these map categories and their defining criteria reveal an internal logic and a certain utility to the number and kinds of terms used. Yet even a cursory examination of these frameworks reveals glaring omissions, frequent exceptions, and the nearly endless permutations to the kinds of maps and categorizations these conceptual models include and exclude.

Why should we want to create such a framework? One simple reason is that modern cartography still has not come to grips with even the most common map categories we use in order to define and distinguish our maps: general reference maps and thematic maps. Despite our efforts, we have done little to ground these two terms and their synonymic allies in a theory of cartographic production, representation, visualization or communication. If we cannot bring definitional rigor and utility to these and other extant terms, then we must dismiss them and pose new terms, meanings and models in their place.

The creation of an effective conceptual framework for maps has other important theoretical applications. In particular, cartography has continuously attempted to construct fundamental ideas and theories around the map interpreter[2] and the mapmaker, methods and testing, map functions atlases, user groups and map elements. How can we link these and other theoretical concerns to a single framework of map types and definitions, especially regarding the kinds of meanings we intend for and derive from maps?

This paper presents a new framework for maps and spatial representation based on how we use description, analysis and synthesis in the creation, revision, representation and communication of spatial meanings. Many of the concepts for this framework have previously appeared in the literature of modern cartography, though they have long been dormant or considered out-dated in their utility. In order to construct this framework, I begin with a review of the literature in modern cartography relevant to map types and frameworks and notions of how we construct spatial meaning. I then revive relevant ideas that might serve as the cognitive and epistemological foundation of a new tripartite framework of inventory, analytical and synthesis maps. Following the definition and elaboration of these terms I demonstrate their utility in several important contexts of cartographic theory and practice, and offer several examples of these new map types.

A REVIEW of MODERN TERMS and FRAMEWORKS

Fisher (1979) provides a useful summary and analysis of modern cartography's attempts at constructing frameworks of map types and their meanings. He tabulated some thirty-five kinds of map types, largely in the form of two complementary and mutually exclusive terms. The most common of these couplets is general reference maps and thematic maps; variations of these terms also appear, with several writers employing three and four terms in their frameworks. Several authors also articulated numerous sub-categories for any given category (Fisher, pp. 11-15).

In many ways these terms simply reflect the research questions of the day. We see a focus on quantitative analysis, derived from the concurrent quantitative revolution and especially its love affair with statistical modeling and economic geography. Statistical maps, decision-making maps and transport and communication maps are but three examples of map types. We see attempts at distinguishing between methodologies and the stages of map making, especially regarding the mapping activities of institutions and professional experts (research maps, common-use maps versus official maps and office-compiled maps versus field-survey maps). We also encounter the incipient concern for how map design transforms mere data into geographically meaningful representations (distribution maps, as well as balanced maps versus weighted maps). We even find in the term school maps a modest concern for a pedagogy of cartography. Finally, we encounter the terms special-subject and special-purpose maps and variants thereof, demonstrating a concern for user groups or specific contexts of use, in

[1] I use *modern* to denote the history of cartography and the mapping sciences since World War II.
[2] Also known as the map user, map reader, map viewer, and map percipient.

both historical and contemporary contexts. Examples here include nautical maps and bathymetric maps, jet maps and radio maps, cadastral maps and route maps (Fisher, pp. 14-15).

While each of these terms has an internal logic, we can also see how inadequate they are. They subsume maps into categories either meaninglessly broad or overly narrow. In fact we could create such terms *ad nauseum*, buoyed by the concerns of the day and limited only by imagination. More to the point, these terms offer little in the way of definitional or conceptual rigor or consistency. Indeed, in his analysis and summary of some thirty-five categories from over two dozen citations, Fisher concluded that there is "***no such thing as any consistent practice***" (Fisher, p. 18, italic and boldface emphases original). Instead, we are left with assertions based more on the charismatic authority and professional research interests of the day than on the veracity or robustness of the frameworks and terms these researchers articulate (Fisher, p. 18). And, despite such inconsistencies and the absence of any theoretical grounding for these terms, we still encounter them. Slocum (1999, p. 2) distinguishes between "general reference maps" and "thematic maps (or statistical maps)," while the fifth edition of the enduring *Elements of Cartography* distinguishes between "general reference maps" and "thematic or special purpose [*sic*] maps" (Robinson *et al*, 1995, p. 13).

That virtually all other terms are now extinct demonstrates how little they offered cartography, then and now. In addition, we have not been able to ascribe any intellectual or theoretical rigor to those terms that we continue to employ. Nor have we referred to them with any frequency in our scholarship. We have not turned to them for any pedagogical utility in our courses or textbooks. And finally, we have not used them as the basis of any methodology or empirical testing in our science. Those terms that remain offer us little; they persist more through the inertia of convention and indifference than through any rigorous articulation of their utility or their meaning. That is, they are useless, in theory and definition, in substance and in application.

How can we create a coherent and comprehensive framework of map types that is relevant to cartography? Two criteria must exist in any such framework. First, we must ground the framework in epistemology and cognition. Nearly twenty years ago Petchenik noted that cartographers had been "erroneously been classifying maps when we should have been classifying forms of knowledge" (Petchenik, 1983, p. 41). The assertion holds today: how can we distinguish the forms and representations of substantive knowledge intended for and derived from maps? This paper asserts that the cognitive and epistemological practices of description, analysis and synthesis, as fundamental modes of meaning making, constitute the basis for such a framework.

Second, any attempt at constructing a comprehensive framework of map types must examine critically the long-standing breach between geography and cartography. That is, these modes of meaning making and their relationship to cartography also derive their import from the substantive, or geographic, message of maps. It is no longer enough to state that the map is a communication device or a medium of visualization. That is, what is a map without its geographical meanings? After all, if we persist in examining the map independently of its geographical meanings, then we insist that a map is just another graphic image that bears no relevance to the spatial or geographical messages that it seeks to convey.

HISTORICAL CONCERN for DESCRIPTION, ANALYSIS and SYNTHESIS in CARTOGRAPHY and GEOGRAPHY

Concern for the cognitive practices of description, analysis and synthesis and their relations to representation and geographic understanding is not new. Until the early 1960s, researchers had linked maps and the creation of the geographical meanings to the processes of "deduction and induction" (Eckert, in Guelke, 1977, p. 2). Garnett spoke of "the science of establishing causal relations between place" through "descriptive…analytic and… deductive" or synthesizing processes (Garnett, 1930, p. 15, 25). Robinson referred to a geographic cartography and its relations to the discerning of "geographical patterns and associations" (Robinson, 1954, pp. 555-556). In these and other examples, map uses and meanings could not be separated from the source of their substantive meaning, geographical reality. We also see in these statements early recognition of the mediating cognitive practices of description, analysis, and the use of comparison, contrast, juxtaposition and differentiation for creating "geographical understanding" (Guelke, 1976).

Concern for Robinson's geographic cartography and its inherent relationship to geographical description, analysis and synthesis would recede after the publication of Robinson's *The Look of Maps* in 1952. Indeed, within little more than a decade of scholarship cartographers had begun to establish cartography as a science of communication grounded in information theory and models of efficient information flows and processes. To establish its standing as a science the young discipline needed models and conceptual frameworks that could predict, a *sine qua non* of science. That processes are predictable – and that the geographic meanings intended for or derived from a map are not – meant that the new cartography would move farther away from defining map types through geographical meanings and conceptions of description, analysis and synthesis (Board, 1981). Indeed, by the mid-1970s cartographers had embraced information theory and Singh's declaration that "the

metrical theory of information is not concerned with the semantic content of the set of messages from which it selects some particular one for transmission" (Singh, 1966). For cartographers, the medium was now the message.

OLD IDEAS for a NEW FRAMEWORK

During the mid-1970s, however, studies in cognitive cartography had renewed questions about the relationships among the mapmaker, the map interpreter and the meanings contained on the map. Guelke (1976, 1977), Salichtchev (1973, 1978, 1983), Board (1981), and others began to address the limits of the communication model and its relations to the kinds of geographic meanings on maps. As early as 1975 Petchenik declared that "if the function of a map is to trigger meaning, then meaning becomes all-important.... Epistemological cartography is not a peripheral concern – it is the heart of the matter" (Petchenik, 1975, pp. 118-120). And by the early 1980s, Olson could state that map interpreters "organize knowledge according to meaning, not according to order of acquisition nor according to form of acquisition.... It is meaning that is the overriding mental force in what we remember" (Olson, 1983, pp. 153-154). Meaning was not inherent in circle size or line weights, in figure-ground or color charts; it resided in the geographic message of a map.

In a series of essays during the mid-1970s and 1980s, Petchenik would elaborate the most relevant ideas regarding cognition and epistemology, cartographic forms of represesntation, and the geographic meanings of maps (Petchenik, 1975, 1979, 1983, 1985). In particular she sought an alternative to the conventional terms known as general reference and thematic maps and in their place proposed two categories: inventory maps and message maps, terms she borrowed from Bertin (1983). We can dismiss as redundant the term message map, for *all* maps carry and convey some message. The term inventory maps, however, invites closer scrutiny. She defined an inventory map as one that predominantly uses "application-neutral" data, data whose meaning lies in the human experience of *being-in-place*. Such maps are cognitively anchored in "here is, there is" representations of phenomena, which allow us to build a "location vocabulary" for a place and what exists in that place. With regard to map design, inventory maps demonstrate "no *emphasis*, conceptual or visual, on the *structure* of the distribution other than to locate, name and distinguish the phenomena" (Petchenik, 1985, pp. 50-1 italics original).[3]

As a complement to inventory maps, her so-called message maps and what we would conventionally call thematic maps constitute representations whose meaning is presented as *knowing-about-space*. Petchenik asserted that such knowledge points to a "distribution-as-thing" and thence to structures of the meaningful continuity of distributions. These latter representations employ what she termed "application-specific" data, or data which we select, generalize, emphasize, and design such that "there is an *emphasis*, conceptual or visual, on the *structure* of the distribution" (Petchenik, 1979, pp. 10-12 and 1985, pp. 50-52; italics original). We should note that Eckert (1908) offered a glimpse of similar ideas when he distinguished between "geographically concrete and geographically abstract maps." The former "reproduced facts as they exist in nature" while the latter "separate the incidental from the essential. Both map types present the results of induction and deduction" (Eckert, in Guelke, 1977, p. 2).

Another useful concept for this new framework comes from Salichtchev (1973), who elaborated the notion of "synthetic maps," which facilitate "the representation and investigation of…qualitatively new information about the pattern and characteristics of spatial systems of varying complexity" (Salichtchev, 1973, pp. 113-115).[4] The term synthetic maps points again to several important ideas. First, contrary to the dominant communication science paradigm of the time, information loss is not inevitable. Second, geographical understanding derived from a map is inherently connected to geography. Third, the creation and adaptation of these meanings involve common but fundamental cognitive processes that include the search for pattern and the comparison of geographical phenomena, both of which move meaning making beyond mere location. We will return shortly to the terms inventory and synthetic, or synthesis maps.

Despite the promise of these ideas, the computer revolution in cartography largely displaced them, leaving them to atrophy while most cartographers returned to the revitalized technical and positivist traditions of the discipline. The rise of geographical information systems, however, helped Nyerges to link analytical cartography to map-use tasks. According to him, these tasks and their implied questions underlie so-called "deep structure" kinds of information, which "consist of geographical *relationships* as part of spatial context and meaning" (Nyerges, 1991, pp. 13-14, emphasis added). His work identified early a key role in how databases and GIS mimic the use of description (inventory maps), analysis (analytical maps) and explanation and correlation (synthesis maps) not only in cartographic representation but as tools for geographical analysis.

[3]She originally presented these ideas in a 1975 essay (Petchenik, 1975).

[4] At the time of writing for the conference submission deadline, I am not certain if this term is original to Salichtchev or if he derived it from Bertin's work.

More recently, studies of the science of visualization and knowledge representation offer fruitful ideas for the relationship among description, analysis and synthesis as modes of making and representing spatial meaning, geographic understanding and cartography. MacEachren's (1995) work represents the most fully developed presentation of the notions of how we use mental categories in knowledge schemata and chunking to construct, modify and visualize spatial meaning. In particular, MacEachren, working from DiBiase's ideas, points out that we construct meaning through "at least four stages: exploration, confirmation, synthesis and presentation" (MacEachren, 1995, pp. 7, 15, 24 and Chapter One in general). I would add analytical and descriptive representation as key stages to this process. MacEachren (in Kraak and Ormeling, 1996, pp. 2-4) also offers an intriguing and relevant model demonstrating the continuous and relational nature of the dimensions to how we create and represent spatial meanings. In particular he links the notions of presentation, analysis and exploration, known and unknown data relations, private and public spheres of use and meaning construction, and degrees of interactivity of data. Both of these works point to the role of such processes as analysis and synthesis in the creation and representation of spatial meaning.

Finally, Ormeling (1995) referred explicitly to such terms as inventory, explanation and synthesis in a discussion of electronic atlases and the promise of information technologies in facilitating geographic understanding. Such technologies facilitate topical, temporal and spatial comparison through juxtaposition. In turn, these techniques, along with the use of quantitative analytical means in a problem-solving approach to spatial analysis, lead to explaining geographical patterns (Ormeling, 1995, pp. 13-17). He does not, however, cite the origin of the terms inventory and synthesis maps.

INTEGRATING A NEW FRAMEWORK

The preceding literature review began with a summary of attempts at creating and using frameworks for map types. In all cases, we found these frameworks and typologies wanting. This review then excavated several ideas from modern cartography that link essential cognitive and epistemological modes of meaning making to representation and geographic understanding. Despite the promise of these latter concepts and linkages in the early 1980s no formal framework of map types appeared. Indeed, in her 1983 paper, Petchenik went as far as to state that though cartographers should be classifying forms of knowledge and not classifying maps, she lamented that "an unambiguous classification of maps on the basis of the type of information depicted is not possible" (Petchenik, 1983, p. 41).

This paper asserts that it is possible to create a framework based on forms of knowledge and their representation. Towards this end, I offer three terms for a new framework of maps: *inventory maps* replace the concept of general reference maps, and *analytical* and *synthesis maps* replace the concept of thematic or special-purpose maps. The theoretical foundation and contextual utility of these three terms derive from two fundamental dimensions regarding how and why we create, represent and communicate spatial and geographical meanings. First, we can link these terms to the cognitive practices of describing, analyzing, and synthesizing, the latter of which is virtually synonymous with demonstrating correlation and causation, or the showing of relationships. Each in turn is a fundamental dimension to and stage of the creation, storage and representation of spatial meanings. As such they are especially relevant to mapmaking and map interpretation, not just the more generic view of representation or visualization. That is, we make and use maps whose *primary* intent is to describe spatial phenomena. We make and use maps whose *primary* intent is to present or facilitate analysis of these phenomena. And we make and use maps whose primary intent is to facilitate or present synthesis and thus the showing of relationships among spatial phenomena.

Along with description, analysis and synthesis, we can also link these map categories to the cognitive and semantic practice of asking and answering questions and the role that these practices play in the creation of spatial meaning. That is, the primary function of inventory maps is to answer the question, What is where? Analytical maps not only show what is where, but they also attempt to answer the questions, How much? How many? In turn, synthesis maps build on both description and analysis in order to help answer the question, Why?

Positing this latter relationship among questioning, spatial meaning and the kinds of spatial representations we make may be a new idea. I sketch aspects of its possible relevance and utility in a later section. I also acknowledge that my grasp of its possible connections is more tenuous. And I should add that I do not intend to examine in this paper the psychological or epistemological foundations of questioning *per se*. For now I can only assert that a mere datum, one among many, becomes meaningful in part because it is linked to or derived from the human act of asking and answering questions. In creating a spatial representation, whether as a public or private representation (MacEachren, in Kraak and Ormeling, 1996, pp. 2-4), the kinds of questions the mapmaker seeks to answer guide in part how he or she selects and represents what to convey. Questioning also guides the map interpreter's search for knowledge, be it the elevation of a location on a topographic map, or why a spatial pattern

or anomaly exists.[5] An elaboration and testing of these assertions about the relationship between questioning and meaning poses a promising avenue of research for cartography.

ELABORATING THE THREE MAP TYPES

Inventory maps present application-neutral data and thus are intended primarily as representations that are spatial descriptions in nature and function. Such maps answer the simple question, What is where? As forms of knowledge, public or private, they are not unlike abridged, spatial dictionaries. As cartographic constructions, these maps typically present many diverse data sets. We also attempt neutrality in data selection, design and visualization such that no one data set is emphasized over another in terms of location or distribution, quantity, structure or meaning. A typical example is a topographic map. We can also liken inventory forms of representation to a spatial database or the locational knowledge we possess in knowledge schemata.

To a large degree, we can liken *analytical maps* to those maps that we know through the conventional term thematic maps. Central to the definition of analytical maps is that their primary function is to facilitate geographical analysis. Such maps thus emphasize distribution, pattern, trend or anomaly, and thus use data that are tend towards being application-specific. In creating such emphases, we perform some number or kinds of operations on our data sets. These operations can be statistical, and thus performed on quantitative data. These operations may involve generalization and data selection, figure-ground, symbolization, or other design practices in order to highlight the structure of the data's distribution. Whether conceptual or visual, these operations mean that while we may lose information, we gain meaning. In addition, analytical maps move us cognitively from representations of information about place to representations of knowledge about space. That is, their dominant function is to help us to see, represent, and convey meaning not only about the location and nature of individual trees but also the nature of the forest, in its pattern, extent and meaning.

The nature of analytical maps appears further when we contrast them with synthesis maps. We create synthesis maps in order to demonstrate why phenomena are where they are. We create such maps by using two or more primary data sets in meaningful visual and conceptual relationship. The predominant function of synthesis maps is thus to show either correlations or causal relations among spatial phenomena. Indeed, the cognitive act of undertaking such correlation involves three inherently connected and largely linear processes. First we must juxtapose two or more primary sets of spatial data, whether as an inventory representation or an analytical one, and whether in a GIS, on a printed map, or in the mind of the maker or interpreter. Only then can we undertake the act of comparing, contrasting and differentiating, activities that we employ as we try to create and revise spatial relationships and their meanings. Such processes allow us to speculate about or even conclude why phenomena are where they are and how they change over space and time.

AUTHOR'S NOTE: Four figures will appear here in the final draft of this paper in order to consider specific examples of these map types. These graphics will also be available at the conference, with explanatory text, as a separate handout.

THE UTILITY OF THE NEW FRAMEWORK

The utility of linking questioning and description, analysis and synthesis in order to create a framework of map types based on forms of knowledge and representation rests not only on creating a coherent and internal logic for its concepts and their meanings. The utility of such a framework resides also in how it might be applied to various dimensions of cartography.

First, the elements of this framework – description, analysis and synthesis – mimic key stages of the scientific method, whether the data are based in field research or laboratory experiment. We must gather, compile and display our data (raw or derived; quantitative or qualitative; point, line, area or volume; and nominal, ordinal, interval or ratio data) before we can begin to make sense of it. This gathering, or taking stock,[6] constitutes the first step in which we seek a locational or descriptive display of our spatial data: what is where? The next stage is analysis, in which we try to make sense of our data. Do we see distributions? Do we see patterns? Do we see anomalies? Can we differentiate? If not, do we need more data or are our phenomena merely random? In this process we often remove some information in order to create more meaning, and so we construct analytical maps

[5] I should add that questioning means more than the rather specific but relevant idea of querying a database.
[6] Indeed, we take stock of our data, much the way we take inventory of stock in a business.

in order to visualize the analyses of our data. Such representations might even be considered as working hypotheses for further or more focused study. Finally, we postulate or hypothesize causal or correlative relationships, and thus juxtapose, compare, contrast, and integrate our findings using synthesis maps. I should add that while this overall process has a general structure of linearlity, the process often loops or jumps among the three forms of spatial representation as we try to understand why phenomena exist where they do. And, we can assert again that each of these kinds of "maps" may be publicly shared paper or digital representations, or they might be private, cognitively based representations in knowledge schemata.

This last point means that we can embed our conceptions of the mapmaker and the map interpreter in this process. Indeed, we can identify both maker and interpreter (without ignoring their important differences) as interpreters of geographical meanings, whether these meanings come from inventories, analyses or syntheses. That is, both the mapmaker and the interpreter undertake these processes of creating descriptive, analytical and synthetic representations of spatial meanings, whether cognitively or publicly (MacEachren, in Kraak and Ormeling, 1996, pp. 2-4). Both engage in interpretation throughout the process.

A framework of maps based on inventory, analysis and synthesis also mimics processes and structures inherent in modern computer cartography and geographical information systems. As already alluded to, a digital database constitutes the most extreme version Petchenik's application-neutral data and thus stands as the most inventory-like compilation or description of data we can make (Petchenik, 1985, pp. 54-56). In contrast, any given map we create from this database will trend on the continuum toward being a representation that conveys application-specific data. The convenience of a GIS for manipulating coverages facilitates juxtaposing, comparing and contrasting, differentiating, correlating and synthesizing diverse data sets.

Related to this last point is that we can apply this framework to our studies of that most underrated of *geographical* texts, the atlas. While we know that atlases are discursive, today's atlases, whether in print or digital format, are still largely descriptive in nature, and are often little better at facilitating synthetic relations than they were thirty years ago. This may be changing. Ormeling writes about the structure of electronic atlases and the promise of increased user access to spatial data and facility with undertaking spatial analysis. Yet he still relies on the alleged liberatory power of technology for improving democratic access to spatial data for solving social and environmental (Ormeling, 1995). That is, while we are continually making more intuitive graphical user interfaces, and while we can create more access to more spatial data, technology alone cannot teach us how to create and to see geographical meanings, especially those that involve juxtapositions, comparisons, and syntheses. Designing hardware and software for increasing the operational ease of these kinds of geographical inquiries is important. But the act of knowing how to postulate possible spatial relations, how to see geographical meanings and how to ask questions about the place or process in question seems to be as important.

The computer and GIS revolutions have also transformed innumerable disciplines and professions that use spatial data in their work. The consequent proliferation of user groups is a boon to cartographic innovation in design and visualization. Yet even in such a context of diversity and innovation, a framework based on description, analysis and synthesis underlies the many kinds of maps and knowledge representations that these disparate user groups make. I would add that the re-assertion of the role of geographical meanings in cartography and in this framework will allow cartographers to study more effectively the design and representation needs of these diverse user groups, whether based on profession or user context, age or gender. An important research question arises: How does each of these diverse user groups employ description, analysis and synthesis in creating, representing and communicating spatial meanings?

Children constitute a special user group for understanding maps and geography, and thus may benefit from this new framework. That is, how often do we cartographers and geographers lament that children rarely move beyond the mere listing (or, perhaps I should say inventorying) of the capitals of provinces and the principal exports of nations! It seems a rather simple exercise for nine-year olds to engage themselves with maps that are descriptive – that is, to make and to use maps that show what is where, be it capitals, national parks, or religious congregations in colonial America. (See Figures 1 and 2.) Can nine-year olds also see the relationship between settlement location and proximity to perennial surface water in the settling of the arid American West? (See Figure 4.) If not, then maybe the ability to create such comparisons and syntheses is a developmental practice that eleven-year olds can do. Whatever the age, children have increasing access to digital databases. Such access allows them to mix and match data sets for a common region at a common scale. Can we show children how to undertake geographical analysis and synthesis – that is, to move them beyond mere capitals and exports, beyond what is where, so that they learn to ask why? To what degree can a framework of maps and forms of knowledge representation based on description, analysis and synthesis aid in this pedagogical practice?

TWO CAVEATS

No framework is all encompassing; we must now test the robustness and veracity of the new model, especially to find its limits. In addition, all frameworks need provisos and warnings. The first caveat for this framework is that we should not be tempted to formalize these new map categories into linear stages of

mapmaking, where one kind of map invariably leads to the next. Creation of meaning is never so simple. That is, while the logic of descriptively mapping (publicly or privately) what is where must precede the showing of relationships among those phenomena mapped, I strongly caution against making inventory, analytical and synthesis maps into a hierarchy, with higher-order and lower-order maps. All three are modes of making and representing spatial meanings, and thus all three matter. Each has its place in the richly complex ways in which we create and represent spatial meanings and especially in the richly complex mapmaking and map interpretation contexts in which we seek different kinds of meanings.

Second, I would also caution against using this framework to undertake a taxonomy of maps. That is, we should not use it in order to try to place maps into mutually exclusive categories. These map types derive their utility because they represent forms of knowledge, not because they require some sense of singular belonging to mutually exclusive categories. To go around asking, "Is this an inventory map or an analytical map?" misses entirely the strengths of the framework.

CONCLUSION

In this paper, I have argued that cartography has long needed a framework for the kinds of maps we make, grounded in theory rather than being based on uncritical conventions. Towards this end I have attempted to resurrect and re-invigorate abandoned or dormant ideas from modern cartography in order to create a new framework of map types. This framework is based on the assertion that questioning and description, analysis, and synthesis are fundamental cognitive and epistemological processes we use in order to create, revise, represent and convey spatial meanings. I have also sought to demonstrate how this new framework might articulate with several important dimensions to contemporary cartography.

What I have not articulated, let alone mentioned, is how we might test this model. I admit that I have given little more than cursory consideration to this question. One clear context for inquiry concerns how disparate user groups might use the framework, especially regarding age and gender.

Finally, implicit throughout this paper have been the rather tentative and elusive links I have made between composition and writing (descriptive writing, analytical or expository writing, and writing that uses argumentation or explanation) and the forms of meanings we seek to represent and convey on maps. We now know that maps are discursive, and we now treat maps as a rhetorical text. Perhaps we should treat mapmakers and map interpreters as writing composers, who create compositions just as writers create a composition. While this term is used largely in the context of writing classes, more broadly applied it can refer to all writers and all interpreters of spatial meanings, just as it can refer to such composers as Beethoven and Mozart. In this light, maps are not just about how we represent and how we visualize spatial meaning. I would add that they are also created in order to communicate spatial meaning.

I close by suggesting that cartography re-visit the map not just as a form of representation and visualization but also as a form of communication. A new communication model for cartography can incorporate these basic but essential modes of meaning making and representation: description, analysis and synthesis. A new communication model thus can move beyond information theory's reductionist and entropic treatment of information, as well as beyond post-modernism's often raffish and politicized treatment of meaning. Most of all, it can re-link spatial representation and visualization to geographical meanings.

Which is to say, what is a map without its geographical meanings? If we persist in examining the map independently of its geographical meanings, then we insist that a map is just another graphic image that bears no relevance to the substantive messages that it seeks to represent *and* to convey.

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