

cartographic perspectives

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Letter from the Editor

Dear Members of NACIS,

This issue of *Cartographic Perspectives* marks the beginning of my tenure as editor. I wrote this column . . . wanting to tell you about the new editorial board, about some ideas for the journal, and to solicit manuscripts. Much of this seems so inconsequential in light of the attacks on the World Trade Center and the Pentagon, and the possible attack on the U.S. Capitol on September 11, 2000 . . . now known as 911. One month after the attack, 911 still is in my thoughts. I am reminded of it daily by the media . . . the newspaper, television, radio, magazines, the internet, the stock market. Some of my students have withdrawn from my classes because they have had to report for active duty. I see the American Flag everywhere . . . it has become such a powerful symbol for a country in mourning . . . a symbol of unity. There are lectures on terrorism on our campus.

(continued on page 83)

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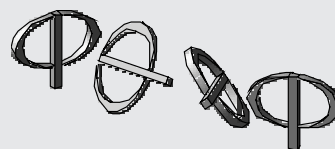
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about the cover



"The cover design was created by Lou Cross. Lou is a cartographer and graphic artist with the Florida Resources and Environmental Analysis Center at The Florida State University.

Whither Cartography?

The great “Is cartography dead?” debate that raged a few years ago has been relatively quiet lately, but discussions of certification and accreditation are raising the issue again. Conversations with colleagues, round table seminars at conferences, and perusing journals, have raised in my mind some disturbing issues about cartography’s future.

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Relative Decline in Cartography Classes

In the past 10 years, the number of GIS courses has increased dramatically, and remote sensing has shown a slight increase, but the number of cartography courses has remained relatively stable. The *AAG Guide to Departments* lists program specialties by department. The table below shows the numbers of departments claiming a specialty out of the total number reporting for the past 10 years (*AAG Guide to Programs*).

	1991–92		1995–96		2000–01	
	Programs	Percent	Programs	Percent	Programs	Percent
Cartography	160/243	66	174/250	70	156/250	63
Remote Sensing	117/243	48	139/250	56	143/250	57
GIS	165/243	68	203/250	81	223/250	89

Table 1. Number of departments claiming a specialty out of the total number of departments reporting.

Few would deny that GIS is a powerful and useful tool, and it would be foolish of any geography department not to offer training in it. However, if 89% of programs claim GIS as a program specialty and only 63% of departments offer cartography (as seen for 2000-2001), there is a strong likelihood that many students are receiving little background in the theory of cartography. Thus, while they may do a fine GIS analysis, they may have difficulty presenting their findings effectively through maps.

Curriculum

There are still those who equate cartography with drafting, especially manual drafting, and GIS with computer cartography. They believe that GIS works with data to create maps automatically by computer, while cartography is simply drawing clean lines, and neat lettering and perhaps involves page layout, name placement, and color selection. This shows a woeful ignorance of the nature of both fields. For many of our colleagues, cartography was one course taken two or even three decades ago, before the PC became a ubiquitous fixture in cartography labs. In those courses there was, of necessity, considerable emphasis placed on drafting just as now there is emphasis on the use of particular software packages. To these people, cartography is “old fashioned” and perhaps irrelevant; they feel

that GIS has replaced cartography. Unfortunately, some of these colleagues are administrators and senior faculty and have a major role in designing department curricula, deciding what courses are offered, and what specialties should be hired. Throughout the past 20 years cartographers have periodically published ideal cartography or mapping science curricula, (Dahlberg and Jensen, Dymon, Taylor), but such curricula are irrelevant if geography departments eliminate cartography classes in the mistaken belief that they are "old fashioned." or obsolete. As cartographers retire, will cartography courses be forced to retire because they are seen as the province of the "old guys"?

Community College Programs

Many community colleges are jumping on the GIS bandwagon. GIS is such a hot subject that two year colleges see GIS courses as enrollment magnets. Some two-year colleges are introducing GIS certificate programs that generally require no cartography training. The best of these programs have ties to four-year institutions, specialist instructors, and the advice of GIS specialists, remote sensors, and cartographers. In the worst case scenario, however, the instructor's entire GIS training may have been one intensive workshop sponsored by one of the software manufacturers. A major concern is that students from these training programs will be "black box" operators who only know how to use one software package but do not really know principles of cartography or GIS. This belief is reinforced by use of software manuals rather than a textbook in classes. Are these students destined to be mere button-pushers; the buggy whip makers and key punch operators of the next decade? With limited background, will they be able to make transitions as the fields grow and change? Will they be able to advance in their careers or will they remain low level technicians?

Textbooks

I was told by one editor recently that "cartography can be covered in one chapter of a GIS book", and by another that there would be "a chapter on cartographic design" in his publisher's text, but has this happened? I examined four current introductory GIS textbooks and found little that would be considered cartographic design in them. If one were to base perceptions of the nature of cartography on some current GIS texts, cartography would appear to be map layout and name placement. There are exceptions, such as Keith Clarke's *Getting Started with Geographic Information Systems*, but the average GIS textbook includes little of the cartographic basics of symbol choice, design, or even scale or projections, on the assumption that those topics are covered in cartography textbooks. As they should, GIS texts focus on analysis of data, data structures, database management, and the like, but there is little on presentation; readers are directed to cartography books or the author suggests that a course in cartography might be useful. That is a reasonable suggestion. There is no need to include the contents of an introductory cartography text in an introductory GIS book; the resulting 600 to 800 page book would be truly daunting. But if no cartography course is offered, no guidelines are given in GIS textbooks, and students do not read a cartography book, then what? Where do they learn the basics?

In addition, the quality of GIS textbooks, as with all texts, is spotty. Some have serious inaccuracies. A significant example is a diagram in one textbook that attempts to simplify projection concepts (Heywood, et

al). Unfortunately, in their attempts to simplify, the authors have created a totally inaccurate diagram in which all cylindrical projections are equal area, all azimuthal projections preserve distance, and all conic projections show correct scale. This is worse than having nothing at all on projections.

Software Programs

GIS software programs have tended to focus on only one or two symbols, and all maps made with the program utilizes those symbols. If the software can't produce a symbol easily, if it can only be created with additional programming, then for the user, especially the inexperienced user, it doesn't exist. Thus, the true dot map is rapidly vanishing and the choropleth is used for virtually all quantitative maps, even when it is inappropriate, because it is the easiest to employ. Much the same is true for color. Despite the amount of recent cartographic research on color maps, too many maps are made using software default colors, which results in maps with no color logic, vegetation and land-use maps with 30 supposedly different but impossible to distinguish colors, and choropleth maps with nine shades of one hue. The concepts here are not sophisticated, but for someone with no knowledge of cartographic principles, default options may seem fine.

The result is an increasing number of maps that violate basic principles of cartography and are inaccurate or misleading. In the 1970s a spate of articles was published and papers presented on the problems and dangers of creating maps by computer with no knowledge of cartography. The problem remains. Some of the maps are quite "pretty," even spectacular, and have been featured in advertising documents for software manufacturers, but a basic fact remains: maps are used in decision making, and if poor maps are used, poor decisions result. It isn't fashionable today to talk about map communication, but if maps convey erroneous or misleading information then they are worse than useless, they are dangerous. Mark Monmonier among others has spent 3 decades trying to convey this fact.

I recognize that I am preaching to the choir, but I believe these concerns need more investigation. Essentially, I am pleading for education in the cartographic basics for geographers and GIS professionals. Essays such as this one will not convince administrators, editors, or those with narrow focus GIS training. Further research on these subjects, through theses and dissertations and articles in the more general professional journals needs to be done to educate the educators.

Association of American Geographers. 1992. *Guide to Programs in Geography in the United States and Canada, 1991-92.*

Association of American Geographers. 1996. *Guide to Programs in Geography in the United States and Canada, 1995-96.*

Association of American Geographers. 2001. *Guide to Programs in Geography in the United States and Canada, 2000-2001.*

Clarke, Keith C. 1999. *Getting Started with Geographic Information Systems*, 2nd ed., Upper Saddle River, NJ: Prentice-Hall.

REFERENCES

Dahlberg, Richard E. and Jensen, John R. 1985. *Education and Training in Contemporary Cartography*, Chapter 9. D.R.F. Taylor, ed. Chichester, UK: John Wiley and Sons.

Dymon, Ute. 1996. "Transition in Cartographic Education in the United States: Challenges and Opportunities in Curriculum Design." *Cartographica*, vol. 33, #3, pp. 39-43.

Fryman, James. 1996. "Geographic Education in the United States and Canada," *Cartographica*, volume 33, #3, Fall 1996, pp. 5-13.

Heywood, Ian, Cornelli, Sarah, and Carver, Steve. 1998. *An Introduction to Geographical Information Systems*, Upper Saddle River, NJ: Prentice-Hall.

Monmonier, Mark. 1996. *How to Lie with Maps*, Chicago: University of Chicago Press.

Taylor, D.R.F. 1985. "Educational Challenges of a New Cartography," *Cartographica*, volume 22, #4, pp. 19-37.

How The Monosemic Graphics Go Polysemic

This paper is a reflection on the semiological tradition after Saussure. The focus here is cartographic. In 1967 Jacques Bertin presented the semiology of graphics, which has had an extensive influence on cartography. Bertin claimed graphics (diagrams, networks and maps) to be a monosemic sign system because graphics transcribe relationships that are previously defined in a data table. This premise is critically revisited regarding maps, resulting in the conclusion that diagrams and networks might be monosemic representations while statistical maps cannot. Polysemy is introduced in statistical mapping because the plan possesses influencing properties on the transcribed meaning, which are not a priori defined in the data table.

There are two dominant semiological traditions, one European, influenced by Ferdinand de Saussure (1857 – 1913), called semiology and one North American influenced by C.S. Peirce (1839 – 1914), called semiotics. Semiology and semiotics are notions generally used by French and Anglo-American writers respectively, but they refer to the same discipline: the general study of signs. ‘The Peircean tradition has provided the most elaborate analysis of the typology of signs and how they “stand-for” their referents, while the Saussurean tradition has had a decisive influence on the semiotic theory of codes (i.e. the study of sign systems)’ (MacEachren, 1995, 217-218).

The two traditions differ in their general model of sign referred to as *dyadic* and *triadic* models, alluding to the number of elements identified in their sign relationships. In Saussure’s dyadic sign model the sign is the union of the two sides that constitute it: a *concept* and a *sound-image*. Concept is a term leading into the semiotic dimension of semantics. Apparently, the term ‘concept’ closely corresponds to the more general semiotic terms meaning and content (Nöth, 1990, 61). Sound-image is a term that according to Saussure’s definition ‘is not the material sound, a purely physical thing, but the psychological imprint of the sound, the impression that it makes in our senses’ (Saussure, 1974, 66). Saussure exemplified his sign model, as in figure 1.a, by illustrating the concept by the image of a ‘tree’ and the sound-image by the Latin word *arbor* (Saussure, 1974, 67). Later he decided to replace concept and sound-image by signified and signifier respectively, since ‘the last two terms have the advantage of indicating the opposition that separated them from each other and from the whole of which they are parts’ (Saussure, 1974, 67). Louis Hjelmslev developed the Saussurian dichotomy but used the notions content and expression. The fact that signified and signifier both are mental entities and independent of any external object in Saussure’s theory of the sign (Nöth, 1990, 60), is the most apparent difference from Peirce’s sign model (figure 1.b). In Peirce’s triadic model the referential object is included as a third category. From one of Peirce’s more elaborate definitions, the three correlates of the sign are called: a *representamen*, an *object* and an *interpretant* (Nöth, 1990, 42). The representamen is by other semioticians designated as the sign vehicle, the signifier, or the expression (Nöth, 1990, 42). Peirce’s second correlate of the sign, the

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INTRODUCTION

“Semiology and semiotics are notions generally used by French and Anglo-American writers respectively, but they refer to the same discipline: the general study of signs.”

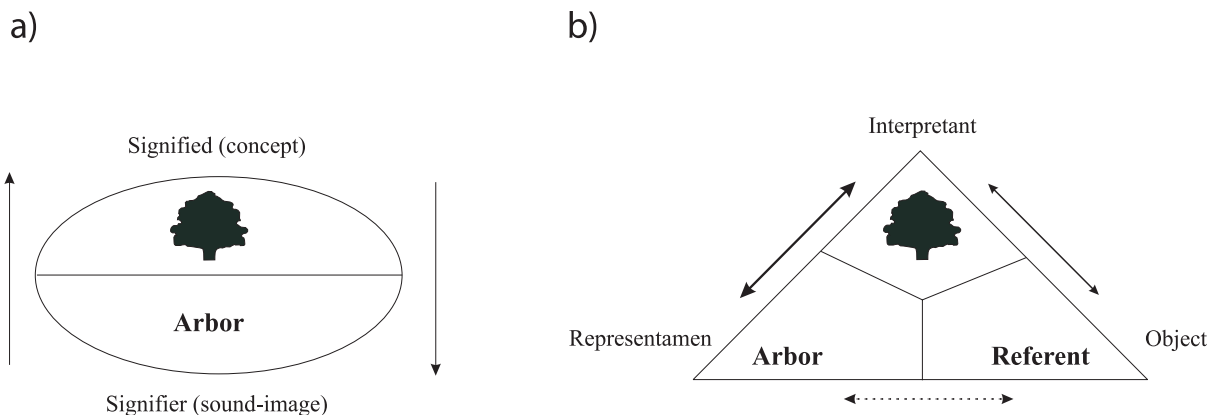


Figure 1. The dyadic sign model (a) adapted from Saussure (1974,67) and the triadic sign model (b) after Peirce. Peirce did not himself make any graphic illustration on his sign model – this one is adapted from Eco (1976,59).

object, corresponds to the referent. This correlate can be a material “object of the world”. It can be a “single known existing thing” or a class of things (Nöth, 1990, 42-43). Interpretant is Peirce’s term for the meaning of a sign, the sign’s significance.

THE GRAPHIC SEMIOLOGY

Saussure called ‘the combination of a concept [signified] and a sound-image [signifier] a *sign*, but in current usage the term generally designates only a sound-image, a word, for example (*arbor*, etc.)’ (Saussure, 1974, 67 – words in brackets are added). When Bertin defined graphics (1983, 2), he stated that the meanings which we attribute to signs can be monosemic or polysemic. The term sign used by Bertin seems not to correspond with Saussure’s ‘sign’ but with Saussure’s ‘signifier’. When Bertin uses the term sign, he often does so in the context of polysemy. Similar to how Bertin excludes the notion of code (as will be shown later) he seems to exclude the notion of sign, probably because he coins both terms as associated with polysemic sign systems. ‘Mathematics and graphics exclude polysemic signs, by only considering relationships among previously defined elements’ (Bertin, 1981, 179). In order to transcribe these relationships, signs were not needed.

“When Bertin defined graphics, he stated that the meanings which we attribute to signs can be monosemic or polysemic.”

The transcription of relationships does not utilize “signs”; it utilizes only the *relationship between signs*. It utilizes visual *variations*. Graphics denotes a resemblance between two things by a visual resemblance *between two signs*, the order of three things by the order of three signs (Bertin, 1981, 177 – originally emphasis).

The relationships to be transcribed are resemblance, order and proportion (Bertin, 1978, 118-119; 1980, 592-593). Without making any reference, Bertin uses the Saussurian terminology and calls the three relationships the three signifieds (Bertin, 1981, 177). Graphics utilizes visual variations between visible marks. This variation has eight variables to its disposal (Bertin, 1983, 7): the dimensions of the plane (variation in x and y location), shape, orientation, color, texture, value, and size. Although Bertin does not explicitly indicate that he takes Saussure’s ideas as a basis for his own research, this article will interpret Bertin’s synthesis along Saussurean lines. I will call the combination of the three relationships as the signifieds (or contents), and the relationships between visual variations as the signifiers (or expressions) of a graphic sign.

Most cartographers accept the contention that there is a limited set of graphic primitives available for cartographic representation. Some authors, however, have found Bertin's graphic semiology incomplete and subsequently extended the visual variable syntactics slightly (Morrison, 1974, 124 and MacEachren, 1994, 33). As Bertin's graphic semiology is closely tied to static classes of representation (point, line, or area), its syntactics is tried extended to also cover 2 ½ and 3 dimensional representations (Slocum, 1999, 23). A dynamic variable syntactics is suggested in order to cover dynamic mapping (MacEachren, 1995, 288). This article is an interpretation and modification to Bertin's original ideas and does thus not include an extended syntactics. The problem that polysemy is introduced in mapping should be of relevance for both static and dynamic maps.

As many of his contemporaries and predecessors (i.e. Robinson, 1952), Bertin tried to distance graphics (diagrams, networks, and maps) from art. Several writers have written about the science/art polarity and its relevance for cartography (for instance Krygier, 1995 and Keates, 1996), but little attention is directed towards how the traditional science/art polarity corresponds to monosemic versus polysemic sign systems. 'A system is monosemic when the meaning of each sign is known **prior to** observation of the collection of signs'. By contrast 'a system is polysemic when the meaning of the individual sign **follows** and is deduced from consideration of the collection of signs' (Bertin, 1983, 2 - original emphasis). Thus, according to Bertin, graphics are monosemic. Graphics 'is an image that transcribes relations between elements or groups of elements (sets) previously definite' (Bertin, 1978, 121). The elements or sets might be, for instance, two factories.

How do we represent a factory? There is an infinite number of "good" representations. The choice is an art. That is pictography. Factory A employs twice as many workers as factory B. There is only one single representation: show that A is twice as large as B. This is not an art since *there is no choice*. This is graphics (Bertin, 1981, 177-178).

Since 'a graphic always begins with a data table' (Bertin, 1978, 121) the relationships between these elements are previously defined, as for instance factory 'A' employs twice as many as factory 'B' (figure 2.a). In a monosemic sign system, there is a consistency in meaning like for instance: twice as large: twice as much (see figure 2.b). Size signifies quantity; variation in size signifies variation in quantities.

This constituted, Bertin claimed, a monosemic sign system. To employ a monosemic system means that 'for a certain domain and during a certain time, *all the participants* come to agree on certain meanings expressed by certain signs, and *agree to discuss them no further*' (Bertin, 1983, 3 - original emphasis). Following Guiraud (1975, 25), the more the relation between the signifier and the signified are precise and widely recognized, the more the sign conforms to a monosemic sign system. Anyone should be able to evaluate the relationships between the marks displayed in figure 3 with a certain degree of accuracy.

A square filled with diagonal lines differs from a square filled with lines having another orientation. We recognize difference in resemblance. A light gray square differs from a dark gray square. We

"Most cartographers accept the contention that there is a limited set of graphic primitives available for cartographic representation."

THE MONOSEMIC GRAPHICS

"... the more the relation between the signifier and the signified are precise and widely recognized, the more the sign conforms to a monosemic sign system."

a)

Data table

Factory	Employed
A	300
B	150

b)

Graphic

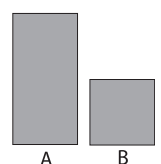


Figure 2. In a data table (a), the relationships between the elements are previously defined. A graphic (b) is monosemic since it transcribes relations between elements previously defined.

recognize difference in resemblance and order. A small box differs from a twofold large box. We recognize difference in resemblance, order, and proportion.

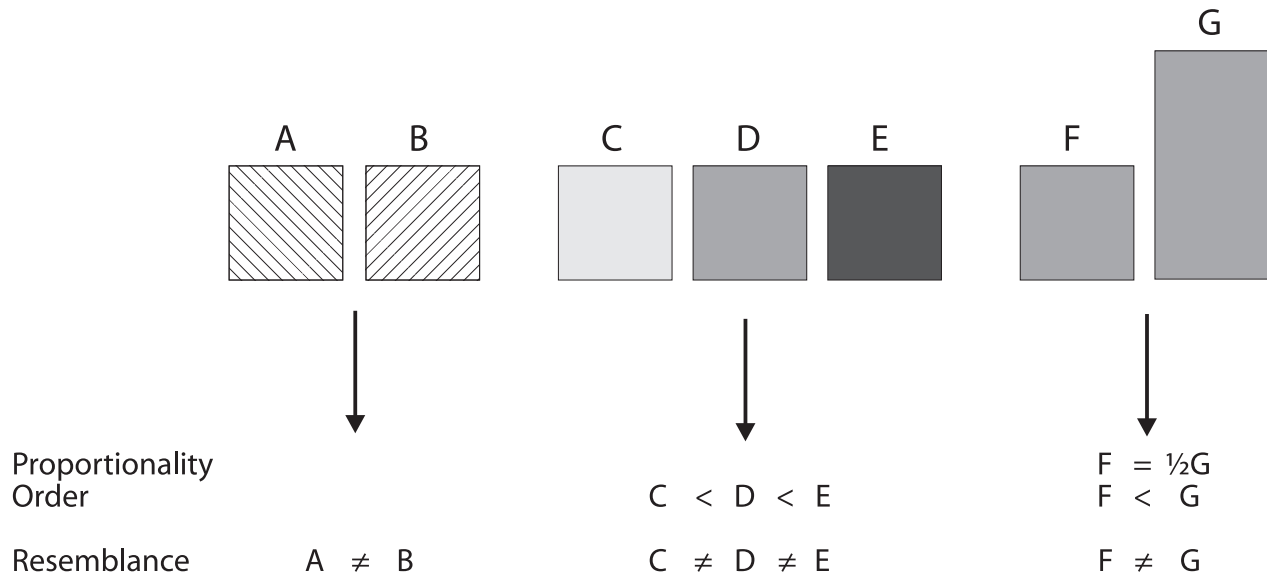


Figure 3. Visual variation between marks and the evaluated relationships.

THE GRAPHIC CODE

Bertin emphasizes the way a monosemic versus a polysemic representation is perceived. 'The attention we pay to a diagram or to a map is different from that paid to a painting, a poster or a traffic signal' (Bertin, 1978, 120). To perceive a polysemic representation requires only one phase of perception: what is it about? The aim of a polysemic representation is to define a set or a concept (Bertin, 1981, 176). To perceive a polysemic representation involves the identification of a few concepts from among the unlimited number of imaginable ones. In order to characterize polysemic communication, Bertin (1978, 118) used the schema: *sender* ↔ *code* ↔ *receiver* (Bertin, 1980, 593), which he had reduced from Shannon and Weaver (1949, 7) and Schramm and Roberts (1971, 23). This schema in its various forms was popular in numerous studies of maps as the medium for cartographic communication where the encoding of the message (the map making) and its decoding (the map reading) were analyzed. 'The map is the coded "message"' (Robinson and Petchenik, 1976, 27).

"To perceive a polysemic representation requires only one phase of perception: what is it about?"

'The aim of graphics is to *make relationships* among previously defined sets appear' (Bertin, 1981, 176 - original emphasis). 'One can then ascertain that any diagram (and consequently any cartography) is or can be considered as the transcription of a data table' (Bertin, 1978, 121). To perceive a graphic requires two distinct phases of perception (Bertin, 1981, 177). 'The first time of perception in 'the graphics' consists in recognizing the three components of this data table' (Bertin, 1978, 121). The three components (Bertin calls them *x*, *y*, and *z*) are the variables (i.e. 'employed'), the units (i.e. factory 'A' and 'B'), and the units' values (i.e. '300' and '150'). In the second phase of perception, the graphic answers questions dealing 'with the relationships existing between the components *x*, *y* and *z* in the data table' (Bertin, 1978, 123), for instance: factory 'A' employs twice as many workers as factory 'B'. The author and the reader are in exactly the same situation. They are the "actors" who ask the questions in the second phase of perception. According to Bertin, their perception follows the monos-

emic schema: *actor* ↔ *three relationships*. According to Bertin, the perception of the graphics does not need any code. 'The reader needs no code to "see" order or proportion' (Bertin, 1978, 123).

The term code has two meanings rooted in two quite opposed domains: the secret sphere of cryptography and the public sphere of laws (Nöth, 1990, 206). The introduction of the term in semiotics had a terminological "landslide effect" (Eco, 1984, 166). Only few scholars adhered to the narrower definition of code as a correlational device, as mere instructions for the translation of signs from one system of signs to another. Mostly, the term became a synonym of sign system. To which of these definitions Bertin coined the term is difficult to say. Schlichtmann (1979, 81) and Board (1981, 61) pointed out that Bertin referred to graphic representation as a code in the form of a sign system, but he never explicitly defined the code. Normally, it is within semiotic theory defined as a set of rules for linking expression and contents (Eco, 1976, 36-37), as a correspondence between signifiers and signifieds (Wood and Fels, 1986, 68). Consequently, for semiology of graphics, a code is the set of rules for linking the visual variation and the three relationships. Thus as Board concluded: 'Bertin's rules do form part of what might well be regarded as a code' (Board, 1981, 61).

It follows from the example in figure 3 that different visual variables have different signifying properties. They signify one or more of the relationships of resemblance, order, and proportion. The relationship of resemblance consists of associative and selective properties. A visual variable is associative when it creates an equalized image like in figure 4.a and 4.b. Shape and orientation are associative variables since they do not cause the visibility of the signs to vary.

'Selective perception is utilized in obtaining an answer to the question: "Where is a given category?"' (Bertin, 1983, 67). It seems that orientation (4.b), value (4.c), and size (4.d) are selective while shape (4.a) is not. The use of value and size, however, construct a visual hierarchy favoring the reactor and coal characteristics. Value and size are thus dissociative (not associative) since they cause the visibility of the signs to vary. According to Bertin (1981, 213) this hierarchy is an error when unjustified, as, for example, when used to differentiate among characteristics. 'When the characteristics are quantitative, size and/or value are used to represent the quantities (or their order)' (Bertin, 1981, 213 – originally emphasis). Figure 5 summarizes the properties of the visual variables identified by Bertin.

Bertin grouped the visual variables into two main classes, the dimensions of the plane and the

"The term code has two meanings rooted in two quite opposed domains: the secret sphere of cryptography and the public sphere of laws."

SIGNIFYING PROPERTIES

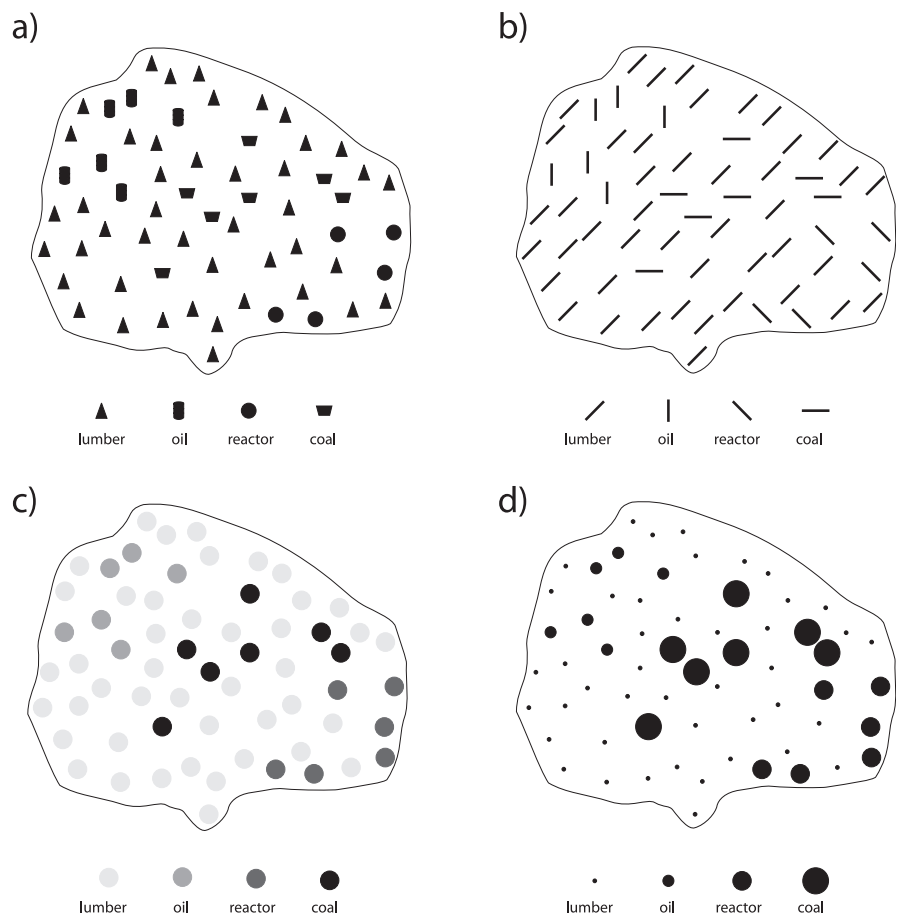


Figure 4. Associative (a, b), selective (b, c, d), and dissociative (c, d) signifying properties.

		Perceptual properties of the visual variables			
Planar dimensions	X,Y	≡	≠	O	Q
	Size	≠	≠	O	Q
Retinal variables	Value	≠	≠	O	
	Texture	≡	≠	O	
	Color	≡	≠		
	Orientation	≡	≠	Point and line implantations	
	Shape	≡			

- Q Quantitative perception - make appear the ratio between signs
 O Ordered perception - make appear the order between signs
 ≠ Selective perception - make appear the image formed by a given category
 ≡ Associative perception - make appear an equalized image where the visibility of the signs are constant (if not as with size and value variation, there is dissociative perception ≠)

Figure 5. The properties of the visual variables (Adapted from Berlin, 1981, 231).

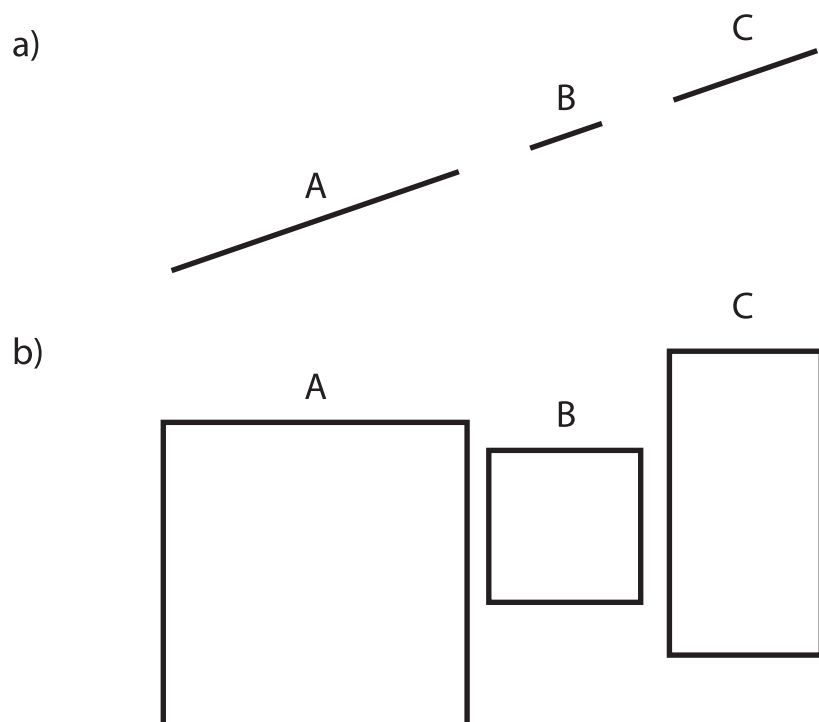


Figure 6. Lines and areas as individual localized signs.

retinal variables. In cartographic theory, the properties of the latter have achieved most attention. The properties of the former have more or less been overlooked, although 'the plane provides the only variables possessing all four perceptual properties' (Bertin, 1983, 49), that is: associative, selective, ordered, and quantitative. In order to "prove" that a variation in position is ordered and that difference in position is quantitative, Bertin used an example with three line segments as in figure 6.a (Bertin, 1983, 49).

Bertin claimed that anyone could evaluate the relationships displayed in figure 6.a with a certain degree of accuracy:

$$A > C > B \quad A = 2C \quad B = C/2$$

Bertin continued with stating that the plan permits us to add segments (Bertin, 1983, 49). Areas and lines are aggregates of points. Schlichtmann (1991, 265) treats space (points or aggregates of points like lines and areas) as individual localized signs, isolated by a notional (content-related) criterion (example: 'country') and a graphic (expression-related) criterion (example: area symbols which indicate a country). Similar to Bertin's example above, anyone should be able to evaluate the relationships displayed in figure 6.b with a certain degree of accuracy:

$$A > C > B \quad A = 2C \quad B = C/2$$

In this article, I adopt Schlichtmann's term 'locational signs' which I will use for the administrative units used for statistical mapping.

The diagram in figure 7.a shows two components: (1) quantities in thousands of salaried workers, according to (2) five 'départements' in Brittany. When constructing a diagram that depicts numerical information, like the one in figure 7.a, one does not need the retinal variables in order to transcribe quantities since one dimension covers the categories (the x-axis) and one dimension covers the quantities (the y-axis). Figure 7.b represent a different situation. 'In cartography, the geographic component occupies the two planar dimensions' (Bertin, 1983, 58). Consequently, 'we must seek new variables to represent additional components. These are the "elevated" or "retinal" variables' (Bertin, 1983, 59).

Figure 7.b is an example of visual variation "above" the plane. The base map composes the two dimensions of the plane. In order to represent a previously defined relationship, it is the variables of the third dimension or the 'retinal' variables that need to be called upon. It is a relationship of proportions; thus, the visual variable size must be used for its representation. The 'retinal' variable size is inscribed "above" the plane and is, according to Bertin, independent from it - independent in the sense that the eye can perceive its variation without requiring movement. Eye movement occurs when the map perceiver needs to scan or read the map in order to conceive the overall meaning (Bertin, 1983, 62-63). Bertin claims that the transcription of meaning (relationship of resemblance, order, or proportions), is left to the 'retinal variables' alone.

To claim that the transcription of meaning is left to the 'retinal variables' alone is a pronouncement I find difficult to accept. I believe that the properties of the plan exert influence on how maps are imbued with meaning. The size of the administrative units to which the marks correspond, make up additionally signs - localized signs. Consequently, in a comparison of two graphic depictions, there are three relations that need to be considered (see figure 8).

First, it is the visual variation "above" the plan, which generate the denotative code (1). Second, 'what people see when confronted with proportional symbols related to areas is a ratio between the size of the symbol and the size of the enumeration area it refers to' (Kraak and Ormeling, 1996, 135). This generates an interlocking code (2). Third, to say that

"... 'the plane provides the only variables possessing all four perceptual properties', that is: associative, selective, ordered, and quantitative."

SUPERIMPOSING LEVELS OF MEANING

"In order to represent a previously defined relationship, it is the variables of the third dimension or the 'retinal' variables that need to be called upon."

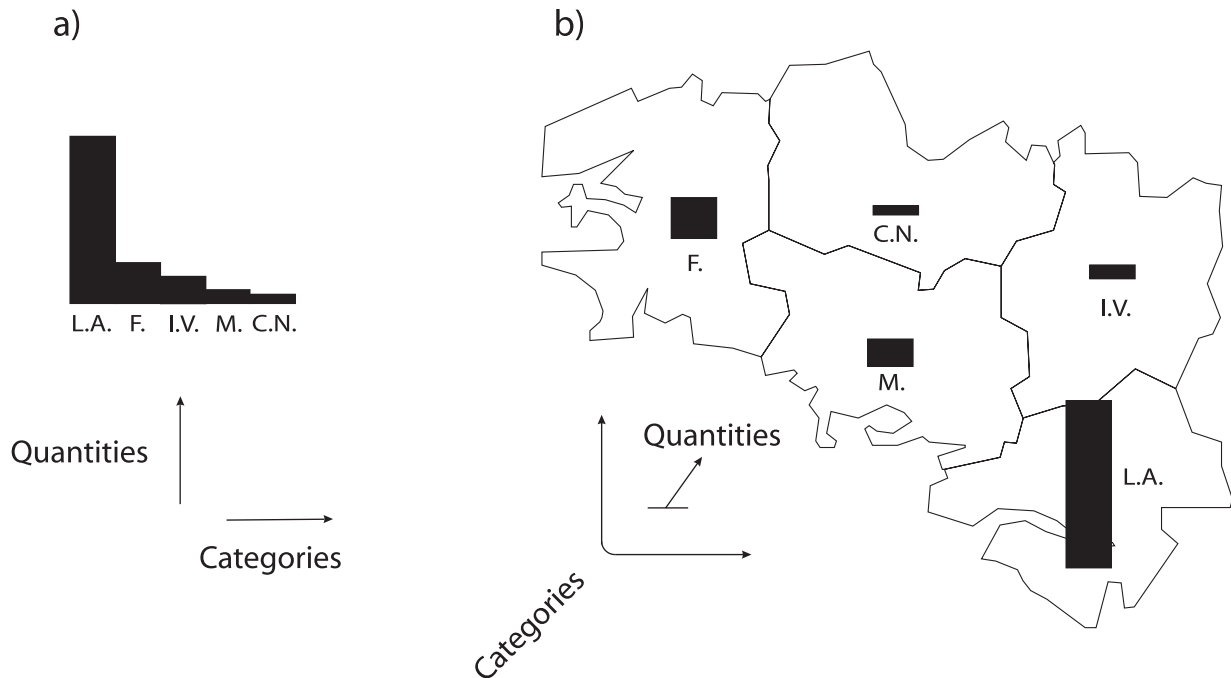


Figure 7. When the various categories are spatially defined and the information produces a map, both dimensions are utilized for their representation. The representation of quantities must be transcribed by "elevated" or "retinal" variables (Bertin, 1983, 58-59).

'space is utilized to signify space' (Bertin, 1983, 58) is too simple. As the administrative units differ in size, the size variation transcribes additional relationships of resemblance, order, and proportion. This generates a superimposed code (3). In this article, only the denotative and superimposed codes are subject for investigation.

The meaning transcribed by the 'retinal variables' alone, is a denotative semiotic (see figure 9). 'In a denotative semiotic an expression plane denotes a content plane' (Eco, 1994, 182). Eco uses as Saussure a dyadic sign model, but exchanged, like Hjelmslev did, the terms signified and signifier by content and expression respectively. Schlichtmann (1979, 1985, 1991) adopts the same terminology. The content of map entries, he outlines, have both plan-free and plan components. 'Items of plan information are denoted, *i.e.* directly expressed, by plan characteristics of symbols' (Schlichtmann, 1985, 24). Plan information is also connoted (Schlichtmann, 1985, 29 – footnote 11). In connotative semiotic 'both expression and content of a denotative semiotic become in turn the expression plane of a new content plane' (Eco, 1994, 182). Connotation is a mediated meaning, *i.e.*, a meaning released by another more basic meaning (Schlichtmann, 1990, note 3, Eco, 1976, 55-56). The basic meaning in figure 9.c is that

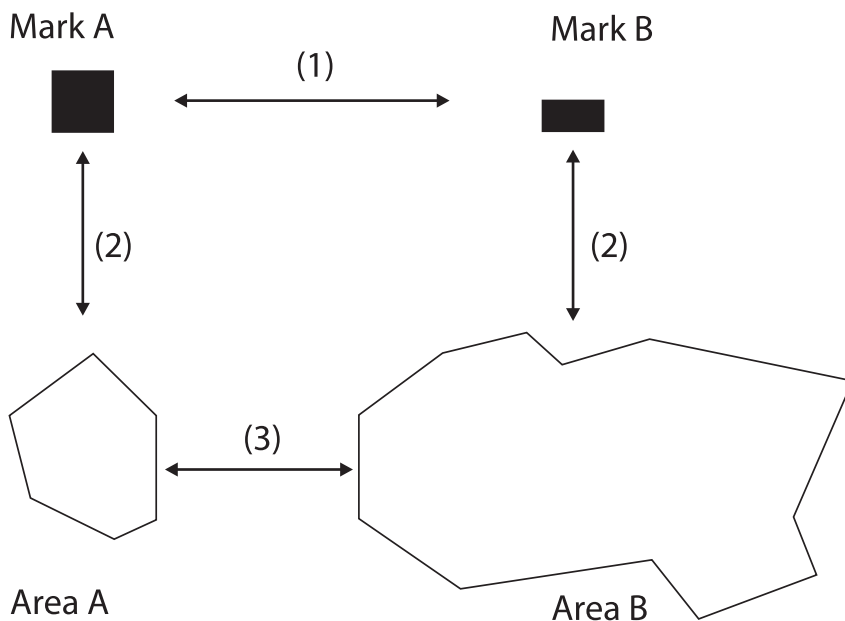
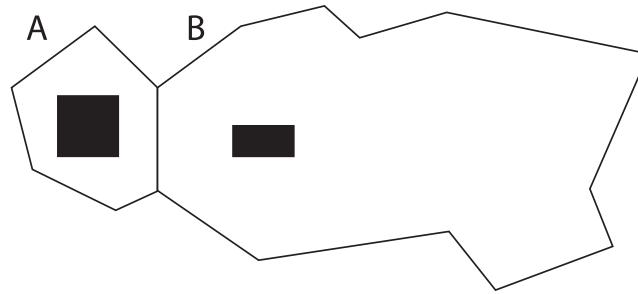



Figure 8. Denotative code (1), interlocked code (2), and superimposed code (3).

a)



b)

Denotative semiotic

Expression		Content	
		Proportions	$A = 2B$
		Order	$A > B$
		Resemblance	$A \neq B$

c)

Connotative semiotic

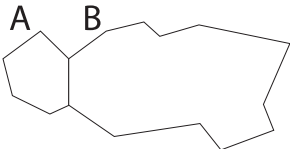
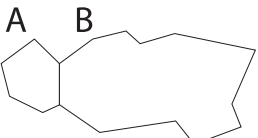
Expression		Content	
Expression	Content		
		Proportions	$6A = B$
		Order	$A < B$
		Resemblance	$A \neq B$
		Space	

Figure 9. Denotative and connotative semiotic when the administrative units varies in size.

'space is utilized to signify space' (Bertin, 1983, 58). 'Whatever else the map may do, in any case it represent a space, and it represents by means of a space' (Schlichtmann, 1985, 24). As shown in figure 9, areas and thus base map units possess signifying properties, which mediate an additional meaning. Inconsistency might arrive in the transcribed meaning if the denoted meaning, for instance twice as large: twice as much ($A = 2B$) differs from the connoted one ($6A = B$).

Probably the only situation in mapping where the graphic message would depend on the 'retinal variables' alone is when the size and form of the area patches is equal and aligned regularly like in figure 10. In nearly



b) Denotative semiotic

Expression	Content
	Proportions $A = 2 B$ Order $A > B$ Resemblance $A \neq B$

c) Connotative semiotic




Expression	Content				
<table> <tr> <th>Expression</th><th>Content</th></tr> <tr> <td> </td><td> Proportions $A = B$ Order $A = B$ Resemblance $A = B$ </td></tr> </table>	Expression	Content		Proportions $A = B$ Order $A = B$ Resemblance $A = B$	
Expression	Content				
	Proportions $A = B$ Order $A = B$ Resemblance $A = B$				
<table> <tr> <th>A</th><th>B</th></tr> <tr> <td></td><td></td></tr> </table>	A	B			Space
A	B				
					

Figure 10. Denotative and connotative semiotic for aligned grid cells.

all situations in statistical mapping, however, administrative units vary in size as in figure 9 (for simplicity ignore that the area patches also differ in shape). If the size and form vary too much between administrative units, a biased picture of the statistical theme might occur. The graphic message does thus not depend on the 'retinal variables' alone. The problem under discussion has been well recognized in empirical research on statistical mapping (Dykes, 1994:105). In this article, the problem has been tackled in a theoretical context.

CONCLUDING REMARKS

Guiraud (1975, 27-28) stated for articulated language that polysemic meaning emerges since one is dealing not so much with one code as with

an aggregate of superimposed and interlocking codes. This article has tried to show that polysemic meaning emerges also for the particular graphic language: statistical mapping. In statistical mapping, it is shown; one is also dealing with an aggregate of superimposed and interlocking codes in addition to the denotative one. In order to better understand the way a map transcribes meaning, it is necessary to consider the dimension of the plane not independently from the retinal variables, but as an influencing part of the graphic sign system. The administrative units do not only signify space, they additionally portray relationships of resemblance, order and proportion. These relationships are not previously defined in the data table. Consequently, they represent a second connotative meaning. In statistical mapping, therefore, the monosemic graphics go polysemic. Inconsistency might arrive if the connoted meaning does not correspond with the denoted meaning. In order to avoid inconsistency, mapmakers should be using aligned grid cells with equal size and form. The grid cells will then connote equally and consequently not interfere with the denoted meaning. Another solution is to use cartograms. According to Bertin's definition on monosemic representations, cartograms are monosemic since the sizes of the administrative units are scaled according to previously defined relationships in the data table.

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Bertin, J. 1978. Theory of communication and theory of 'the graphic'. *International Yearbook of Cartography*. 18:118-126.

REFERENCES

Bertin, J. 1980. The basic test of the graph: A matrix theory of graph construction and cartography. In *Processing of Visible Language 2*, eds. P. A. Kolers, M. E. Wrolstad, and H. Bouma. 585-604. New York: Plenum Press.

Bertin, J. 1981. *Graphics and Graphic Information Processing*. Berlin: Walter de Gruyter. Originally published as *La graphique et le traitement graphiques de l'information*. (Paris: Flammarion, 1977).

Bertin, J. 1983. *Semiology of graphics: Diagrams, networks, maps*. Madison: University of Wisconsin Press. Originally published as *Sémiologie graphique. Les diagrammes - les réseaux - les cartes*. (Paris: Mouton & Gauthier-Villars, 1967).

Board, C. 1981. Cartographic communication. *Cartographica*. 18:2:42-78.

Dykes J. 1994. Area-value data: New visual emphases and representations. In *Visualisation in geographical information systems*, eds. H. M. Hearnshaw and D. J. Unwin, 103 - 114. Chichester: Wiley.

Eco, U. 1976. *A Theory of semiotics*. Bloomington: Indiana University Press.

Eco, U. 1984. *Semiotics and the philosophy of language*. Bloomington: Indiana University Press.

Eco, U. 1994. Denotation/connotation. In *Encyclopedic dictionary of semiotics*. 2nd ed., ed. T. A. Sebeok. Berlin: Mouton de Gruyter, 1:181-183.

Guiraud, P. 1975. *Semiology*. London: Routledge & Kegan Paul. Originally published as *La sémiologie*. (Paris: Presses universitaires de France; 1971).

Keates, J. S. 1996. *Understanding maps*. 2nd ed. Essex: Longman.

Kraak, M. J. and Ormeling, F. J. 1996. *Cartography - Visualization of spatial data*. Essex: Longman.

Krygier, J. B. 1995. Cartography as an art and a science? *Cartographic Journal*. 32:6: 3-10.

MacEachren, A. M. 1994. *Some truth with maps: a primer on symbolization & design*. Association of American Geographers. Resource publications in geography.

MacEachren, A. M. 1995. *How maps work: Representation, visualization and design*. New York: Guilford Press.

Morrison, J. L. 1974. A Theoretical framework for cartographic generalization with emphasis on the process of symbolization. *International Yearbook of Cartography*. 14: 115-127.

Nöth, W. 1990. *Handbook of semiotics*. Bloomington: Indiana University Press.

Robinson, A. H. 1952. *The Look of Maps - An Examination of Cartographic Design*. Madison: The University of Wisconsin Press.

Robinson, A. H. and Petchenik, B. B. 1976. *The nature of maps: Essays toward understanding maps and mapping*. Chicago: University of Chicago Press.

Saussure, F. 1974. *Course in general linguistics*. Rev. ed. London: Owen. Originally published as *Cours de linguistique générale*. (Paris: Payot, 1916).

Schlichtmann, H. 1979. Codes in map communication. *The Canadian Cartographer*. 16:1: 81-97.

Schlichtmann, H. 1985. Characteristic traits of the semiotic system 'map symbolism'. *Cartographic Journal*. 22:1: 23-30.

Schlichtmann, H. 1991. Plan information and its retrieval in map interpretation: The view from semiotics. In *Cognitive and linguistic aspects of geographic space*, eds. D. M. Mark and A. U. Frank. Dordrecht: Kluwer Academic Publishers. 263-284.

Schramm, W. and Roberts, D. F. 1971. *The process and effects of mass communication*, rev. ed. Urbana: University of Illinois Press.

Shannon, C. E. and Weaver, W. 1949. *The mathematical theory of communication*. Urbana: University of Illinois Press.

Slocum, T. A. 1999. *Thematic cartography and visualization*. Upper Saddle River, N.J.: Prentice-Hall.

Wood, D. and Fels, J. 1986. Design on signs / Myth and meaning in maps. *Cartographica*. 23:3: 54-103.

Visualizing Data Certainty: A Case Study Using Graduated Circle Maps

Several techniques have been proposed for displaying data certainty on maps, but few have been empirically tested for effectiveness. While it is important to make data certainty information easily accessible, the addition of such data should not unduly increase map complexity. Thus, it becomes important for cartographers to examine the available methods for displaying this aspect of metadata and to test each for its effectiveness. The focus of this study was the display of data certainty information on graduated circle maps. Four types of accuracy indicators were evaluated for their effectiveness in communicating data certainty information. Two were traditional accuracy indicators: reliability diagrams and legend statements. Two were bivariate in form, one using a value-size combination and the other mimicking the idea of *focus* by varying the line value of the graduated circles to suggest a fading of symbolization for least certain data. The study was designed to assess whether subjects could identify data certainty information on test maps, and evaluate how accurately and confidently they could extract and interpret both thematic and data certainty information. Mean accuracy and confidence rates were compared for maps using different accuracy indicators to evaluate their relative effectiveness. Results suggest that subjects had most difficulty identifying and extracting data certainty information using maps that employed legend statements. They were most successful when data certainty was wedded to thematic data on the map using the bivariate accuracy indicator that mimicked the concept of focus. Identification and extraction of thematic data values were not significantly affected by choice of accuracy indicator.

Map accuracy is often equated with graphic quality. As noted by both Wright (1942) and McGranaghan (1993), well-drawn, precise maps are typically taken as scientifically authentic, regardless of the quality of their underlying data. Aesthetically pleasing maps, however, can conceal problems with the data and methods used in their creation. Wright (1942:527) provides perhaps the most interesting analogy on this subject: "A map may be like a person who talks clearly and convincingly on a subject of which his knowledge is imperfect." Always a problem cartographically, this particular issue has become even thornier as we have moved from manual, hand-drawn maps into the digital environment where nearly anyone who can master a software package can be a "mapmaker". Technology provides us with amazing capabilities in creating, editing, and displaying spatial data, capabilities that are offset by the fact that many of these maps are inappropriately used given the data upon which they are based. Since the validity of the underlying data is the key to making credible decisions, it makes sense that reporting and spatially depicting data certainty information should be addressed in a contemporary cartographic framework. Yet, as MacEachren (1994:67) points out: "The cartographic literature has largely ignored the question of depicting uncertainty. Insuring viewer understanding of uncertainty, then, will depend on developing a means to represent it."

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INTRODUCTION

"Since data validity is the key to making credible decisions, it makes sense that reporting and spatially depicting data certainty information should be addressed in a contemporary cartographic framework."

"The ease of extracting and processing both thematic and data certainty information are likely to be affected by the cartographer's symbolization choices."

"Inherent in the mapmaking process is cartographic abstraction . . . Abstraction, however, introduces uncertainty . . ."

BACKGROUND

"Information regarding variation in the certainty of spatial data has been most often given using either legend statements or reliability diagrams."

The objective of this study was to assess several methods for displaying data certainty, using the graduated circle map as a case study for displaying this information in the thematic mapping arena. While there has been a wealth of theoretical publications on the subject, there has been surprisingly little empirical research published on this topic. In spite of this dearth of research, the choice of symbolization technique used may have a profound effect on map use. Both the ease of extracting and processing thematic data, as well as the ease of extracting and processing data certainty information are likely to be affected by the cartographer's symbolization choices (Buttenfield, 1993). Our goals with this study were basic. We sought to answer whether or not one could, by manipulating symbolization design parameters:

- understand that some information on the map varies in certainty
- interpret that information in the context of the thematic data presented on the map

Data from this study contributes to cartography because it provides information on the integration of data certainty symbolization with traditional graduated circle symbolization. It also presents empirical evidence outlining workable ways of wedding data certainty information with quantitative information in a thematic mapping context. The experiment was designed to test four unique display techniques. Each was evaluated using accuracy rates and confidence ratings. These measures were used to assess the effectiveness of each technique for:

- displaying data certainty information
- enhancing one's ability to answer questions about both the thematic data and the data certainty information displayed on the map

Inherent in the mapmaking process is *cartographic abstraction*, without which we would not be able to graphically portray the complexity of the real world. Abstraction, however, introduces uncertainty - uncertainty about data quality and about the relationships between variables, both of which can affect location and attribute quality on the map (MacEachren, 1994).

Discussion on the topic of data certainty is often complicated by terminology. Several terms have been bandied about and used interchangeably in the literature: *uncertainty/certainty*, *error*, *quality*, and *reliability* are typical examples. Although these terms tend to vary in scope of definition, they are usually taken to encompass not only the completeness of the data mapped, but also temporal variability and the spatial and attribute variability due to aggregation processes. Perhaps the actual term we use is less important than *how* we choose to portray the consequence of abstraction. Ultimately, the goal is to provide a tool in which the portrayal of data certainty is adequate enough to give the map user a sense of how much faith to put into the information extracted from the map (MacEachren, 1994).

Visualizing Data Certainty

Traditionally, information regarding variation in the certainty of spatial data has been most often given using either textual information, such as a *legend statement*, or by a graphic known as a *reliability diagram*, usually located in the map's margins (van Der Wel, et al., 1994). These types of *traditional accuracy indicators* are the most non-intrusive. An example of a

legend statement, which is typically a simple verbal description of data certainty variation, can be found in Figure 1a. Reliability diagrams, more graphically oriented, consist of outline maps or abstract block diagrams that provide a visual sense of the spatial variation of data certainty associated with the source data mapped (Muehrcke and Muehrcke, 1992). Figure 1b shows an example of this type of accuracy indicator. The primary risk with both of these indicators, however, is that data certainty information may be ignored, as it is separated from the thematic data.

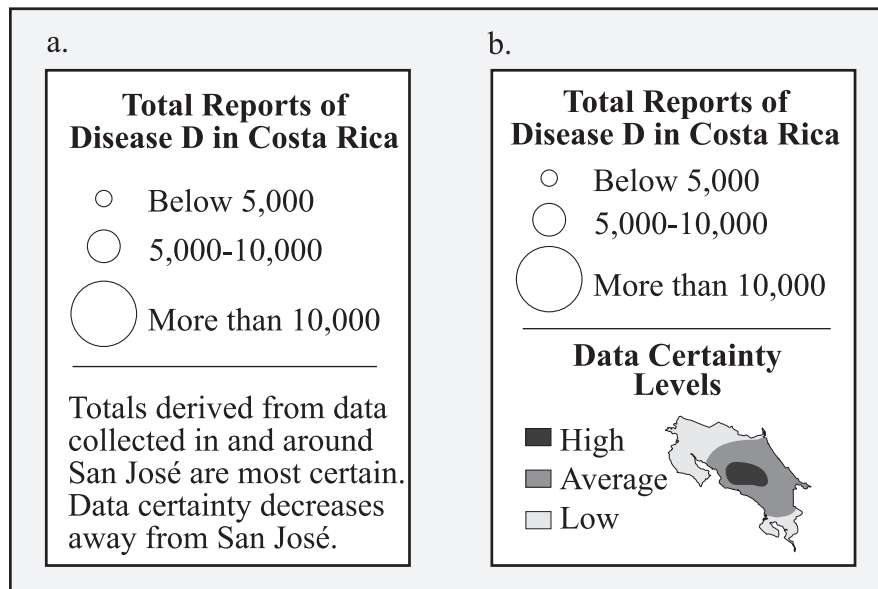


Figure 1. Traditional accuracy indicators: (a) Legend statement, (b) Reliability diagram

Cartographic research, in recent years, has extended the above options by establishing a broader set of theoretical guidelines regarding the visualization of data certainty on maps and in GIS (Buttenfield, 1991; MacEachren, 1992; van Der Wel, et al., 1994). These guidelines address both the wedding of data certainty information to the actual mapped spatial data using *bivariate accuracy indicators* (Figure 2), as well as newer techniques, such as animation and sound, resulting in accuracy indicators that we might categorize as *novel*. The starting point for the development of both of these groups of indicators has generally been Bertin's (1983) set of six visual variables (shape, size, orientation, hue, value, and pattern), which has provided the discipline of cartography with its basic structure for visualizing spatial data. To these six, several other variables have since been added, providing an even larger taxonomy from which to draw symbolization choices (MacEachren, 1992; Muehrcke and Muehrcke, 1992; Fisher, 1994). Few of these guidelines, however, have been tested in empirical studies that would either confirm these ideas or suggest the most appropriate framework for visualizing data certainty (Leitner and Buttenfield, 2000).

One study that does examine these guidelines from an empirical perspective is Schweizer and Goodchild (1992). They tested the potential of bivariate choropleth maps for displaying quantitative thematic data using saturation, coupled with variation in value to indicate differing levels of data certainty. Value is one of Bertin's visual variables that has been most often mentioned as being potentially effective for displaying variation in data certainty (Buttenfield, 1991; MacEachren, 1992; van Der Wel, et al.,

"The primary risk of both of these indicators, however, is that data certainty information may be ignored, as it is separated from the thematic data."

"Cartographic research has extended the above options by establishing a broader set of theoretical guidelines that address both bivariate accuracy indicators, as well as newer techniques such as animation and sound . . ."

"Few of these guidelines, however, have been tested in empirical studies . . ."

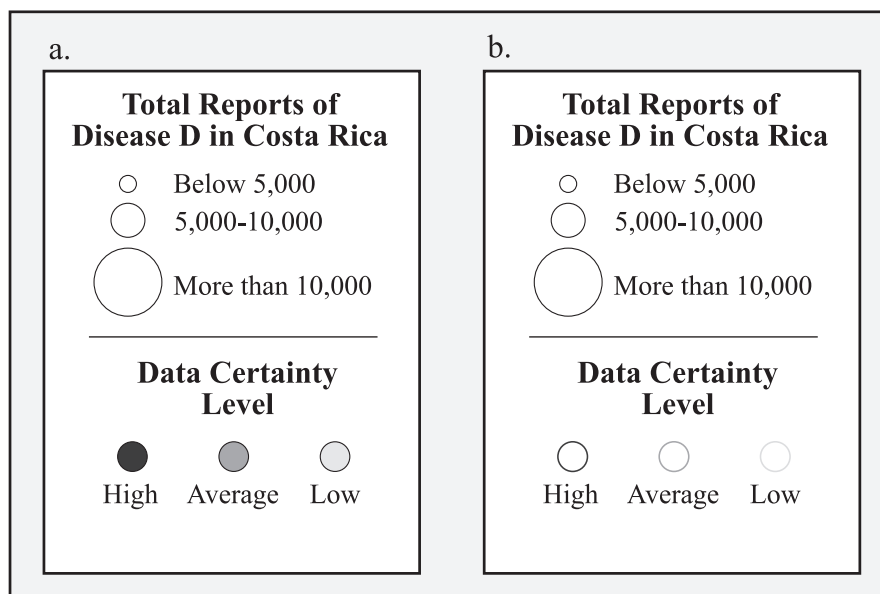


Figure 2. Bivariate accuracy indicators tested in the study: (a) Value-size, (b) Focus

"Four unique accuracy indicators were evaluated in the context of displaying data certainty information on graduated circle maps."

1994). Results from this study led the authors to conclude that at least in the case of a value-saturation combination, we tend to combine the two dimensions in decision-making processes. Instead of focusing on variation in value alone to determine data certainty levels, subjects tended to assume a "darker is more, lighter is less" maxim that relied on a combination of value and saturation and caused incorrect interpretations of the maps.

Saturation is often considered a logical extension of Bertin's original six, and has been suggested as another possible alternative in the display of data certainty (MacEachren, 1992). Leitner and Battenfield (2000) tested this variable, along with texture and value, in their study. Their research focused on spatial decision support systems; one emphasis was on evaluating how the timing, accuracy, and confidence of decisions could be affected by choice of visual variable used to represent data certainty information in the map display. Results of the study suggest that the addition of data certainty information can increase the number of correct responses in a decision-making task, provided that the information is symbolized using either lighter values or finer textures for more certain information. Saturation may also be used, but is ranked a distant third choice by the authors.

THE EXPERIMENTS

Four unique accuracy indicators were evaluated in the context of displaying data certainty information on graduated circle maps. Two accuracy indicators, legend statements (Figure 1a) and reliability diagrams (Figure 1b), were chosen because they represent the traditional means of communicating data certainty. To these were added two variations of a bivariate accuracy indicator, representing the implementation of some of the newer theoretical guidelines that have been proposed in the literature. One bivariate indicator was comprised of variation in values and sizes of the circles, with value representing variation in data certainty (Figure 2a). The other was designed to mimic the idea of *focus*, a means of visualizing data certainty by varying value to suggest a fading effect (van Der Wel, et al., 1994). Here data certainty was symbolized by varying the value of the lines defining the graduated circle sizes (Figure 2b). More novel tech-

niques were not tested, as we chose to work in a printed environment for the study.

Research Questions

Heading into the experiments, we anticipated that the traditional accuracy indicators - legend statements and reliability diagrams - would be the most difficult for subjects to use effectively. Muehrcke and Muehrcke (1992) lend support to this expectation, as does Fisher (1994: 185), who states the problem perhaps the most succinctly: "... embedding the error in the display makes it impossible to ignore it, which is otherwise the tendency of the user." We also expected, however, to see a difference in subject performance between the legend statement and reliability diagram. Although in both cases data certainty information is separated from the mapped thematic data, we anticipated that subjects would be more likely to notice and process the information provided by a graphic than by a comparable verbal statement.

Bivariate accuracy indicators are more complex, and may reach a complexity threshold quickly (McGranaghan, 1993), but we expected that subjects would find data certainty information easier to notice and process when it was wedded to the actual thematic information in the map. Results of the Leitner and Bittenfield (2001:14) study support this: "... the inclusion of certainty information is not associated by map viewers as an addition of map detail ... It would seem that map certainty is understood as clarification rather than adding complexity to a map display." Of the two bivariate accuracy indicators tested, we expected that the more typical value-size indicator would be most effective, as it was more familiar and had the most graphic "punch". The indicator mimicking *focus*, in which the value of the line surrounding each circle varied, appeared much more subtle from a figure-ground perspective. With these thoughts in mind, the following research questions were posed:

- What effect does the type of accuracy indicator have on one's ability to recognize the existence of data certainty information on the map?
- What effect does the type of accuracy indicator have on one's ability to comprehend data certainty variation in the context of mapped thematic data?

These questions can be answered by comparing how accurately and how confidently one can

- identify data certainty patterns on maps using these types of accuracy indicators
- answer questions about the spatial variation of data certainty displayed on maps using these types of accuracy indicators

Maps

Sixteen graduated circle maps, an example of which can be seen in Figure 3, were prepared for use in two related experiments. All maps utilized the same base. They differed in the manner in which data certainty was symbolized and in spatial complexity (Table 1). Each of the sixteen maps displayed one of four fictitious data sets tied to spatial complexity and one of four accuracy indicators. For graphic examples of the spatial patterns

"We anticipated that ... legend statements and reliability diagrams would be most difficult for subjects to use effectively."

"We expected that subjects would find data certainty information easier to process when it was wedded to the actual thematic information in the map."

"Of the two bivariate accuracy indicators tested, we expected the more typical value-size indicator would be most effective, as it was more familiar and had the most graphic punch."

"Sixteen graduated circle maps ... were prepared for use in two related experiments."

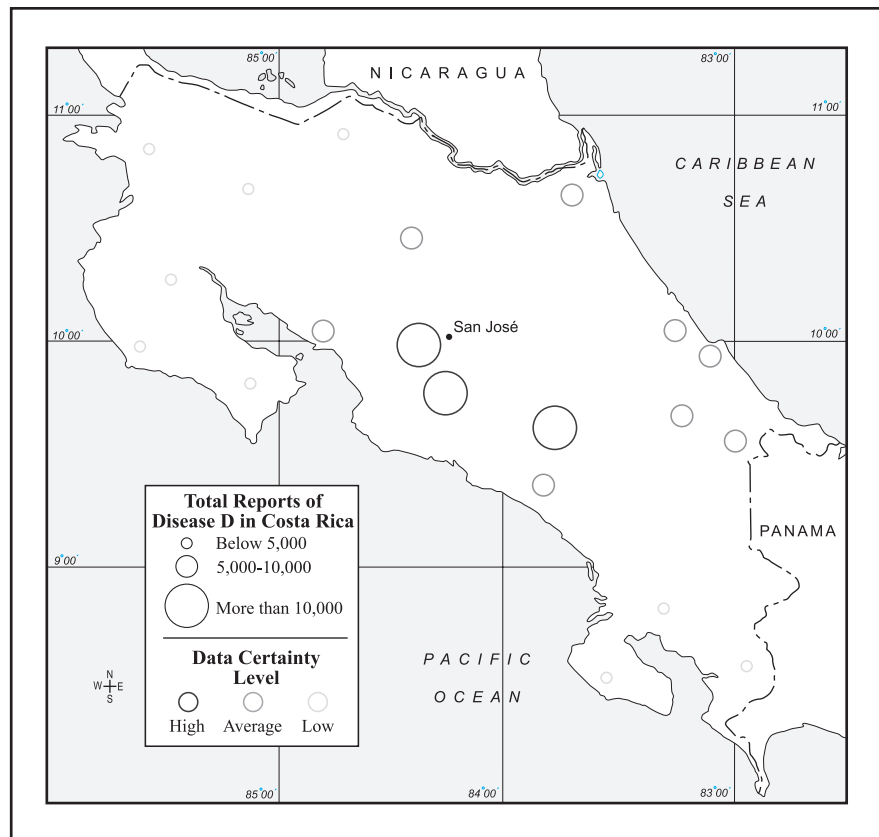


Figure 3. Example of a test map used in the experiments.

Accuracy Indicator	Spatial Pattern: Thematic Data	Correlation with Data Certainty Information
<i>Legend Statement</i>	Clustered I	Yes
<i>Legend Statement</i>	Clustered II	No
<i>Legend Statement</i>	Random	No
<i>Legend Statement</i>	Systematic	Yes
<i>Reliability Diagram</i>	Clustered I	Yes
<i>Reliability Diagram</i>	Clustered II	No
<i>Reliability Diagram</i>	Random	No
<i>Reliability Diagram</i>	Systematic	Yes
<i>Bivariate Value-Size</i>	Clustered I	Yes
<i>Bivariate Value-Size</i>	Clustered II	No
<i>Bivariate Value-Size</i>	Random	No
<i>Bivariate Value-Size</i>	Systematic	Yes
<i>Bivariate Focus</i>	Clustered I	Yes
<i>Bivariate Focus</i>	Clustered II	No
<i>Bivariate Focus</i>	Random	No
<i>Bivariate Focus</i>	Systematic	Yes

Table 1. Characteristics of the sixteen test maps.

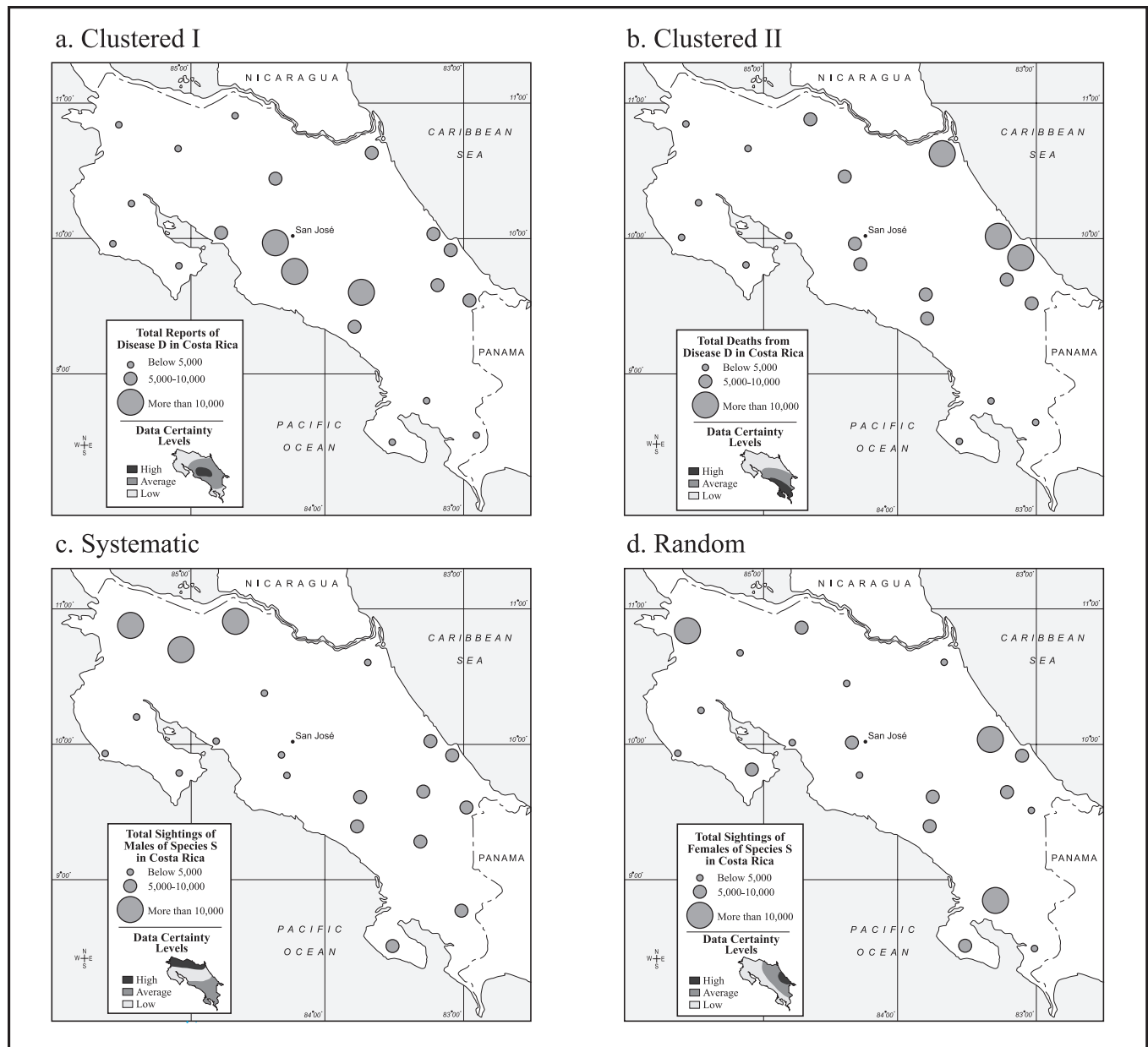


Figure 4. Four spatial patterns used to test the effectiveness of accuracy indicators. These examples use reliability diagrams to symbolize data certainty variation.

used, see Figure 4. The different data sets with varying levels of spatial complexity were necessary to prevent subjects from memorizing mapped conditions over the course of using several test maps. They were also useful for mimicking a variety of real world conditions.

Assessing map complexity. MacEachren (1982) defined map complexity as being composed of the nature of the distributions being mapped, along with the symbolization used to display those distributions. In our case, the distribution of data values and correlation of data values with data certainty information were used to determine spatial complexity, since symbolization was already a variable being studied independently. A distribution should be easier to remember when the data is grouped or chunked, so in theory, those distributions in which the data are clustered and in which the data certainty information is correlated with data values

"The different data sets . . . prevented subjects from memorizing mapped conditions over the course of using several test maps."

"Variation in spatial complexity should affect ease of map use, but since this was not a variable we were interested in studying, we opted to quantify it and use it as a covariate in our analysis."

"On each map, the symbolization used to communicate data certainty was defined in the legend below the graduated circle information."

"Subjects were instructed in the use of graduated circles . . . they were also given an explanation of data certainty and . . . participated in a practice test prior to taking the actual experiments."

should result in distributional patterns that are less complex. Variation in spatial complexity should affect ease of map use, but since this was not a variable we were interested in studying, we opted to quantify it and use it as a covariate in our analysis.

To establish a measure, a panel of five experienced cartographers was asked to rank the levels of complexity used in producing the maps. Each cartographer on the panel individually ranked the maps on the basis of ease of extracting both data values and data certainty information. Rankings were then averaged across all cartographers to arrive at an average ranking for each map. Those maps in which the thematic data values were correlated with data certainty information were judged to be the least complex (Figure 4a and c, Table 2). Those in which data certainty information was not correlated with data values were judged the most complex (Figure 4b and d, Table 2).

Spatial Pattern: Thematic Data	Correlation with Data Certainty Information	Complexity Rankings*	Complexity Measure
Clustered I	Yes	1,1,1,2,2	1.4
Systematic	Yes	1,1,2,2,2	1.6
Clustered II	No	3,3,3,3,4	3.2
Random	No	3,4,4,4,4	3.8

*1 = least complex, 4 = most complex

Table 2. Complexity rankings and resulting measures for the four spatial complexity patterns used in the test maps.

Symbolizing Data Certainty. On each map, the symbolization used to communicate data certainty was defined in the legend below the graduated circle information. For the legend statement method, for example, there was a verbal description of how data certainty varied across the mapped region (Figure 5a). Reliability diagrams, on the other hand, were small copies of the base map in which categories of data certainty were symbolized using a light to dark areal shading scheme (Figure 5b). For the bivariate focus indicator (Figure 5c) and bivariate value-size indicator (Figure 5d), a light to dark shading scheme was again used to depict the change in certainty occurring across the map. In all cases where value was manipulated to represent changes in data certainty, lighter values represented lower levels of data certainty and darker values represented higher levels of data certainty.

Subjects

Eighty students taking geography classes at San Diego State University were recruited for testing. All subjects volunteered for the experiments; none were compensated with extra credit or money. Subjects were instructed in the use of graduated circle maps prior to the experiments. They were also given an explanation of data certainty and how it relates to mapped data. Prior to actual testing, they participated in a practice test using a different base map and data. This familiarized the subjects with the experimental procedures and map symbology and exposed them to the types of questions they would be required to answer. Subjects were not required to have previous cartographic courses or experience to take the experiments. Testing occurred in a group environment, with 6 groups of 7 - 16 students participating at any given time. Subjects ranged in age from

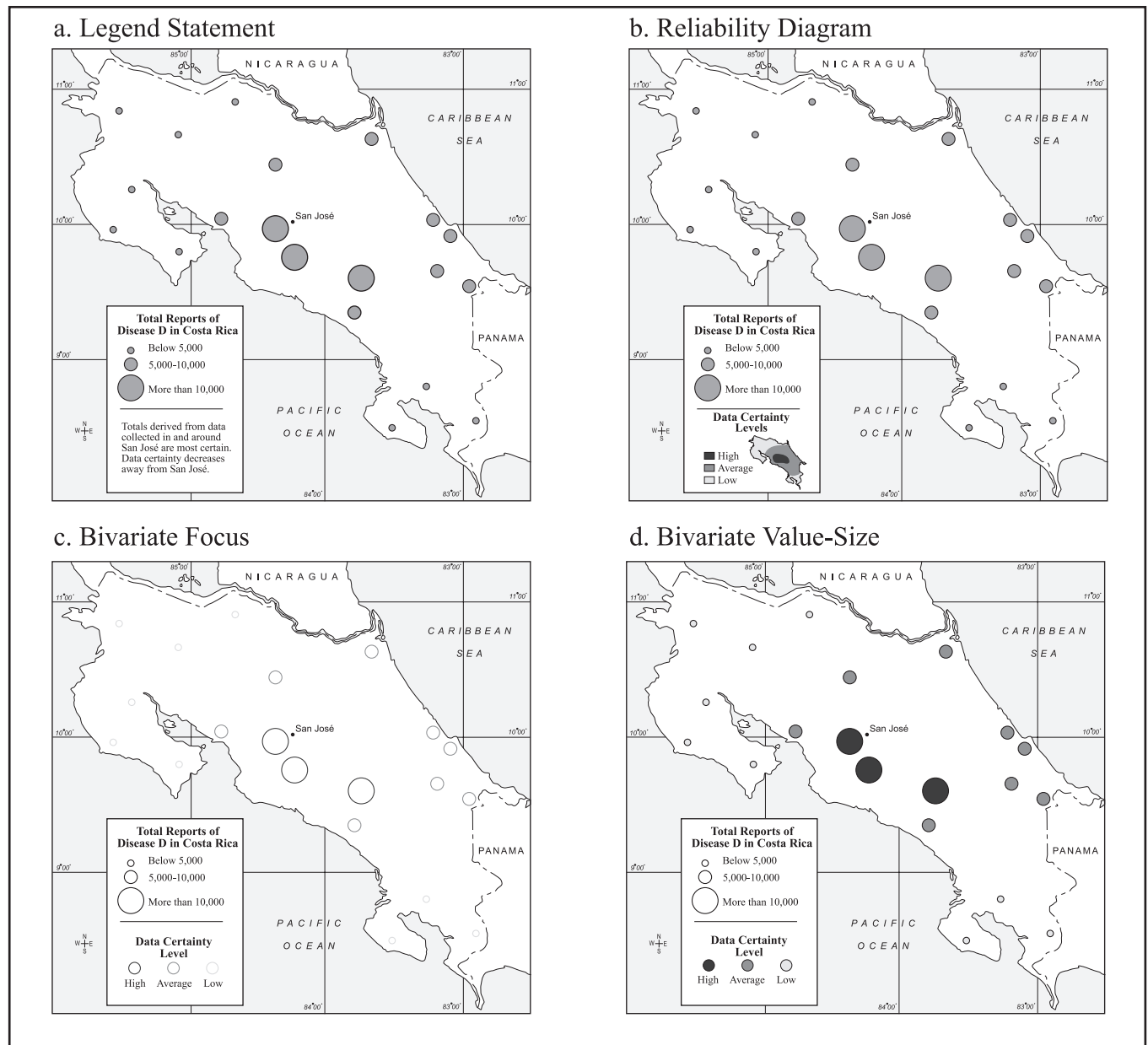


Figure 5. Four accuracy indicators used to symbolize data certainty information.

21 to 52 years, with the average age being 28.5 years. Two-thirds were male; three-quarters were geography majors.

Procedures and Analyses

Eighty printed test packets were prepared for the study, one for each subject tested. Each packet included eight maps. Four of these maps, each portraying data certainty with a unique accuracy indicator and using a unique spatial complexity pattern, were evaluated in Experiment I. The remaining four maps, used in Experiment II, were also comprised of four unique accuracy indicators and used unique spatial complexity patterns, with the additional caveat that the combinations tested here were distinct from those tested in Experiment I. For example, if a subject worked with a map using a reliability diagram as the first map in the Experiment I, s/he

"Eighty printed test packets were prepared for the study, one for each subject tested. Each packet included eight maps."

"The selection of the eight maps from the sixteen and the order in which they were presented to each subject was determined using the method of Latin Squares."

would see no other maps using reliability diagrams in Experiment I, and that particular map would also not be used in Experiment II. S/He would evaluate a map using a reliability diagram in Experiment II, but the spatial complexity of the data mapped would be different to minimize subject familiarity with the spatial patterns being assessed. The selection of the eight maps from the sixteen and the order in which they were presented to each subject was determined using the method of Latin Squares (Bogomolmy, 1996). This procedure, which minimized the effect that map order would have on subjects' performances, also insured that each of the 16 maps would be evaluated by 20 of the 80 subjects for each experiment. See Table 3 for an example of the map contents of a typical test packet.

Experiment	Accuracy Indicator	Spatial Pattern: Thematic Data	Correlation with Data Certainty Information
I	Reliability Diagram	Clustered I	No
	Legend Statement	Clustered II	Yes
	Bivariate Value-Size	Random	No
	Bivariate Focus	Systematic	Yes
II	Bivariate Value-Size	Clustered I	No
	Legend Statement	Random	No
	Bivariate Focus	Clustered II	Yes
	Reliability Diagram	Systematic	Yes

Table 3. An example of the map contents and order presented for one test packet.

"... subjects performed a rapid pattern detection task for each of the first 4 maps in the test packet."

Experiment I - Procedure. In this experiment, patterned after that performed in DiBiase, et al. (1994), subjects performed a rapid pattern detection task for each of the first 4 maps in the test packet. Subjects examined a map for 15 seconds. They then turned the page to an outline map of the same area and were given 15 seconds to:

- mark the area(s) in which they believed data values to be the highest with a circle or circles
- mark the area(s) in which they believed the data to be most certain with an X or Xs

A time limit of 15 seconds for each step was established during a pilot test of the methodology. Time pressure was used to test symbolization effectiveness for discerning data patterns quickly. This sequence of steps was then repeated for 3 other maps, where each map used a different accuracy indicator and a different level of spatial complexity.

"The data collected from this experiment were first subjected to a visual analysis . . ."

Experiment I - Analysis. The data collected from this experiment were first subjected to a visual analysis similar to the one performed by DiBiase, et al. (1994) in the assessment of their rapid pattern data. As the first step in the process of informally identifying which accuracy indicator did the best job of alerting map users that data certainty information was part of the map display and available for interpretation, we created two composite figures for each of the sixteen maps. The first figure for each map depicted all the circles drawn by subjects to indicate areas of highest data values. The second figure depicted all the X marks drawn by subjects to indicate areas of highest data certainty for each of the maps. The composite figures were created by scanning in subject response maps, registering

these maps to an outline base map, and transferring the center points of the circles and Xs to the digital bases. Patterns extracted from these figures were then used to informally assess differences in responses for each accuracy indicator and spatial complexity pattern represented.

Composite results for patterns of data values showed relatively little visual variation in amount of clustering across the test maps. Circles were almost always clustered around the area of highest data values, regardless of the accuracy indicator used or the pattern of spatial complexity imposed on the map. The same, however, was not true for the composite results depicting variation in perceived areas of highest data certainty. In these cases, 3 of the 4 maps using legend statements as the accuracy indicator showed relatively weak visual clustering compared to maps using other accuracy indicators (see Figure 6 for examples). Maps with areas of strong visual clustering were also easy to identify for data certainty information, but they do not seem to be consistently tied to any particular accuracy indicator.

It is also possible to assess the *sparseness* of subject responses for the composite figures by tallying the number of blank responses for Experiment I. The number of blank responses per accuracy indicator provides

"Composite results for patterns of highest data values showed relatively little visual variation in amount of clustering across test maps . . . The same was not true of results depicting variation in perceived areas of highest data certainty."

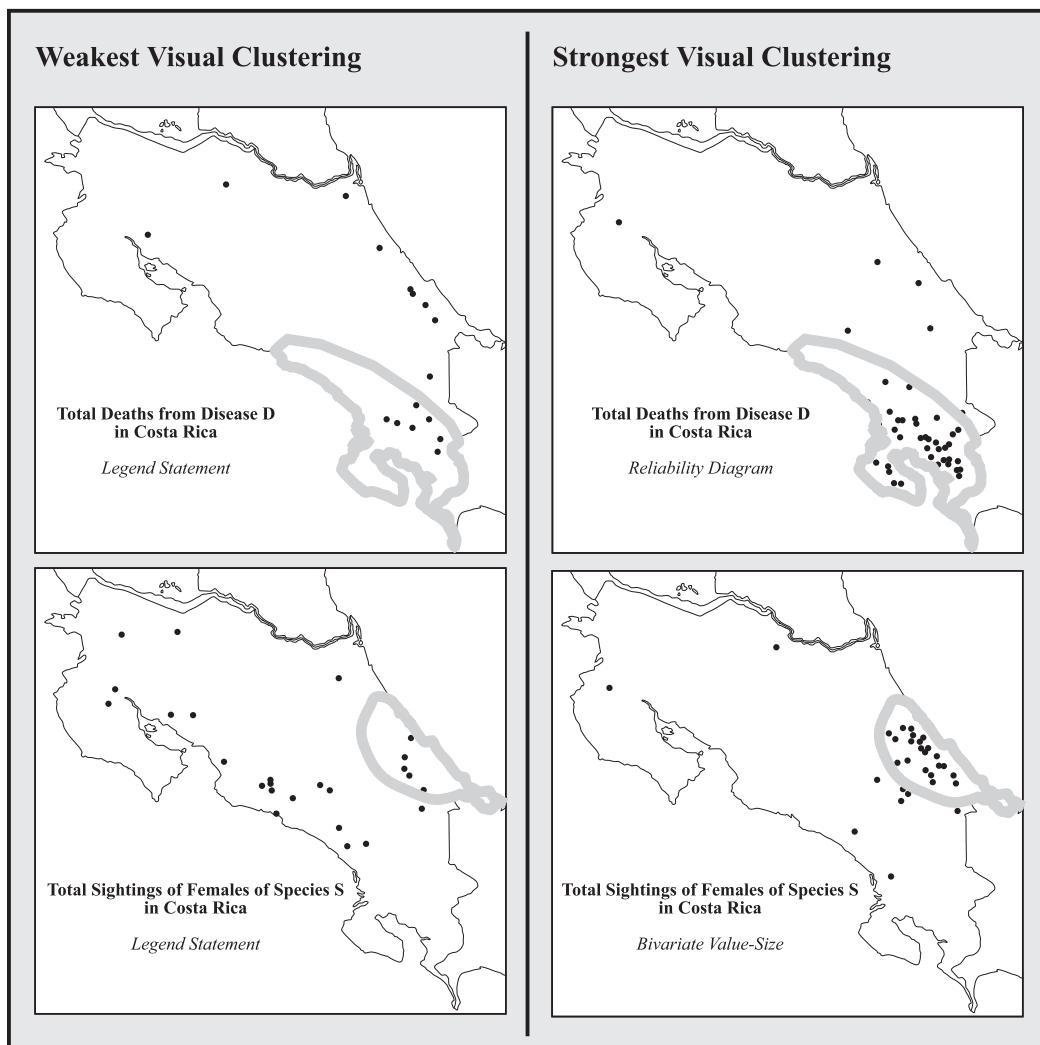


Figure 6. Examples of composite drawings showing the weakest and strongest visual clustering of perceived areas of highest data certainty for 5 of the 16 test maps. Gray outlines indicate the true areas of highest data certainty for each map.

"Maps using legend statements accumulated the highest number of blank responses."

additional clues as to whether subjects could identify and extract data certainty information from the maps. Theoretically, if all accuracy indicators portray data certainty information equally well, there should be no significant difference in the number of subjects who do not identify an area of highest perceived data certainty for any given map. As can be seen in Table 4, however, the number of blank responses for the task varies quite considerably from one type of accuracy indicator to another. A chi-square

Accuracy Indicator	Total Number of Blank Responses	Percentage of all Blank Responses
<i>Legend Statement</i>	39	40%
<i>Reliability Diagram</i>	36	37%
<i>Bivariate Value-Size</i>	12	12%
<i>Bivariate Focus</i>	11	11%

Table 4. Number of blank responses per accuracy indicator for Experiment I.

"The final 4 maps in the test packet were evaluated . . . using a memory/recall task . . ."

analysis in which the observed frequencies were the number of blank responses for each accuracy indicator and the expected frequencies were the total number of blank responses divided by 4 (the number of accuracy indicators tested), shows that these differences are indeed significant ($= 21.607$, $p < 0.0001$). Maps using legend statements accumulated the highest number of blank responses. These are followed closely by maps using reliability diagrams. The bivariate accuracy indicators accumulated the least number of blank responses.

Experiment II - Procedure. The final 4 maps in the test packet were evaluated in this experiment, using a memory/recall task to assess the influence of the accuracy indicator on one's ability to comprehend data certainty variation over the mapped data. This experiment required subjects to examine a map for 30 seconds. Subjects were then instructed to turn the page to an outline map of the same region with 2 labeled areas (Figure 7). They were given thirty seconds to:

- answer a multiple-choice question about the variation in mapped data values
- rate their level of confidence in their answer by circling a number between 1 and 7
- answer a multiple-choice question about the variation in data certainty across the map
- rate their level of confidence in their answer by circling a number between 1 and 7

"Mean accuracy rates and mean confidence ratings for each of the four accuracy indicators were analyzed using analyses of covariance models . . ."

A time limit of 30 seconds for each step was established during a pilot test of the methodology. This sequence of steps was then repeated for 3 other maps, where each map used a different data certainty indicator and a different level of spatial complexity.

Experiment II - Analysis. Mean accuracy rates and mean confidence ratings for each of the four accuracy indicators were analyzed using analyses of covariance models (ANCOVA) to determine whether statistically significant differences existed between the indicators when used to

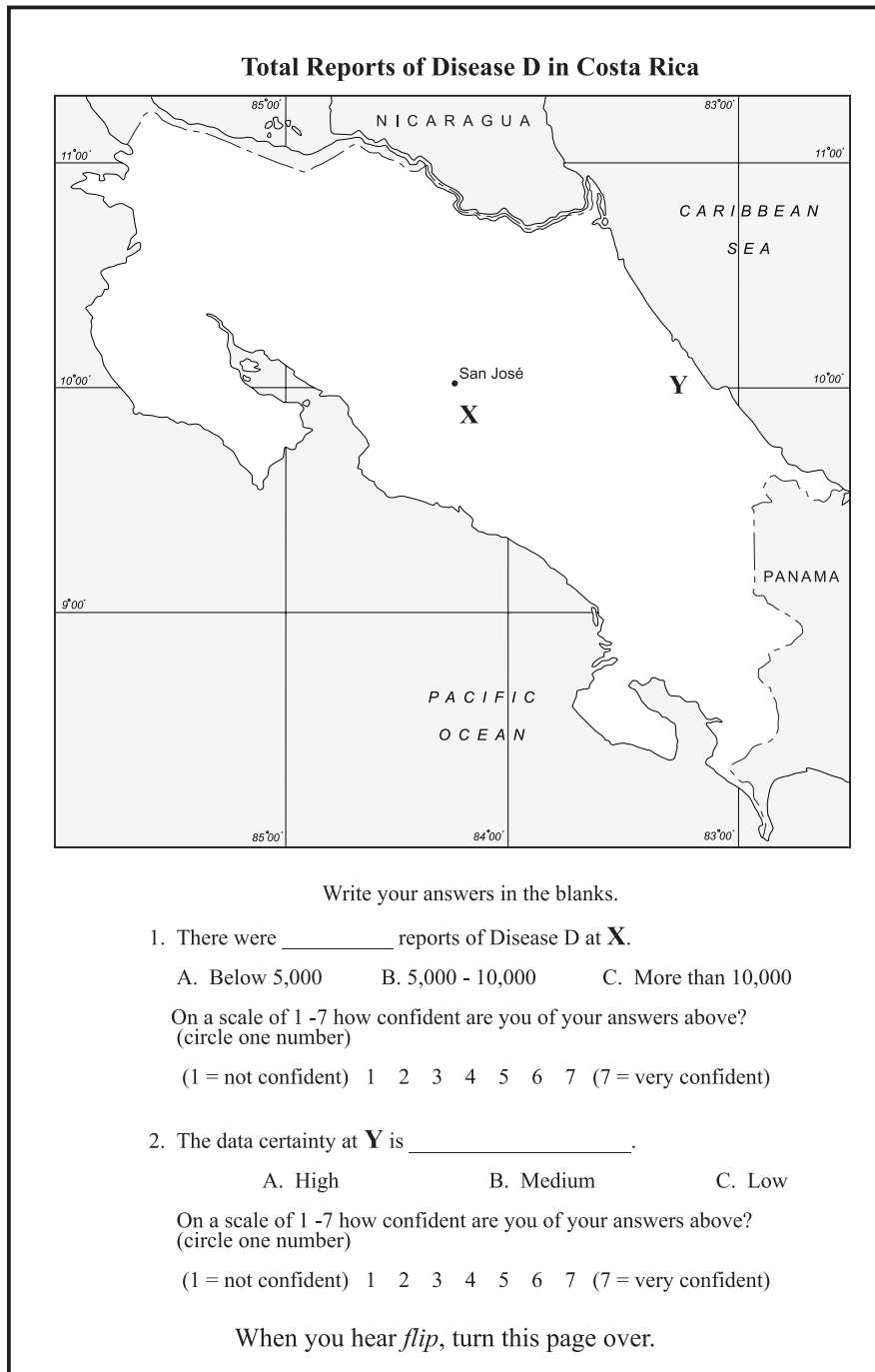


Figure 7. Example of testing material used in Experiment II.

assess spatial variation in data values and patterns of data certainty on a map. *Mean Accuracy Rates* and *Mean Confidence Rates* served as the dependent variables in these analyses; the independent variable in each analysis was *Accuracy Indicator*. The covariate for all analyses was *Map Complexity Level*. An ANCOVA model is often used when it is not possible to control a covariate directly in an experiment. In this study, *Map Complexity Level* is a covariate because it is significantly correlated with the dependent variables. By using an ANCOVA, the variation in map complexity associated with *Mean Accuracy Rates* and *Mean Confidence Rates* can be removed for the error variance. This allows for more precise estimates and more

"An ANCOVA model is often used when it is not possible to control a covariate directly in an experiment. In this study, Map Complexity Level is a covariate . . ."

"The accuracy indicator used on the map did not significantly affect one's ability to answer questions about mapped data values . . ."

powerful statistical testing (Stevens, 1992).

A total of four models were run, one for each of the dependent variables tested:

- mean accuracy rates for questions targeting data value variations
- mean accuracy rates for questions targeting data certainty variations
- mean confidence rates for questions targeting data value variations
- mean confidence rates for questions targeting data certainty variations

Confidence ratings were weighted following a procedure used by Nelson (1996) prior to analysis. This procedure, which multiplies all incorrect responses by -1, then adds 7 to all responses, results in a rating system that gives less weight to confidence levels associated with incorrect responses.

Although the ANCOVA models for *Mean Accuracy Rates* and *Mean Confidence Rates* associated with **data value variations** on the maps were significant, the main effect of *Accuracy Indicator* was not significant for either mean accuracy rates ($p > F(0.475) = 0.700$) or mean confidence rates ($p > F(0.801) = 0.494$). Thus, the accuracy indicator used on the map did not significantly affect one's ability to answer questions about mapped data values or significantly affect one's confidence in these answers (Figure 8a).

"... one's ability to answer questions about data certainty variation accurately and confidently did vary by accuracy indicator . . ."

The ANCOVA models for *Mean Accuracy Rates* and *Mean Confidence Levels* associated with **data certainty variations**, on the other hand, suggest quite the opposite. Both of these models were significant, as were the main effects of *Accuracy Indicator* used in both models. Both the mean accuracy rates ($p > F(9.051) = 0.0001$) and mean confidence ratings ($p > F(7.165) = 0.0001$) for accuracy indicators were significantly different at the 0.05 level, suggesting that one's ability to answer questions about data certainty variation accurately and confidently varied with the accuracy indicator used to symbolize data certainty. (Figure 8b). In these instances, responses tied to legend statements were shown to be significantly less accurate. Subjects were also significantly less confident of their answers for this method of data certainty representation.

DISCUSSION

"Subject agreement on areas of highest data certainty varied the most for maps that used legend statements . . ."

The results from both experiments that stand out most prominently - both visually and statistically - are those that separate legend statement effectiveness from the effectiveness of the other accuracy indicators tested. Subject agreement on areas of highest data certainty varied the most for maps that used legend statements to communicate information about data certainty. These maps also resulted in more blank responses for Experiment I, further suggesting that data certainty information was less easily identified and extracted from these maps. If all accuracy indicators had been equally effective at portraying data certainty information, then the number of blank responses should have been evenly distributed between the maps. As the chi-square analysis indicated, this was clearly not the case. These particular results should not surprise most of us, as noted previously by both Fisher (1994) and Muehrcke and Muehrcke (1992). In the first place, this mode of portraying data certainty information requires map users to process and integrate two distinctly different forms of information: verbal and graphic. Secondly, the information from both must be mentally overlaid to create a composite picture from which one can answer questions about the spatial patterns of data certainty. The men-

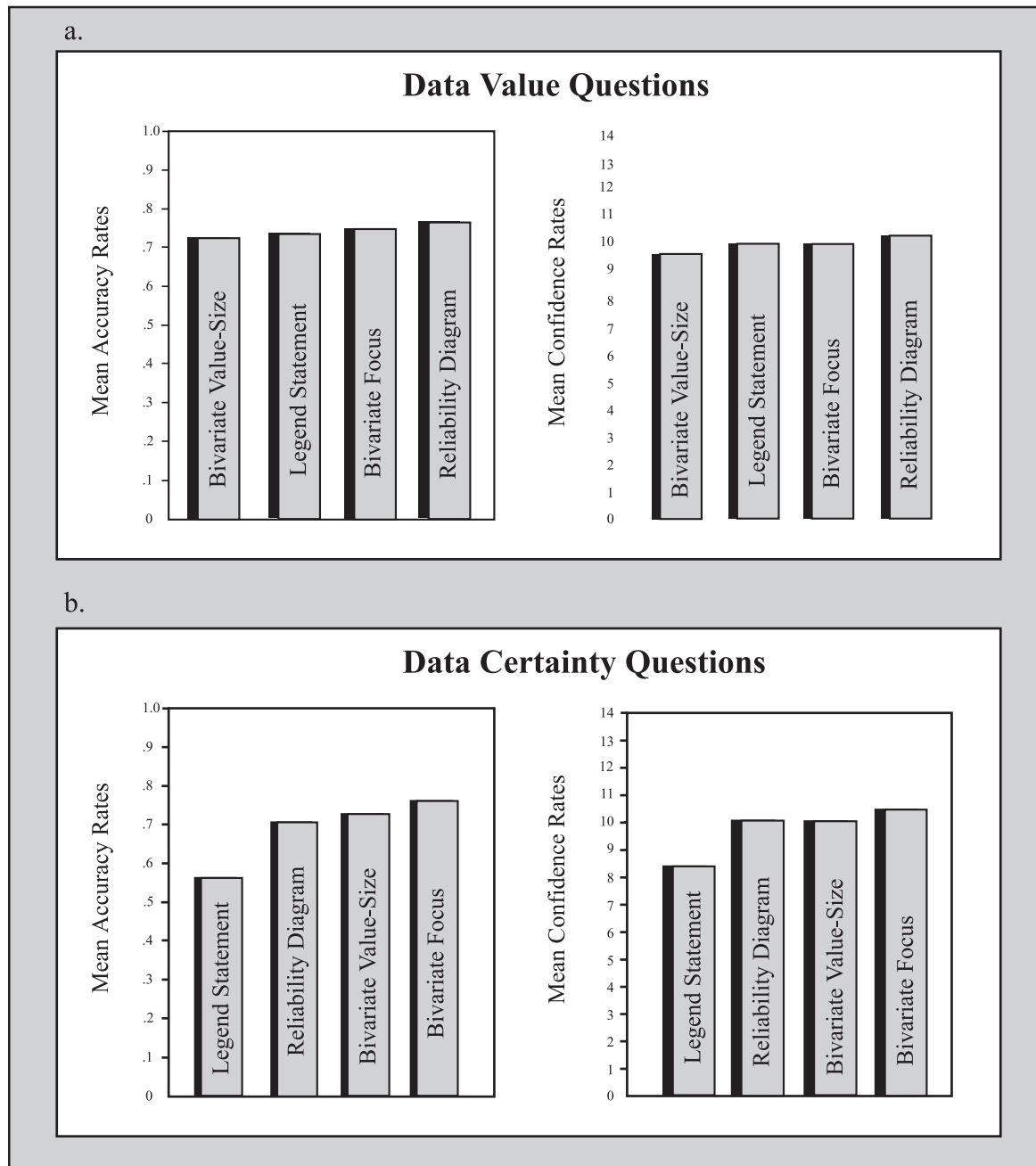


Figure 8. Mean accuracy rates and confidence rates for (a) data value questions and (b) data certainty questions for each type of accuracy indicator tested.

tal overlay process is also problematic for reliability diagrams, although perhaps less so since the information is already in graphic format. This traditional accuracy indicator did perform better than the legend statement, with the increase in performance most likely attributable to the graphic nature of the indicator.

Although not statistically significant, there are definite trends in the data that also warrant discussing the differences in effectiveness of the other accuracy indicators. The bivariate accuracy indicators, for example, resulted in more accurate and more confident interpretations of data certainty information (Table 5). Despite, then, the increased complexity of symbolization, subjects were not only able to effectively process these

"The bivariate accuracy indicators . . . resulted in more accurate and more confident interpretations of data certainty information."

Accuracy Indicator	Mean Accuracy Rates	Mean Confidence Rates*
<i>Legend Statement</i>	0.56	8.4
<i>Reliability Diagram</i>	0.70	10.0
<i>Bivariate Value-Size</i>	0.72	10.0
<i>Bivariate Focus</i>	0.77	10.5

*Confidence rates range from 0 – 14

Table 5. Mean Accuracy and Confidence Rates for Data Certainty Questions in Experiment II.

symbols, but to process them more efficiently than the traditional means of displaying data certainty information. These results confirm those of Leitner and Battenfield's (2000), which suggest that subjects do not find the addition of data certainty information embedded in the thematic data symbolization to negatively affect map interpretation. Apparently, the co-location of the two datasets does, instead, offer significant advantages: eye movements are reduced, and the mental overlay required of traditional accuracy indicators is eliminated.

"... the bivariate focus indicator, much to our surprise, out-performed the bivariate value-size indicator."

Perhaps the most important findings in this context are the differences noted between the bivariate value-size indicator and the bivariate focus indicator. Both of these means of displaying data certainty performed particularly well, but the bivariate focus indicator, much to our surprise, out-performed the bivariate value-size indicator. We found this particularly interesting for the following reasons:

- It is not one of the more common forms of bivariate symbolization in graduated circle mapping
- It seems to violate one of cartography's principle design rules, which is to always have the thematic information - all of it - at the top of the visual hierarchy

Is it possible that this very violation is what makes the symbolization so effective for processing data certainty information? More certain data gets the graphic punch, at the expense of the less certain data, so much so that perhaps it becomes a more effective means of displaying the two data sets in tandem.

CONCLUSIONS

Information on data certainty is a vital component of metadata. It is also a component that should be easily accessible to the map user to facilitate effective decision-making. This study has empirically examined the effectiveness of displaying data certainty on printed graduated circle maps using both traditional accuracy indicators and bivariate accuracy indicators. Results from both experiments indicate that subjects perform pattern identification and interpretation tasks more accurately and more confidently when data certainty is symbolized using bivariate indicators. Legend statements and reliability diagrams separate the two data sets and require not only extra eye movements, but also a mental overlay process to complete the map tasks. This particular finding does not provide new information for guiding the symbolization process, but is instead confirmatory. It gives us empirical evidence that points to the need for developing and testing new forms of accuracy indicators, both bivariate and novel.

The most interesting result from the study was the better task performance seen with the bivariate focus indicator as opposed to the bivariate

value-size indicator. This finding strongly suggests the continued need to assess new ways of combining visual variables in bivariate symbolization specifically for displaying data certainty in combination with thematic data. Perhaps data certainty information is unique and will require a new type of framework for designing symbolization. Although this is a controversial viewpoint, the results of our study suggest this may be the case, and there are others in cartography that also believe this may hold true (Buttenfield and Beard, 1991; Buttenfield, 1993). If so, then it will be very important for cartographers to continue work in expanding visualization research to accommodate new and updated frameworks for data symbolization.

"This finding strongly suggests the continued need to assess new ways of combining visual variables in bivariate symbolization."

We gratefully acknowledge the insights and constructive comments made by the anonymous reviewers and Dr. Patricia Gilmartin of the University of South Carolina. Their input was essential to the final product seen here. We would also especially like to thank Dr. Richard Wright and Dr. Sandra Marshall of San Diego State University for their contributions, support, and encouragement in the development of this research.

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Bogomolmy, A. 1996. Latin Squares. <http://www.cut-the-knot.com/arithmetic/latin-intro.html>. Accessed May 1999.

REFERENCES

Buttenfield, B.P. 1991. Visualizing Cartographic Metadata. *NCGIA Research Initiative 7: Visualization of Spatial Data Quality*. Scientific Report for the Specialist Meeting (Castine, ME). NCGIA Technical Paper: 91-126.

Buttenfield, B.P. 1993. Representing Data Quality. *Cartographica*, 30(2):1-7.

DiBiase, D., Sloan II, J. L. and Paradis, T. 1994. Weighted Isolines: An Alternative Method for Depicting Statistical Surfaces. *Professional Geographer*. 46(2):218-229.

Fisher, P. 1994. Animation and Sound for the Visualization of Uncertain Spatial Information. In *Visualization in Geographic Information Systems*, ed. D. Unwin and H. Hearnshaw, pp. 181-185. New York: John Wiley.

Leitner, M. and Buttenfield, B. P. 2000. Guidelines for the Display of Attribute Certainty. *Cartography and Geographic Information Science*. 27(1):3-14.

MacEachren, A.M. 1982. Map Complexity: Comparison and Measurement. *The American Cartographer*. 9(1):31-46.

MacEachren, A.M. 1992. Visualizing Uncertain Information. *Cartographic Perspectives*. 13:10-19.

MacEachren, A.M. 1994. *Some Truth with Maps: A Primer on Symbolization & Design*. Washington, D.C.: Association of American Geographers.

McGranaghan, M. 1993. A Cartographic View of Spatial Data Quality. *Cartographica*. 30(2):8-19.

Muehrcke, P.C. and Muehrcke, J.O. 1992. *Map Use: Reading, Analysis, and Interpretation*. 3rd edition. Madison, Wisconsin: JP Publications.

Nelson, E.S. 1996. Cognitive Maps: Encoding and Representing Spatial Information within the Mind. *Cartography and Geographic Information Systems*. 23(4):229-247.

Schweizer, D.M., and Goodchild, M.F. 1992. Data Quality and Choropleth Maps: An Experiment with the Use of Color. *Proceedings, GIS/LIS*. 2:686-699.

Stevens, J. 1992. *Applied Multivariate Statistics for the Social Sciences*. 2nd edition. Hillsdale, New Jersey: Lawrence Erlbaum Associates, Inc.

Wright, J.K. 1942. Map Makers are Human: Comments on the Subjective in Maps. *Geographical Review*. 32(4):527-544.

van der Wel, F.J.M., Hootsmans, R.M. and Ormeling, F. 1994. Visualization of Data Quality. In *Visualization in Modern Cartography*, ed. A.M. MacEachren and D.R.F. Taylor, pp. 313-331. New York: Pergamon/Elsevier Science.

The Poet As Map-Maker: The Cartographic Inspiration and Influence of Elizabeth Bishop's "The Map"

New Year's Eve of 1934 found Elizabeth Bishop recuperating from the flu. Out of her isolation, the recently orphaned 23-year-old created "The Map." Inspired by a map's depiction of the North Atlantic, Bishop's exquisite poem alludes in part to the "seashore towns" and coastal waters of her childhood home, Nova Scotia. A seminal twentieth-century poem about maps, Bishop's "The Map" has inspired a host of other map-poems since it opened her Pulitzer prize-winning collection, *Poems: North & South—A Cold Spring*, in 1955. My paper, the third in a series advocating the use of poetry in the teaching of geography, will attempt to elucidate Bishop's masterpiece and introduce the map that, I believe, inspired her poem. The paper also will present two works influenced by "The Map": Howard Nemerov's "The Map-Maker on His Art" (1957) and Mark Strand's "The Map" (1960). Linking these three acclaimed American poets even further is their recognition of an intimate and explicit connection between poets and cartographers.

Keywords: Poetry about Maps, Map/Geography Education, Poets as Cartographers

Maps have inspired poets since the 8th century BCE when Homer sang about Achilles' shield, the first verbal description of a cosmological map in classical literature (*Iliad* 18.483-607; cf. Aujac 1987, 131-32). Although poetic descriptions of maps can be traced through every period, especially the Early Modern, the twentieth century is unique in its range, quality, and sheer number of poems about maps. In the first third of the century alone, no fewer than five pre-eminent poets used maps as their subject or theme. Thomas Hardy, whose books often include a map of South Wessex (i.e., Dorset, England), composed "The Place on the Map" about a pivotal moment in an affair: "the map revives her words, the spot, the time" (Hardy [1914] 1930, 918). G.K. Chesterton began his parody of the British Empire, "Songs of Education, ii: Geography, Form 17955301, Sub-Section Z," with the famous lines (Chesterton 1927, 86):

The earth is a place on which England is found,
And you find it however you twirl the globe round;
For the spots are all red and the rest is all grey,
And that is the meaning of Empire Day.

Robert Frost produced "A Brook in the City," in which he bemoans the fate of a brook, imprisoned now in an urban "sewer dungeon" and remembered only by him and a few "ancient maps" (Frost [1921, 1922/24] 1969, 231). Marianne Moore created "Sea Unicorns and Land Unicorns," a celebration of the mythical beasts that once graced maps (Moore [1924] 1967, 77-79). And two years before attempting suicide, Laura Riding ended "The Map of Places" in despair: "All is known, all is found./ Death meets itself everywhere./ Holes in maps look through to nowhere" (Riding [1928] 1980, 87).

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"Although poetic descriptions of maps can be traced through every period, . . . , the twentieth century is unique in its range, quality, and sheer number of poems about maps."

"... in 1935, Elizabeth Bishop (1911-1979) published 'The Map.' A classic in its own right, 'The Map' is one of the seminal twentieth-century poems about maps and map-makers."

Then, in 1935, Elizabeth Bishop (1911-1979) published "The Map." A classic in its own right, "The Map" is one of the *seminal* twentieth-century poems about maps and map-makers. Bishop recognized the importance of her poem and used it to open several works, including her 1955 collection *Poems: North & South—A Cold Spring* (Bishop 1955). After that volume won a Pulitzer Prize in 1956, "The Map" immediately inspired at least four other American poets to create their own map-poems. African-American poet Gloria C. Oden (b.1923) wrote two as a tribute to Bishop: "A Private Letter to Brazil" (1956-57), referring to the country where Bishop was living at the time, and "The Map," a critique of the Rand McNally world-map that once hung on Oden's livingroom wall (1961)¹. Howard Nemerov (1920-1991) contributed "The Map-Maker on His Art" (Nemerov 1957). May Swenson (1913-1989) composed "The Cloud-Mobile," a poem about map-shaped clouds, which first appeared in her *Cage of Spines* (1958), then in her collections of verses for children, *Poems to Solve* (1966) and *The Complete Poems to Solve* (1993; see Haft 1999, 36-38). And Mark Strand (b.1934) completed his own poem "The Map" in 1960 (Strand 1963 and 1964).

Since space prevents examining each of these here, my paper will focus on Bishop's masterpiece and two of the poems it influenced, Nemerov's "The Map-Maker on His Art" and Strand's "The Map." The poems by Oden and Swenson pay more overt homage to Bishop, whom they regarded as a mentor and friend, respectively (Redding 1978; Knudson 1993, 69-76 and 95). With Nemerov and Strand, Oden shares Bishop's understanding of the map-maker's art—its imaginative power and limitations, its technical achievement and arbitrary nature. Because Oden also critiques the map as overtly political, her poem awaits analysis in my study of ideological map-poems. For now, Nemerov and Strand take center stage since they follow Bishop in recognizing an intimate and explicit connection between poets and cartographers.

Bishop's recognition was revolutionary. According to poet Lloyd Frankenberg, an early reviewer of "The Map" (Frankenberg 1949, 333):

"The exact craft of the cartographer is perhaps least associated, customarily, with our ideas of poetry."

The exact craft of the cartographer is perhaps least associated, customarily, with our ideas of poetry. By showing us how human the map-maker's decisions have to be, and how imaginative our reading of a literal map, the poem prepares us for poetry's exactitudes. It demolishes prejudice without alluding to it.

Bishop's sensitivity to art may have led her to associate poets with map-makers. Over a year before she composed "The Map," Bishop had begun painting watercolors (letter of 22 October 1933: Bishop 1994, 9), some of which became book jackets for her collections (see Bishop 1996; Parker and Brunner 2000). Even more telling is her attempt—as a poet—to emulate Vermeer, the Dutch artist famous for his photographic eye and penchant for maps. After poet/critic Randall Jarrell praised *Poems: North & South—A Cold Spring* in his review for *Harper's*, Bishop responded (letter of 26 December 1955: Bishop 1994, 312):

I still, from the bottom of my heart, honestly think I do NOT deserve it—but it has been one of my dreams that someday someone would think of Vermeer, without my saying it first, so now I think I can die in a fairly peaceful frame of mind any old time, having struck the best critic of poetry going that way . . .

Strand and Nemerov also have an artist's perception. Strand not only

received a Bachelor of Fine Arts from Yale but has written three books about art, including one on Edward Hopper (Strand 1994), to whom his poetry has been compared (Hamilton 1996, 525). As for Nemerov, he once confessed, "My vocation as a grownup has to do with making pictures" (Nemerov 1965, 80). Poetry's relationship to painting is explored in many of his poems, like "Vermeer" ("Taking what is, and seeing it as it is . . ."), "The World as Brueghel Imagined It," "Still Life II," and "The Painter Dreaming in the Scholar's House," the latter inspired by his affinity to Paul Klee. In his essay "On Poetry and Painting," Nemerov argues that, while writing diverged from painting long ago, there remains "one instance" in which their "immense powers" have fused. For him that "one instance" turns out to be

the making of maps, charts, diagrams, blue prints . . . where the representation of the visible, at which painting is supremely capable, is accomplished in parallel with the strict and abstract syntax of writing able without modification of its own nature to transmit an infinite variety of messages, which is the supreme contribution of writing language (Nemerov 1971, 107).

Nemerov adds, "Might this somewhat elementary compound of writing and painting have still some way to go in the world?"

Since the 1980s, Brian Harley and other cartographic historians have been indebted to Erwin Panofsky, who published his ground-breaking *Studies in Iconology* in 1939, shortly after Bishop composed "The Map," and his *Meaning in the Visual Arts* in 1955 (Harley 2000). According to David Woodward, co-editor of the monumental *History of Cartography* Project (Woodward 1992, 122):

We can trace Harley's application of post-modernist approaches to maps back to his adoption of Erwin Panofsky's art historical analysis of layers of meaning in art images. The deepest layer—which Harley argued had all but been ignored in map history—consists of those latent iconographical meanings that reveal the basic social, religious, or philosophical attitudes of the maker.

The poems by Bishop, Nemerov, and Strand also resemble the maps they describe in revealing the most basic attitudes of their authors and culture.

One of our cultural assumptions is the art/science dualism. Used uncritically, it implies that "science" is progressive and primary, "art" immutable and secondary. Such stereotypes not only denigrate art (as "aesthetics, intuition, creativity") at the expense of science (as "rationality, reason, analytical, objective")—and *vice versa*—but also obscure their similarity "in attempting to envision and understand complex ideas, theories, and data" (Krygier 1995, 8-9).² By showing what poets and map-makers have in common, Bishop, Nemerov, and Strand bridge such artificial divides. This paper will unlock their secrets and offer—for the first time—what may be the cartographic inspiration for Bishop's "The Map."

"Since the 1980s, Brian Harley and other cartographic historians have been indebted to Erwin Panofsky, who published his ground-breaking Studies in Iconology in 1939, shortly after Bishop composed 'The Map,' and his Meaning in the Visual Arts in 1955."

"One of our cultural assumptions is the art/science dualism."

"By showing what poets and map-makers have in common, Bishop, Nemerov, and Strand bridge such artificial divides."

ELIZABETH BISHOP'S "THE MAP" (1935)

Land lies in water; it is shadowed green.
 Shadows, or are they shallows, at its edges
 showing the line of long sea-weeded ledges
 where weeds hang to the simple blue from green.
 Or does the land lean down to lift the sea from under,
 drawing it unperturbed around itself?
 Along the fine tan sandy shelf
 is the land tugging at the sea from under?

The shadow of Newfoundland lies flat and still.
 Labrador's yellow, where the moony Eskimo
 has oiled it. We can stroke these lovely bays,
 under a glass as if they were expected to blossom,
 or as if to provide a clean cage for invisible fish.
 The names of seashore towns run out to sea,
 the names of cities cross the neighboring mountains
 —the printer here experiencing the same excitement
 as when emotion too far exceeds its cause.
 These peninsulas take the water between thumb and finger
 like women feeling for the smoothness of yard-goods.

Mapped waters are more quiet than the land is,
 lending the land their waves' own conformation:
 and Norway's hare runs south in agitation,
 profiles investigate the sea, where land is.
 Are they assigned, or can the countries pick their colors?
 —What suits the character or the native waters best.
 Topography displays no favorites; North's as near as West.
 More delicate than the historians' are the map-makers' colors.

New Year's Eve of 1934 found Elizabeth Bishop in her New York City apartment recuperating from the flu and examining a map that depicted—at the very least—the North Atlantic from Canada to Scandinavia. What emerged was "The Map," the poem that launched her career when it appeared in the anthology *Trial Balances*, introduced by poet Marianne Moore (Winslow 1935, 78-79). "The Map" later opened Bishop's first book, *North & South* (1946; Houghton Mifflin Poetry Award winner) as well as her Pulitzer Prize-winning *Poems: North & South—A Cold Spring* (1955), her *Complete Poems* (1969; National Book Award winner, 1970), and the definitive *The Complete Poems, 1927-1979*. (Copyright © 1979, 1983 by Alice Helen Methfessel. Reprinted by permission of Farrar, Straus and Giroux, LLC.)

Nineteen-thirty-four had been particularly memorable for the twenty-three-year-old Bishop. She met Marianne Moore, her mentor and life-long friend; she graduated from Vassar College; and she learned of her mother's death. Elizabeth had not seen her mother since 1916, the year her mother finally lost her sanity following her husband's unexpected death just months after the birth of their only child. Orphaned in all but name, Elizabeth was raised by a succession of relatives. Her happiest times—vividly recalled toward the end of her life in *Geography III* (1976)—were the childhood years and subsequent summers she spent with her mother's parents in the Canadian Maritime province of Nova Scotia. "The Map" alludes to her youthful geography not only in its focus upon coasts, peninsulas, and "seashore towns" but in its naming of areas directly north of Nova Scotia: Newfoundland and Labrador, whose Atlantic coastal waters

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have long provided fish for the Inuit. In an interview shortly before her death in 1979, Bishop credits her maternal family with the wanderlust that enabled her to create "The Map" (interview with Alexandra Johnson, quoted in Monteiro 1996, 10):

My mother's family wandered a lot and loved this strange world of travel. My first poem in my first book was inspired when I was sitting on the floor, one New Year's Eve in Greenwich Village, after I graduated from college. I was staring at a map. The poem wrote itself. People will say that it corresponded to some part of me which I was unaware of at the time. This may be true.

On the last day of 1934, Bishop found inspiration in a map that reflected her past and presaged her future. In 1935, the same year that "The Map" was published, Bishop took the money she had inherited from her father's wealthy relatives, and, for the first time, crossed the Atlantic for Europe (Travisano 1988, 25; Bishop 1994, 28 and 30). Bishop traveled abroad from 1935-37. Although she bought her beloved house in Key West, Florida a year after her return, it was not until settling in Brazil in 1951 that Bishop regularly spent more than a few seasons in any one place.

"The Map" mentions several types of physical and cultural features found on small-scale reference maps of the world—bays, peninsulas, mountains, towns, cities, countries. Otherwise, Bishop's poem provides little detail. Nowhere in the poem does Bishop identify the map that inspired her masterpiece. Instead, there are three place-names, a sprinkling of colors, and a possible allusion to the map's glassed surface; an indication that the map may have decorated her apartment, or that she was peering at it through a lens. Whatever its role in Bishop's decision to travel, the map as transformed into "The Map" is not a practical guide for ascertaining distance or direction. Instead, Bishop focuses on the more abstract relationships between geographical space and artistic representation, map and map-maker, map-maker and poet, and, ultimately, poet/map-maker and reader.

"Land lies in water." From the very beginning of her first stanza, Bishop is an astute map-reader. A map can make landmasses resemble floating islands, detached and supported by the sea. But the "shadowed green" of the mapped coastal waters in contrast to the "simple blue" of the sea reminds her that land extends below the surfaces of water and map. Diving into the third dimension implied by such "shadows," Bishop pictures in words the "sea-weeded ledges" of kelp that the map can only suggest, then explores what the map obscures altogether—the land extending below the oceans. "Or does the land . . . lift the sea from under?" she wonders in the second half of the first stanza. Perception, she implies, is a matter of perspective. Later Bishop suggests that the map reverses some natural balance between active sea and passive land: "Mapped waters are more quiet than the land is . . ."

From mid-first stanza on, land dominates the foreground of her poetic map and becomes increasingly animated as it "leans," "lifts," "draws," "tugs," "takes," "runs," and "investigates" the ever more "quiet" sea (Parker 1988, 78). Deprived by the map of its currents and wind, the sea appears buffeted by wave-like coastlines. This does not mean that the map that inspired "The Map" failed to present land-water forms clearly nor that the poem necessarily alludes to what was known at the time about the ocean (see *Mercator's World* 1998). Instead, land and sea have become symbolic of all spatial relationships on maps: at any given minute, each reader determines what is foreground and what is background (Wood

"Nowhere in the poem does Bishop identify the map that inspired her masterpiece."

"Land and sea have become symbolic of all spatial relationships on maps."

"By shifting perspective and juxtaposing the conflicting realities of map image and actual geography, Bishop creates a poem that interprets both."

"Bishop, . . . , understands that maps—like poems—are constructions of the human mind: they mirror culture and civilization, not the world."

"Far from condemning map-makers, however, Bishop considers them kindred spirits for their powers of observation, technical expertise, and artistry."

1992, 140). By shifting perspective and juxtaposing the conflicting realities of map image and actual geography, Bishop creates a poem that interprets both. As Howard Nemerov observed in his review of Bishop's *Poems: North & South—A Cold Spring* (Nemerov 1955, 180):

She chooses a subject in which art and nature, as it were, compare themselves to one another, or stand in such a relation that a remark about one is a remark about the other.

Like any map or person's observation of nature, "The Map" is one of any number of possible interpretations of the same "facts". The title's specificity becomes a paradox (Rotella 1991, 206).

There is perhaps no more seemingly transparent record of geographical reality than a well-drawn reference map. With its mathematical projection, scale of distance, and subdued colors, the map conveys an appearance of unimpeachable scientific truth. Bishop, however, understands that maps—like poems—are constructions of the human mind: they mirror culture and civilization, not the world. No matter how anonymous in appearance, every map reflects its map-maker, or rather a host of map-makers, living and dead, who have contributed to the formulation, standardization, and transmission of the cartographic conventions their society takes for granted. With these rules, map-makers reduce the distances and complexities of geography to create a map's comprehensible scale and selection of "facts."

Yet legibility and aesthetics make their own demands. Consider Eduard Imhof's recommendation to other map-makers: "On small-scale maps which usually have a dense series of places and names, *place all names of coastal places on the ocean*" (Imhof 1975, 133, emphasis mine). However scrupulously map-makers may depict the land's profile and its varied features, the convention of labeling these overrides the usual rules of proportion and scale: "The names of seashore towns run out to sea,/ the names of cities cross the neighboring mountains." As Denis Wood observes in his provocative *Power of Maps* (Wood 1992, 123):

In the map image, entire words and arrangements of words are given iconic license, generating a field of linguistic signs best likened to concrete poetry. Letters expand in size, increase in weight, or assume *majuscale* [*sic*] form to denote higher degrees of importance.

Conventions of coloration are particularly arbitrary. There is nothing factual about making Labrador "yellow," or about representing the sea, at all times and in all places, as either "quiet" or "simple blue" (Ehrensward 1987). In fact, a palette of "simple blue" and coastal "green" is completely inadequate for representing the silt or rapids of individual "native waters."

Far from condemning map-makers, however, Bishop considers them kindred spirits for their powers of observation, technical expertise, and artistry. Throughout her career, Bishop shared her experience of geographic space, especially of places near the sea. She returned to the map as a metaphor in her poems "Florida" (1939), "Roosters" (1941), and "Song for the Rainy Season" (1960).³ She designed the book jacket of her final volume, *Geography III*, to resemble "an old-fashioned schoolbook" (letter of 24 Dec. 1975: Bishop 1994, 602) and prefaced the collection with an epigraph from James Monteith's *First Lessons in Geography* (Monteith's Geographical Series, A. S. Barnes & Co., 1884). To these works and others, she brought her famous "eye," which enabled her to describe what she saw with the

apparent detachment and objectivity of a map-maker (Leibowitz 1977, 7; cf. Estess 1977, 1983).

Like a responsible cartographer, Bishop avoids cluttering her image with too much information. Bishop satisfies her reader's expectation of geographic detail yet maintains clarity through her selection and ordering of the features on her verbal map. She communicates ideas by employing a formal structure with its own elements and conventions (rhythm, meter, and rhyme). The brevity of Bishop's poem and the simplicity of her language allow the piece, like a map, to be taken in quickly by the eye. She frames her poem, not with a map-maker's neat line, but by enclosing the longer unrhymed middle stanza within the conspicuously rhymed *a b b a* pattern of the first and final stanzas. Inside this frame, she creates the poem's most vivid images—the poet's answer to the map's pictorial quality. "We can stroke these lovely bays, under a glass as if they were expected to blossom,/ or as if to provide a clean cage for invisible fish." And, "These peninsulas take the water between thumb and finger/ like women feeling for the smoothness of yard-goods."

Bishop's identification with map-makers is obvious in the last quatrain. Yet the lines themselves are tantalizingly ambiguous:

Are they assigned, or can the countries pick their colors?
—What suits the character or the native waters best.
Topography displays no favorites; North's as near as West.
More delicate than the historians' are the map-makers' colors.

Bishop speaks for poets, historians, and cartographers by implying that all must describe what they see as accurately as possible, yet how each sees is conditioned by a range of individual and cultural experiences. Countries' boundaries are as arbitrary as their mapped colors; in both cases it is human beings, not scientific logic, that have determined the "suitability" of these features. Yet a map gives these features the same acknowledgment, the same aura of permanence and objectivity, as features from the physical environment. As if to emphasize this point, Bishop denies authorial omniscience to the map-maker and herself by punctuating her poem with unanswered questions: "Shadows, or are they shallows?" "Are they assigned, or can the countries pick their colors?"

Equally open to interpretation is the statement "Topography displays no favorites; North's as near as West." If the map that inspired Bishop's poem was a small-scale reference map of the North Atlantic or, more likely, of the world, then "topography" seems an imperfect word at best: its associations with small areas and the representation of relief was commonplace even when Bishop wrote "The Map" (*Webster's New International Dictionary* 1933). But there are other possibilities. Bishop may have chosen "topography" because it implies both verbal description and graphic portrayal of a "place" (*topos*). Since "-graphy" derives from the Greek verb "to express by written characters" as well as "to represent by lines drawn" (*Greek-English Lexicon*, 1968, s.v. *grapho*), the derivation of "topography" enables Bishop to articulate the ways poets—like/as map-makers—portray place. Bishop also plays with the definitions of "topography." One of these, "the determination of the position of the various parts and organs of the body" whether human or animal (*New English Dictionary* 1888-1928), corresponds to the poem's reading of coastlines and countries as "profiles" or "hares" as well as its underlying exploration of physical intimacy (e.g., Harrison 1993, 42-46; see below).

But if Bishop intends "topography" to mean the "surface configuration of the earth" (McKnight 1984, 525; cf. *Webster's New International Diction-*

"The brevity of Bishop's poem and the simplicity of her language allow the piece, like a map, to be taken in quickly by the eye."

"Since '-graphy' derives from the Greek verb 'to express by written characters' as well as 'to represent by lines drawn', the derivation of 'topography' enables Bishop to articulate the ways poets—like/as map-makers—portray place."

"'The Map' had to do with a red map. There was nothing particularly noteworthy about it, but I was attracted by the way the names were running out from the land into the sea."

ary 1933), then favoritism—it is true—has little or no place. Because of the earth's sphericity, furthermore, one can set off from any point on the globe and, under the (admittedly) ideal circumstances of comparable terrain and weather, travel in a given time-period the same distance in any direction. But the statement "topography displays no favorites" becomes questionable if "topography" refers to the *mapping* of the earth on a flat surface, especially the mapping of such a large area as the North Atlantic (see *Multilingual Dictionary* 1973, 278, s.v. "topographic map"). Once a map-maker endeavors to translate so much space onto a two-dimensional map, the process of flattening the earth's spherical shape distorts the original shape, area, distance, or direction in some regions. To minimize such distortions, cartographers must show "favoritism". Faced with a startling variety of projections, they are forced to choose the mathematical grid that best "suits" the given area and the map's intended use.

Until now, no one has suggested what map may have inspired Bishop, let alone its projection. Her only hint is an enigmatic statement made in an interview four decades after she wrote "The Map" (1976 interview with J. Bernlef, quoted in Monteiro 1996, 66):

"The Map" had to do with a red map. There was nothing particularly noteworthy about it, but I was attracted by the way the names were running out from the land into the sea.

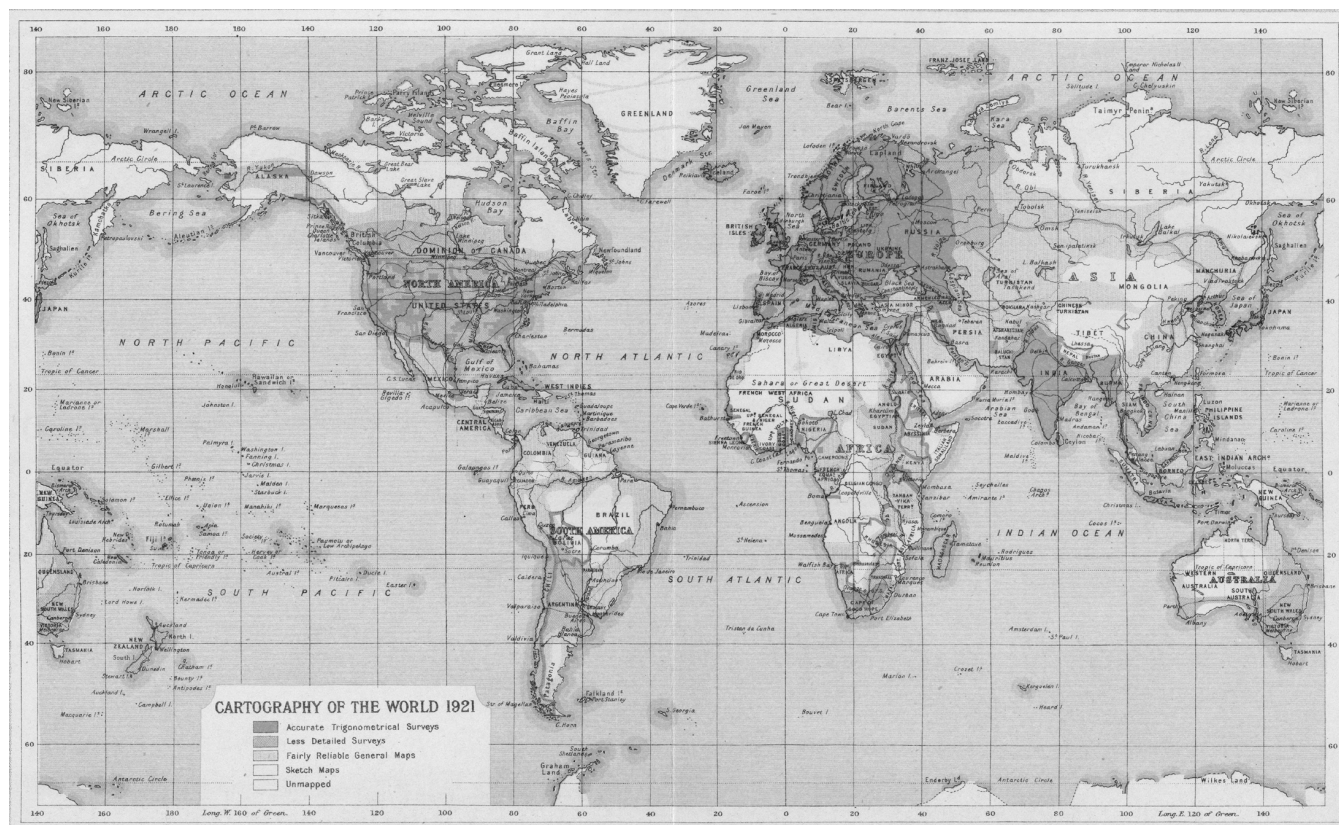


Figure 1: "Cartography of the World 1921." Detail of Plate 1, "Mapping of the World," in *The Times Survey Atlas of the World*, London: *The Times*, 1922. This central map, measuring approximately 6 3/4" x 11 1/4", was prepared at the Edinburgh Geographical Institute under the direction of John George Bartholomew. The *Times Survey Atlas of the World* was a landmark atlas with a general index of over 200,000 names and one hundred maps reflecting national surveys, explorers' reports, and the territorial redistributions ordained by the 1919 Peace Conference in Paris. (This digital file image was supplied by David Rumsey of the David Rumsey Collections, <http://www.davidrumsey.com>. His stunning online collection of privately owned maps utilizes cutting-edge software and features thousands of maps scanned at very high resolution.)

Intriguingly, a “red map” opens *The Times Survey Atlas of the World* (1922), the culminating achievement of John George Bartholomew (1860-1920), third scion in the prestigious John Bartholomew family of map-makers and publishers (Snyder 1993, 256; Gardiner 1976, 53 and 63-64). Titled “Cartography of the World 1921,” this thematic map shows how well the earth was mapped at that time (Figure 1). As the legend explains, several colors indicate the types of maps existing for various regions. A deep brick-red denotes “accurate trigonometrical surveys”; slanted lines of brick-red mean “less detailed” surveys; dots of brick-red imply “fairly reliable general maps”; yellow indicates “sketch maps”; and white is labeled “unmapped” to highlight an absence of maps. Since “Cartography of the World 1921” touts cartography’s current sophistication, much of the mapped surface appears in red—particularly areas bounding the North Atlantic (Figure 2).⁴ And while we cannot expect any map to match Bishop’s poetic description exactly, “Cartography of the World 1921” does picture a yellow Labrador, a sea dominated by “simple blue,” and place-names running conspicuously out to sea.⁵ More important, the map is not “particularly noteworthy.” The reason Bishop did not overlook the map entirely is that it appears as the atlas’ first plate, at the center of a page filled with maps showing the earth imperfectly represented in earlier periods (Figure 3). How appropriate if Bishop’s inspiration turns out to be a map about maps.

Although “Cartography of the World 1921” may be the one Bishop remembered, however vaguely, she had only to flip to the next page of the atlas to find a truly beautiful map, the “World Bathy-Orographical” (Figure 4). As its name suggests, this thematic map showcases ocean depths and mountain heights, so much so that “profile” views above and below the world-map compare the depth of sea with the height of land at various latitudes. Fourteen shades of subdued blue-greens and browns make the “World Bathy-Orographical” more attractive than any of its other incarnations in John Bartholomew atlases (e.g. two in 1890; one each in 1909, 1917, and 1924). The map epitomizes J.G. Bartholomew’s famous “sensitivity to colour harmony” (Gardiner 1976, 31). With its delicate colors, its aura of conveying the most up-to-date scientific knowledge, and its emphasis on the relationship between sea and land, “World Bathy-Orographical” is—I believe—the second, unacknowledged, inspiration for “The Map.” After five years of perusing twentieth-century maps and atlases published before 1935, I submit that Bishop conflated two adjacent maps opening the most highly regarded and exquisite English-language atlas published between the World Wars.⁶

Like all the maps in *The Times Survey Atlas*, the red map and “World Bathy-Orographical” were prepared by J.G. Bartholomew’s Edinburgh Geographical Institute. Yet they do not have the same projection. Although *The Times Survey Atlas* names neither, a look at J.G. Bartholomew’s *Library Reference Atlas of the World* (1890) confirms that “World Bathy-Orographical” uses the Mercator Projection and that other world-maps employ Gall’s Stereographic Projection, the very one used on “Cartography of the World 1921” (Snyder 1993, 163; cf. 109). What makes the Mercator

“How appropriate if Bishop’s inspiration turns out to be a map about maps.”



Figure 2: Detail of “Cartography of the World 1921,” showing the area bounding the North Atlantic. With the obvious exception of Labrador, much of eastern North America and most of Europe appear in red or shades of red, thus proclaiming the accuracy of maps available for those areas. Great Village, home of Bishop’s maternal grandparents, is located fifty miles north of Halifax (Nova Scotia) at the eastern end of the deeply indented bay. (This digital file image was supplied by David Rumsey of the David Rumsey Collections, <http://www.davidrumsey.com>.)

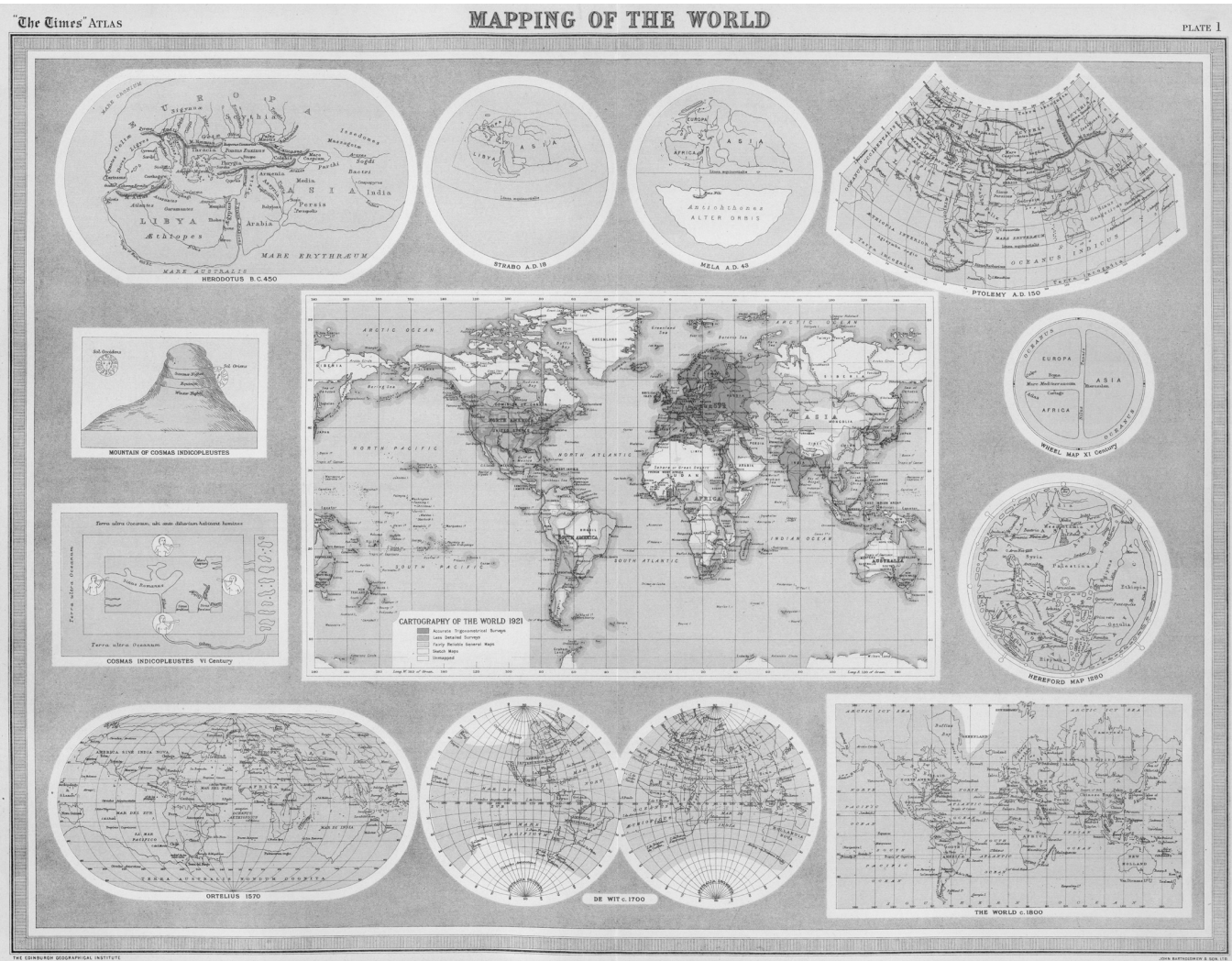


Figure 3: "Mapping of the World." Plate 1 in The Times Survey Atlas of the World, London: The Times, 1922. The map measures approximately 16 1/4" x 21". (This digital file image was supplied by David Rumsey of the David Rumsey Collections, <http://www.davidrumsey.com>.)

Projection relevant here is not how it revolutionized navigation charts, although an earlier bathy-oro-graphical map is called "Mercator's Chart" (see J.G. Bartholomew, *Cassell's Atlas*, 1909, Pl.2). Rather, it is that the Mercator Projection stretches scale and area to such an extent that at 60° North Latitude—roughly the location of the Scandinavian city of Oslo, Norway—mapped distance is twice that at the Equator, where the scale remains true, and area is four times as great (Greenhood 1964, 126; Robinson, et al. 1978, 156). Yet, despite its distortion of the higher latitudes, the sixteenth-century Mercator Projection remained the most popular world-map projection during Bishop's early years; not until the 1930s and 1940s were its limitations on small-scale maps widely recognized in the United States (Schulten 2000, 14; cf. Monmonier 1995, 16-19). As for "Cartography of the World 1921," in 1855 James Gall had attempted to lessen the north-south exaggeration of the Mercator Projection by making his scale accurate at 45° North and South Latitudes. Yet, because it distorts shape, Gall's Stereographic Projection has its own problems. At 60° North Latitude, a place to the west of a point on the ground will appear farther away *on the map* than a place the same distance to the north of that point (see Snyder 1993, 149 and fig. 3.37).

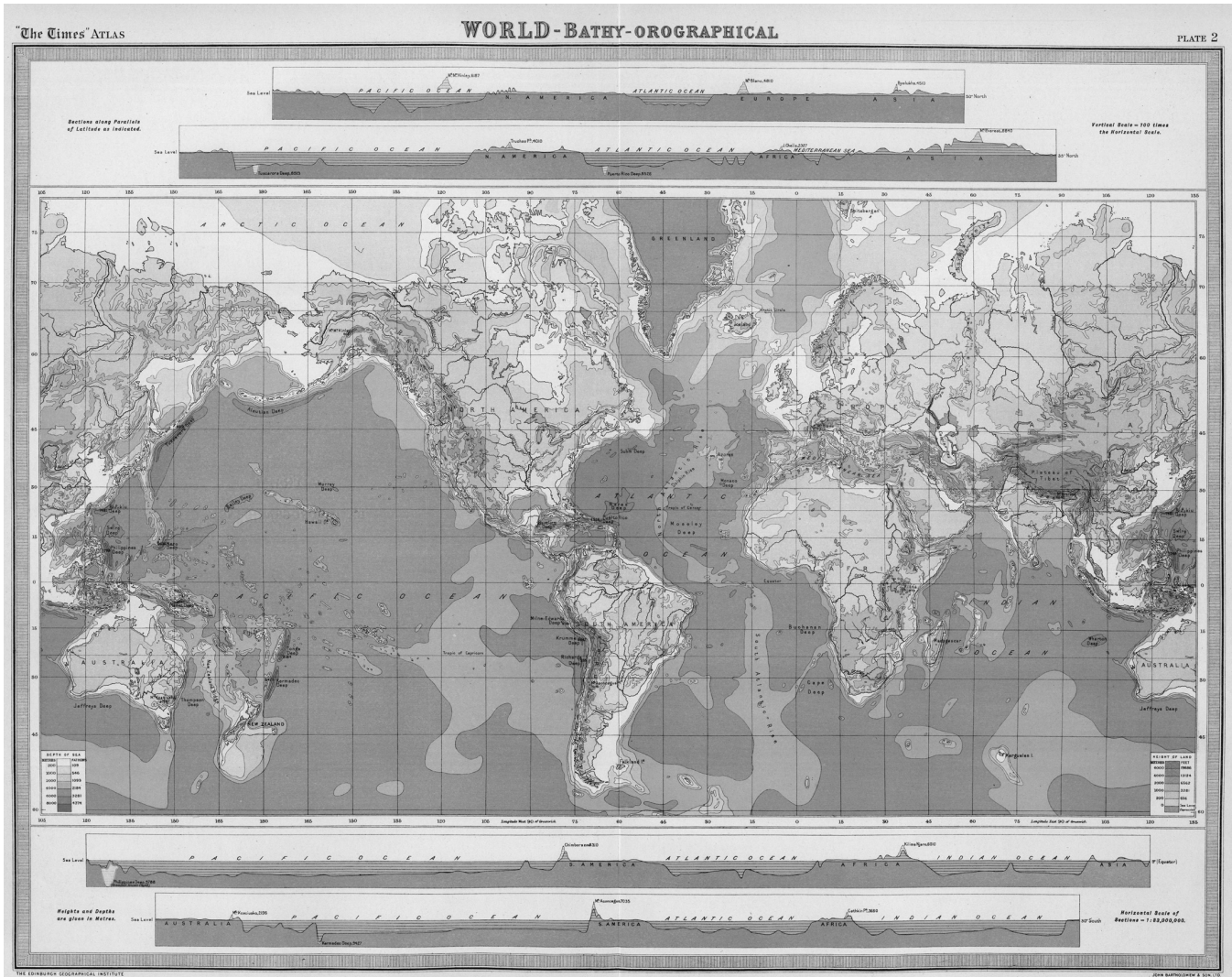


Figure 4: "World Bathy-Orographical." Plate 2 in The Times Survey Atlas of the World, London: The Times, 1922. Measuring approximately 16 1/4" x 21", "World Bathy-Orographical" was prepared at the Edinburgh Geographical Institute under the direction of John George Bartholomew. The map's vertical scale is one hundred times greater than its horizontal. (This digital file image was supplied by David Rumsey of the David Rumsey Collections, <http://www.davidrumsey.com>.)

All of which means one of two things. Either Bishop's statement "Topography displays no favorites; North's as near as West" is as ironic as her previous line "what suits the character or the native waters best." Or it indicates that Bishop—like most people—did not recognize the inevitable limitations of *any* map projection.

"More delicate than the historians' are the map-makers' colors." Bishop's distinction between historians and map-makers in her final line has nothing to do with differences in observation, record-keeping, judgment, or even strict adherence to "fact": history is no less prone to fiction-making than cartography. Yet readers astute enough to detect in a history text the underlying interests of its author are often unaware that every map, as Denis Wood says, "embod[ies its] author's prejudices, biases, partialities, art, curiosity, elegance, focus, care, attention, intelligence, and scholarship" (Wood 1992, 23). And Brian Harley contended as recently as 1990 that historians seldom study maps precisely because they regard them as scientific and transparent "mirrors" (Harley 1990, 3-4). Bishop does not make this mistake. Instead, she considers historians' ways of

"Either Bishop's statement . . . is as ironic as her previous line . . . Or it indicates that Bishop—like most people—did not recognize the inevitable limitations of any map projection."

communicating their interpreted “facts” (“colors”) to be less “delicate” than map-makers’.

In choosing the word “delicate,” Bishop epitomizes her responses to the map as well as her hopes for the poem it inspired. Both are not only “subdued,” “fragile,” and “exquisitely sensitive,” but also “possess subtle craftsmanship” and “give pleasure” (*New English Dictionary* 1888-1928; *Webster’s Dictionary* 1933). Coupled with her recognition of the art inherent in every map, Bishop’s final words remind us of what philosopher and poet George Santayana wrote in *The Sense of Beauty* (Santayana [1896]/1936, 158):

*“In choosing the word
‘delicate,’ Bishop epitomizes her
responses to the map as well as
her hopes for the poem it
inspired.”*

A map is not naturally thought of as an aesthetic object . . . The mind is filled either with imaginations of the landscape the country could really offer, or with thoughts about its history and inhabitants. These circumstances prevent the ready objectification of our pleasure in the map itself. And yet, let the tints of it be a little subtle, let the lines be a little delicate, and the masses of land and sea somewhat balanced, and we really have a beautiful thing; a thing the charm of which consists almost entirely in its meaning, but which nevertheless pleases us in the same way as a picture or a graphic symbol might please. Give the symbol a little intrinsic worth of form, line, and color, and it attracts like a magnet all the values of the things it is known to symbolize. It becomes beautiful in its expressiveness.

Years after Bishop penned her famous conclusion to “The Map,” a 1948 draft of a letter provides insight into her distinction between historian and map-maker:⁷

*“A map is not naturally
thought of as an aesthetic object
. . . The mind is filled either
with imaginations of the
landscape the country could
really offer, or with thoughts
about its history and
inhabitants.”*

A sentence in Auden’s *Airman’s Journal* has always seemed very profound to me—I haven’t the book here so I can’t quote it exactly, but something about time and space and how “geography is a thousand times more important to modern man than history”—I always like to *feel* exactly where I am geographically all the time, on the map,—but maybe that is something else again.

Near the end of her life, Bishop acknowledged, “Most of my poems are geographical, . . . and most of the titles of my books are geographical, too: *North & South*, *Questions of Travel*, and . . . *Geography III*.”⁸ Some critics even regard the poem’s final line as programmatic for Bishop’s entire writings; a confession, they argue, to what would become her lifelong preference for geography over history.⁹

Whatever preference Bishop reveals in “The Map,” it is not one of place over people. Contemplating a map devoid of the life-forms studied by geographers, Bishop imagines that she sees plants, animals, and people. Canadian bays appear to “blossom” and “provide a clean cage for invisible fish,” Norway becomes a “hare,” “profiles investigate the sea,” and the Scandinavian peninsulas resemble “women feeling for the smoothness of yard-goods.” So animated is the interdependence of land and sea as to symbolize the give-and-take of human relationships and emotions. In his study of Bishop’s notebooks, Brett Millier discovers the inspiration for the lines “The names of seashore towns run out to sea,/ the names of cities cross the neighboring mountains” (Millier 1993, 77; cf. 57 and Bishop 1994, xi and 9):

Months earlier, Elizabeth had written in her notebook: “Name it friendship if you want to—like names of cities printed on maps, the word

is much too big, it spreads all over the place, and tells nothing of the actual place it means to name." When she first began working on the image, Elizabeth was contemplating the nature of her attachment to Margaret Miller, and that undefinable emotion is invested in the poem as well. The astonishing cool of the lines, "the printer here experiencing the same excitement/ as when emotion too far exceeds its cause" disguises the fact that Elizabeth is working here at the heart of all that mattered to her personally and poetically.

Bishop relates to geography by the "feel" of a place on a map. Once again, the poet allies herself to cartographers who, in addition to their other skills, have been draftsmen, colorists, and printers. "The Map" not only alludes to these facets of the map-maker's craft but ascribes to land the sensation of touch. For Bishop, as for Denis Wood, "maps are about relationships," whether among landscapes (e.g., towns, countries, waterways) or between map and map-reader (Wood 1992, 139, 132). Cartographers communicate with map users most obviously through the lettering they apply to their maps (Dent 1993, 280). Like map-makers/printers overrunning "names" on the map, Bishop reaches out to readers in her evocative lines "experiencing the same excitement/ as when emotion too far exceeds its cause." And she uses the first person only once in "The Map"—to encourage her readers: "We can stroke these lovely bays . . ." For Bishop, in the end, the peculiar "truth" of any map derives from its marriage of science and art, scale and perspective, map-maker/poet and reader. "The Map" enriches us all through the delicacy of Bishop's observations and her recognition that not all questions have answers.

"For Bishop, . . . maps are about relationships, whether among landscapes (e.g., towns, countries, waterways) or between map and map-reader."

HOWARD NEMEROV'S "THE MAP-MAKER ON HIS ART" (1957)

After the bronzed, heroic traveler
Returns to the television interview
And cocktails at the Ritz, I in my turn
Set forth across the clean, uncharted paper.
Smiling a little at his encounters with
Savages, bugs, and snakes, for the most part
Skipping his night thoughts, philosophic notes,
Rainy reflexions, I translate his trip
Into my native tongue of bearings, shapes,
Directions, distances. My fluent pen
Wanders and cranks as his great river does,
Over the page, making the lonely voyage
Common and human.

This, my modest art,
Brings wilderness well down into the range
Of any budget; under the haunted mountain
Where he lay in delirium, deserted
By his safari, they will build hotels
In a year or two. I make no claim that this
Much matters (they will name a hotel for him
And none for me), but lest the comparison
Make me appear a trifle colorless,
I write the running river a rich blue
And—let imagination rage!—wild green
The jungles with their tawny meadows and swamps
Where, till the day I die, I will not go.

Howard Nemerov's "The Map-Maker on His Art" first appeared in *The New Yorker* on 30 November 1957. The following year, the poet included this slightly revised version in his fourth collection of verse, *Mirrors & Windows* (1958); and, two decades later, in the *Collected Poems of Howard Nemerov* (1977), which won the 1978 National Book Award and Pulitzer Prize. (Reprinted courtesy of Mrs. Howard Nemerov, for the estate of Howard Nemerov.)

"Nemerov's poem is far more masculine than Bishop's."

Like so many other pieces in *Mirrors & Windows*, "The Map-Maker on His Art" is about the art of poetry and the need for some sort of framing device—mirrors, windows, television screens, maps, or poetry itself—to mediate between the mind and the world's insane variety (Bartholomay 1972, 91). In "The Map-Maker on His Art," Nemerov assumes the persona of a map-maker, whose masterful blend of science, technical skill, and artistry can transform a blank piece of paper into a unique creation that delimits and orders the world it reflects. But Nemerov's map-maker is also a poet. With his "fluent" pen, he "translates" journeys into his "native tongue" and "writes the running river a rich blue."

This affinity between poet and map-maker owes much to Elizabeth Bishop's "The Map." It is no coincidence that Nemerov composed "The Map-Maker on His Art" within two years of reviewing her Pulitzer Prize-winning collection *Poems: North & South—A Cold Spring* for the journal *Poetry* (Nemerov 1955). But Nemerov's poem is far more masculine than Bishop's. Whereas she feminizes "The Map" with lines like "these peninsulas take the water between thumb and finger/ like women feeling for the smoothness of yard-goods" (Parker 1988, 57), Nemerov explicitly compares his map-maker persona to another man, the "heroic traveler" whose notes he translates into his map/poem. Like Bishop, Nemerov plays with the imaginative possibilities and limitations of the map-maker's art. Yet his gentle self-mockery—as well as the influence of other sources besides Bishop—make the poem entirely his own.

"Recognizing his importance to the 'heroic traveler,' the map-maker reveals the smugness of the armchair explorer who experiences unusual places vicariously, but without his subject's expense, loneliness, or danger."

Just as the poet memorializes his subject, Nemerov's map-maker ensures that the journey of the heroic traveler is known and reproducible. In our high-tech society, television has almost entirely usurped the poet's traditional role of entertainer and transmitter of culture. Yet television leaves a patina of slick commercialism even on the exploits of "the bronzed, heroic traveler" it idolizes. Nemerov's map-maker, caught up in same ambivalence of packaging the traveler's route in a way that makes it "common and human," uses his "modest art/ [to] bring wilderness well down into the range/ of any budget." Recognizing his importance to the "heroic traveler," the map-maker reveals the smugness of the armchair explorer who experiences unusual places vicariously, but without his subject's expense, loneliness, or danger. The map-maker assumes the mantle of scientific reason to ignore most of the traveler's personal, and therefore irrelevant, reflections. "The instruments of science," Nemerov would later assert in his *Poetry and Fiction*, "have as their aim the creation of an objectivity as nearly as possible universal in character" (Nemerov 1963, 15). The map-maker treats the traveler as if he were as alien as the wilderness, and even boasts about having to "translate his trip/ into my native tongue of bearings, shapes,/ directions, distances."

That Africa is the locale of the traveler's adventure is implied by the Swahili word "safari" and the poem's offhand reference to "savages." Fifteen years before Nemerov composed his poem, Beryl Markham—the well-known aviatrix from England and East Africa—published her acclaimed autobiography, *West with the Night*, about life in Africa (1942). In it, she praises the map for keeping us from being "alone and lost," then criticizes its sublime indifference (245-46):

Yet, looking at it, feeling it, running a finger along its lines, it is a cold thing, a map, humourless and dull, born of calipers and a draughtsman's board . . . This brown blot that marks a mountain has, for the casual eye, no other significance, though twenty men, or ten, or only one, may have squandered life to climb it. Here is a valley, there a swamp, . . . ; and here is a river that some curious and courageous soul, like a pencil in the hand of God, first traced with bleeding feet.

Here is your map. Unfold it, follow it, then throw it away, if you will. It is only paper. It is only paper and ink, but if you think a little, if you pause a moment, you will see that these two things have seldom joined to make a document so modest and yet so full with histories of hope or sagas of conquest.

Like Markham, Nemerov understands the courage and adventure behind the map. But whereas she sees only a draftsman producing the image, Nemerov recognizes an artist as well. By the 1950s, map-makers were making large-scale maps of Africa with the help of aerial photographs supplemented by triangulation and height control (Stone 1995). Although Nemerov had flown for the Canadian and American forces during the World War II (Labrie 1980, 11 and 135), "The Map-Maker on His Art" hints at none of the technological advances in cartography made possible by the airplane or the war. (See Robinson et al. 1978, 5 and 98ff.). This is not surprising, since Nemerov did not consider photography an art, although such a sentiment may seem strange coming from the brother of noted photographer Diane Arbus (Nemerov 1965, 81-84). Instead, like a painter or a poet, Nemerov's map-maker transforms documentary materials with only pen, ink, and paper.

But even if his tools are old-fashioned, Nemerov's alter-ego knows his craft and designs his map in such a way as to inspire others to retrace the traveler's journey. He keeps his visual images simple, since map readers tend to find such images more memorable (Arnheim 1976, 9). Understanding that the critical eye relishes contrasts (Robinson et al. 1978, 285), he chooses a bold palette and exuberant style to complement his "bearings, shapes, / directions, distances." As a map-maker, he uses colors conventionally—blue for water, green for vegetation, tan for drier areas (Robinson et al. 1978, 312). Yet he recognizes that his unnaturally changeless hues are, as Denis Wood observes, "metaphors proclaim[ing] the map as *ideal* (or at least hyperbole), at once an analogue of [the] environment and an avenue for cultural fantasy about it" (Wood 1992, 122). And so his blue is "rich"; his green, "wild"; and his tan, "tawny," like lions on the African plains. As eminent cartographer Arthur Robinson reminds us, "One can be taught a craft (i.e., the mastery of the materials and techniques with which one works), but one cannot be taught the art" (Robinson et al. 1978, 280).

In "The Map-Maker on His Art," Nemerov emphasizes that poet and map-maker are linked by their art. Yet he also knows that aesthetic urges are complex and human. Even as the map-maker objectifies the traveler's adventure, he is seduced by the romance of the safari he is mapping. "I . . . set forth across the clean, uncharted paper" shows his desire to emulate the traveler; so does "my fluent pen / wanders . . . / over the page, making the lonely journey . . ." The defensiveness behind the map-maker's condescending posture is brought home when he protests too much about the hotel that will be built and named for the traveler. Afraid of appearing as "colorless" as his hero is "bronzed," the map-maker lets his "imagination rage" in coloring his map. And so Nemerov's map-maker blows his cover of being entirely scientific and technically proficient: he unwittingly

"But even if his tools are old-fashioned, Nemerov's alter-ego knows his craft and designs his map in such a way as to inspire others to retrace the traveler's journey."

reveals his resemblance to the traveler, whose poetic "night thoughts, philosophic notes,/ [and] rainy reflexions" he had tried to suppress. Not that Nemerov equates science with "truth," or poetry with its opposite:

In his essay "Poetry, Prophecy, Prediction" Nemerov has observed that scientific language is the language in which we "tell each other myths about the motions and the purposes of mind disguised as world, as time, as truth," adding dryly that "myth believed is never called a myth" (Labrie 1980, 17).

"The implication that Africa is the locale of the traveler's adventure leaves little doubt that Joseph Conrad's 1899 classic Heart of Darkness can be far from Nemerov's mind."

Unlike cartographers who enjoy being out in the field, Nemerov's map-maker is active only in terms of his creation. But like most poets, this map-maker distances himself from what he records in order to see it whole. In his commitment to his art and his pretense of objectivity, he sacrifices a fuller participation in life: the world of his maps becomes a convenient substitute for the world itself. The traveler, by contrast, risks life and sanity for knowledge. In the wilderness, the only frames that circumscribe his experience are the spatial and chronological boundaries of his journey, and the diary with which he defines that experience for himself.

The implication that Africa is the locale of the traveler's adventure leaves little doubt that Joseph Conrad's 1899 classic *Heart of Darkness* can be far from the poet's mind. Nemerov's favorite fictional character was Marlow, the narrator of *Heart of Darkness* (Nemerov 1965, 152). Early in the novel, Marlow utters one of the most celebrated passages about a map's effect on others. After his harrowing adventure in the Belgian Congo, he recalls how this part of central Africa had seemed "the biggest, the most blank" space on the maps of his childhood (Conrad [1899] 1969, 10):

Now when I was a little chap I had a passion for maps. I would look for hours at South America, or Africa, or Australia, and lose myself in all the glories of exploration. At that time there were many blank spaces on the earth, and when I saw one that looked particularly inviting on a map (but they all look that) I would put my finger on it and say, "When I grow up I will go there."

Marlow's story reflects that of his creator (Baines 1960; Allen 1967; Sherry 1971). In his autobiographical *Some Reminiscences*, Conrad confesses that he had resolved at the age of nine to visit "the blankest of blank spaces on the earth's figured surface" (Conrad 1912, 41). For him that meant the sixty-mile stretch of rapids on the upper Congo River known as Stanley Falls. Eighteen years later, in 1890, Conrad got his chance to command a steamship on the Congo, one of the longest rivers in the world. In "The Map-Maker on His Art," the traveler's "great . . . running river" may allude to the fascination his literary predecessor experienced when confronted by the sight of the Congo River "on the map, resembling an immense snake uncoiled" (Conrad [1899] 1969, 10).

"Conrad himself never overcame his disillusionment with the reality of African exploration."

But there is a dark side to maps that depict empty spaces in far-off countries. In *The Power of Maps*, Denis Wood suggests that "mapmaking cultures [like American, Belgian, and British] differ from non-mapmaking cultures [like African and Native American] by the need, among others driven by mapmaking, to fill in the blanks within and without maps" (Wood 1992, 44). Such "empty spaces" imply that the area is uninhabited, except perhaps by "savages, bugs, and snakes"; and that it is open to foreign exploration, exploitation, or settlement (Wood 1992, 115; Harley 1994, 308). Conrad himself never overcame his disillusionment with the reality of African exploration. He later confessed that reaching Stanley

Falls brought him “a great melancholy . . . and the distasteful knowledge of the vilest scramble for loot that ever disfigured the history of human conscience and geographical exploration” (Conrad 1926, 17).

“The Map-Maker on His Art” differs from Conrad’s novel in tone and in its emphasis upon “uncharted” *paper*, not wilderness. Yet the poem reveals the cultural imperialism and economic colonialism of mid-twentieth-century American society as clearly as *Heart of Darkness* reflects the colonial mentality of Victorian England. Though Nemerov’s map-maker and “bronzed, heroic traveler” are dissimilar in so many ways, both are pawns and manipulators of their society’s curiosity and acquisitiveness. Nemerov contrasts the hero’s mythical journey with the hype that greets him afterwards. In his footsteps, developers and tourists will follow, staking out claims and converting the wilderness into an exotic theme-park ringed by hotels that offer the comforts of home. Just as a poem or a map are one remove from the experience they record, so is the creation of this artificial wilderness in the heart of another people’s land. Although insisting that he will never go there, the map-maker contributes to this transformation by making his inexpensive maps attractive to any would-be “heroic traveler.”

Conrad never names the Congo or its great river in *Heart of Darkness*. This may explain why Nemerov remains so vague about the location of his traveler’s adventure. But there may be another reason as well. His name is Ernest Hemingway, and he appears to be Nemerov’s third inspiration for “The Map-Maker on His Art.”

“Writer, soldier of fortune, big-game hunter, deep-sea fisherman, and bullfight buff” (L. Hemingway 1962, 13), Hemingway was a darling of the media from the 1940s until his suicide in 1961 (Lynn 1987, 545). Relentlessly associated with his own fictional heroes, he is the obvious model for Nemerov’s “bronzed, heroic traveler.” By 1957, Hemingway had made two celebrated safaris to East Africa, and had canceled a third only recently. Hemingway transformed his 1933-34 hunt for big-game into his *Green Hills of Africa* (Hemingway 1935) and the acclaimed short-story “The Snows of Kilimanjaro” (Hemingway 1939). In 1953-54, he returned to Kenya and Tanganyika. Then, while flying over Murchison Falls on the Victoria Nile in Uganda, Hemingway’s plane crashed (Baker 1956, 330; see Hemingway’s “The Christmas Gift” in *Look* magazine, 20 April and 4 May 1954). Feared dead, Hemingway later delighted in reading the obituaries and retractions that proliferated in late January 1954. There was even an apocryphal story about Hemingway’s press conference in the Lake Victoria Hotel days after the crash: it is said that he was carrying “a bottle of gin and a bunch of bananas and defiantly proclaiming that his luck was running good” (Lynn 1987, 572). Three years later, however, poor health forced Hemingway to abandon plans for his third safari. Instead of Africa, the Paris Ritz became his home from November 1956 through January 1957 (M. Hemingway 1976, 440-441).

“The Map-Maker on His Art” reveals other correspondences to Hemingway. In the autobiographical *Green Hills of Africa*, Hemingway intersperses his own “night thoughts, philosophic notes, / rainy reflexions”—most of them on writers and writing—with graphic accounts of hunting lions, antelope, and rhinoceros. He complains of tsetse flies, mosquitoes, and locusts; abhors snakes; and describes several encounters with Masai villagers (Hemingway 1935: e.g., 19ff., 59, 70ff., 108ff., 195ff., 218-24, 283ff.). Critic Edmund Wilson panned *Green Hills of Africa* in part because of its treatment (or lack thereof) of the Africans themselves: “As for the natives . . . the principal impression we get of them is that they were simple and inferior people who enormously admired Hemingway”

“Though Nemerov’s map-maker and ‘bronzed, heroic traveler’ are dissimilar in so many ways, both are pawns and manipulators of their society’s curiosity and acquisitiveness.”

“Conrad never names the Congo or its great river in Heart of Darkness. This may explain why Nemerov remains so vague about the location of his traveler’s adventure. But there may be another reason as well.”

"Nemerov's 'bronzed, heroic traveler' appears to be a composite of Conrad, Hemingway, and their semi-autobiographical heroes who, like themselves, could not resist the lure of Africa."

(Wilson [1939] 1941, 228). The amebic dysentery and prolapsed lower intestine that hospitalized him early in the 1933-34 safari become the gangrenous leg that kills his writer hero, Harry, in "The Snows of Kilimanjaro." Before Harry succumbs, he hallucinates about being flown over Mount Kilimanjaro, the tallest mountain in Africa (Hemingway 1939). Although I know of no Hotel Hemingway in Kenya or Tanganyika, the Ritz in Paris was such a favorite haunt that its smaller bar ("and cocktails at the Ritz") was renamed in Hemingway's honor (Fitch 1990, 158). Thus, Nemerov's "bronzed, heroic traveler" appears to be a composite of Conrad, Hemingway, and their semi-autobiographical heroes who, like themselves, could not resist the lure of Africa.

Stanley Hyman once said that Nemerov regards "history from the point of view of the losers" (quoted in Duncan 1971, 15). Perhaps being Jewish contributed to his identification with those whom society needs but rarely rewards—like the anonymous map-maker in the poem. Nemerov himself felt "absolutely neglected" at the time "A Map-Maker on His Art" was released in *Mirrors & Windows* (Nemerov 1965, 17). Within a few years, however, he had become "practically a pillar of the church, or ruined temple, of poetry" (*ibid.*). That acclaim lasted the rest of his life, culminating in his appointment as Poet Laureate of the United States (1988) shortly before his death, at seventy-one, in 1991. Always aware that our brief lifespan forms the ultimate frame of our experience, Nemerov has his map-maker/poet conclude with the wistful, yet defiant, realization that he has circumscribed his life within the margins of his art.

MARK STRAND'S "THE MAP" (1960)

Composed, generally defined
 By the long sharing
 Of contours, continents and oceans
 Are gathered in
 The same imaginary net.
 Over the map
 The portioned air, at times but
 A continuance
 Of boundaries, assembles in
 A pure, cloudless
 Canopy of artificial calm.
 Lacking the haze,
 The blurred edges that surround our world,
 The map draws
 Only on itself, outlines its own
 Dimensions, and waits,
 As only a thing completed can,
 To be replaced
 By a later version of itself.
 Wanting the presence
 Of a changing space, my attention turns
 To the world beyond
 My window, where the map's colors
 Fade into a vague
 After-image and are lost
 In the variable scene
 Of shapes accumulating. I see
 A group of fields

Tend slowly inland from the breaking
 Of the fluted sea,
 Blackwing and herring gulls, relaxed
 On the air's currents,
 Glide out of sight, and trees,
 Cold as stone
 In the grey light of this coastal evening,
 Grow gradually
 Out of focus. From the still
 Center of my eyes,
 Encompassing in the end nothing
 But their own darkness,
 The world spins out of reach. And yet,
 Because nothing
 Happens where definition is
 Its own excuse
 For being, the map is as it was:
 A diagram
 Of how the world might look could we
 Maintain a lasting,
 Perfect distance from what it is.

Mark Strand wrote "The Map," one of his earliest poems, while on a Fulbright to Italy in 1960 (telephone conversation with Mark Strand, 17 May 2001). Although the twenty-six-year-old poet sent the poem to *The New Yorker* shortly after, it was not until 1963 that "The Map" appeared in print. The following year, Strand made minor changes before including this version in his first collection of verse, *Sleeping with One Eye Open* (Strand 1964, 19-20; reprinted courtesy of Mark Strand). Since then, the painter-turned-poet has achieved the highest recognition, including a MacArthur Fellowship (1987), his election as Poet Laureate of the United States (1990), and a Pulitzer Prize for Poetry (1999).

Strand had not met Elizabeth Bishop when he wrote "The Map," but befriended the older poet only when he went as a Fulbright lecturer to the University of Brazil in 1965. Both Strand and Bishop shared fond memories of their early years in Nova Scotia; and both eventually translated contemporary Brazilian poets into English. Strand regarded Bishop and Nemerov as two of his favorite poets (Kelen 1991, 62-65) and included several of their poems in his anthology *Contemporary American Poets* (Strand 1969).

Strand's poem is full of their influence. From Nemerov, he borrows the devices of map and window as frames for perception. From Bishop, Strand gleans his title, her "decisive delicacy" (Howard 1980, 592), and his meditation on the map's relation to the world. Like Bishop, Strand remains vague about the map: all we know is that it shows the world covered by a coordinate system. Like Bishop, Strand animates the map in the part of his verse that calls most attention to the similarity between maps and poems. After all, Strand's "imaginary net" alludes not only to the grid indicating lines of latitude and longitude but to the devices that shape words and ideas into poetry rather than prose. In Strand's case, however, it is not the mapped land that appears animated, but the map itself. The map "draws," "outlines" and "waits," as if that "composed" object were creating itself—Escher-like—without the aid of map-maker or poet. And unlike Bishop, Strand uses the first person several times in "The Map." His lines "from the still/ center of my eyes,/ encompassing in the end nothing/ but their own darkness" indicates an inwardness, a concern

"... Strand's 'imaginary net' alludes not only to the grid indicating lines of latitude and longitude but to the devices that shape words and ideas into poetry rather than prose."

*"Some might find comfort in
the aura of immutability and
permanence the map lends even
to such notoriously unstable
features as coastlines and tides.
Not Strand."*

for "the interior universe" that distinguishes Strand's "The Map" from Bishop's insistent focus on the "external environment."¹⁰

For Strand, the map presents a world frozen in time, like a photograph or completed poem. Some might find comfort in the aura of immutability and permanence the map lends even to such notoriously unstable features as coastlines and tides. Not Strand. Instead, he protests against the map's "pure, cloudless/ canopy of artificial calm." Although clouds would obscure the earth's "continents and oceans," their absence on the map denies the presence of an atmosphere, the very thing that makes the earth a unique, life-bearing planet. Without clouds, the map is "not a portrait of the earth but at best a picture of its *land* and *sea surfaces*" (Wood 1992, 63). Strand's "pure . . . canopy" refers to another convention of most maps: the uniform lighting of the mapped surface, even though half the areas they represent on earth are hidden by night at any given time. Without night, the map refers neither to the earth's rotation on its axis nor to its sphericity (Wood 1992, 63). "A later version" of the map Strand had in mind is the so-called "portrait map" of the earth created by artist Tom Van Sant and scientist Lloyd Van Warren. "The Earth From Space"—a stunning map that has become an icon of the late twentieth century and its perception of our planet—looks like a photograph but is, in fact, a heavily manipulated product of three years and thirty-five-million satellite-scanned sections of the earth (Figure 5).

"Wanting the presence/ of a changing space, my attention turns/ to the world beyond/ my window." There Strand finds what is missing in the map's static, "artificial calm": life, movement, accumulating shapes, sound, cold, haze, light's disappearance. Yet his window frames perception just as the map's edges do. While the map offers a view of the entire world, the window opens on a very limited area, one too insignificant to appear on a small-scale map. While he watches, birds "glide out of sight" and trees "grow gradually/ out of focus." Denis Wood has his own comments about the relationship between maps and windows (Wood 1992, 21):

Only by the slimmest margins does the map fail to be a window on the world, margins which, because we can control and understand them, no more interfere with our vision than does a sheet of window glass.

All you have to do is ignore the frame.

All you have to do is ignore the way the window isolates this view at the expense of another, is open at only this or that time of day, takes in only so much terrain, obligates us to see it under this light...or that.

*"Maps offer us a reality that
'exceeds our vision, our reach,
the span of our days'."*

As the darkness of evening descends, Strand understands that the ultimate frame of perception is not the window but his own eyes, "encompassing in the end nothing/ but their own darkness." And that darkness, in turn, forces him to acknowledge the universe's terrifying and uncontrollable mutability as the "world spins out of reach." Today, scientists who have mapped only 1/100,000 of the volume of the visible universe complain that they cannot produce maps drawn to scale. The universe is so empty and the distances between galaxies so great that, as one astrophysicist puts it, "even the tiny points shown in the more schematic maps are too large: true to scale, the galaxies would be invisible" (Geller 1997, 38).

If maps generally "extend the normal range of vision" and make the world's size and variety comprehensible to "diminutive human beings" (Robinson et al. 1978, 5 and 149, respectively), they also offer us a reality that "exceeds our vision, our reach, the span of our days" (Wood 1992, 49; cf. 5). Strand's final lines contrast the world beyond his window with the



The Earth — From Space A New View of the World

Figure 5: "The Earth—from Space: A New View of the World" (1990), created by Tom Van Sant and the GeoSphere Project, Santa Monica, California, and processed by WorldSat International Inc., Mississauga, Ontario, Canada. The scale is approximately 1:46,000,000; and at the Equator, 1" = 726 miles. Courtesy of © 1990 The GeoSphere® Project/ Tom Van Sant, (800) 845-1522. (A later version is also available at www.geosphere.com.) I photographed this map courtesy of the Map Division, The New York Public Library—Astor, Lenox and Tilden Foundations.

unified, unchanging, and idealized version on his map. For Strand, in the end, the map must be viewed as a poem: "a diagram/ of how the world might look could we/ maintain a lasting,/ perfect distance from what it is."

Each of these poems has something to offer the geography student. Nemerov's "The Map-Maker on His Art" raises several questions. What is the relationship between a map-maker and his sources? How well does the poetic description of a map-maker's craft reflect the current technology? What are a map-maker's ethics as well as aesthetics? Bishop's "The Map" alludes to many issues vital to poets, cartographers, and their readers. By blurring the distinction between nature and its representation on the map, Bishop forces us to consider the boundaries between imagination and accuracy, between what we see and what we (think we) know. Perhaps no better way exists to explore these distinctions than requiring students to find the cartographic inspiration for a poem or other work of fiction. Yet since "The Map" is about reading maps and poems astutely, it can supplement introductory cartography texts or the groundbreaking article "Maps in Literature" by Philip and Juliana Muehrcke (1974), whose many literary examples give students a broad perspective on the nature of maps and mapping.

The poems also invite a post-modernist reading of maps. Only their concise poetic form distinguishes them from essays by Brian Harley or Denis Wood, works already fundamental to geography and cartography classes. Take, for example, Wood's critique of Van Sant's "The Earth From Space" (Figure 5). Though the map did not appear until 1990, thirty years after Mark Strand wrote his poem, Wood's deconstruction of the Van Sant map bears an uncanny resemblance to Strand's critique of *his* map's artifice and air of transcendence (see Wood 1992, 48-69; and above). Reading Strand's "The Map" in conjunction with chapter 3 of Wood's *The Power of Maps* makes us realize how pervasive the post-modern critique of maps had become in the second half of the twentieth century—thanks, in part,

CONCLUSION

"The poems also invite a post-modernist reading of maps."

to Bishop. And it makes us wonder what the world map of the twenty-first century will look like.

Meanwhile, poets continue to explore their relation to cartographers. One of them is Beatriz Badikian. Her poem "Mapmaker" brings us back to the classical world where this paper—and map-poems—began (Badikian 1994, 10: emphasis mine):

I am Eratosthenes' heir—the librarian
 who measured earth
 A cartographer of sorts—I measure
 earth with words

 this journey never ceases,
Mapmaking is a life-long task.

ENDNOTES

1. In my telephone interview with Gloria Oden on 9 August 1995, the poet recalled writing the poems in these years. Both poems appear in Hughes 1964.
2. In 1973, the International Cartographic Association defined cartography as "the art, science, and technology of making maps, together with their study as scientific documents and works of art" (*Multilingual Dictionary* 1973, 1). Only twenty years later, however, "art" was banned from the definition. The 1992 "Report of the ICA Executive Committee" currently defines cartography as "the discipline dealing with the conception, production, dissemination and study of maps" (*ICA Newsletter* 20, reprinted in *Cartography and Geographical Information Systems* 20.3, 188; quoted in Krygier 1995, 3). So ingrained is this dualism in American culture that even *Webster's Dictionary* defines cartography as the "art or science" of making maps (*Merriam Webster's Collegiate Dictionary*, 10th ed., 1996). Fortunately, cartographers continue debating the best definition of "map" and "cartography" for the twenty-first century. (See the 2001 *Bulletin of the Society of Cartographers* 34.1 and 34.2).
3. For the dates of Bishop's poems, see Wyllie 1983.
4. A similar map, entitled "Mapping of the World," appeared for the first time in J.G. Bartholomew's *The Advanced Atlas of Physical and Political Geography*; but it occupies the bottom half of a much later page and uses a deep brown to indicate the most sophisticated trigonometrical surveys (Bartholomew 1917, 24). In the next monumental atlas prepared by John Bartholomew, the map is black-and-white and embedded in a Bartholomew Sinusoidal Projection (*Times Atlas of the World: Mid-Century Edition* 1958, xix). Finally, it is worth mentioning that *The Times Survey Atlas* in which the "red map" appears is itself bound in red.
5. The "yellow Labrador" detail distinguishes the map Bishop describes from the "red" map Virginia Woolf refers to in her novel *The Voyage Out* (Woolf 1915, 89). Like G.K. Chesterton in his parodic "Songs of Education, ii: Geography, Form 17955301, Sub-Section Z" (Chesterton 1927, 86; see above), Woolf alludes to the maps representing the British Empire as red. Though Labrador's boundaries were the subject of a dispute from 1902-27 between Canada and Newfoundland (which became part of Canada as late as 1949), Labrador is red—or actually pink—on such maps because Canada and Newfoundland were both members of the British Empire.

6. Bishop might have seen the atlas at the home of any one of her wealthy friends or paternal relatives, and borrowed it subsequently. She certainly would have found the atlas at the New York Public Library, where I discovered it over sixty years later. That fine library is one reason Bishop moved to New York City after graduation. No sooner had she settled at 16 Charles Street in July 1934 than Bishop "established a work space in the New York Public Library" (Millier 1993, 60 and 64).
7. Bishop to "Leo," 26 April 1948, quoted in Millier 1993, 78 n.12. See also her letter to U.T. and Joseph Summers, 19 October 1967, quoted in Goldensohn, 1992, 239-40, and Bishop 1994, 477.
8. Bishop's acceptance speech for the Books Abroad/Neustadt International Prize for Literature, April 1976; quoted in Millier 517 and n.32.
9. For instance, Gordon (1973, 1985), Liebowitz (1977) and Millier (1993). Those who discern a more complex relation between history and geography in Bishop's various periods include Parker (1988), Travisano (1988), Goldensohn (1992), and Harrison (1993).
10. Beatriz Schiller's 1977 interview with Elizabeth Bishop. Quoted in Monteiro 1996, 76; cf. Kirby 1990, 13-14.

Allen, J. 1967. *The Sea Years of Joseph Conrad*. New York: Doubleday.

SELECTED BIBLIOGRAPHY

Arnheim, R. 1976. The Perception of Maps. *American Cartographer* 3.1:5-10.

Aujac, G. 1987. The Foundations of Theoretical Cartography in Archaic and Classical Greece. In *The History of Cartography*, vol. 1: *Cartography in Prehistoric, Ancient, and Medieval Europe and the Mediterranean*, ed. J. B. Harley and D. Woodward, 130-147. Chicago: Univ. of Chicago Press.

Badikian, B. 1994. *Mapmaker*. Chicago: Red Triangle Books.

Baines, J. 1960. *Conrad: A Critical Biography*. New York: McGraw-Hill.

Baker, C. 1956. *Hemingway: The Writer as Artist*. Princeton: Princeton University Press.

Bartholomay, Julia A. 1972. *The Shield of Perseus: The Vision and Imagination of Howard Nemerov*. Gainesville: University of Florida Press.

Bartholomew, J. G., ed. 1890. *The Library Reference Atlas of the World*. New York and London: Macmillan.

—. 1917. *The Advanced Atlas of Physical and Political Geography: A New Series of Maps Specially Designed for Schools, Colleges and Private Students*. London and New York: Oxford University Press.

—. 1922. *The Times Survey Atlas of the World*. London: The Times, and prepared by The Edinburgh Geographical Institute under the direction of J. G. Bartholomew. In the D. Rumsey Collection [online]. Cartography Associates, © 2000. Available at <http://www.davidrumsey.com>. (Accessed 24 May 2001)

- Bartholomew, J., ed. 1958. *Times Atlas of the World: Mid-Century Edition*. London: The Times.
- Bishop, Elizabeth. 1946. *North & South*. Boston: Houghton Mifflin.
- . 1955. *Poems: North & South—A Cold Spring*. Boston: Houghton Mifflin.
- . 1965. *Questions of Travel*. New York: Farrar, Straus & Giroux.
- . 1969. *The Complete Poems*. New York: Farrar, Straus & Giroux.
- . 1976. *Geography III*. New York: Farrar, Straus & Giroux.
- . 1983. *The Complete Poems, 1927-1979*. New York: Farrar, Straus & Giroux.
- . 1994. *One Art: Elizabeth Bishop Letters*. Edited by R. Giroux. New York: Farrar, Straus & Giroux.
- . 1996. *Exchanging Hats: Paintings*. Edited by W. Benton. New York: Farrar, Straus & Giroux.
- Chesterton, G. K. 1927. *The Collected Poems of G.K. Chesterton*. London: Cecil Palmer.
- Conrad, J. [1899] 1969. *Heart of Darkness*. New York: Heritage Press.
- . 1912. *Some Reminiscences*. London: Eveleigh Nash.
- . 1926. *Last Essays*. Garden City, New York: Doubleday, Page & Company.
- Dent, B. D. 1993. *Cartography: Thematic Map Design*. 3rd ed. Dubuque, Iowa: Wm. C. Brown.
- Duncan, B. (ed.) 1971. *The Critical Reception of Howard Nemerov*. Metuchen, New Jersey: Scarecrow Press.
- Ehrensward, U. 1987. Color in Cartography: A Historical Survey. In *Art and Cartography: Six Historical Essays*, ed. D. Woodward, 123-146. Chicago: University of Chicago Press.
- Estess, S. P. 1977. Elizabeth Bishop: The Delicate Art of Map Making. *The Southern Review* 13:705-727.
- . 1983. Description and Imagination in Elizabeth Bishop's "The Map." In *Elizabeth Bishop and Her Art*, eds. L. Schwartz and S. P. Estess, foreword by H. Bloom, 219-222. Ann Arbor: University of Michigan Press.
- Fitch, N. R. 1990. *Walks in Hemingway's Paris*. New York: St. Martin's Press.
- Fothergill, A. 1989. *Heart of Darkness*. Philadelphia: Open University Press.
- Frankenberg, L. 1949. *Pleasure Dome: On Reading Modern Poetry*. Boston and Cambridge: Houghton Mifflin Company.

Frost, R. [1922/24] 1969. A Brook in the City. In *The New Republic* 9 March 1921. Then in *New Hampshire: A Poem with Notes and Grace Notes*. New York: Holt, 1922; London: G. Richards, 1924. Reprinted in *The Poetry of Robert Frost*, ed. E. C. Lathem. New York: Holt, Rinehart & Winston.

Gardiner, L. 1976. *Bartholomew: 150 Years*. Edinburgh: John Bartholomew & Son.

Geller, M. J. 1997. A Voyage Through Space...and Time: Mapping the Universe. *Mercator's World* 2.6:34-39.

Goldensohn, L. 1992. *Elizabeth Bishop: The Biography of a Poetry*. New York: Columbia University Press.

Gordon, J. B. [1973] 1985. Days and Distances: The Cartographic Imagination of Elizabeth Bishop. *Salmagundi* 22-23:294-305. Reprinted in *Elizabeth Bishop*, ed. Harold Bloom, 9-20. New York: Chelsea House.

Greek-English Lexicon. 1968. Edited by H. G. Liddell, R. Scott, and H. S. Jones. Oxford: Clarendon Press.

Greenhood, D. 1964. *Mapping*. Rev. by G. L. Alexander. Chicago: University of Chicago Press.

Haft, A. 1999. The Poet and the Map: (Di)Versifying the Teaching of Geography, I. *Cartographic Perspectives* 33:33-48.

Hamilton, I. 1996. *The Oxford Companion to Twentieth Century Poetry*. New York: Oxford University Press.

Hardy, T. [1914] 1930. *Satires of Circumstance: Lyrics and Reveries with Miscellaneous Pieces*. Reprinted in *The Collected Poems of Thomas Hardy: With a Portrait*. London: Macmillan.

Harley, J. B. 1990. Text and Contexts in the Interpretation of Early Maps. In *From Sea Charts to Satellite Images: Interpreting North American History Through Maps*, ed. D. Buisseret, 3-15. Chicago: University of Chicago.

—. 1994. New England Cartography and the Native Americans. In *American Beginnings: Exploration, Culture, and Cartography in the Land of Norumbega*, ed. E. W. Baker et al., 287-313. Lincoln: University of Nebraska.

—. 2000. *The New Nature of Maps: Essays in the History of Cartography*. Edited by P. Laxton and introduced by J.H. Andrews. Baltimore: Johns Hopkins University Press.

Harrison, V. 1993. *Elizabeth Bishop's Poetics of Intimacy*. Cambridge: Cambridge University Press.

Hemingway, E. 1935. *Green Hills of Africa*. New York: Charles Scribner's Sons.

—. 1939. The Snows of Kilimanjaro. In *The Fifth Column and the First Forty-Nine Stories*, 150-75. New York: Charles Scribner's Sons.

- Hemingway, L. 1962. *My Brother, Ernest Hemingway*. Cleveland and New York: The World Publishing Company.
- Hemingway, M. W. 1976. *How It Was*. New York: A. Knopf.
- Howard, R. 1980. *Alone with America: Essays on the Art of Poetry in the United States since 1950*. Enlarged edition. New York: Atheneum.
- Hughes, L. , ed. 1964. *New Negro Poets: USA*. Bloomington: Indiana University Press.
- Imhof, E. 1975. Positioning Names on Maps. *American Cartographer* 2.2:128-44.
- Kalstone, D. 1989. *Becoming a Poet: Elizabeth Bishop with Marianne Moore and Robert Lowell*. New York: Farrar, Straus & Giroux.
- Kelen, L. 1991. Finding Room in the Myth: An Interview with Mark Strand. *Boulevard* 5.3-6.1:61-82.
- Kirby, D. 1990. *Mark Strand and the Poet's Place in Contemporary Culture*. Columbia: University of Missouri Press.
- Knudson, R. R. 1993. *The Wonderful Pen of May Swenson*. New York: Macmillan.
- Krygier, J. B. 1995. Cartography as an Art and a Science? *The Cartographic Journal* 32:3-10.
- Labrie, R. 1980. *Howard Nemerov*. Boston: Twayne /G.K. Hall.
- Leibowitz, H. 1977. The Elegant Maps of Elizabeth Bishop [Review of *Geography III*, by Elizabeth Bishop]. *New York Times Book Review*, 6:7,20,22.
- Lynn, K. S. 1987. *Hemingway*. New York: Simon and Schuster.
- Markham, Beryl. [1942] 1983. *West with the Night*. Boston: Houghton Mifflin. Reprint, San Francisco: North Point Press.
- McKnight, T. L. 1984. *Physical Geography: A Landscape Appreciation*. 2nd ed. Englewood Cliffs, New Jersey: Prentice-Hall.
- Mercator's World*. 1998. Special issue, "The Call of the Ocean." 3.6.
- Millier, B. C. 1993. *Elizabeth Bishop: Life and the Memory of It*. Berkeley: University of California Press.
- Monmonier, M. 1995. *Drawing the Line: Tales of Maps and Controversy*. New York: Henry Holt and Company.
- Monteiro, G. 1996. *Conversations with Elizabeth Bishop*. Jackson: University Press of Mississippi.
- Moore, M. [1924] 1967. *Observations*. New York: Dial Press. Reprinted in *The Complete Poems of Marianne Moore*. New York: Viking/Macmillan.

Muehrcke, P. C. and Muehrcke, J.O. 1974. Maps in Literature. *The Geographical Review* 64.3:317-338.

Multilingual Dictionary of Technical Terms in Cartography. 1973. Edited by E. Meynen. Wiesbaden: Franz Steiner Verlag, for the International Cartographic Association, Commission II.

Nemerov, H. 1955. Review of *Poems: North & South--A Cold Spring*, by E. Bishop. *Poetry* 87.3:179-182.

—. 1957. The Map-Maker on His Art. *The New Yorker* 23:54.

—. 1958. *Mirrors & Windows: Poems*. Chicago: University of Chicago Press.

—. 1963. *Poetry and Fiction: Essays*. New Brunswick: Rutgers University Press.

—. 1965 [1981]. *Journal of the Fictive Life*. New Brunswick: Rutgers University Press. Reprint, Chicago: University of Chicago Press.

—. 1971. On Poetry and Painting, With a Thought of Music. *Prose* 3: 101-108.

—. 1977. *The Collected Poems of Howard Nemerov*. Chicago: University of Chicago Press.

New English Dictionary [i.e., *The Oxford English Dictionary*]. 1888-1928. Edited by J. A. Murray. Oxford: Clarendon Press.

Panofsky, E. [1939] 1962. *Studies in Iconology: Humanistic Themes in the Art of the Renaissance*. New York: Oxford University Press. Reprint, New York: Harper & Row.

—. 1955. *Meaning in the Visual Arts*. Garden City, New Jersey: Doubleday.

Parker, R. D. 1988. *The Unbeliever: The Poetry of Elizabeth Bishop*. Urbana and Chicago: University of Illinois Press.

—, and Brunner, E., eds. 2000. Elizabeth Bishop Book Jackets. In *A Multimedia Companion to the Anthology of Modern American Poetry*, ed. Cary Nelson. Oxford University Press. http://www.english.uiuc.edu/maps/poets/a_f/bishop/jackets.htm.

Redding, S. 1978. Interview with Gloria Oden [14 July 1977]. *Weid: The Sensibility Revue* 14.1.

Riding, L. [1928] 1980. *Love as Love, Death as Death*. London: Seizin. Reprinted in *The Poems of Laura Riding*. rev. ed. London: Carcanet; New York: Persea Books.

Robinson, A. H., Sale, R., and Morrison, J. 1978. *Elements of Cartography*. 4th ed. New York: John Wiley & Sons.

Rotella, G. 1991. *Reading and Writing Nature*. Boston: Northeastern University Press.

- Santayana, G. [1986] 1936. *The Sense of Beauty: being the outlines of an aesthetic theory*. Reprint, New York: Charles Scribner's Sons.
- Schulten, S. 2000. The Limits of Possibility: Rand McNally in American Culture, 1889-1929. *Cartographic Perspectives* 35:7-26.
- Sherry, N. 1971. *Conrad's Western World*. Cambridge: Cambridge University Press.
- Snyder, J. P. 1993. *Flattening the Earth: Two Thousand Years of Map Projections*. Chicago: University of Chicago Press.
- Stone, J. C. 1995. *A Short History of the Cartography of Africa*. African Studies, 39. Lewiston, New York: The Edwin Mellon Press.
- Strand, Mark. 1963. The Map. *The New Yorker*, 20 July, 30.
- . 1964. *Sleeping with One Eye Open*. Iowa City: Stone Wall Press.
- , ed. 1969. *The Contemporary American Poets: American Poetry Since 1940*. New York: World Publishing Company.
- . 1994. *Hopper*. Hopewell, New Jersey: Ecco Press.
- Swenson, M. 1958. *A Cage of Spines*. New York: Rinehart and Co.
- . 1966. *Poems to Solve*. New York: Charles Scribner's.
- . 1993. *The Complete Poems to Solve*. Illustrated by C. Hale. New York: Macmillan.
- Travisano, T. J. 1988. *Elizabeth Bishop: Her Artistic Development*. Charlottesville: University Press of Virginia.
- Webster's New International Dictionary of the English Language*. 1933. Edited by W.R. Harris. Springfield, Massachusetts: G. & C. Merriam Co.
- Wilson, E. [1939] 1941. *The Wound and the Bow: Seven Studies in Literature*. Cambridge, Massachusetts: Houghton Mifflin Company.
- Winslow, A. [Verna Elizabeth Grubbs] ed. 1935. *Trial Balances*. Introduced by Marianne Moore. New York: Macmillan.
- Wood, D., and Fels, J. 1992. *The Power of Maps*. New York: The Guilford Press.
- Woodward, D. 1992. Obituary: J.B. Harley (1932-1991). *Imago Mundi* 44:120-23.
- Woolf, V. 1915. *The Voyage Out*. Reprinted, London: Hogarth Press, 1990.
- Wyllie, D. E. 1983. *Elizabeth Bishop and Howard Nemerov: A Reference Guide*. Boston: G. K. Hall.

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cartographic techniques

Physical Terrain Modeling for Geographic Visualization

Modern Technology Meets An Ancient Art Form

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Introduction

The physical terrain model, constructed from solid materials such as sand, wood, or foam have long been a favored tool for geographic visualization. Dating back to the time of Alexander the Great, physical models have been used for terrain orientation and familiarization. As reduced scale, three-dimensional representations of the terrain, they are immediately familiar to model viewers. They can be interpreted without having to decode abstract two-dimensional representations such as contours or hachures. Physical terrain models are also appealing because viewers can directly interact with terrain, touch mountaintops and trace paths of rivers through valleys. Small physical models may be handheld while larger models on tabletops may be viewed closely, farther away, or circled, providing a wide range of perspectives.

In an era filled with virtual reality and other digital interactive three-dimensional spaces, physical models may seem outdated. However, the straightforward simplicity of physical models makes them appealing and accessible. Conversely, relatively few people are trained to oper-

ate the sophisticated software for visualizing terrain. Ideally, virtual modeling and physical terrain modeling should be seen as complementary rather than competitive technologies. Together they provide natural multiple modalities and media for viewing the terrain.

Physical models have not received wide recognition or use among cartographers, although they are popular with the military, landscape architects, realtors, engineers, lawyers, and the gaming community. Three factors have inhibited the wider adoption of physical models. First, it has been difficult to obtain the terrain information necessary to construct a model, second, many models have been generated by hand, which is time-consuming and costly,¹ and third physical models are bulky, not disposable, and in many cases not recyclable. Those models constructed using automated methods required highly specialized equipment not readily accessible to cartographers.

Today, justifications for avoiding physical terrain modeling are eroding. Digital elevation data are now readily available to the general public from a number of sources, including complete coverage of the United States by the U.S.G.S. Geographic Information Systems (GIS) can manipulate and transform this data, making it suitable for modeling. In addition, the technology for constructing models has significantly advanced and become more prevalent. Advances in numerical control software for milling and routing machines have made it possible to use this data. Physical modeling is an active area of research in the manufacturing community and cartographers will benefit from these developments. The cost of model construction is falling and the number of organizations with

modeling capabilities is increasing. Often a short trip across campus or across town is all that is required to find the necessary resources.

Given this progress, it is time to revisit the role of physical terrain models in cartography. This article will reintroduce the cartographic community to the world of physical terrain modeling by briefly reviewing the state of the art in manufacturing technology and addressing some of the cartographic issues associated with physical modeling.

Manufacturing Technologies for Physical Models

Physical terrain modeling technologies fall under the general manufacturing category of rapid prototyping. Within the manufacturing community, the term rapid prototyping "refers to a class of technologies that can automatically construct physical models from Computer-Aided Design (CAD) data."² Rapid prototyping technologies are used for small production runs, while molding technologies are more appropriate for mass production. Rapid prototyping technologies are usually divided into three classes, subtractive, additive, and formative.³ Subtractive technologies carve material away from a solid block, additive technologies add material to create a model, and formative technologies shape materials through the application of opposing pressures. Physical terrain models are most commonly produced using subtractive or additive processes.

Subtractive Processes for Modeling

Subtractive processes for modeling, using computer numerically controlled (CNC) milling and routing machines, have been available since the 1940s.⁴

This technology was used in the production of molded plastic relief quadrangle maps by the Army Map Service (AMS), now the National Imagery and Mapping Agency. Between 1951 and the 1970s, AMS produced around 2,000 master molds and more than 2 million plastic relief reproductions.⁵ While the early molds were produced from hand-modeled terrain surfaces, later models were created with Digital Terrain Elevation Data (DTED) and CNC milling. Interestingly, the elevation data that drives the virtual worlds of today has its historic roots as a more cost-effective and efficient way to generate molds for plastic relief maps.

Milling and routing machines use cutting bits that spin rapidly to carve the model from a block of material (Figure 1). They are the most flexible devices in terms of the material selection and size of the output. Most terrain models are carved from synthetic foam, but it is possible to carve

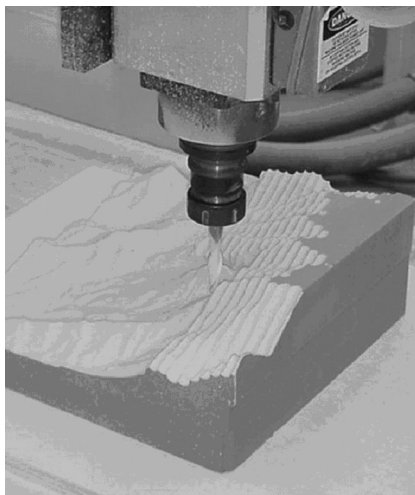


Figure 1. Physical terrain model constructed of foam and carved with a router.

This model is being cut in two passes. The first pass is a rough cut to remove excess material. This is followed by a fine cut to provide the detail for the final surface.

Credit. Physical terrain model created at the Waterways Experiment Station in Vicksburg, MS.

them from wood, acrylic, composites, and even metal. Very large models can be created on milling and routing machines. Thermwood (<http://www.thermwood.com>), a leading CNC company, has options up to 20 feet long by 10 feet wide.⁶ Milling and routing machines are designed to cut 2.5-dimensional surfaces and cut vertical edges. The more advanced models can cut overhanging surfaces, such as cliffs. They vary widely in cost, from a few thousand dollars to several hundred thousand dollars. The costs are dependent on the number of axes in the machine, size, speed, and materials that can be cut. A 3-axis machine is sufficient for 2.5-dimensional models without overhangs, while 5- and 7-axis machines are required for overhangs and more complex models.

Additive Processes for Modeling

Additive processes for modeling are a recent innovation in manufacturing, appearing in the last fifteen years. Additive modeling is of particular interest to the manufacturing community, where complex three-dimensional models are often required. Additive modeling technologies support the generation of fully three-dimensional models, which include not only vertical edges and overhangs, but also interior holes and cavities. Additive models are usually higher resolution than subtractive models. Additive modeling systems typically cost tens of thousands of dollars, but the costs are coming down rapidly.

Currently, additive process systems do not support models with large footprints and each particular system is linked to a single material or limited range of materials. Despite these current limitations, additive modeling technologies are being con-

stantly improved and will play an increasingly important role in terrain modeling. There are four basic processes for additive modeling: selective curing, selective sintering, aimed deposition, and bond-first pattern lamination.⁷

Selective curing uses a liquid resin, which is hardened by light from a laser or masked lamp. Stereolithography, a form of selective curing, was the first additive technology developed and is the benchmark by which other methods are compared.⁸ The SLA Systems Series printers from 3D Systems (<http://www.3dsystems.com>) are representative of selective curing systems.

A powder that melts with heat from a laser and fuses is the basis for selective sintering. Carl Deckard developed this technology at the University of Texas and obtained a patent for it in 1989. DTM Corporation (<http://www.dtm-corp.com/>) sells the Sinterstation product line for model production. Models can be built from plastic, metal, or ceramic.

The aimed deposition process streams material into specific locations. The most common methods are drop-on-drop, which sprays ink from an ink-jet printhead; and continuous, where a material is continuously sprayed through a nozzle. The Thermojet Solid Object Printer from 3D Systems employs drop-on-drop deposition and can produce models in neutral, gray, or black using Thermoplastic build material. This device has one of the smallest footprints and can create objects, which are only 10 x 7.5 x 8 inches. The Stratasys (<http://www.stratasys.com/>) family systems use the Fused Deposition Modeling (FDM) process of continuous aimed deposition. Models can be created from ABS (acrylonitrile/butadiene/styrene), high impact ABSi (methyl methacrylate ABS), investment casting wax, or a

polymer with the elastic properties of rubber.

Bond-first pattern lamination uses a sheet of material: paper, plastic, ceramic, or metal powder. A layer of the material is bonded onto a stack and cut with a laser. In addition, the laser cuts a grid pattern in the surface of each layer to facilitate removal of the excess material. The next layer is bonded onto the previous layer and the cutting process is continued. The model is built as layer upon layer is bonded and cut. Helisys, Inc. was the initial developer of a family of machines using their patented Laminated Object Manufacturing (LOM) technology.

LOM models produce artifacts that are particularly interesting cartographically (Figure 2). When cut as a series of contours, the laser burns the edges of the contours, creating a brown color. This gives the model viewer an indicator of slope, as steeply sloped areas are darker brown and larger flat areas are white or the color of the material (Figure 3). The grid pattern, which is burned into the model, can also be turned to cartographic advantage. It can be sized and spaced so it represents a true map grid that links the model with real-

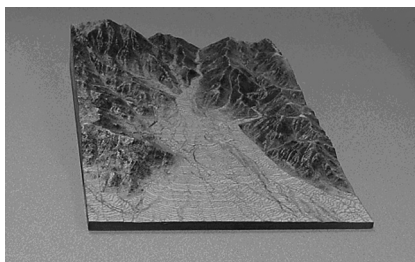


Figure 2. Laminated Object Manufacturing (LOM) model.

The Laminated Object Model (LOM) is created by bonding and cutting successive layers of paper from the bottom to the top of the model.

Credit. LOM model created by the Center for Visualization Prototypes at the San Diego Supercomputer Center, University of California at San Diego.

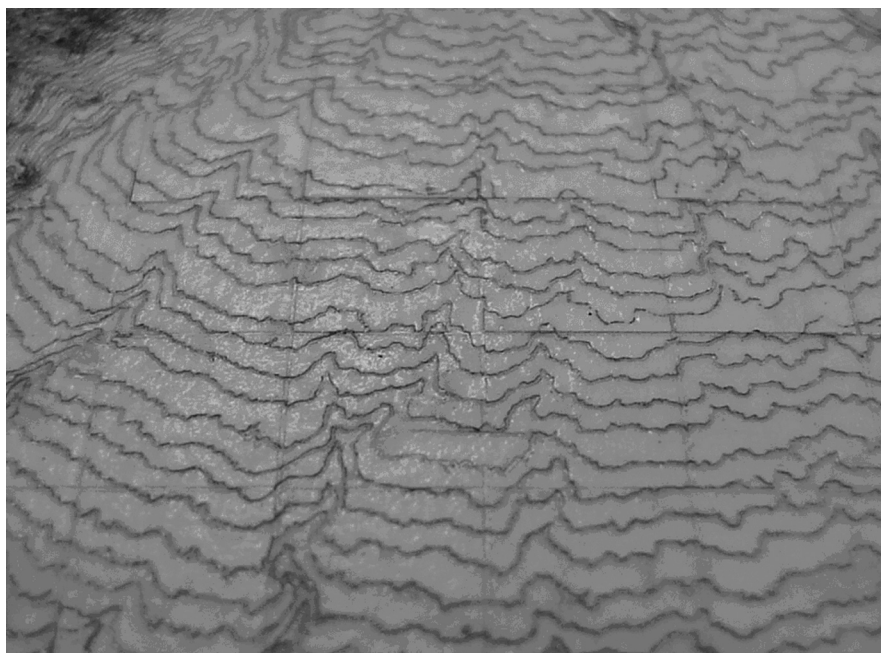


Figure 3. Close-up image of Laminated Object Manufacturing (LOM) model.

This model was built using a contour tool path. The edges of the contours are darkened as a result of being cut with a laser. The grid pattern is an artifact of the process that facilitates removal of excess material from the model.

Credit. LOM model created by the Center for Visualization Prototypes at the San Diego Supercomputer Center, University of California at San Diego.

world coordinates. After production, the LOM models are sealed and finished to prevent damage from handling or moisture.⁹

While all the additive modeling technologies have advantages, disadvantages, and unique characteristics, bond-first pattern lamination and aimed deposition have the greatest cartographic potential. LOM models have an attractive look and feel and their unique artifacts are ideal for giving the model viewer an appreciation of the terrain. Aimed deposition technology is advancing rapidly and shows the greatest potential for eventually producing multicolor models.

The Stereolithography Format – The Lingua Franca of Physical Terrain Modeling

The goal of rapid prototyping is the automated production of models from CAD or GIS data. The

data format accepted by virtually all subtractive and additive equipment manufacturers is the Stereolithography or .stl format¹⁰. Originally developed by 3D Systems, Inc. for their stereo-lithography equipment, the format has gained broad acceptance for all technologies within the rapid prototyping community. The .stl files can be produced in either ASCII or binary format. They contain a list of the triangles with coordinates that describe the surface of the solid model. The .stl model is closely related to the Triangulated Irregular Network (TIN) model found in GIS systems, but TINs describe only the top of a model, while .stl files describe a complete surface, including the top, bottom, and sides. An .stl file can be created from gridded or tinned data using CNC CAD/CAM modeling software.

While the .stl file contains the description of the physical

model, it is not usually used directly in model creation. The file is read into CNC CAD/CAM modeling software, such as Mastercam (<http://www.mastercam.com/>). The software converts the .stl files to machine-specific tool instructions that are used to craft the final model. In fact, this is very similar to how a map in GIS software is printed.

Cartographic Issues

Producing a physical terrain model is like creating any cartographic product. It involves planning, design, data collection, data preparation, production, and distribution processes. The model designer needs to consider the purpose of the model, the environment in which it will be displayed, and the intended audience. Based on this information the model designer makes a series of design decisions that impact the look and feel of the model. These decisions include determining the size, resolution, scale exaggeration, material, tool path, surface content, and finish for the model. These design decisions often affect the suitability and choice of a production method, limiting the range of appropriate and feasible technologies.

Model Size

After determining the purpose and the appropriate content for the model, the designer needs to select an appropriate size. For large models, the designer must choose between creating a single large model or tiling a number of smaller models together. Often, tiling is a more flexible solution because the individual models are stronger and less prone to warping. In addition, the design is more flexible as tiles can be added or taken away to vary the size and location of the modeled area. Routing and

milling are the most appropriate rapid prototyping technologies for generating larger models, while the additive technologies are suitable for smaller models and tiled models.

Resolution

The resolution of the model is dictated by the size, intended purpose, and limitations of the manufacturing equipment. In general, smaller models will be examined more closely and should have a higher level of resolution. Larger models, which will be viewed from a distance, do not require as much detail. Additive technologies are preferable for producing higher resolution models.

Vertical Scale Exaggeration

Selecting the correct vertical exaggeration of the model is something of an art. The vertical exaggeration needs to be great enough to show relief, yet not so high as to look unrealistic. Rarely will the horizontal and vertical scales of the model be equivalent.

Todd Blyler, a model designer at the U.S. Army Topographic Engineering Center in Alexandria, VA, uses anaglyph images to assist in determining the appropriate vertical exaggeration. He creates plots of the maps at the desired horizontal scale and varies the vertical exaggeration. By viewing the plots, he has an idea of the look and feel of the final model. In addition to using anaglyph images, Mr. Blyler creates simulated versions of the model using the ERDAS Virtual GIS software. This enables him to 'fly' around the model and view it from different perspectives. It is an interesting twist . . . using virtual modeling techniques to assist in the specification of physical terrain models.

Terrain Characteristics

The terrain characteristics also drive the selection of the most appropriate modeling technology. Most rapid prototyping technologies can model 2.5-dimensional surfaces without multiple elevations at any location. Vertical edges and overhangs in the terrain surface require a higher level of sophistication, more commonly found in the additive processes. While the ability to create cavities is limited to the additive processes. The ability to model vertical edges is a key element in modeling urban terrain, where the underlying terrain and structures are integrated in a single surface. Alternatively, the terrain and structures can be modeled separately and the structures can be placed on the terrain model.

Material

The color and texture of material from which the model is made greatly affects the look and feel of the final product. Additive technologies like Laminated Object Manufacturing and Stereolithography have a limited range of materials that can be used in the model manufacturing process. Subtractive technologies support the widest range of materials, including wood, acrylic, composites, foams, and metal. Lightweight, durable materials should be selected. Most terrain models are created using special closed cell foams, in order to decrease their weight. Model weight concerns are especially important for larger models. The durability of the model material is also a concern because non-durable materials can chip easily.

Interesting cartographic effects are possible with the creative selection of materials. Laminated wood materials have a contoured look with the different laminated layers

appearing like geological strata (Figure 4).

Tool Path

The tool path determines the direction and distance the bit, nozzle, print head, or other tool follows when creating the model. The choice of a tool path greatly affects the appearance of the resulting model. The three main alternatives are contour, profiling, or flowline paths. These are described below in terms of a routing machine, which cuts the surface down. However, the concepts are applicable to additive modeling technologies.

With a contour tool path the resulting model is a terraced surface, where the terraces are defined by the contours. This type of tool path emphasizes the shape of the terrain by incorporating the contours in the terrain surface (Figure 3). It is useful when display of terrain configura-

tion is the primary goal of the model. This becomes a disadvantage when the model focuses on information other than terrain, such as land cover. In this situation a profile or flowline toolpath is more appropriate.

With a profile path, the tool moves in equal steps along a profile in the x or y axis before stepping to the next profile. Profiling produces a smoother terrain surface than contouring.

The smoothest possible surface is created with a flowline tool path. Flowlines follow the terrain surface, either along equal steps of the surface distance along a profile or following the lines of steepest descent. While flowline tool paths produce the most accurate surface, profile tool paths are much faster and provide nearly identical results.

In addition to carving the terrain surface, the tool path can engrave natural and man-made fea-

tures into the surface. Lawrence Faulkner, of Solid Terrain Modeling (<http://www.stm-usa.com/>), in Fillmore, California, makes effective use of this technique in his models. He engraves vector data in the model by cutting the paths a small distance below the terrain surface, thus integrating the vector source information with the terrain surface (Figure 5).

Surface Content

After the basic model construction is completed, the designer selects information to be displayed on the surface. It can be left in its natural state, painted, or imprinted with a photographic print. Again, the choice of a particular solution depends on the intended use of the model. Laminated Object Manufacturing models, models carved from laminated wood, and models cut with contour tool paths are often left in their natural state, because they are effective at showing the terrain. The addition of information on top of the contours tends to obscure the contours.

Models may optionally be painted to realistically represent the natural terrain. Natural and single color models are suitable for interactive multimedia displays, where static or dynamic maps can be projected onto the surface. Mike Bailey, of the Center for Visualization Prototypes (<http://cvp.sdsc.edu/>) at the San Diego Supercomputer Center of the University of California at San Diego, has done innovative research on terrain models and chemical and biological models. He has developed a prototype where images are projected onto a translucent physical terrain model¹¹.

Model makers are also making rapid advances with printed images, such as aerial photographs, satellite images, or maps on the surfaces of physical terrain mod-

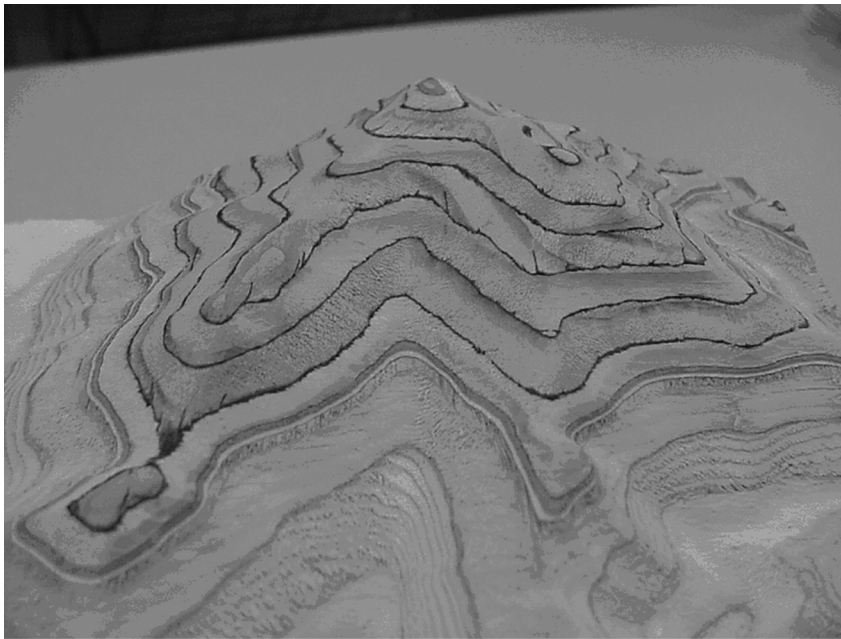


Figure 4. Model constructed from laminated wood.

The use of laminated wood for the model produces an interesting effect, giving an appearance of geological strata. However, the pattern is a function of the wood type and laminate size only. It does not represent the information in the real world.

Credit. Physical terrain model created by the Waterways Experiment Station in Vicksburg, MS.

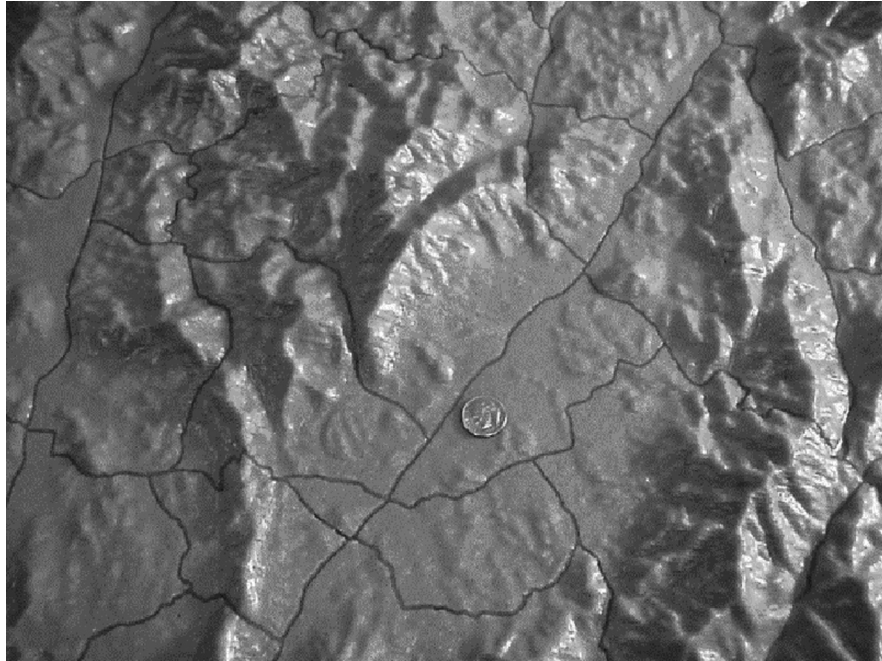


Figure 5. Physical terrain model with engraved surface.

Vector feature information can be engraved in the surface of the model, integrating the feature and elevation information.

Credit. Physical terrain model created by Solid Terrain Modeling, Inc., in Fillmore, CA.

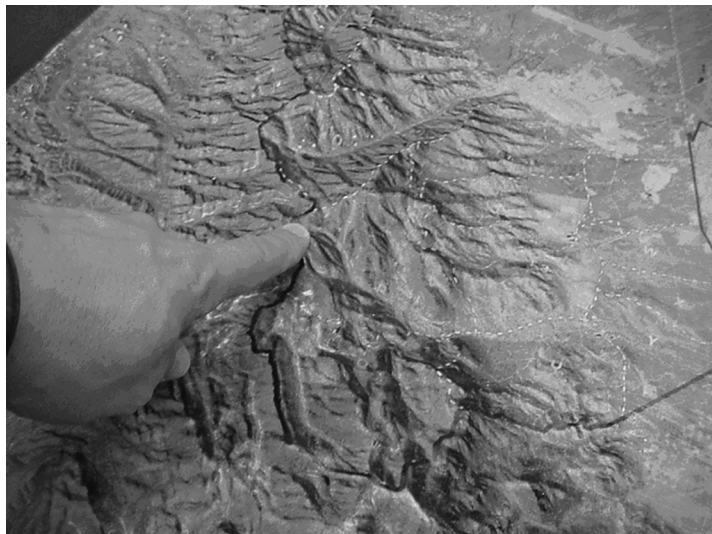


Figure 6. Physical terrain model with photographic image printed on the surface.

Information can be painted or printed on a model. This image shows a model with a grayscale aerial photograph printed on it.

Credit. Physical terrain model created by Solid Terrain Modeling, Inc., in Fillmore, CA.

els. Both Solid Terrain Modeling, Inc. (Figure 6) and Observera (<http://www.observera.com/>) in Chantilly, VA, can print gray-

scale images on terrain models. This technique adds texture and richness to the models and is especially effective when large

portions of the model are flat. Printing color images on models has been a more difficult challenge. Solid Terrain Modeling, Inc. is developing a way to print color images on the surface of a model using ink jet technology. Also, manufacturers of rapid prototyping equipment are investigating methods for creating models from multicolor materials. However, the additional printed information usually comes at the expense of a clearly defined terrain surface, which becomes slightly less discernable.

Model Finishing

In model finishing, the model designer chooses whether to coat the model surface and the type of coating material. Coating makes the surface more durable and less likely to chip. While coating is useful and often required, it does generalize the surface and reduce the detail.

With a polyester or epoxy coating on the surface the model can be annotated with a dry erase marker, enabling the surface can be reused many times. This capability is especially useful when models are used for collaborative planning.

The type of coating material affects the usability of the final model. A glossy coating reflects light off the terrain surface, making it difficult to see the underlying information when the model is viewed in an environment with overhead lights.

Production

Once the design decisions are made production can begin. Companies such as Solid Terrain Modeling, Observera, or HowardModels.com (<http://www.howardmodels.com>) specialize in the construction of terrain models, but any qualified rapid prototyping service bureau or manufacturer

can also do production. Service bureaus, like Quickparts.com (<http://www.quickparts.com>), offer choices in modeling technology and can provide cost quotes and service over the Internet.

Today, model production is generally measured in hours and costs range from several hundred dollars to tens of thousands of dollars, depending on the size, material, and type of model being constructed. These costs will likely drop significantly in the next few years as the technology continues to develop and become more widely used.

Summary

Physical terrain modeling is an ancient art form that continues to be relevant. Models provide a tangible, easily comprehended version of terrain that is immediately recognizable by viewers. Impediments to model construction, such as the difficulty in collecting data and lack of accessible automated manufacturing technology have largely been overcome. Digital elevation models are widely available and the number and variety of manufacturing technologies have significantly increased in the past decade. In addition to traditional subtractive processes, such as milling and routing, new additive processes have been invented. Technologies such as Laminated Object Manufacturing (LOM), stereolithography, and fused deposition modeling increase a modeler's production options and creates the potential for true three-dimensional modeling.

Building a model has much in common with creating a traditional map. The intended purpose of the model, the abilities of the audience, and the viewing environment are all factors to consider when developing a production strategy. GIS data can drive the production process, but the model designer must make decisions

about the model size, resolution, and scale exaggeration, material, tool path, surface content, and model finishing. Production can be done by terrain modeling specialists or rapid prototyping service bureaus. The cost of model generation, now between several hundred and several thousand dollars, is continually decreasing. In the future, cartographers may view three-dimensional printing as an equally viable option for publishing their maps.

Note: Any references to companies or products is for information purposes only and does not reflect the use or endorsement of these products by the U.S. Government.

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References

¹ Terrain Models and Relief Map Making. TM 5-249. Department of the Army Technical Manual. April 1956.

² Lamancusa, John S. Rapid Prototyping Primer. October 5, 2000. <http://www.me.psu.edu/lamancusa/rapidpro/primer/chapter2.htm>

³ What is a Fabber? An Introduction to the 21st Century. Ennex Corporation. October 5, 2000. <http://www.ennex.com/fabbers/fabbers.sht>

⁴ Ibid.

⁵ Globes and Terrain Models. Library of Congress. October 5, 2000.

<http://lcweb.loc.gov/rr/geog-map/guide/gmillgtm.html>

⁶ Thermwood Corporation. October 13, 2000. http://www.thermwood.com/Thermwood_Routers/5-Axis-Fixed-Table.htm

⁷ Ibid.

⁸ Lamancusa, op. cit.

⁹ Industrial Prototyping Technology: Laminated Object Manufacturing. TNO Industrial Technology. October 13, 2000. <http://www.ind.tno.nl/en/productiondevelopment/prototyping/technology/prototyping/lom.html>

¹⁰ Stl Format Description. Tele-Manufacturing Facility Project, San Diego Supercomputer Center, University of California at San Diego. October 13, 2000. <http://www.sdsc.edu/tmf/Stl-specs/stl.html>

¹¹ D. Clark, R. Marciano, R. McKeon, and M. J. Bailey, "Rear-Projecting Virtual Data Onto Physical Terrain." Proceedings of IEEE Visualization '98, Research Triangle Park, NC, October 1998. On-line copy available at <http://www.sdsc.edu/~mjb/pow.pdf>

map library bulletin board

The Map Library's Future

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Abstract

The status quo of map libraries is challenged by the digital information revolution. Map libraries must strategize and act to make the transition into the virtual world. What are the issue to think about and how to proceed?

Changing Times

Map libraries were constructed to facilitate the dominant paradigm of geographic information management. But, the dominant paradigm of geographic information management has changed. When reviewing today's map library operations and when planning for the future, we therefore must focus attention on the relationship between map libraries and the new paradigm, and we should not be afraid to be bold in our vision. Perhaps, using an analogy, instead of reviewing the operations of a stable to manage horses while planning to make allowance to accommodate some motorcars, we should rather commence planning a completely new garage for the arrival of the motorcar, but that will continue to accommodate some horses.

The paper map emerged through time as the dominant paradigm of spatial representation and the primary tool by which to store and communicate geographic information. Map libraries became very important and

flourished during the *Golden Days* of the paper map, facilitating their physical storage, organized access, and use. Society needed map libraries to reign, to administrate, and to explore the world. During these *Golden Days* paper maps, globes and map libraries were associated with wealth, opportunity and power; with emperors and others aspiring to an image of leadership insisting on being photographed with a globe or map in the background.

These *Golden Days* are over. Times have changed, and so have the role and importance of the paper map and their stables. Today, we live in the *Technology Society*, the *Information Society*, and the era of *Globalization*. We find ourselves in the middle of uncertain times, somewhere between the *Pre-technology* and the *Post-technology* era. Today, those wishing to be associated with status and power no longer insist on having their picture taken next to a map or globe. Instead they opt to pose with images of computing hardware displaying information.

Knowledge gained during the ongoing technology and information revolutions is allowing us to challenge centuries of cartographic excellence by picking at the paper map's fundamental weaknesses (Goodchild, 1999). Namely, the paper map:

- is static (snapshot in time);
- is fixed in what it shows ;
- is unconnected to other information sources about space and place;
- is awkward and expensive to use for measurement and information retrieval;
- usually is 2D or at best 2.5D;
- requires a flat medium;
- often is too generic; and
- carries an air of authority often not justified.

So the traditional paper map

does not meet the information requirements of today's high technology world. Challenged by GIS and the database concept, we are busy re-thinking the map. We are changing the focus away from the map as a form of representation and as an end-product towards the map as part of an information infrastructure, as a means of communication, as a stage in process, and as a tool to facilitate analysis and decision-making (MacEachren, 1995). The GIS and cartographic research agendas therefore are advocating a new paradigm of spatial representation that embraces communication, and that facilitates a geographic information environment where the map equivalent of the future must:

- not be an end-product, but a database;
- not only facilitate "final communication" but offer communication of a "stage in process";
- be fully connected to other data sources about space and place;
- no longer be a physical but a virtual (digital) medium;
- support fully digital measurement and analyses;
- be dynamic;
- be a multi-media concept;
- be flexible and 'customizable'; and
- seek to represent reality and the truth.

The primary implication of all this to map libraries is that today's users of geographic information no longer think of the traditional map library as a primary resource. They think of the map library as the traditional "stable" for paper maps, looking somewhere else to find the "garage" housing the digital mapping environment. This implies that map libraries face risk of being perceived obsolete by the present and future geographic information user community.

As we enter the post-technology society, it is only where a map library can establish a reputation as a serious player in the virtual information world that it will remain competitive and viable. So we must work hard to move the traditional map library to fit the new paradigm of geographic information, in the process giving it a new image.

Visions for a Future

Let us role the clock forward, therefore, to a few decades down the road. What will the map library equivalent of the future look like? The primary mandate for such a facility will continue to be to "facilitate access and use of geographic information", but the mandate will have broadened to include "access and use of information associated with geographic information". The mandate will have expanded in this direction to meet the requirement that the map of the future should be fully connected to other data sources about space and place. 'Storage' of geographic information, on the other hand, will in the future be dropped from the mandate since this will become increasingly less of an issue in a digitally networked world.

So the foci of the mandate of the future will be on "access" and "use" of geographic and associated attribute information. This implies that in order to plan for the future map library facility, we must understand the nature and format of tomorrow's information needs, how tomorrow's clients will wish to use the information made accessible, and what the 'facilitating' role of the future map librarian should be.

Geographic information requirements of the future will consist primarily, if not completely, of digital information. There will continue to be demand for access to historical analogue maps and

other analogue maps stored in map libraries today. However, it is only a question of time and organization before scanning techniques become sufficiently cost effective to scan historical and contemporary analogue geographic information without any loss of detail. This will allow us to facilitate digital access to these traditional analog sources, thereby broadening access to them, while facilitating cheaper storage of the original analogue sources by archiving them somewhere off-site. The move towards digitizing the analog world already has commenced.

The sceptic may point out that viewing a scanned facsimile of a paper map on a computer screen is not the same as having access to the real thing. Given today's technology solutions, this is correct. But advances in digital display capabilities will allow tomorrow's users to view even large map information digitally in full size and in as much detail as the source. As well, advances in printing technology will allow tomorrow's users to be able to print and take away a hard copy of a digital facsimile in full size and exceptional quality, if desirable. The technology to do all this exists today.

There can exist little doubt that tomorrow's computer solutions will allow us to view and print a full size map digitally the same way or better than we can view a full size analogue map today. But given the size and likely expense of such large format display and printing devices, access to them will continue to be the exception, not the norm. The majority of readily accessible personal and corporate computing facilities of the future will continue to be compact, therefore not facilitating the digital display and printing of full size map sheets. Large display and printing devices thus likely will remain a unique

requirement offered by a specialized facility, such as a map library.

It would appear, therefore, that a map library that exists today simply because it stores and makes accessible paper maps will risk becoming obsolete. In order to survive, the map library of the future must focus on expertise in and access to digital geographic and associated attribute information, and hardware and software required to view, use and print everything in large dimensions.

Beyond this, the future map library must argue its existence on the basis of diverse geographic information services it can offer to clients. These services will fall into two broad categories:

- assistance finding and understanding information; and
- assistance with access and actual usage of the information.

The first category contains filter functions. Clients will turn to a map library of the future to receive help finding and understanding information to meet a specific need. They will want advice on the quality of this information, to learn of any legal requirements that apply, and to obtain assistance with the process of down-loading and possibly processing of this information.

Some will argue that these information 'gate keeper' or 'filter' functions can be offered outside the domain of a human and/or a physical library by telephone tree services, digital data browsers, or on-line help features, and that these browsers and on-line help features are getting better by the day. Examples exist in the real world today to validate this point of view. We have evidence today that, in most cases, a computational solution can be found that will replicate or outperform a human solution when confronted with a standard information

request. However, computational solutions are unlikely ever to outperform the insights of real human experts who make it part of their business to study the flaws of the data browsers and on-line help systems available, building their personal skills on from there.

Map libraries of the future offering human filter functions or gatekeeper services that exceed the capabilities of data browsers and on-line help functions therefore will have grounds to justify continued existence. On the other hand, map libraries of the future that cannot develop a reputation for offering excellence in this area must excel somewhere else, or face eventual closure.

The second category of services noted above deals with help a client may receive with the use of digital geographic and associate attribute information once the information has been found and accessed. Some map librarians of the future will argue that is it good enough for a map library simply to help a client find and view data, and to down-load or print them for use elsewhere? But others will recognize and aim to capitalize on opportunity.

A map library's aggressive expansion into facilitating "usage" of geographic information can be justified by arguing that we live in a period of history associated with globalization. Today, it is acceptable that a supermarket can also be a liquor store, bookstore, post office and banking outlet. Some banks today are allowed to sell insurance and to trade shares and stocks. So why should globalization not extend to the map library of the future? Why should map libraries not be encouraged to:

- conduct locational searches;
- consult in business geographics and other geographic information analysis;

- assist with navigation and vacation planning;
- assist in housing searches;
- teach classes in geographic information related subjects;
- consult in cartographic communication and offer map design and production services; or
- offer assistance with the interpretation and understanding of space and place?

As far-fetched as this may seem, there already exist map libraries today that have globalized by branching out to become geographic information service providers, including government and university map libraries. Examples include the Pennsylvania State University Map Library, the Montana State Library's National Resource Information Center (NRISS), and the University of Virginia Alderman Library (Adler and Larsgaard, 1999).

The vision that emerges is of a map library whose justification and reputation are based not on what maps and related information it stores in its collection, but on how it can help you find and access geographic and associated information in the virtual world, and how it can facilitate you to achieve the final goal for which you sought this information. It will be a facility people turn to to seek order in a bewildering information plethora, where they can receive help how to understand the galloping technology world surrounding the virtual map, and where they can gain insight into a digital map's reputation, quality and legal status. A primary focus will be on "just-in-time" service. Perhaps humans will continue to staff these facilities. Their roles will be to instruct in how to obtain maximum advantage of digital data browsers, to answer general questions concerning geographic and associated information, and to offer consulting services. Of course, in

today's world of "user pays", it is highly likely that there will be pressure to levy fees for information access and user services. This will imply a shift in thinking away from a facility attempting to support universal access to geographic information to a more elitist environment.

Bridging Future Vision with Today's Status Quo

How to make the transition from today's map library to tomorrow's vision? Two primary questions stand out, namely who is likely to champion the transition, and what are the key issues these champions must deal with?

Today's map libraries need to find champions who believe strongly in the continued demand for a physical facility specializing in access to and use of geographic information. Such dedicated individuals already have come forward from within today's map libraries. Their excellent work and progress can be followed through the professional associations they belong to, including the *Association of Canadian Map Libraries and Archives* (ACMLA) at <http://www.sscl.uwo.ca/assoc/acml/acmla.html>, the *International Federation of Library Associations, Section of Geography and Map Libraries* at <http://www-map.lib.umn.edu/map-libraries.html>, the *Special Libraries Association, Geography and Map Division* at <http://www.sla.org/>, the *Western Association of Map Libraries* at <http://gort.uscd.edu/mw/waml/waml.html>, or the *Digital Librarian (Maps and Geography Australian Library Association)* at <http://www.ala.au>. However, not all map librarians and/or map library administrators have the skills or the motivation to take on the role of champions, leaving some map libraries in trouble.

Other places where champions already can be found

are amongst politicians with a vision, the geographic information user community, and within the corporate world. An example of a politically championed initiative is the American Digital Earth vision for a global geo-spatial information network <<http://digitalearth.gsfc.nasa.gov>>. Champions also have stepped forward from within the digital geographic information user community, in some cases teaming up with map librarians, as in the case of the Alexandria Project <<http://alexandria.sdc.ucsb.edu>>, and for example at the University of Connecticut's MAGIC (Map and Geographic Information Center) initiative <<http://magic.lib.uconn.edu/>>. These efforts must be complimented for their excellent vision, work and leadership. But today's map libraries need far more energy from the digital geographic information user community. Too many of today's geographic information users simply are abandoning map libraries, turning elsewhere in their struggle to satisfy their geographic information needs.

There also is activity from within the corporate GIS world. Corporations offer give-away and special deals on their software and training in an attempt to move map libraries into the digital era, challenging map libraries to answer the following questions:

- how can map librarians become literate in today's GIS solutions; and
- how can today's GIS solutions be integrated into map libraries?

These corporate initiatives must be applauded, as must corporate efforts to package digital geographic data for use by libraries. However, the transition agenda is far bigger than installing today's GIS solutions in map

libraries and making map librarians GIS literate. Indeed, today's GIS solutions are very complex and may not be a workable answer for map libraries. As well, some would argue that corporate efforts invariably are driven by corporate agendas, agendas that may distract from the real transition questions that need to be answered.

The bottom line: Those map libraries that can find a champion will most likely make the transition to a map library of the future, while those without vision and leadership will fade into the backwater and face eventual closure. The task ahead looks daunting. Many of those suitable to champion the transition are shying away from serving because of the sheer work and effort involved. The good news is that there already exist dedicated champions paving the way forward. Some of these initiatives have been identified above. Others can learn a lot from these initiatives, making their own task easier.

Those willing to take up the challenge of leading a map library's transition into the virtual world must find answers to a number of key issues phrased below as questions:

- Who are the present and future clients? What are their present and future geographic and associated information needs?
- Are there logical partnership opportunities or collaborators to team up with, for example other libraries, spatial analysis laboratories, Geography Departments, ...?
- What geographic and associated information services should my library offer in the future? Where are the opportunities and how can these opportunities be delivered?
- How does one go about negotiating and facilitating access to

digital geographic and associated information that resides off-site somewhere in the virtual world?

- How will the new facility be financed? Should there be a fee-for-service? If yes, what should that fee be for access and for services/use?
- How to re-train existing staff and what should be the selection criteria for hiring future staff?
- What are the best ways to acquire, amortize, maintain and replace hardware and software?

In other words, every map library must understand its clients, its mandate, and its users' needs. It must invest efforts to understand what digital geographic and associated information is out there that may be of interest to its clients, how that information can be accessed from off-site and within the library, and if and how the information can be passed on to the user. Each library must develop a regulatory and physical environment to access and view these digital data. Each library must decide further how far it wishes to support usage of these data within the library.

Financial viability of tomorrow's map libraries will depend on the goodwill of those financing today's map libraries, the ability to negotiate or raise new funds, and the entrepreneurial skills on behalf of map libraries to become revenue generating. The notion of financing the future map library through revenue generation by charging a fee for service may be alien or despicable to many of us. However, there is opportunity here, and it may prove difficult to ignore a general societal trend towards fee-for-service.

Moving a map library from an analogue into a digital world is unlikely to happen without full cooperation from the map librarians. Those in charge of map

libraries cannot make the assumption that today's map librarians have the skill or will to participate in a digital geographic information world. Many map librarians opted for their career path because of their love for traditional librarianship and maps. Tomorrow's map librarians will require a new blend of skills, a blend that combines understanding of geographic information with skills in handling sophisticated digital information technologies. Managing this human resource transition will not be easy.

Summary

The map is in rapid transition, moving from analog map sheets to virtual digital databases. Map libraries must embrace the virtual medium or risk becoming obsolete in the post-technology world. Map libraries will change to become "geographic and associated information resource centers". This implies little conceptual change if you think of the "map" as "geographic information", and of "libraries" as "resource centers". It does, however, imply considerable change in the physical nature of the facility and in its mode of operation.

Will we need map librarians in the future? The map librarian of the future will be the *expert* who knows best where to find what in a bewildering world, who can help us to understand the galloping technology surrounding the virtual map world, and who can shed insight on a digital map's reputation, quality and legal world. Digital browsers will become as good as a mediocre map librarian. But no digital data browser will match an expert map librarian who is up-to-date on what is going on in the geographic information world. So there will always be a continued need for *expert* map librarians. However, these experts could be accessed in tomorrow's sophisticated digital world without the

need for an elaborate physical map library facility.

So will we need physical map libraries in the future? The primary role of the physical map library will switch from storing paper maps to facilitating digital geographic and associated information search and access, with a focus on "just-in-time" service. The physical facility will specialize in hardware, software and network gadgets not easily accessible to the average home or office computing installation. While physical map libraries therefore have an opportunity to be an important part of tomorrow's geographic information service provision, they will not be essential. A map library's continued existence cannot be guaranteed, it must be earned.

To make a successful transition, map librarians and their map libraries must be pro-active and visionary in the provision of geographic and associated information access and services. They must be advocates of change and direction. In today's political, corporate and fiscal climates, map libraries need to find opportunities to team up, to form partnerships, and to diversify to achieve WIN/WIN situations. Those of us who know of map libraries and reading rooms face options. To do nothing implies the risk of a gradual demise of many of our traditional map libraries into oblivion.

References Cited

- P.S. Adler and M.L. Larsgaard (1999). Applying GIS in libraries. Pages 901-908 in *Geographical Information Systems: Principles, Techniques, Applications and Management*, 2nd Edition, by P.A. Longley, M. F. Goodchild, David J. Maguire (Editors), 2 Volume Set, 1296 pages, John Wiley & Sons.
- M.F. Goodchild (1999). Cartographic Futures in a Digital World. Pages 5-14 in *Touch the Past, Visualize the Future*, by C. P. Keller (Editor), Conference Proceedings of the 19th International Cartographic Conference, Ottawa ICA 1999, 1908 pages, Natural Resources Canada. (re-printed in *Cartographic Perspectives*, No. 36, Spring 2000)
- A. MacEachren (1995). *How Maps Work*. 513 pages, Guilford Press.

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online mapping

Cyber Rights and Cyber Maps

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An examination of the articles in this and related journals quickly gives the impression of a number of exciting and cutting-edge developments in Web-based mapping. During the 1990s, as the Internet doubled in size every 18 months in compliance with Moore's Law, cartographers and GIS companies alike began to explore previously unrealizable goals of distributing maps and applications (such as ESRI's Ar-

cIMS) via the Internet. Although the dot-com collapse of 2000 necessitated a rethinking of the business plans among “purely” Internet based companies (who take their orders only over the Web and do not have an appreciable physical presence, as opposed to the “clicks and bricks” companies) it seems that every week brings something new to be grateful for (or worried about). And the Dow and NASDAQ are still at an (almost) all time high, and retail e-commerce sales alone for the 2001 1st quarter were \$7 billion, up 33.5% over 1st quarter 2000 (Census Bureau, 2001).

While I am as appreciative about technological advances as the next person; for example teaching Internet GIS with ArcIMS 3 since Fall of 2000, there does seem to be a voice missing from the conversation about Web-based mapping. We have been so concerned about “cyber maps” that we have perhaps forgotten about “cyber rights”.

The notion of rights is one that is familiar to most readers. In the United States, during the 1960s civil rights were brought to prominence successfully by leaders such as Martin Luther King (now resting just a few blocks from where I write this). In Europe, “May 1968” is synonymous with the student protests for social justice. These movements and their achievements were all the more remarkable because they arose from the will of the people, rather than from government legislation (at least initially). Today, a country without equal rights (human or civil) is in fact and almost by definition, unjust. A good example is the United Nations Development Report that ranks the world’s countries by how many rights its citizens enjoy (see <http://www.undp.org/hdro/>).

On the other hand, rights are quite problematic for some commentators—even unjust. But

how can equal rights be unjust? It’s worth thinking about this. The answer lies in two implicit characteristics of rights in general: namely who gets to define the rights in question, and that rights are “inalienable”, or if you prefer the words of Jefferson in the Declaration of Independence “We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness”. Both of these ideas, that rights are inalienable or an inherent part of being human, and how rights are applied, can and have been challenged. The most interesting of these is when the two implicit parts of rights are joined: *rights are fine in theory, but when they get operationalized they suffer*. Thus when rights move from the absolute to the practical, they also become subjectified, politicized, and somewhat inflexible. Whose rights become *the* rights? After all, Jefferson owned slaves.

The same critique is possible against cyber mapping. The vision implicit in Internet GIS, MapQuest and the like is a positive one. Providing mapping and GIS services over the Internet

will surely stimulate interest in cartography as a practice and as a part of business, increasing demand for jobs for the spatially trained (the OpenGIS Consortium likes to say that 80% of all business data has a locational component). The idea is fine in theory but how does it play out? I will argue that “cyber rights” are currently enjoyed by very few people around the world, and will continue to be so for the foreseeable future.

In the rush to embrace the Internet it is often forgotten just how few people can get access to it. Globally, somewhat under 7% of the world’s population can and do use the Internet. That is to say, *ninety-three percent* of people in the world are without Internet access! Given that over a billion people live on less than a dollar a day, this shouldn’t be too surprising. Regionally, the picture is even more revealing, as Table 1 shows.

This table reveals how regions with lower levels of access generally are also growing more slowly than regions with higher levels of access, with the exception of South America. This is the geography of the digital divide. North America (Canada and the USA) is still the predominant center of the Internet, both in terms of

	Percent Access to Internet 2000	Total Persons (M) 2000	GAGR (%) 1997–1999 1999
North America	48.5	167.12	63.6
Europe	17.5	113.14	46.2
Asia/Pacific	7.1	104.88	48.8
Middle East	4.9	2.4	n.a.
Latin America	2.5	16.45	111.2
Africa	0.5	3.11	30.9
Global	6.7	407.1	59.5

Table 1. The digital divide by region, 2000. (Source: NUA, http://www.nua.ie/surveys/how_many_online/index.html and World Bank, <http://www.worldbank.org/data/databytopic/GNPPC.pdf>). All figures approximate and represent adults and children with access to the Internet. Figures vary within region. CAGR = compound annual growth rate of hosts per region.

numbers and as a percentage of all people online. However, the global share of users in these two countries is now well below half, at about 40% by year-ending 2000 (about 1/3 in the United States). This is a decline from effectively 100% in the early 1990s. So the Internet is itself getting less concentrated. *But it is not flowing out evenly.* Vast areas of the world, especially in Africa, the Middle East (where there are cultural and religious barriers to adoption) and Asia are effectively not online. Within the United States there have now been four reports by the Department of Commerce on the digital divide, the most recent, "Falling through the Net" appearing in October 2000 (NTIA & ESA, 2000). In the case of African Americans as a whole the differential in Internet access is as much as 18 percent (23.5% vs. 41.5% access rate nationally, summer 2000). Furthermore, figures show that the differential is *widening*, rather than narrowing. According to the report, the gap between African American and national access rates has widened by 3 percent in two years. Critically, these differentials cannot be entirely accounted for by income or education. When Black households are normalized for income and education and their Internet access rate is estimated, these two factors account for only about one half of the actual differences.

Globally, Figure 1 shows that the Internet is still concentrated in the US, Europe and Australia and Japan (only four countries in 2000 had majority access to the Internet out of about 175 for which there is data; they are [in order] the USA, Sweden, Norway, and Iceland). Even within these countries, it is important to note that access may only be available in the capital. Although most countries in the world now have Internet access, this is misleading. In Africa for ex-

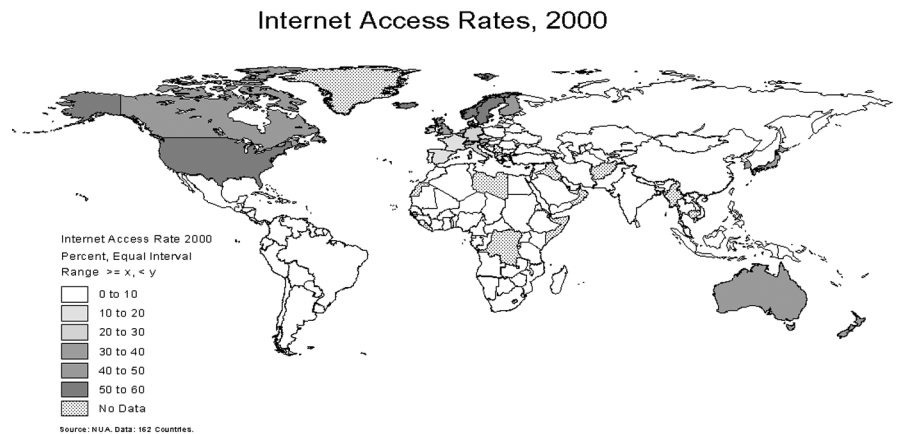


Figure 1. Internet Access Rates for 2000 by country. (Source: NUA, http://www.nua.ie/surveys/how_many_online/index.html. Map by author.)

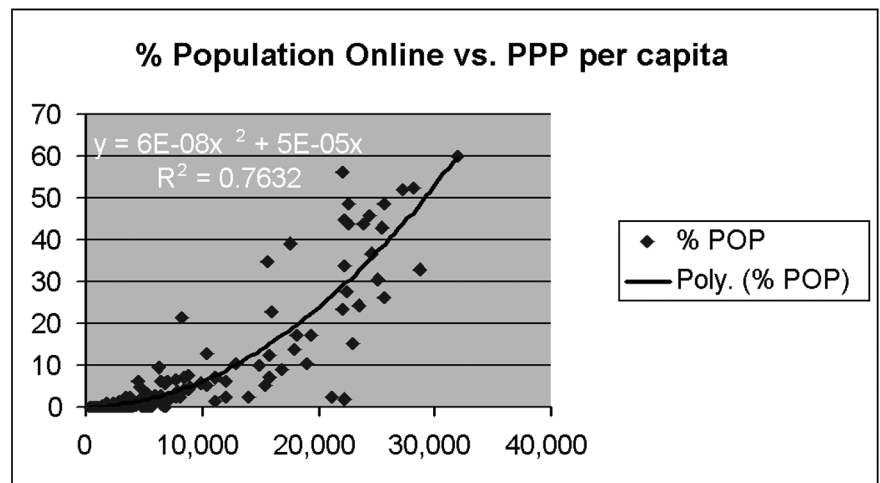


Figure 2. The relationship between income and Internet connectivity is non-linear. In this scatter plot, income is measured through purchasing power parity (PPP) and connectivity through percent online. (Sources: NUA, World Bank, <http://www.worldbank.org/data/databytopic/GNPPC.pdf>).

ample, the best-connected country (South Africa) has only 4% of its population online (in May 2000), and there is a continent wide average of just half a percent (Table 1). By the beginning of the 21st century only 1 out of 200 people had Internet access in Africa (Jensen, 2001). According to the latest UNDP *Human Development Report* (UNDP, 2000) sub-Saharan Africa has 0.27 Internet hosts per 1,000 people, compared to 112.77 for the United States and a global average of 7.42 (a host can connect more than one person).

Given that income is usually held to be the primary predictor

of access, and to a lesser extent, education, is it possible to detect any variance between "standard of living" and access? In order to answer this question we can derive a straightforward scatter graph matching standard of living with Internet access (Figure 2). As this graph shows, income accounts for about 75% of the variability in Internet access, but the relationship is non-linear. In other words, adding more income ceases to have an effect on connectivity at a certain threshold level (about \$21,000 in PPP international dollars; all the countries with incomes greater than this are in Europe or North

America, except for Hong Kong, Singapore, and French Polynesia, i.e., former colonies). We can also identify two separable groups or clusters of countries, those with higher incomes and connectivity (though more similar in income than connectivity) and those with effectively non-access (under 10% and even under 5% access). If we wanted to go further with this, we could also create a map to show which countries have greater than predicted access, predicted access, or lower than predicted access.

An R^2 of 76%, although reasonable, does not tell the whole story. That is to say, another quarter of the variability is not accounted for by income. Candidate variables that could be tested include attitudes to the Internet (perceiving it as irrelevant due to a historical lack of similar technology in the country or a lack of "killer apps"), lack of physical or cyber-infrastructure to provide access, and some related variables such as literacy and educational attainment rates.

But the digital divide is not just a technological problem alone and cannot be captured just by measuring "percent online". It is really better to think of it as a divide in opportunity for being part of the information economy (worth hundreds of billions of dollars in the US alone). This is therefore not just a question of technology; there are at least three divides in the information economy; technological, political, and social-economic. These divides are not independent. For example, the United Nations observed in its 1996 Development Report that there has been a significant concentration of wealth into fewer and fewer hands since the 1960s, so that by 1991 more than 85% of the world's population received only 15% of its income, and the net worth of the 358 richest people (the dollar billionaires) equaled the income of the poorest 45% of the world, or some 2.3 bil-

lion people (cited in Harvey, 2000, pp. 42–43). This concentration of wealth has occurred at precisely the same time as the best and most exciting deployment of technology in human history. Matthew 25:29 has never looked so apposite.

Why are these differentials important? For that half of Americans, which have access to the Internet, it is clear that it is used in a wide variety of ways. These include business transactions, job searches, online voting, information searches and retrieval, entertainment, and educational advancement. For the other half of America, those who are digitally divorced, it is equally clear that they are increasingly disadvantaged. In some instances there have been reports of "cyber redlining" by companies in terms of where broadband is first installed or where some online companies are prepared to deliver goods. Even without active discrimination those without access are relatively disadvantaged in using information and knowledge that is available to others.

I would conclude by noting that it is not inappropriate to be excited by technological advance, or the deployment of mapping applications on scales never before seen. But I would suggest that all technology comes with a social (and political) larger context in terms of who gets it, how it is used, and who benefits. It is just as appropriate to resist the negative effects of technological deployment, as it is to embrace the positive ones. What that resistance might look like I would not presume to say in this short discussion, but it seems clear enough that a solely technological "fix" without a social/political thrust, would be inadequate.

References

Harvey, D. 2000. *Spaces of Hope*. Berkeley & Los Angeles: University of California Press.

Jensen, M. 2001. The African Internet. A Status Report May 2001. Online. Available: <http://www3.sn.apc.org/africa/afstat.htm>

National Telecommunications and Information Administration (NTIA) & Economics and Statistics Administration (ESA), 2000.

Falling Through the Net: Towards Digital Inclusion. Washington, DC: Department of Commerce. Online. Available: <http://search.ntia.doc.gov/pdf/fttn00.pdf>

United Nations Development Program (UNDP), 2000. *Human Development Report 2000*. New York, Oxford: Oxford University Press.

United States Census Bureau, 2001. Retail E-Commerce Sales. Online. Available: <http://www.census.gov/mrts/www/current.html>

book review**Geographic Information Systems, An Introduction, Second Edition**

By Tor Bernhardsen

English translation by Michael Brady Consultants and Mahala Mathiassen.

Published by John Wiley & Sons, U.S.A., 1999.

372 pages, numerous maps, diagrams and photographs. Hard-bound.

ISBN 0-471-32192-3

*Reviewed by Gordon Kennedy
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Washington State Department of
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This attractively designed book presents in a single, handy volume an encyclopedia of GIS. In twenty-one chapters, the author presents a wide-ranging overview of GIS that encompasses nearly every aspect of the technology and its use. Bernhardsen intends this as an introduction for those who have little or no knowledge of GIS. The first three chapters offer a definition of GIS in the context of information technology, a brief history of geographical information, and a summary overview of contemporary geo-spatial data concepts.

Chapters Four through Six present a more detailed review of spatial data models, attribute data, and map projections. Hardware and software for GIS are presented in the next two chapters, followed by a lengthy excursion into data-related topics occupying Chapters Nine through Thirteen. This section presents such topics as data collection, data quality and database management systems.

Spatial analysis is covered in the next two chapters, followed by one on visualization. Implementation receives lengthy treatment in Chapters Seventeen and Eighteen. Chapter Nineteen reviews standards and data exchange issues, and Chapter Twenty contains a discussion of legal and financial issues. The final chapter offers a brief recapitulation of the book's major topics in the context of future possibilities.

This book uses many two-color graphics and tables to illustrate and exemplify the author's ideas. There is a map, diagram, or table on nearly every page. The text is well organized in logical, numbered chapters and sections; the prose is generally clear and easily understood. A generous list of references, including a number of Nordic works that North American readers may find intriguing, completes the volume.

Bernhardsen sets out to "... meet the need for a comprehensive presentation of the various fields currently associated with... GIS," and admits that an appropriate alternate title might have been "Geographic Information Technology." This work is largely descriptive with little theory or analysis, and in this respect seems to be a compilation of topics in GIS technology. The major contemporary topics of GIS, from cartography to metadata, are methodically delineated, but few are presented with depth or context.

The extensive treatment of data found in this book is a refreshing departure from texts grounded in the cartographic and spatial analysis paradigms for GIS. Bernhardsen repeatedly emphasizes the importance of data as a foundation of GIS and of information technologies in general. From the beginning, he places data at the center and in different ways reminds us of its importance: the difference between

maps and data, the fact that data represent imperfect measurements of reality rather than a presentation of reality; that spatial analysis operates on such data as is available, for better or for worse. He presents a serviceable introduction to formal data modeling and its importance to designing useful data-bases. He describes the essential concepts distinguishing accuracy from precision. He effectively explains mechanisms for linking spatial and attribute data.

Data quality issues are discussed at some length in this volume. Bernhardsen provides clear, sensible descriptions of how data can be misused by exceeding accuracy limitations or by making assumptions about the compatibility of disparate spatial data. In addition to quantitative accuracy, he includes logical consistency, completeness, and timeliness to provide a well-rounded and instructive review of the elements of data quality. A summary outline of "Probable Sources of Error" along with a list of strategies for reducing errors are examples of the author's consistently practical approach to his topic.

The difficulty that many novice GIS users and map customers have in grasping the significance of data resolution, accuracy, and scale for analysis and mapping is something that GIS practitioners and cartographers are all too familiar with. Many geographic analysis projects have deteriorated into disappointment and frustration as the real capabilities and limitations of the available data were recognized. This book brings out the distinction between data and its representation on several occasions, and repeatedly makes the point that uses of data should be constrained by the quality of the data. The idea is presented as relevant to both geospatial data and tabular attribute data, and is one of many

instances when GIS is presented as a discipline interrelated to a larger realm of information science and technology. This is a thoughtful approach not widely found in books on GIS.

Another way that Bernhardsen places GIS in context is his applied approach to the discipline. He consistently discusses issues of design, implementation, and use in terms of people using a tool. The human context is never far from the topic at hand. Throughout the book, technical matters arise as explanatory background underlying the practical applications of GIS. There is little celebration of technology and science for their own sake.

Considerable attention is given to GIS implementation issues. Two large chapters delineate the organizational and technical issues surrounding GIS acquisition and deployment. These appear to be the most carefully written chapters and reveal some of the author's conceptual foundations. In the historical background offered under "Choosing a GIS—Organizational Issues," Bernhardsen argues that GIS technology presents advantages and opportunities for applied geography questions, but that there are associated costs—both apparent and invisible—for an organization adopting new technologies and methods. Readers who have worked with large organizations trying to adopt GIS will recognize the issues and find Bernhardsen's recommendations sound. He states that GIS projects "... tend to overfocus on technology and underestimate the organizational tasks." Most veterans of IT implementation projects will readily acknowledge this and appreciate his methodical and thorough analysis of how GIS can be planned for and introduced into an organization. In the implementation discussions, he attempts to con-

solidate the more technical chapters as background for a careful examination of how one might plan, organize, implement and measure the efficacy of a GIS. A partial list of his topics includes Business Concept, Appraisal of Current Setting, Review of other GIS's, Cost/Benefit Analysis, Strategic Planning, and Data Modeling. The technical issues chapter presents such topics as Pilot Project, Request for Proposal, Contracts, and Database Maintenance.

This book succeeds in circumnavigating the world of GIS, but at the cost of overlooking some of the most important places along the way. While we are introduced to nearly every GIS-related topic one can imagine, it is apparent that compromises were made to contain the size and scope. Bernhardsen admits explicitly to having made choices, and it is this selection of what to emphasize and what to de-emphasize that is problematic.

First, there is the problem of map projections. The chapter devoted to georeferencing and coordinate systems falls short of a reasoned, clear, orderly explanation of these complicated topics. In an introductory text, one expects a methodical description of the earth and its shape, the logic of geographic coordinates, the need for map projections and grid coordinate systems, the methods employed in creating them, and some thoroughly developed examples to illustrate these concepts. Instead, Bernhardsen starts with a discussion of "continuous" and "discrete" georeferencing as types of measuring systems and then abruptly pursues a very abbreviated description of datums, map projections, and coordinate systems. Those new to geographic concepts will certainly be confused by his use of inadequately defined terms ("projection," "geo-

metrical computations," "meridian") and minimally explained concepts (the ellipsoid, local grid systems). He claims that geographic coordinates provide "... only relative ..." positions. Only after studying the context repeatedly was it apparent that this was intended to say that longitude-latitude values could not be used directly for planar calculations.

The diagrams provided with this chapter are minimal and confusing. He presents the "three groups" of map projections ("cylindrical, conical and azimuthal") in a diagram that is very difficult to interpret. The depiction of the azimuthal case is a graphic I have yet to understand. A lengthy narrative about the Universal Transverse Mercator system is offered with a graphic that fails to illustrate the method of identifying zones. Other technical and theoretical problems abound in this chapter.

The second major problem is the chapter on visualization. This is the mapping chapter, but Bernhardsen seems unsure of exactly what he wants to say about cartography. He considers "visualization" an extension of cartography through sound, imagery, animation, and text. He states that maps are often the primary product of GIS and contribute to the decision-making processes that GIS is supposed to support. Given this importance of presentation as a part of GIS, his treatment of cartography seems inadequate. He presents the basics of graphic variables and map symbology in a condensed but adequate manner, but fails to provide specific guidance on some of the challenges he identifies. He notes that color is the most frequently misused variable in mapping, but does not take this issue anywhere. He offers no remedy for a non-intuitive color sequence for classes of data. He

offers no strategy for selecting point-feature symbols.

Although "multi-media" is mentioned in this chapter there is nothing about Internet mapping. There is nothing about lithography, nothing about title, scale, or page layout, and no examples of finished, presentable maps.

The final paragraphs of this chapter reveal Bernhardsen's limited concept of cartography. He indicates that GIS is an analytical tool with "... few aesthetic capabilities," and that it is "... unable to manipulate the overall aesthetic appeal of a map" Cartography, on the other hand, is said to be an ancient, well-developed art and craft. His conception of maps as "static presentations" suggests that for Bernhardsen "cartography" is for manual paper map construction, whereas "visualization" is an extended set of presentation capabilities, some of which are drawn from cartography. I would expect many contemporary practicing cartographers and GIS practitioners to disagree. He makes no mention of the perception studies that have provided quantifiable design principles, nor of the desktop publishing software that now makes GIS data so readily available for presentation design, nor of the eagerness with which GIS vendors are developing mapping capabilities for the Internet.

Many other principles, techniques, and theories of the mapping sciences fall victim to Bernhardsen's approach to describing GIS. Photogrammetry, surveying, satellite imagery, and spatial analysis are some of the other topics laced with various shortcomings in this book. The two problems discussed above, however, are for me the key indicators of this book's principle trouble. There is no theoretical framework embracing and organizing the many topics discussed. As noted earlier, his conceptual

foundation appears to be that GIS is essentially an IT tool set, and an understanding of its components is an understanding of GIS. He devotes 154 pages to implementation issues and only 22 to geo-referencing and cartography combined.

Clearly, geo-referencing methods and map projections are fundamental to GIS. The brief treatment given this topic by Bernhardsen is especially surprising given his data orientation. Map projections are data transformation methods that affect all later spatial operations applied to the data. Cartography is another kind of data transformation method. In cartography, the outcomes of all forgoing GIS analyses are brought to life in a presentation intended to communicate, provoke, or inspire—in short, to influence in some way. A more extensive, careful treatment of such core concepts of GIS might have contributed to a unifying idea, weaving together all of the chapters, but this opportunity was missed.

This book may serve best as a general reference for IT professionals participating in GIS development and management or for business people working with GIS staff. There are moments of striking clarity as Bernhardsen describes a concept in a refreshingly non-geographic way, and this is a genuine contribution to expanding the appreciation of GIS among other disciplines. It would not serve well as a textbook or reference book for a GIS practitioner, however. It lacks a consistent, organized presentation of those core principles of geography that thread together spatial data frameworks, transformations, analyses, and presentations. Without such a unifying presentation, the book remains a catalog of GIS methodology.

*Letter from the Editor
(continued from page 1)*

our campus. Some students in my introduction to maps course have talked about mapping terrorism. There are "donation cans" scattered everywhere for surviving families of NY police and firefighters. I have seen numerous memos from our University's President reminding us of the campus' staunch policy on equal rights. I think about the potential consequences of the war in Afghanistan. It weighs heavy on my mind when I look at my 4 sons ... my two oldest 1.5 years away from age 18 ... I never had to register for the draft ... I wonder if they will? In spite of this, we move forward. We have to. So CP moves forward.

Over the past several years, under the guidance of Michael Peterson, CP enjoyed steady growth in article submissions and journal circulation. On behalf of all the members of NACIS, I would like to thank Mike for his commitment and dedication to CP. Under his leadership, CP has prospered. It is my intension to build on this prosperity, and encourage CP to grow and prosper. The members of NACIS enjoy a journal that is dedicated to issues central to cartography and geographic visualization. CP is unique when compared to other cartographic journals. Our journal is different; our journal is inclusive. We recognize the breadth of cartography, and publish papers across a wide spectrum of sub areas within cartography. Consider the current issue: we have papers on semiotics, on historical cartography, and on human perception of map symbols.

To continue this spirit of change, CP has a mostly new editorial board. With much guidance and input from the previous editor, a slate of people was assembled that represents all walks of cartography and visualization. The board includes Jim Anderson, Florida

Resources and Environmental Analysis Center, Florida State University as the returning assistant editor. Ren Vasiliev from the Department of Geography at SUNY Geneseo joins the board as book review editor. Charlie Frye from Environmental Systems Research Institute joins us as techniques editor. Jeremy Crampton from the Department of Anthropology and Geography, Georgia State University, reprises his role as online mapping editor. Jeremy began this column three years ago, and I am delighted to have him remain in that position. We have created a new position on the editorial board, that of Opinion Editor. Matthew McGranaghan from the Department of Geography, University of Hawaii-Manoa will head up this column, soliciting views and opinions on current issues from various cartographers and geo-visualization folk. Melissa Lamont from the Woods Hole Oceanographic Institution will continue as Map Library Bulletin Board Editor. The remainder of the Editorial Board include Carolyn Weiss,

Geography Division of Statistics Canada; John Krygier, Department of Geology and Geography, Ohio Wesleyan University; Aileen Buckley, Department of Geography, University of Oregon; Gary Allen, Department of Psychology, University of South Carolina; Margaret Pearce, Department of Geography, Humboldt State University; Jeremy Crampton, Department of Anthropology and Geography, Georgia State University; Sara Fabrikant, Department of Geography, University of California Santa Barbara; Robert Lloyd, Department of Geography, University of South Carolina; Elizabeth Nelson, Department of Geography, University of North Carolina-Greensboro; Michael Peterson, Department of Geography and Geology, University of Nebraska-Omaha; Janet Mersey, Department of Geography, University of Guelph; Kenneth Foote, Department of Geography, University of Colorado; Patricia Gilmartin, Department of Geography, University of South Carolina; and Matthew McGranaghan, Department of Geography, University

of Hawaii. I want to thank all of these people for agreeing to help move CP forward. I look forward to working with them over the next few years.

Lastly, no journal can prosper without solid manuscript submissions. I want to encourage you to consider CP as an outlet for your work. The editorial board has set as it's goal to have papers reviewed and returned to the authors within two months of receipt by the editor. This is a lofty goal, one which I am beginning to see become common practice. This is a good sign for CP, and for the authors of the manuscripts. I am excited to be editor of CP for the next three years, and to be working with the above cast of talented people. If you have ideas or suggestions for the editorial board to consider, please send them my way, or give me a call.

Warmest Regards,

Scott Freundschuh