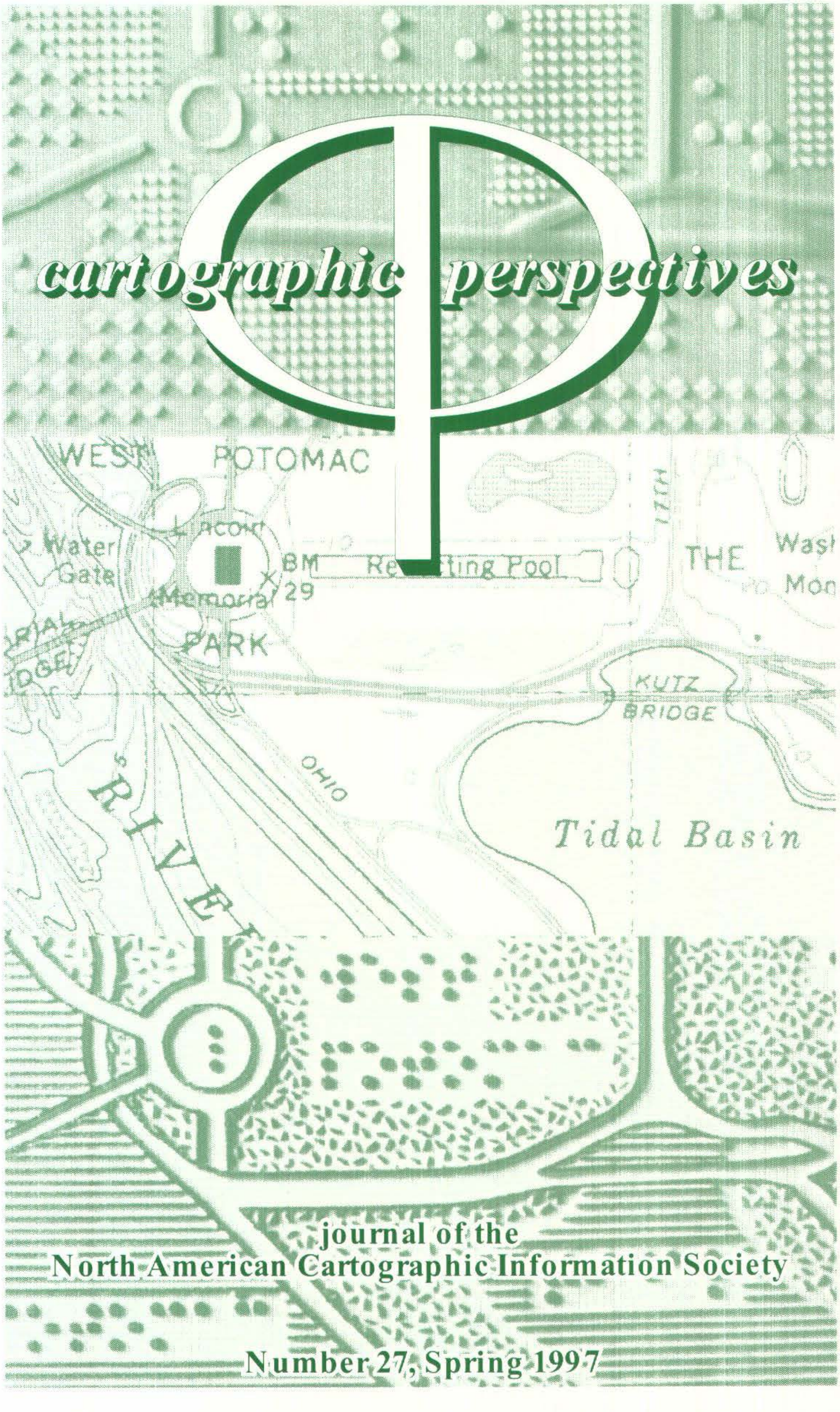
cartographic perspectives



journal of the
North American Cartographic Information Society

Number 27, Spring 1997

journal of the North American Cartographic Information Society

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Number 27, Spring 1997

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messages

FROM THE GUEST EDITORS

This particular issue of *Cartographic Perspectives* is dedicated to one of the greatest North American cartographers who passed away in October, 1996, Professor Dr. John Clinton Sherman of the Department of Geography at the University of Washington. Professor Sherman produced 15 Ph.D.'s plus numerous graduate and undergraduate students in cartography, one of the most productive and influential professors of our time. Many of his graduate and undergraduate students continued to finish their Ph.D.'s elsewhere and became influential faculty members in cartography.

NACIS is proud to dedicate this issue in honor of Dr. Sherman because of his tremendous contribution to cartography in North America. At a time when cartography was at its infancy as an academic discipline, Dr. Sherman, along with Dr. Arthur Robinson and Dr. George Jenks pivoted their roles as professors and guided the discipline to new academic heights. These three professors, along with the students they

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ISSN 1048-9085
Cartographic Perspectives
is published triannually

produced, basically shaped and influenced the directions of North American cartography today. Many of Dr. Sherman's students enthusiastically contributed articles to this issue. These articles fall into three different categories. The first category includes technical cartographic articles. The second category consists of major tributes to Dr. Sherman's career achievements and his unique and effective teaching style. Both of these categories are refereed. The third category is made up of brief articles from students' fond memories of Dr. Sherman. Even with this entire issue dedicated to Dr. Sherman, it is inadequate to fully account for his lifelong dedication to cartography, his contributions to academia, his influence on the direction of the discipline, and his unique place in the development of tactile [a.k.a. tactual] maps. The developments in tactile mapping have now become a worldwide interest with the establishment of the International Cartographic Association's Committee on Tactile Mapping. Most of the members of NACIS (if not all) have been touched one way or another by Dr. Sherman's contributions. We, the co-editors of this special issue, had the great fortune of either working with Dr. Sherman (Greg Chu's Census Mapping Workshop at Honolulu in 1978) or studying under him (Barbara Buttenfield's Ph.D. program). Greg also received his Ph.D. degree under the direction of one of Dr. Sherman's students, Everett Wingert of the University of Hawaii. It is with great pleasure that we were charged with the duties of editing this special issue in honor of a great professor, cartographer, and warm-hearted person. We also wish to thank Dr. Arthur Robinson for his contribution to this tribute, Betty Wheeler for her efforts in copy-editing, and the North American Cartographic Information Society for dedicating this issue to a special cartographer.

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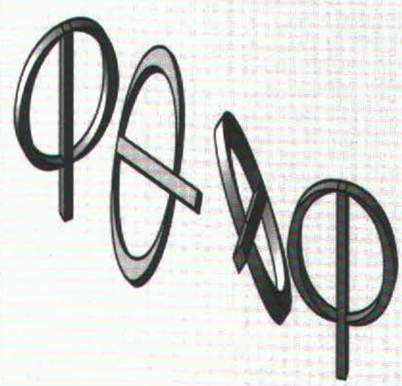
in this issue *(continued)*

about the cover



The images for the cover were supplied by Eugene Turner at the Department of Geography, University of California-Northridge. The topographic map is a portion of the 1:24,000 topo for Washington, D.C. The other two images are a standard topo with a raised tactual image embossed into it and a second version with a partially-sighted image (black and white) with a raised tactual image embossed into it. The maps were produced by John C. Sherman in a project sponsored by the U.S. Geological Survey in 1976. They were printed by the USDA and DMA-TC.

The cover design was created by Louis Cross III, a cartographer with the Florida Resources and Environmental Analysis Center at Florida State University.

Dr. John Clinton Sherman (May 3, 1916 – October 21, 1996)

A Tribute

John Sherman was a leader who played a large role in helping academic cartography become a reality in the United States. He began his teaching career in 1942 when "cartography" was an obscure term rarely used even by those who knew its meaning. An English language textbook first appeared in 1938, when it is unlikely that there were more than a half-dozen mapmaking courses in colleges and universities, and most of those would today be labeled academically unacceptable. World War II changed that profoundly. While the field burgeoned, John insisted that it must have a sound scholarly base during its period of rapid growth and technological change.

Through his own teaching and the development of a well-rounded program of instruction he made the Department of Geography at the University of Washington one of the primary centers in the United States for the emerging discipline of cartography. His promotion of the field was wide-ranging, from active advisory work for the National Atlas, the U.S. Geological Survey, and the Office of Naval Research, to hosting an institute in advanced cartography for college teachers. He was an exemplary academic representative, working closely with state, municipal, and university departments on a wide variety of projects, from atlases to road maps, that required expertise in cartographic design and production. While being the cartographic expert he found time to serve as the chair of a large and active geography department for ten years. John Sherman not only directed cartography and taught it, he practiced it. As a "freelance" cartographer he made scores of maps as illustrations in books. He was very concerned with the problem of representing the landform. However, his continuing major research interest, in which he published widely and made notable contributions, involved the design and production of maps for the partially-sighted and blind.

John was a good friend and professional colleague who was always ready to help advance the discipline. We are fortunate to have had him in our field, for he set a wonderful example in the critical years of cartography's development.

Arthur H. Robinson

Introductory Comments on Information Theory and Cartography

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Maps contain information. A method by which the amount of information contained on a map can be measured is given by Claude Shannon's theory of information (1948, 1949). The context of this work was the measurement of channel capacity required to send a message, but it provides a counting mechanism for any type of information, including symbols on a map. More recent works include Cover and Joy (1991), and Crowley and Mitchell (1994). It is necessary, however, to recognize that this important theory does not imply anything concerning the veracity or value of the information. It just measures how large a quantity of information is contained in the message or on the map. To explain this, consider the representation of phenomena that can take on several states, in the sense of cybernetics. A convenient convention is to write the number of states in the so-called binary number system, which uses only two symbols, zero and one. If there are two possible states then these can be uniquely identified by the tags 0,1. If there are four states (perhaps called A, B, C, D) these can be labeled with the four symbols 00, 01, 10, 11. Eight states (e.g., A, B, C, D, E, F, G, H) can be distinguished if one uses the eight names or labels 000, 001, 010, 011, 100, 101, 110, 111. Each state, of the eight, is thus identified by the two symbols, arranged in three positions. It can then be said that three binary digits are required to specify the eight states. The two words, ***bi**nary digi**ts**, are* usually contracted to the one term, **bits** so that a scheme of eight states is specified by three bits, one of sixteen states by four bits, and so on. Many desk top computers use a system of bytes, made up of eight bits to yield 256 possible symbols. The newer computers use 16 or 32 bits and can represent larger numbers of symbols, for example for international languages.

"The context of this work was the measurement of channel capacity required to send a message, but it provides a counting mechanism for any type of information, including symbols on a map."

The number of bits is equal to the exponent of two required to yield the necessary number of states or symbols, e.g.,

2 states = 2^1 -> 1 bit
4 states = 2^2 -> 2 bits
8 states = 2^3 -> 3 bits
16 states = 2^4 -> 4 bits
32 states = 2^5 -> 5 bits,
etc.

The bit then is a measure of the amount (not importance) of information contained in the states, in the sense that it tells one the number of symbols required to specify that state when the binary coding scheme is used. This is especially appropriate if all of the states actually occur with equal probability.

"An example would be a one decimal digit for each census tract."

One cartographic application is as follows. Suppose some census data are given as a variable that can take on several states. An example would be a one decimal digit for each census tract. There are ten decimal digits so that the number of bits would be $10 = 2^{bits}$, or taking the base two logarithms of both sides of this equation, gives $\log_2 10 = \log_2 2^{bits}$. This converts to the correct number of bits, recalling that $\log_2 2 = 1$. From a base two logarithmic table one finds that $\log_2 10 = 3.32$. Thus the number of bits of information in a single decimal digit is 3.3219. A classification into ten land use types (a nominal variable) would yield the same number (3.32) of bits. A two-digit decimal number contains more bits (6.64 or twice as many, as one would expect), and so on. The number 3.32, although it represents the information contained in a single one digit number, does not seem very informative. One would normally round this up to the next higher whole number, i.e., to four bits.

The meaning of bits can be explained somewhat further by using a cartographic example. For this example suppose that the number of possible states pertaining to some integer census data is 128, a convenient seven bits. This means that there are 128 classes into which an observation may fall. Suppose further that the cartographer produces a choropleth map from these data using only four grey levels, a convenient two bits. One interpretation is that five bits, (namely 7 bits - 2 bits = 5 bits) of information have been lost, for a compression ratio of 7/2=3.5. The calculation here uses $2^2 = 4$ (four grey levels yields a two bit map), and five bits ($2^5 = 32$) have been lost. The 128 states have been reduced to only four grey levels, and the amount of information loss is by 32 times.

"The meaning of bits can be explained somewhat further by using a cartographic example."

If there are N census tracts, and the values for each tract are independent of each other, then the measure of information for the entire data set is the number of tracts times the possible information (bit count) for each tract. If each tract can take on any of the 128 values the information contained in the data is 7 times N bits; that of the four grey level map is 2 times N bits. Another way of looking at this is to say that if there are N tracts, each of which has the possibility of taking on one of the 128 values, then there are 128^N possible data sets, and the same number of possible maps. The number of possible maps, using the four grey levels, however, is only 4^N. The actual number of maps is thus much smaller than the number of possible data sets or maps. This means that some (32 times N) data sets could not be distinguished by viewing the choropleth maps.

If, besides reducing the number of states (e.g., to four grey levels), one also combines census tracts to form M "regions", with M less than N, then the information content is reduced even further, from 7N bits to 2N bits to 2M bits.

The assumptions that (a) all states are equiprobable, and (b) that neighboring census tract states are independent of each other, are usually not true for geographical data. A consequence of (a) is that it is theoretically possible to construct more efficient codes, i.e., select a special symbol or code for frequently occurring states (Hamming, 1986). This is discussed in advanced works on information theory, e.g., Roman (1992). Morse code provides a simple textual example for the English language. The more frequently occurring letters use the simpler codes. In the choropleth example the cartographer would likely use unequal class intervals to more closely approximate the data distribution.

"The assumptions that (a) all states are equiprobable, and (b) that neighboring census tract states are independent of each other, are usually not true for geographical data."

The consequence of (b, above) is that one must consider the conditional probabilities of the states, somewhat like the fact that the letters "th" occur in combination in the English language more frequently than one would expect from the separate occurrences of these letters. Again advanced information theory covers these cases, albeit less adequately with respect to two dimensional phenomena; but see Hammer (1995).

The geographical reason for (a) is that geographical data need support: valleys (and low elevations generally) must occur more frequently than mountain tops because the latter must rest on the former. Much geographical data has this hierarchical structure. Similarly (b) occurs because geological materials cannot exceed their angle of repose: try to make a "cliff" in a pile of dry sand. Similar autocorrelation principles seem to hold for the geographic arrangements of people, income, land use, etc., although these have not, until recently, been studied as carefully. Of course this is what allows one to make contour maps from scattered observations, predicting unknown values from nearby known values. Extending the bit count to continuous images, such as elevations on a topographic map, presents additional challenges.

"Extending the bit count to continuous images, such as elevations on a topographic map, presents additional challenges."

More advanced information theoretic studies introduce the concept of entropy, which allows for expectations or probabilities of occurrence. Entropy then measures the amount of new information, beyond what was previously known. A paper by Pipkin (1975) explores this in the context of cartography, as does a discussion paper by Sheppard (1975) in the more general context of geography (also see Thomas, 1981).

It is known that the channel capacity (bits per second) of humans is not terribly large (estimates vary but it seems to be circa three bits). One interpretation in cartography has been that the number of grey levels on a choropleth map should be kept small. The foregoing equation (e.g., 7N -> 2M) shows, however, that a reduction in the number of bits can also be achieved by aggregating spatial units, or tracts. This is equivalent to reducing the spatial resolution, perhaps by differing amounts in different parts of the area. Average map resolution can be defined as the square root of the total map area divided by the number of observations, e.g., for the contiguous USA with data by state, the average resolution is circa 400 km and one cannot expect, from the sampling theorem (Jaehne, 1991, p. 45-52), to see features smaller than 800 km in size. Some have suggested that people are able to reduce the bits/second by reducing resolution when examining pictures. By squinting at a picture (or map) one can reduce the detail; this form of spatial filtering sometimes helps make the picture more understandable. Others have suggested that only the difference in grey levels from a local neighborhood are used by people in studying pictures. Since the number of different states would be expected to be less than the total possible states (by (b) above) fewer bits would be needed. Probably people are more sophisticated than this; compare Marr (1982). A black and white television set may have five bits (32 greys) or more, but one does not look at these. Instead I break the scene into "background," "face," "tree," and similar high level concepts, possibly not at a rate exceeding three bits per second. It can be expected that information theory will be useful in clarifying this and other aspects of cartography in the future. The attempts to date have emphasized the cognitive aspects of maps instead of measuring the amount of information contained therein (MacEachren, 1995, provides a good summary). An exception is in the related field of picture processing, where the bulk of the work has concentrated on image compression for electronic transmission.

"It can be expected that information theory will be useful in clarifying this and other aspects of cartography in the future."

As an exercise for students, let them calculate how many distinct images could result from a ten cm by ten cm format aerial photograph, with a crude resolution of only ten lines per millimeter (for a total of 10,000 pixels), and with 256 grey levels (8 bits) possible for each pixel. This could turn into a computer exercise, perhaps using a real digitized aerial photograph, reducing the resolution by combining pixels, or by collapsing the grey levels, and recomputing the information amount. Eventually the scene will no longer be recognizable.

REFERENCES

Cover, T. and Joy, A., 1991, *Elements of Information theory*, Wiley, New York.

Crowley, D. and Mitchell, D., 1994, *Communication Theory Today*, Stanford U. Press, Stanford.

Hammer, E., 1995, *Logic and Visual Information*, CSLI Publications, Stanford.

Hamming, R. 1986, *Coding and Information Theory*, 2nd ed., Prentice Hall, Englewood Cliffs.

Jaehne, B., 1991, *Digital Image Processing*, Springer, Berlin, 383 pp.

MacEachren, A., 1995, *How Maps Work*, Guilford, New York.

Marr, D., 1982, *Vision*, Freeman, San Francisco.

Pipkin, J.C., 1975, "The Map as an Information Channel: Ignorance Before and After Looking at a Choropleth Map," *The Canadian Cartographer*, 12,1:80-82.

Roman, S., 1992, *Coding and Information Theory*, Springer, New York.

Shannon, C.E., 1948, "A Mathematical Theory of Communication," *Bell System Technical Journal*, 27:379-423,623-656.

Shannon, C.E., and W. Weaver, 1949, *The Mathematical Theory of Communication*, University of Illinois Press, Urbana.

Sheppard, E., 1975, *Entropy in Geography*, Discussion paper # 18, Department of Geography, Toronto.

Thomas, R., 1981, *Information Statistics in Geography*, CATMOG # 31, Norwich.

John Sherman and the Origins of GIS

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The academic career of Professor John Sherman at the University of Washington spanned a half-century during which the technology of maps and geographic information handling changed dramatically. Sherman participated directly in the development of academic cartography and through this process influenced the nature of the computer-based technology that has developed. Many of the roots of this technology can be glimpsed in his 1957 article on the multiple use of graphical materials in photographically-based cartography. This review of John Sherman's career is based as much on an archeology of his artifacts as it is on traditional textual exegesis.

Revolutions in Technology: Rooted in Things

The twentieth century can be charted as an accelerating expansion of stuff. Each decade has brought new categories of things with the industries and technologies to produce them. This century of high-tech began with the automobile and ends with the GPS wrist-watch. While the expansion of transportation and communication have built new paths for everyday life, the rates of change in the information fields have been the most dramatic, particularly in the second half of the century, the period of John Sherman's academic career. Cartography has not been immune from the overall trends in technology and development. Maps have become more and more tightly integrated into the lives of people far from the academically trained. This is a period of marvelous changes.

"Cartography has not been immune from the overall trends in technology and development."

In setting forth the remarkable changes, it is all too easy to slide into a kind of technological determinism (Feenberg 1995). The avalanche of new things, new industries and new technologies seem to be essentially inevitable. The common terminology speaks of "discoveries" like the light bulb or the transistor as if these were territories lying in some hidden landscape waiting for the explorer. The terminology of discovery actually serves to diminish the role of the inventor, because it implies that anyone similarly placed would uncover the same thing. It also reduces the importance of the specific nature of the object created, since there is a kind of Platonic ideal awaiting those able to read the shadows on the cave wall. The paths of technological change are much more complex than this simplified story. The process of innovation branches in mazes of potentiality and comes with no guarantees of success. The particular nature of things intervenes to constrain the actions of later participants.

"It will center its focus on John Sherman not because this remarkable cartographer "discovered" GIS in some kind of solitary exploit, but because the personal strengths of this gifted teacher made it possible for others to construct an expanded set of tools that became the GIS technology."

This article will chart some of the developments of cartography that served as key stages in creating the technology now identified as "geographic information systems (GIS)." It will center its focus on John Sherman, Professor of Geography at the University of Washington, not because this remarkable cartographer "discovered" GIS in some kind of solitary exploit, but because the personal strengths of this gifted teacher made it possible for others to construct an expanded set of tools that became the GIS technology. Much of the story depends on the artifacts of Sherman's cartography, the photographic materials of darkroom reproduction. Sherman's maps survive, but the final product does not testify to all the intricate gestures required to construct them. Without the skilled practitioners, the pile of negatives curl and crack, left high and dry in a digital world. Because the maps speak most directly, this article is based as much on archeology as on texts.

Theoretical Framework for History of Technology

The common understanding of the history of science places a great premium on the world of ideas. Kuhn's "paradigm shifts" (Kuhn 1962) have moved from an academic classic to the world of self-help books. While there is certainly a role for creative thinkers, the actual paths of change are a lot more complex (Usher 1954; Latour and Woolgar 1986). This paper adopts a "constructivist" approach to the study of technology and science, following the approach of the "strong program" of Barnes (1974) and Bloor (1976) as further developed by Bruno Latour (1987; 1993). To summarize, this body of research describes the close interaction between people, human organizations, material objects and scientific facts. In such mundane objects as door openers and the timing of elevator doors, there are codes of social conduct and traces of cultural values. There is no guarantee that any one of these "worlds" (the social, the political, the ideological, and so on) provides the sole explanation. And it is certainly important to remember that "things" are not necessarily subservient to ideas. Frequently, technological innovations are tied in a series of complex contingencies. This story about the origins of GIS and the role of John Sherman cannot be played out simply in some abstract world of ideas, but it must make reference to the chemical smells of darkrooms, the optical tricks of exposures and lights, and the tangible models of raised relief models and maps for the blind.

"This story about the origins of GIS and the role of John Sherman cannot be played out simply in some abstract world of ideas, . . ."

Multiple Use in Cartography

John Sherman did not produce a huge volume of traditional publications; in a complete list of his career work (Velikonja 1997) the list of maps is longer than the list of articles. A key event was the short (two and one half page) article in *Professional Geographer* with Waldo Tobler (Sherman and Tobler 1957) titled "Multiple Use Concept in Cartography." To the casual reader forty years later, some of this article would be obscure. It requires the explanations I can offer from having performed the archeological task of packing up the rooms and rooms of Sherman's cartographic materials.

"A key event was the short article in Professional Geographer with Waldo Tobler titled 'Multiple Use Concept in Cartography'."

The term "multiple use" is connected to the justifications used to support hydroelectric power projects. Certainly the Pacific Northwest of forty years ago saw these dams as the kind of progress portrayed in Woody Guthrie's songs, not with the perspective of dwindling salmon stocks that now dominate the public debate. A few years after this paper appeared, the "Land of Many Uses" signs appeared around National Forests, following the revised enabling act (The Multiple Use-Sustained Yield Act (76 Stat. 215) adopted in 1960). So, Sherman and Tobler positioned cartography in the context of the kind of political discourse used at the time to justify public investment. It connected to the cost-benefit methods and operations-research logistics developed during World War II, though with no explicit references nor ponderous exposition. The paper argues that cartography, when all its little steps were taken into account, amounted to a large effort.

"The paper argues that cartography, when all its little steps were taken into account, amounted to a large effort."

The multiple use concept is not presented directly with graphic examples; it is actually referenced to some published and unpublished maps produced at the University of Washington. The "medium and small scale maps" for which this technique was originally applied were most likely the Washington State 1:500,000 produced by the US Geological Survey. Lying in a neatly crafted box, deep in a pile of Sherman's materials, I found a large (2 m by 1.5 m) poster display taken to some conferences in this period. It shows how the graphic materials used to produce the USGS state map can be reused to produce other presentations. The readership of *Professional Geographer* were expected to have seen these displays, perhaps.

In addition, the article says: "the concept has proven of equal validity for large-scale (engineering type) maps (p. 6)." I have discovered an experimental series of positive and negative graphical materials for a facilities inventory of the University of Washington campus illustrating this approach. Each graphic layer (labelled from A through V) holds a different class of objects (roads, wires, pipes, buildings) or the lettering for another layer. These layers were intended to be used to produce a graphic product with virtually infinite flexibility in choosing the color or grey tone of each feature. While such flexibility might seem totally obvious to a graphics professional raised with AutoCAD as a part of their cultural heritage, this was the era when the graphic materials were equated with the inks for a particular product. There was no "road" layer; some roads would be on a black plate, and others on a red plate. But, there would be no direct way to extricate the roads from the other symbols on the black plate.

"These layers were intended to be used to produce a graphic product with virtually infinite flexibility in choosing the color or grey tone of each feature."

The article defines the multiple use concept as "the complete separation of all elements (even in the case of a map to be reproduced in black and white) at the drawing stage and later selective reassembly depending on purpose (p. 6)." In Sherman's map of the University of Washington campus (first produced in 1959, but firmly based on the principles of this article), there were over forty graphic separates. For example, the buildings that had libraries are on a distinct layer since the library system required a version of the map that indicates the location of all branch libraries. While the article talks about flexibility to respond to unforeseen demands, the decisions on which elements belonged on distinct layers required substantial understanding of the content.

"While the article talks about flexibility to respond to unforeseen demands, the decisions on which elements belonged on distinct layers required substantial understanding of the content."

The multiple use concept, as expounded by Sherman and Tobler, signals a change in how cartographers positioned themselves. Instead of executing a specific design for a particular printing technology, as it had to be when there was no technology to transfer the engraving from one copper plate to another, the photographic method permitted new combinations. As with many innovations, the darkroom techniques were first used to automate the prior view of the map. The press plate translated directly to a single manuscript and negative. The new possibilities are latent until recognized and mobilized. It is important to refrain from using the word "discovered," a term that implies that the technology lies somewhere "out there" so that any mariner sailing west from Iceland will certainly encounter the same Greenland. The ways in which technical potentials could be mobilized are not so fixed or certain. There is no guarantee that other teams will do the same thing. The essential leap involved moving from the goal of reproducing a particular design to representing the attributes of features to support any design.

"As with many innovations, the darkroom techniques were first used to automate the prior view of the map."

The multiple use approach led Sherman to propose a "New Horizon" for cartography at the first full meeting of the International Cartographic Association in Stockholm (Sherman 1961a). His vision of automation was influenced by the remote sensing potentials of early weather satellites, but it also included a call for a "universal world data bank" in computer form. This proposal depended upon a number of rash assumptions about technical feasibility [that were quite clear when Sherman reflected on this later (Sherman and Turner 1987, p. 81)]. At its root, the multiple use concept was concerned with map content, not a particular optical photographic technology. Sherman's developments were intimately tied to his experience in the darkroom, but there was also a sense that he mobilized these tools for larger purposes.

"Sherman's developments were intimately tied to his experience in the darkroom, but there was also a sense that he mobilized these tools for larger purposes."

Origins of GIS

It is extremely easy to misread the past as a single track of inevitable progress from one stage to another. The story of geographic information systems is frequently recorded in this manner (Chrisman 1993). A simple chronology of developments is not enough to establish which ideas and techniques influenced others. Prior discovery does not necessarily ensure a direct influence.

Sherman's co-author on the multiple use paper was Waldo Tobler, and the paper was written when the original gang of graduate students in the Department of Geography were plotting the original campaign of what turned into the quantitative revolution. While the connection is direct, there is only the most tenuous sign of multiple use cartography in the statistically-oriented view of progress. Berry's Ph.D. thesis (Berry 1960) made an attempt to explain factor analysis as a multilayer set of maps, but the analogue does not hold, since the space in which factors operate is based on the attribute values, not any cartographic or spatial axes. This lack of connection between the Sherman cartography and the quantitative geography of the period may explain why GIS emerges from other threads (Chrisman 1997).

Sherman's view of cartography was not confined to geography. He developed and maintained strong connections to related academics, particularly in Civil Engineering at the University of Washington. Around 1960, Professor Edgar Horwood began teaching courses about geocoding and the use of computers to make maps. Sherman's students took Horwood's courses, and I have found samples of computer-produced maps from Sherman's seminar in 1961 (archive of Professor William Beyers). The fact they were of Michigan by county demonstrates the firm connection that Sherman retained with Tobler. Then a geography student, William Beyers was Horwood's assistant in giving a workshop on automated cartography at the Regional Science meetings in Chicago. The workbook produced for the event (dated January 1963) is full of the minutiae of punched cards and a software package nowhere near the polish we now expect. Of all those in attendance, it was an architect, Howard Fisher, who became motivated to take the next steps (Chrisman 1997, for more details on the connection to Harvard). The crude nature of line printer maps did not meet Sherman's demands for artwork, but he did support the adventurous explorations of the digital pioneers.

"Sherman's view of cartography was not confined to geography."

"Of all those in attendance, it was an architect, Howard Fisher, who became motivated to take the next steps."

Perhaps the most direct connections between Sherman's multiple use concept and the development of GIS comes in the tangible products of cartographic production. The last sentence of the 1957 article talks about the more rapid completion of mapping for the whole country. Through his efforts supporting the Topographic Division at the US Geological Survey (Sherman 1961b), the National Research Council's Cartography Panel, and the series of proposals for a National Institute of Cartography (Sherman and Heath 1959; Sherman 1969), Sherman promoted his approach to separations. While it is difficult to alter existing programs, this method was adopted in the 1970s for the 1:100,000 series. Feature separates (and the consequent ease of digital scanning) was a key reason that

"Perhaps the most direct connections between Sherman's multiple use concept and the development of GIS comes in the tangible products of cartographic production."

the TIGER project selected the 1:100,000 as the source for the TIGER project in the 1980s (Starr and Anderson 1991, p. 16). Perhaps the 1:100,000 series would have been designed in this way without the efforts of Sherman; perhaps a more accurate TIGER would have been developed from the 1:24,000 series. But, given the state of scanning technology at the time, TIGER could not have been completed in time for the 1990 Census from the traditional separation plates of the 1:24,000 series. Availability of TIGER early in the transition to digital data sources provided the multiple use resource of Sherman and Tobler's vision.

CONCLUSION

John Sherman became captivated by the challenge of maps for the blind, and did not pursue the multiple use concept. Yet, the concept contributed to the evolution of cartography into its current form.

ACKNOWLEDGMENTS

The physical artifacts used for this chapter were examined through the duty of moving Sherman's collected materials out of various rooms in Smith Hall. The University of Washington Archives in the Allen Library now have the bulk of the material mentioned.

REFERENCES

Barnes, B. 1974: *Scientific Knowledge and Sociological Theory*. London: Routledge & Kegan Paul.

Berry, B. J. L. 1958: *Shopping Centers and the Geography of Urban Areas: A Theoretical and Empirical Study of the Spatial Structure of Intraurban Retail and Service Business*, unpublished Ph.D. dissertation, University of Washington.

Bloor, D. 1976: *Knowledge and Social Imagery*. London: Routledge & Kegan Paul.

Chrisman, N. R. 1993: Beyond spatio-temporal data models: A model of GIS as a technology embedded in historical context. *Proceedings Auto-Carto* 11: 23-32.

Chrisman, N. R. 1997: Academic origins of GIS. In *History of Geographic Information Systems*, ed. T.Foresman. London: Taylor & Francis.

Feenberg, A. 1995: Subversive rationalization: Technology, power and democracy. In *Technology and the Politics of Knowledge*, eds. A. Feenberg and A. Hannay. Bloomington: Indiana University Press, 3-22.

Kuhn, T. 1962: *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.

Latour, B. 1987: *Science in Action*. Cambridge Massachusetts: Harvard University Press.

Latour, B. 1993: *We Never Were Modern*. Cambridge Massachusetts: Harvard University Press.

Latour, B. and Woolgar, S. 1986: *Laboratory Life: The Construction of Scientific Facts*. Princeton NJ: Princeton University Press, 2nd edition.

Sherman, J. and Tobler, W. 1957: The multiple use concept in cartography. *Professional Geographer* 9(5): 5-7.

Sherman, J. C. 1961a: New horizons in cartography: functions, automation and presentation. *International Yearbook of Cartography* 1: 13-19.

Sherman, J. C. 1961b: Recognizing and meeting the map requirements of the population explosion in the Western United States. *Topographic Division Bulletin*. US Geological Survey.

Sherman, J. C. 1969: *The National Institute of Cartography: A Proposal*. Draft proposal National Research Council.

Sherman, J. C. and Heath, W. R. 1959: Preliminary proposal regarding a National Institute of Cartography. *Second Cartographic Conference*. Institut fur Angewandte Geodasie, Series II, no 7, 81-85.

Sherman, J. C. and Turner, E. 1987: Interview. *The American Cartographer* 14: 75-87.

Starr, L. E. and Anderson, K. E. 1991: A USGS perspective on GIS. In *Geographical Information Systems: Principles and Applications, 2* , eds. D. J. Maguire, M. F. Goodchild and D. W. Rhind. Harlow, Essex: Longman's Scientific and Technical, 11-22.

Usher, A. P. 1954: *A History of Mechanical Inventions*. Cambridge Massachusetts: Harvard Press, 2nd edition.

Velikonja, J. 1997: John C. Sherman May 3, 1916 - October 21, 1996. *Chronicle of the Department of Geography*, University of Washington 11:4-10.

John Clinton Sherman Academic Cartographer on the Brink of a New Age

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Analyzing the importance of a mentor's career from the elevated perspective of hindsight may be hopelessly presumptuous. Some of the small professional turnings indicative of a philosophical or practical approach become blurred with time and distance while others may take on a greater importance than warranted when trying to bring a long and fruitful professional life into focus.

The field of academic cartography is neither old nor mature enough to have spawned a philosopher and it may never achieve this degree of sophistication. Accelerating transitions in Remote Sensing, Geographic Information Systems (GIS), and Global Positioning Systems (GPS) in the last 20 years have transformed the field in a way that may not survive the expansion. Some of us still argue that cartography is an area apart from GIS and, although the argument may have merit, it is at best an academic argument. GIS is a technology that spreads far beyond geography and threatens to subsume cartography completely.

In the late 1950's, an academic cartography lab might have a small process camera, cast off by a local printer, in the corner of an unventilated darkroom. A few light tables, maybe a programmable calculator, and sometimes an abandoned plane table rounded out the lab. In contrast, the technological base of a current cartography program may require hundreds of thousands of dollars invested in workstation labs and software.

"John Sherman's career spanned the period from academic cartography's beginnings to the accelerating changes of the last decade."

Current GIS programs sometimes appear to be a teetering juggernaut as they force geography programs out of their traditional tracks. John Sherman's career spanned the period from academic cartography's beginnings to the accelerating changes of the last decade. His educational legacy transcends changes in the field.

The Beginnings

John Sherman did not start out as a cartographer. His Master's thesis at Clark was on the Dutch West Indies, and his Ph.D. at Washington was on the precipitation of Eastern Washington, a companion piece to Arch [Archibald] Gerlach's work on precipitation of Western Washington. Both Gerlach and Sherman continued to develop an interest in cartography.

"As a member of the Advisory Committee for the National Atlas, John played an active role in this large project from beginning to end."

The idea of a National Atlas of the United States brewed for a long time under the aegis of the American Geographical Society and other interested parties. In the early 1950's, the Association of American Geographers petitioned the National Academy of Science to form a Committee on a National Atlas. In 1961 the Committee concluded that because of the scope of the task, it should be placed in a federal agency. The United States Geological Survey (USGS) was chosen and Gerlach was loaned to the USGS by the Library of Congress to serve as editor of the project.

As a member of the Advisory Committee for the National Atlas, John played an active role in this large project from beginning to end. Under his direction, students compiled a number of maps, using these real world subjects for map design experiments, and his students still point to those pages with a sense of participation.

It's impossible in the space allotted here to summarize all of John's projects and achievements but a few were particularly important to the fulfillment of his main academic goals of cartographic education and experimental cartography. Throughout his career, John maintained a vital interest in tactual mapping and developing resources for the blind. His work with the blind began in the early 1950s and was described in the article "Maps the Blind Can See" in the 1954 *Journal of Geography.* He enlisted many students to help in this area of endeavor, and development of special maps was often a part of his courses' subject matter. He participated in many conferences on the subject and spoke at length about it to anyone who would listen.

"Throughout his career, John maintained a vital interest in tactual mapping and developing resources for the blind."

John was also interested in terrain representation, especially, shaded relief and physical models. His list of professional works includes several models for parks and one very interesting model of a part of the moon made under contract to the Boeing Company for development use in early space exploration. During this project, John and his students explored many methods of molding and casting to fit the modeled surface to the moon's shape.

His interest in outdoor activities and terrain led him to begin producing perspective hiking maps in conjunction with his wife, Helen, in the late 1950s. The Sherman name is associated with the Mountaineers and other groups for their many publications. John also illustrated many texts and research articles throughout his career.

John Sherman was very comfortable with the small experimental research and production lab. It was small enough to keep people working together and talking about each other's work. Yet, it sometimes produced innovative products. John was uncomfortable, however, with some of the philosophical trends that began in the early sixties. He was always open minded about student exploration of the range of concepts and theories that were common currency of the 1960s and '70s, but he wanted his students to first learn the graphic language that they were to research.

"John Sherman was very comfortable with the small experimental research and production lab."

A cheery "What's cookin?" started most mornings as John sailed into the lab and moved from desk to desk chatting about problems and commenting on progress. This was the way the University of Washington Cartography Lab worked in the late 1960s and early '70s. While map design and cartographic production will always be associated with John's name, both in practice and in the classroom, John also derived great satisfaction from stimulating students to bring new technologies to bear on cartographic problems.

"John also derived great satisfaction from stimulating students to bring new technologies to bear on cartographic problems."

"New" Technologies

From the beginnings of the cumbersome mainframe computers, John was very curious about the possible applications of this new technology. Led by the experiments of Waldo Tobler and others of the time, John took Fortran programming and data base development classes along with his students from Edgar Horwood, in the Planning Division of Washington's Civil Engineering Department.

Given the extremely crude output from line printers of the time, John was very interested in the rare line plotters. He was especially interested in the photographic film plotter, built by the Experimental Cartography Unit (ECU) of London's Royal College of Art. In every class after his visit to ECU, John discussed the future of the computer in cartography using the samples he obtained from ECU and from the Central Intelligence Agency's pioneering efforts in automated cartography in the early 1960s.

When John organized his 1966 National Science Foundation (NSF) Summer Institute in Advanced Cartography, Howard Fisher was among the lecturers. Fisher had developed the widely publicized SYMAP program, which was produced by the Harvard Laboratory for Computer Graphics. Fisher's acid comments about academic cartography provided the stimulus for many debates that lasted well beyond the classroom that summer.

"In the mid-1960s, John also became involved with some of the new technologies in Remote Sensing."

In the mid-1960s, John also became involved with some of the new technologies in Remote Sensing. He participated in the National Aeronautics and Space Administration (NASA) workshops that were held to help define the characteristics of the future ERTS and later LANDSAT programs. He was particularly interested in thermal imaging. At that time John, working with colleague Bill Heath, became interested in animal census possibilities using thermal sensing. The projected subject was the seal populations of the Pribolof Islands. We counted the seals from low-altitude aerial photographs but since many of the seals were at sea during the daylight hours, John thought that thermal methods might work better at night when there might be more thermal contrast between the seals and the land, so he set out to acquire the equipment for a test.

At that time the Department of Geography was co-sponsoring a Remote Sensing Conference. John managed to convince the Bendix Corporation to display one of their thermal sensing units and permit the Department to fly it before the conference to produce local data for the meetings. While a local pilot flew the sensor over Seattle, John and some of his students were at the Woodland Park Zoo, with a handheld thermal sensor, recording the temperature of the seals jumping in and out of the water of their enclosure, every time a small aircraft passed overhead.

". . . he made sure that all of the students were exposed to everything new that came along . . ."

While John did not often incorporate the new technologies into his own work, he made sure that all of the students were exposed to everything new that came along and that we had the opportunity to explore the accelerating changes in the field. In the rare times that we could pull him away from his work for coffee, John almost always had some new technique he had heard about and wanted to discuss. The main area where John applied new technology to his own work was in tactual cartography. From DyLux relief printing plates to Braille computer printers, John and his students used these technologies in preparing materials for the wide range of contacts that John maintained with blind University students and local schools for the blind.

Teaching

Even with John's interest in all manner of cartographic technology, he had other agendas. He devoted many hours each week to his students of all levels. John also hungered for the intellectual interaction of professionals whenever possible. To this end John organized and helped teach three very successful NSF Summer Institutes in Advanced Cartography that attracted students from U.S. and foreign academic ranks and from as far away as Japan and Thailand.

Knowing that the NSF Institutes were limited to occasional short summer sessions, John sought something more permanent for the education of research cartographers. For several years, he worked very hard with others in the field to establish a National Institute of Cartography. John was convinced that there was a need for this type of unit in North America with both permanent and rotating faculty and staff, but that no

John Sherman, George Jenks, and Howard Fisher with some of the participants in the 1966 NSF Institute on Advanced Cartography.

single university could afford to fund and maintain such a facility. John was not concerned about the location of the Institute, but felt certain that it should not be located in a federal agency or in Washington D.C., where its planned research focus would be diverted into training government technicians. John worked tirelessly for the Institute, often flying to Washington to lobby for its formation. In the end it was not funded. In his later years, John often spoke wistfully of his goals for such a facility and I think its loss was John's largest professional disappointment.

Teaching anyone who was interested was John's main avocation. His definition of teaching was widely defined. His door was open to all-colleagues, community members, students. He was happy to talk about cartography for hours with anyone, even when it often meant giving up class preparation time. He accumulated many stories about teaching colleagues. One of his favorite stories to tell involved a chance discussion with a noted limnologist about the research he was conducting on Western Washington lakes. While discussing the patterns of data, John suggested that the limnologist plot the data to aid in its interpretation and analysis. Grinning from ear to ear, John always ended the story by repeating the limnololgist's startled response "You mean I could make a map from my data!"

"Teaching anyone who was interested was John's main avocation."

One term we experimented with texture and symbols in prototype maps for the blind, using fabric, sandpaper, split peas, and noodles for symbols despite some amusement from people in the department who joked that we could always eat our maps if we got lost. When we completed our maps of the Seattle Center, the project was not considered finished until we met a bus load of students from a local School for the Blind at the Center. Each class member was assigned to talk with a blind student about maps and to spend an hour testing our designs in the field. We walked with the students and teachers through the Center, watched how they used our maps, and answered questions. After that session, where many of the blind students used and 'saw' their first map - indeed several maps were spirited away in lunch bags -we never quite thought of maps in the same way again. I still have the map that I made in that class and whenever I see it in the files, I spend a few quiet moments reflecting about John's teaching.

A Changing Cartography

Later in his career, Dr. Sherman devoted much time to discussing conceptual and technical progress made in the 1970s and '80s. He felt that the thousands of hours spent on psychophysical research did not improve the field of cartography enough. He felt that subjects of this type of research were often so narrowly focused that they did not make a major impact. However, we all conducted the symbol and design experiments that were popular at the time. John was particularly distressed by the deconstruction work of the '80s and '90s. He felt that any cartographer or person who understands maps knows that maps are products of the people who made them and that there is no inherent reality in a map itself. He understood that maps are made for many political agendas and he expected such understanding to be common knowledge, not a subject needing analysis by a technique borrowed from literary research.

"John simply felt that many, in their rush to embrace the technological culture of the day, forgot why we were mapping."

"He worried that, although we were making rapid strides forward, we were simultaneously taking many steps backward."

As John was ending his career, the ground swell of technology that transformed cartography into Computer Cartography then Computer Assisted Cartography and finally GIS had already affected how and what he taught. He was disgusted to hear students refer to traditional cartography as "old-fashioned cartography" and computer cartography "modern cartography" or the "new cartography." Many colleagues and students mistook these feelings for a resistance to change, but this was as far as possible from the truth. John simply felt that many, in their rush to embrace the technological culture of the day, forgot why we were mapping. He was especially troubled by the rapid digitization of any available map and the files used for maps and analysis without concern for the inherent errors in the original maps. He would shake his head when he saw data of limited accuracy digitized and enlarged to scales and applications far beyond their originally intended use. He worried that, although we were making rapid strides forward, we were simultaneously taking many steps backward.

John often joked about what he saw as one of the major impacts of the computer on cartography. We could now make badly designed and error-filled maps faster than we ever could with traditional techniques. When making thematic maps manually, staining our hands with peelcoat developer and addressing registration problems by analyzing their sources, we thought about the data and analyzed the patterns. Patterns of data on maps were very important to John.

"He was a graphics thinker."

Atlases played a large part of John's career. He often came into the classroom with a pile of atlases from his collection and we would spend many hours analyzing their content. He often spoke about a dream to make "an atlas without words." Every time he returned from a cloudless flight across the country, he again broached the subject. He was convinced that if a set of maps were properly compiled and designed, the interplay of physical and cultural patterns on the landscape could be formed into a composite data set that would tell us much more about our environment than most conventionally prepared atlases did. He was a graphics thinker.

He viewed the early "computer atlases," so common in the '70s and early '80s, as exercises in bad design. Although he was fascinated by some of the interactive digital atlases that were coming out at the end of his career, he felt that the age of thematic atlases was at an end. He was probably premature in this judgment, but he concluded that many of the well designed atlases of the past could simply not afford to be made with modern technology. John's career ended just a little too soon to see GIS technology begin to mature and to see the many forms of artistic software come on the market that give the cartographers a new set of powerful tools.

John would have been excited about the many forms of mapping tools that are being put in the hands of students, cartographers, and the general public by a new family of visualization software. At the same time, he would have been frustrated by the design defaults built into mapping software by non-cartographers. A current philosophy that often accompanies digital production would have dismayed John. He would simply not understand the oft noted idea that if you cannot make a map by computer, it's not worth doing.

The education that we had in the '60s at Washington never tied the reasons why we map to technology. Quite simply, you used the best and most efficient technology available for mapping. Terms like "computer cartography," "manual cartography," and "traditional cartography" frustrated John. A map was independent of the technology used to produce it, and the joy and excitement of mapmaking was in compilation and design. The ultimate measure of a map's success was in how it communicated ideas and information. Just making a map was not enough, a map had to show the cartographer's attention to information and detail, and every map needed to be crafted carefully to best possible product terms of clarity and graphic design.

"The ultimate measure of a map's success was in how it communicated ideas and information."

Final Reflections

If John had a mission philosophy, it was to involve students in the exploration of cartography as a mode of communication and visualization. He felt that education was never meant to be a passive process. He encouraged students to participate actively in their education, teaching themselves and their peers. He always constantly pushed us to produce the highest quality work we could and to bring every bit of imagination we could muster into making maps that would inform and educate readers. He was always very concerned about the quality of data and the accuracy of representation. And although John was an avid experimentalist, he invariably wanted us to bring things back to real world applications.

John always wanted his graduate students to know their heritage and he took every opportunity at meetings and when visitors were in Seattle to introduce us to his colleagues and to invite us to join their discussions. One of the most valuable experiences that I had as a beginning graduate student was when John invited me to join a lunch that included Erwin Raisz, Ricky Harrison, George Jenks and others at the AAG meetings in Washington, D.C. To see how these men interacted professionally and personally gave a new meaning to the term colleague.

"John's philosophy of constant experimentation and learning is his greatest legacy to all of us who had the privilege of working with him."

While John Sherman was a teacher of high stature and a cartographer whose ideas have stood the test of time, his real impact was in how he gave us all an excitement about learning and made us understand the importance and value of people's ideas. He always made sure that we separated why we were making maps from how we made them. John's philosophy of constant experimentation and learning is his greatest legacy to all of us who had the privilege of working with him.

Talking in the Tree House: Communication and Representation in Cartography

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John Sherman was a teacher. He was tireless and patient in the classroom, and always approachable for one-on-one discussions of cartography in a cluttered fifth floor office whose windows opened into the crowns of a leafy wooded quadrangle. John's office had the feel of a tree house to me, and I learned as much sitting with John in his tree house as I did in lectures or working with him in the darkroom. One day he said that cartographic representation must be based in communication. I misheard him, and asked how representation could be biased by communication. He was thoughtful for a moment, and then came that wonderful ear-to-ear grin and the comment "Well, yes, in cartography both statements are probably true".

The communication basis for representational principles in mapping is easy to demonstrate. Take the example of assessing a representation's fitness for use. Fitness for use can be established inferentially by assessing positional accuracy, attribute accuracy, logical consistency, etc. (Guptill and Morrison, 1995) Fitness for use can be established empirically by determining response time and percentage of correct answers to a specific task. In both cases, the point is to document that the represented information is communicated as the map user expects it, for a given application.

". . . to insure effective communication, cartographers might purposely introduce measurable flaws of size and shape and color, positional displacements, or textual exaggeration. . ."

Shannon and Weaver's (1963) determinist model establishes the effectiveness of a representation by measuring 'information loss in the communication channel'. In contrast, Kevin Lynch's (1960) model is behaviorist: errors in a navigational representation don't matter in the end, so long as the communicated information is 'sufficient to get a person home'. John Sherman embraced both as operable models in his lectures on compilation, symbolization, and generalization. But his perspective was humanist: to insure effective communication, cartographers might purposely introduce measurable flaws of size and shape and color, positional displacements, or texture exaggeration, in order to compensate for map readers' documented perceptual and cognitive limitations.

Clearly, John was not the first to recognize that map communication can be improved by biasing the representation strategy. A long history of literature reporting task performance studies in the very short cognitive bands (microseconds) threads back to numerous experiments by S. S. Stevens (1946). The advent of disciplines such as Cognitive Science and Human-Computer Interaction has extended studies of task performance into longer cognitive bands (seconds to minutes). The point of John's comment (that communication forms a basis and a bias in map representation) underscores the paradox of cartographic design. Communicative bias can in fact improve the effectiveness of a map representation. I didn't fully appreciate his comment then, but subsequently, I have come to realize that we cartographers are in a business of deceit. Moreover, it is our responsibility to deceive as many map users as possible, and as often as possible. No wonder John was grinning!

"I have come to realize that we cartographers are in a business of deceit."

This particular tree house talk changed direction, to consider generalization of map features. What relationships can be established between representation and communication, what biases? Generalization differs from symbolization with respect to scale; that is, the point of a generalization strategy is to carry a map representation across a range of scales, preserving either geometric information, topologic relations, or visual logic (i.e., the information by which a feature is recognized). It may help readers if I narrow the focus of my recounting to specific types of cartographic features. Three currently prioritized cartographic data themes in the United States mapping community are hydrography, terrain, and transportation (Clinton, 1994).

Traditional (manual) cartographic depictions of hydrography and terrain relied heavily upon an understanding of the underlying geographic (particularly geomorphic) processes that had formed them (e.g., Imhoff, 1982; Raisz, 1948; Pannakoek, 1962). Representational criteria were intuitive, and required a good deal of artistic talent. The objective was clear, however. Features compiled on a map at a given scale must represent the spatial processes that should be evident if one viewed the real landscape from a distance producing a view at that scale. With changing scale, different spatial processes become evident, and the criteria for feature compilation must vary accordingly. Features are represented on the map to communicate the evidence of process within a particular range of map scale.

"Features are represented on the map to communicate the evidence of process within a particular range of map scale."

As digital storage of geographic features came of age, strategies to automate feature representation drew from theories in computer science (e.g., Ballard, 1981), applied mathematics (e.g., Mandelbrot, 1982; Carpenter, 1980), and computational vision (e.g., Davis, 1980). Theoretical approaches tended to lose sight of the context of scale in developing representational strategies, although they still prioritized communication. For example, Nackman and Pizer (1985, p. 187) distinguished 'a representation' from 'a description' of an object on the basis of how much information is encapsulated and thus available for communication. "An object representation contains enough information from which to reconstruct (an approximation to) the object, while a description only contains enough information to identify an object as a member of some class of objects."

However clever our computational skills become, without acknowledgment that geometry, topology, and appearance vary across scale change, any representation strategy will be biased for some depictions. This is because a representation cannot communicate evidence of different spatial processes utilizing a single set of details over and over again. Scale-dependent map compilation remains one of the most important challenges for automated cartography, is what John said. He encouraged me to work on scale-dependent bias for dissertation research (Buttenfield, 1984), and invited Tom Poiker (Peucker, 1975) to join us for computational advice and vision. John's statement was true in the late 1970's, and nearly twenty years later, it is still true, in spite of great progress by many cartographers around the world. It's a very difficult problem. I believe that John understood that, and understated it. I'm so grateful for both. It's easy to stay on a difficult path once some forward progress has been made.

"Scale-dependent map compilation remains one of the most important challenges for automated cartography, is what John said."

So here is a recollection of one tree house talk with John Sherman. It did not occur in the space of a single day, or week. It surfaced and disappeared through discussions about other topics, and led me in those and following years into the literature of fields that some would argue lie well beyond the confines of map design and generalization. My recounting of this particular tree house talk is embellished by subsequent readings (I left Seattle in 1982), and by a decade and a half of reflection, collaboration with other colleagues, and my own continued learning. What has not been embellished is my awe and affection for John's ability to let our tree house talking wander all over the place, without losing sight of the prophetic theoretical thread. His ideas have guided my research all these years; and there is much more to work through yet. Yes indeed. John Sherman was a teacher.

REFERENCES

Ballard, D.H. (1981) Strip-Trees: A Hierarchical Representation for curves. *Communications,* ACM. 24(5): 310-321.

Brady, M. (1983) Criteria for Representations of Shape. In Beck, J. & A. Rosenfeld, Eds.) Human and Machine Vision. New York: Academic Press, p.39-83.

Buttenfield, B.P. (1984) Line Structure in Graphic and Geographic Space. Unpublished Ph.D.. Dissertation, University of Washington.

Carpenter, L.C. (1980) Computer rendering of fractal curves and surfaces. *Proceedings,* ACM SIGGRAPH conference, Seattle, Washington.

Clinton, W. 1994 Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure. Executive Order 12906, Federal Register 59(71): 17671 - 17674.

Davis, L.S. (1980) Representation and Recognition of Cartographic Data. In Freeman, H. and Pieroni, G.G. (eds.) Map Data Processing. New York: Academic Press: 169-189.

Guptill, S.C. and Morrison, J. L. 1995 Elements of Spatial Data Quality. London: Elsevier.

Imhof, E. 1982 Cartographic Relief Presentation. Berlin: Walter de Gruyter.

Lynch, K. 1960 The Image of the City. Cambridge, Massachusetts: MIT Press.

Mandelbrot, B.B. (1982) The Fractal Geometry of Nature. (2nd Edition) San Francisco: W.H. Freeman.

Marr, D. (1982) Vision. W.H. Freeman and Company, San Francisco.

Nackman, L.R. & S.M. Pizer, (1985) Three-dimensional Shape Description Using the Symmetric Axis Transform I: Theory. *IEEE Transactions on Pattern Analysis and Machine Intelligence.* 7(2): 187-202.

Pannakoek, A. J. (1962) Generalization of Coastlines and Contours. *International Yearbook of Cartography,.* 2: 55-74.

Peucker, T. K. (1975) A Theory of the Cartographic Line. *Proceedings,* AUTO-CARTO II. Reston, Virginia: .508-518.

Raisz, E. J. (1948) General Cartography. New York: McGraw-Hill, Inc.

Shannon, C.E. and Weaver, W. 1963 The Mathematical Theory of Communication. Chicago: Univeristy of Illinois Press.

Stevens, S. S. 1946. On the theory of scales of measurement. *Science,.* 103: 677-680.

John Sherman's Doctoral Advisees and their Dissertations

Tobler, Waldo R. (1961) *Map Transformations of Geographic Space.*

Willberg, Calvin G. (1965) *Problems in Establishing an Automated Mapping System.*

Greenberg, Gerald L. (1968) *Map Design for Partially Seeing Students: An Investigation of White Versus Black Line Symbology.*

Meihoefer, Hans-Joachim (1968) *The Use of the Circle in Thematic Maps: A Study in Visual Perception of Cartographic Symbol.*

Kilcoyne, John R. (1972) *Pictography Symbols in Cartography: A Study of Efficiency in Map Reading.*

Vanselow, Glen (1973) *Spatial Imagery and Geographic Scale.*

Wingert, Everett A. (1973) *Potential Role of Optical Data Processing in Geo-Cartographic Spatial Analysis.*

Delucia, Alan A. (1974) *The Map Interpretation Process: Its Observation and Analysis Through the Technique of Eye Movement Recording .*

Turner, Eugene J. (1977) *The Use of Shape as a Nominal Variable on Multipattern Dot Map.*

Ogrosky III, Charles E. (1977) *The Ordinal Scaling of Point and Linear Symbols for Tactual Maps.*

Kelley, Philip S. (1977) *Information and Generalization in Cartographic Communication.*

Taketa, Richard A. (1979) *Structure and Meaning in Map Generalization .*

Hiatt, Charlette K. (1982) *The Function of Color Legibility of Linear Symbology on Maps for Partially Blind.*

Buttenfield, Barbara P. (1984) *Line Structure in Graphic and Geographic Space.*

Child, Jois C. (1984) *The Poetics of Cartography.*

John Sherman - Some Recollections

I always liked maps. I used to enjoy browsing through atlases and wondering what places were like when I would place a finger at some location. When I discovered topographic maps, I made a wall mosaic of twelve of them of an area I liked to fish and hike. So I suppose it is not surprising that when I attended college at the University of Washington in 1964 that I migrated toward the geography department which offered a number of courses in cartography.

I met John Sherman in the second class in cartography. His teaching domain was a room with soaring ceilings on the top floor of Smith Hall, one of those ivy-covered brick buildings built in the 1920s that seem to epitomize a university building. On one wall were two narrow windows which provided the only real link to the outside world. However, one had to stand on a drafting table to be able to reach the base of them.

"He had many little projects and experiments in his mind and tried to interest students in pursuing one of them."

Sherman typically wore a white, short-sleeved shirt to class and proceeded to lecture in a deep, monotonic baritone voice with a gravely quality, perhaps a result of regular smoking. Although he was not a dynamic lecturer, he projected a fascination with the use and construction of maps. When a student faced defending a proposed design for a map he would often make the comment "but did you ever stop to think about..." and then make a series of suggestions which the student hadn't really considered. He had many little projects and experiments in his mind and tried to interest students in pursuing one of them. Often he would bring unusual maps to class to encourage students to look at maps in fresh ways or at least to be aware of how their content and design reflect individual needs. These examples included a map printed on silk for use by downed military pilots, a map folded origami style so that it would snap back to a small size, a terrain model constructed of sheets of clear plastic with a contour on each level, a map printed in special inks for use under red lighting, and a map of sandpaper, noodles, and buttons for use by a blind person.

"Of the numerous topics that Sherman investigated, it was the tactual map that seemed to most occupy his time and energy."

Of the numerous topics that Sherman investigated, it was the tactual map that seemed to most occupy his time and energy. He often related the story of how a blind student had come to him in the 1950s and inquired about a campus map. It was a type of map he had never thought about before and it seemed to offer a number of challenges. So over the next few weeks he attempted to develop a map that was tactually readable and contained elements that would be useful for the mobility of a blind student. For example, features such as curbs, traffic signals, benches, large open paved areas, steps, building entrances, and distinctive ambient sounds are important to blind mobility. Tactual maps also had to be presented in a three-dimensional form and this meant they were constructed out of various bits of material much like a model. The result was a rather large map on plywood which seemed to please the student.

The first campus map was too large to be carried, and so a series of smaller maps were produced. In addition it was clear that some form of copying was necessary since considerable time was required to generate each map. Sherman eventually acquired a thermoform machine which would heat a sheet of plastic and then create a vacuum under it in order to draw it tightly against a relief model. This produced inexpensive copies of the model. A real problem with all Braille maps is that the symbol density must be greatly limited to maintain readability. Sherman was able to improve on this by laminating two sheets of plastic back to back. Symbology was on the top and Braille was on the bottom and both sides were read simultaneously with both hands.

A problem with these copies was that they had no readable text on them and Sherman reasoned that they would be more useful if sighted persons could read them as well. Furthermore he found that visual impairment may take on a variety of forms besides total blindness. Many persons have enough vision to recognize oversized symbols and so he reasoned that maps might also be designed for sighted, partially-sighted, and totally blind persons. Thus I participated in a quest for some type of material that could be used to create an image on the thermoform plastic. The material was very resistant to inks and pens, and most photosensitive coatings would not adhere to it. Eventually we achieved a little success by first exposing the material to a color-proofing material called Kwik-Cote and then vacuuming the sheet against a tactual model.

Later he devised a number of ways of using conventional drafting materials to create visual renderings of tactual images. Negatives of these were exposed to photosensitive materials that would render a raised-relief image. In some cases these were used as models and in others they were used in the thermoform machine. One offset printing plate had a particularly durable surface and also was used for Braille elevator signs in various buildings around the campus.

John Sherman was an easy-going person and very considerate of students. I never saw him lose his temper and he would apologize after occasionally saying "damn" when something went wrong. Some of us used to laugh at his embarrassment during a summer session when George Jenks was visiting. Unlike Jenks, Sherman would use the most gentle expressions.

"John Sherman was an easy-going person and very considerate of students."

In all ways John Sherman was a true gentleman. He seemed fascinated by the challenge of making the map and he wanted us to join him in his exploration of them. I think I most appreciated his insistence on thinking about the function of a map before starting to produce it. Only when a topic had been thought through would one begin to assemble the graphic marks that would eventually become a map to communicate information.

Eugene Turner
Department of Geography
California State University, Northridge

A Tribute

In the autumn of 1989 I went to Hershey, Pennsylvania to attend the meetings of the National Council for Geographic Education (NCGE). John Sherman was going to be there: he was to receive an award for teaching excellence at the college level, and I'd been asked if I would present something. Here is just a bit of what I said (which has not appeared in print previously):

"When I first was asked if I would present a paper at these sessions of the NCGE in honor of John Sherman, my immediate response was 'Of course; there is no question'. . . [a]s the panic grew, a letter appeared in the mail from Ev [Everett] Wingert suggesting some sort of coordinated effort, with a suggestion that BITNET might help coordination if only we all would use it. So I learned how to use BITNET from the Mac in my office. Along with the note, Ev sent a copy of a message from B. [Barbara]

Buttenfield in which she went on at some length about a lot of things, with a passing reference to all the principles underlying wise cartography that Sherman had so skillfully nurtured in us all. It dawned upon me that here was something of great potential I might work on, so I sent a quick BITNET note to Babs [Barbara] asking if she wouldn't just note down all those principles so I could see if what she thought they were corresponded in any way with what I thought they were. I asked Ev to do the same. There was a hidden agenda here, of course: although John Sherman was my dissertation advisor, I actually had but one course from him in my life, and I hadn't the vaguest concrete idea of what his principles for wise cartography were. Ev said he couldn't remember either. . . when I started searching out written evidence of the principles, all I found in my library was the 1961 International Yearbook of Cartography with the 'Horizons' paper in it . . . but it didn't seem to be quite what I was looking for. Only when I scanned through Gene Turner's interview with Sherman in the January 1987 The American Cartographer did I find what I sought. John's discourse there on the issues of map design read somewhat like the outline (at least in my lecture notes) for my introductory cartography course. In this I found great comfort: I did know, after all, what John had been saying in the one class I took and during all those hours in his office talking about things and stuff, and I was in fact passing the tradition along."

"Herein lies the greatest tribute I can offer to John Sherman: I was his student, my students are his students."

Now it is many years later. I am teaching more GIS and much less cartography. I continue to be careful in my classes to ensure that my students know my background and who taught me most of what I know about the creation and interpretation of maps. I use John Campbell's text in my map-reading-and-use class, and my students know who that John is and where he learned a lot of what is in that book. In short, my students are Sherman's students even though they've never had the pleasure of meeting the man. Those principles that we've found hard to articulate for so long are in fact remarkably durable as they pass through the various professorial filters and on to today's students. Herein lies the greatest tribute I can offer to John Sherman: I was his student, my students are his students.

Phil Kelley
Professor of Geography
Mankato State University

My Remembrance of John Sherman

Students are seekers, pilgrims on personal journeys of transformation. Students yearn for revelations that enlighten, insights that bring their own chaotic ideas into focus. Each student's journey is unique, though others have taken the path before. Each finds the route individually, in their own time, with their own set of companions. As pilgrims, students follow their urge to explore the deepest forest, to pursue the more difficult and confusing trails in hope of gaining the most rewarding experience. Many who would take an easier route, or hesitate to start, are swept along by the enthusiasm of the group.

But in the heart of the forest the pilgrims become lost. The trail fades and there appears no clear way through. Some retreat to the familiar paths from which they entered; some panic and are immobilized by fear;

others blunder repeatedly down dead ends into thickets and bogs. Eventually the tired pilgrims chance upon a guide, a master they understand to be the guru of their pilgrimage, and eagerly ask him to show them the way out of the woods. Patiently, the guide explains that he, too, is lost, but has been there longer and so already knows many of the brambles and dead ends. "I cannot point you to the way out," he says, "but working together we will avoid the hazards and discover the rewarding paths."

John Sherman knew that the destination is often much like the journey. He knew that only by revealing himself as a seeker would the students who so urgently sought answers of him become continual learners capable of creating answers themselves. He understood that the manner in which a journey proceeds greatly affects its conclusion, and so he was reliably optimistic, kind, and patient. He quickly grasped the essence of a student's quest and walked with him or her for a while as a fellow pilgrim until the student recognized how to continue alone.

John never mistook learning for being taught. He seldom answered questions directly, but rather helped me reshape and hone a question until avenues toward explanation were revealed. He conveyed confidence in my ability to find a goal without his constant help. He made it clear that learning was my responsibility; while his as a teacher was to provide some basic tools to work with, occasional guidance when the thickets became impenetrable, and most importantly, an enthusiastic audience to witness my progress.

"John never mistook learning for being taught."

His greatest gift to his students was to offer each one the opportunity to re-draw their maps of themselves, to create a map on which each of us is at once a student, teacher, seeker, guide in a land where the past is never completely forgotten and the future is always brimming with opportunity. Many of us who learned from him carry such maps in our minds. When the issues are contentious, the questions baffling, the risks worrisome, when hope dims as the forest closes in, we bring out that map and consult it anew and find it again delightfully revealing.

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Tribute

My memories of John Sherman are vivid and fond. When I first met him, in 1951, he was a young faculty member in the Geography Department at the University of Washington. He immediately impressed me with his concern for students and his immersion in everything cartographic. His overarching goal was that his students should come to love the field as much as he did. In the early 1950s, a project to produce a City Guide map of Seattle and vicinity exemplified his approach.

"He immediately impressed me with his concern for students and his immersion in everything cartographic."

Characteristically, John insisted that the project, which he could have mounted as a strictly commercial venture, be set up to provide a professional growth opportunity for cartography students. He made certain that students were involved in design and production planning activities, besides working on the more mundane drafting and type laying activities. He also made certain that this student labor was not exploited; the $5/

hour received by the workers was quite a kingly wage in those days, especially for an undergraduate. Also, John wanted the result to be a professional looking, high-quality map, by selecting appropriate lettering styles, symbols, colors, and general layout. Although the project generally met these goals, production turned out to be a bit of a problem. He found that working with inexperienced student help was a challenge, as was using the rather primitive materials and techniques of the era.

The most difficult problems arose because we used standard pen-and-ink drafting techniques on large sheets of lightweight Strathmore paper. The finished map was large, about five by eight feet, and the drawings were drawn at a larger size to give the impression of high-quality linework without requiring the sometimes clumsy students to produce fine lines (final reduction was somewhere in the 50% range). In addition, the multiple colors required separation of the art work into several layers. When a professional lithographic firm photographed the dimensionally unstable drawings, the technician who had to register the negatives for plate-making faced an almost insurmountable task. Only John's equanimity kept the project from foundering on this potentially disastrous problem. He calmed and cajoled everyone until the problems were finally resolved. Certainly, the experience burned the need for dimensionally-stable materials into all of our minds.

"John threw himself into all of his projects with enthusiasm and always involved his students in what he was doing."

John was also certain that requiring a thorough field check of the source maps would ensure the accuracy of the final map. As it turned out, he was absolutely correct. Many errors were found in the source maps, including those from official sources, such as the city engineer's office. For example, we found underwater streets, platted but unbuilt subdivisions, and subdivisions occupying the sites of golf courses. In the end, we all had learned the value of field checking.

When the maps were finally printed and put into several permanent mountings at the airport and other key locations, they served travelers well for some years to come. This result was obtained only because of John's devotion to the project's goals.

John threw himself into all of his projects with enthusiasm and always involved his students in what he was doing. This was true whether he was devising illustrations of map projections, perfecting hill-shading techniques, or designing maps to serve the needs of those with vision impairments. He was a true exemplar of the best in cartography and a role model for us all.

John Campbell
Professor Emeritus
Department of Geography
University of Wisconsin-Parkside

Undergraduate Memories of John Sherman 1969-72

"Nevertheless, my memories of John have served me well in my own career, as a model of the qualities a professor should possess."

In my mind I can still see John Sherman walking down the fourth floor hallway of Smith Hall, wearing his seemingly never changing dark pants and white shirt, holding a lit cigarette in his right hand. Phil Muehrcke was my undergraduate advisor so I did not get to know John, then departmental chair, as well as his many graduate students did, who have contributed their recollections here. Nevertheless, my memories of John have served me well in my own career, as a model of the qualities a professor should possess.

Enthusiasm for cartography was John's first virtue. I still recall his contagious enthusiasm for map design and even for the inherently dry map intelligence class material on sources of maps. Good humor was his second wonderful personality trait. John was always friendly, cheerful, and encouraging toward students, and we hence found him very easy to talk with. This recollection is remarkable considering that I later was told that my undergraduate career at the University of Washington (UW) spanned the period immediately following his son's tragic death in Vietnam, something he never mentioned in my classes from him. Patience with students was his third great virtue. I remember John several times took the time to invite me into his cluttered office, piled high with papers, maps, books, and other cartographic treasures (to the point of being a fire hazard!) to slowly and carefully expound further upon a topic I found confusing or wanted to know more about. Interest in the cutting-edge of cartographic research was John's fourth positive quality, which was so important to his many graduate students but also to undergraduates like myself. I remember his upper division class lectures were interspersed with references to recent research and technical developments, particularly when dealing with remote sensing or tactual mapping. Indeed his design class, where we made a tactual campus map and then met with potential blind map users, was one of the most humanly rewarding events in my undergraduate years.

"Indeed his design class, where we made a tactual campus map and then met with potential blind map users, was one of the most humanly rewarding events in my undergraduate years."

I believe that a little of John's enthusiasm, kindness, and patience has rubbed off on many of us and that we are much the better for it. I know that all of us will keep his memory fondly in our hearts as we miss his kind spirit.

Jon Kimerling
Corvallis, Oregon

A Tribute

I first met John Sherman toward the end of my first tumultuous year at the University of Washington (UW) which was, to put it mildly, a debacle. Entering as a scholarship forestry student, I proceeded to flunk out twice, finding it difficult to study while also majoring in long distance athletics and mountaineering. As luck would have it, I joined a co-op where a housemate, a Geography Department major, raved about the inspiring cartography curriculum. What tiny twists of fate shape one's destiny! Soon I was enrolled in the same coursework, which led to some incredible classes in the English, Far East Studies, and Geology departments, all first-rate programs and faculty. So began my introduction to the mapping sciences and to higher education.

"This enthusiasm carried over to staff, graduate students, and students alike, resulting in a rather impressive center of cartographic excellence."

Despite his characteristic modesty, Sherman's pre-eminence as a geographer and cartographer was well known at the time, and this of course was a source of pride and inspiration for his students and colleagues. This became evident in several ways as I proceeded in my studies. For instance, his obvious enthusiasm for the subject coupled with an unusually patient, sincere demeanor, put those around him at immediate ease and created a potent environment for scholarly discourse. This enthusiasm carried over to staff, graduate students, and students alike, resulting in a rather impressive center of cartographic excellence. I found it impossible not to immerse myself in such an environment.

Another example of Dr. Sherman's zeal was the visibility he gave cartography within the geography curriculum. He articulated better than most scholars the cartographic body of knowledge and its relevance in modeling our environment and world. He effectively elevated the discipline to a legitimate subject, in contrast with the widely held, somewhat patronizing view of cartography as map drafting. It was also no small accomplishment that Sherman firmly but good-naturedly promoted his vision for the field of cartography before, during, and after the transition of the social sciences to quantitative methods.

It was in the area of cartographic relief representation that this man made the greatest impact on my schoolwork. He refused to let me relax at the completion of the usual 3-D class exercise, asking "Have you checked with Peucker on the algorithm he's working on? You might learn something there." Or, "Read what Jenks has to say on this. That's a good start." Before long I was into some rather involved research involving optical and photographic techniques, primarily to derive oblique views of a surface which could be graphically enhanced for illustration purposes. The cognitive advantages, if any, of this product versus the usual orthogonal map view could then be evaluated. Today, we are inundated in digital elevation data that with a few keystrokes can be manipulated and viewed at will, without the user ever having to think or understand much at all. I appreciate this capability and its potential pitfalls, perhaps more than most, having been schooled on the basic problem in the Sherman fashion.

"I suppose it is trite to say that John Sherman's legacy is his commitment to his students and his profession."

I suppose it is trite to say that John Sherman's legacy is his commitment to his students and his profession. To those of us who knew him as a teacher, colleague, and friend, it is remarkable to observe the far-reaching effect his life work had. On a personal level, many of the acquaintances I made in those early days have been cherished friends and professional associates ever since. Unquestionably, Sherman proteges have achieved an impressive record in their own right in academic pursuits, research, government programs, and a vastly improved cartographic design standard. The richness he brought to all of our lives will not be forgotten.

Karl Johansen
King County Geographic Information Systems (GIS) Project
Seattle, WA

Tribute to Professor Sherman

I was a student of Dr. John Sherman's primarily from 1982 through 1984. He was an institution in the Department of Geography on the fourth floor of Smith Hall at the University of Washington, and he was nearing the end of his career. As a young student studying cartography, I was eager to learn all that this great, but unimposing man could teach me about making maps. However, as I realized many years later, the most profound lessons I took with me had less to do with my education in cartography than they had to do with life.

"How can I use the knowledge I have to serve humanity?"

First of all, he always had a warm smile for his students. His face, his attitude, his gait, his mannerisms all conveyed a desire to see the best in others. This came through in the constant smile that I can still see as clearly as though he were smiling at me at this moment.

Secondly, he successfully answered the question a lot of people spend a lifetime trying to formulate. That was "How can I use the knowledge I have to serve humanity?" Dr. Sherman did this through the successful development of maps for the blind.

Last of all, an event that I witnessed in his office as I was discussing my senior thesis with him, had a strong impact on me. The phone rang and it was the department's secretary telling him that his wife, Helen, was on the line. As he apologized to me for the interruption, he picked up the phone, smiling broadly, and with unbridled affection said, "Hi Honey." Such a simple statement, yet I can still hear the love in his words as he spoke to his wife. As he clutched the receiver with his left hand, I noticed hundreds of tiny scratches on his shiny, gold wedding band, evidence that he had been married for a very long time. Judging by the way he was talking to his wife on the phone, his marriage was a commitment he not only took seriously, but embraced with happiness.

"Clearly, Dr. Sherman was a man of great character and integrity."

Clearly, Dr. Sherman was a man of great character and integrity. He always looked for the best in people, he used his knowledge of cartography to serve humanity, and he honored his marriage extraordinarily by small, ordinary acts. These very profound but simple things, in addition to the art and science of cartography, are what I learned from Professor John Sherman fifteen years ago. Now, I am no longer a cartographer. I have since become an artist, yet the things I learned from him continue to serve me well today.

Mary Stewart Aslin
B.A. with distinction in Geography, 1984
University of Washington

Recollections of John Sherman

When I arrived at the University of Washington in the fall of 1969 John Sherman was the Geography Department Chairperson. He was a busy man. In part this was due to his active intellect. His mind was full of ideas and plans. Since he was also unselfishly motivated to help others, he always seemed to be working on a series of projects, trying to finish some while nurturing others into being.

"More than anything John loved mapping."

More than anything John loved mapping. Indeed, he was "Mr. Cartography" to the Seattle region. His skill and energy were limitless when it came to convincing others of the magical powers of well-designed maps. He and [his wife] Helen tirelessly worked away evenings, weekends, and vacations in their home studio for almost no financial reward to ensure that these maps were completed. Thus, John was one of the few academic cartographers who also practiced what he taught. Much of his cartographic legacy rests in the design standards set in the maps he produced. Although most of the skill and knowledge he exhibited in these maps never got into the professional literature, his students benefited tremendously from his vast practical mapping experience.

"John was also a cartographic visionary."

John was also a cartographic visionary. He was deeply interested in theoretical and conceptual issues related to cartography. Evidence of his imagination and insight cluttered his office. He surrounded himself with research reports and one-of-a-kind map projects that he used in his teaching. John was a pioneer in nurturing the emerging field of analytical cartography. Waldo [Tobler], of course, came out of that environment. I was brought to Washington to develop a curriculum in analytical cartography. When I decided to move from Seattle to Madison after spending only four years in the Washington department, John apologized for the little time he had been able to spend with me. He assured me that when he no longer was department chair he would have the time needed to work with me to build the cartography program we had planned. But I knew that it was not to be. John's attention and energy always would be spread widely among ideas, projects, department, profession, family, and friends. Thank goodness, that was John. He was a man of grace and intellect and action.

I regret that John and I drifted apart after I left Washington. My leaving apparently was as awkward for him as it was for me. He had been a real father figure for me in a professional sense, so it felt like I was leaving home. I did always remember him as a cherished colleague and friend, however. I will miss John. And I feel particularly sad for those who will never have the chance to know this very special person as I did.

Phil Muehrcke
Madison, Wisconsin

cartography bulletin board

New Cartography and Geographic Information Systems (GIS) Lab at the University of Wisconsin-La Crosse

by Gregory Chu
Dept. of Geog./Earth Science
Univ. of Wisconsin-La Crosse

This past year, I received a National Science Foundation (NSF) ILI Equipment Grant for the amount of $38,000, a typical amount for an NSF undergraduate equipment grant. In addition, a related grant of $5,000 was provided by the Environmental Management Technical Center (EMTC) of the U.S. National Biological Survey in Onalaska, Wisconsin. These two grants with a total of $43,000 were matched by the University of Wisconsin-La Crosse (UW-L), giving a grand total of $86,000 as the budget to build a new Cartography/GIS Lab.

The primary function of this proposed lab was to allow the integration of different courses that relate to the mapping sciences into a GIS. These courses include introduction to GIS, remote sensing, aerial photo interpretation, field mapping and Global Positioning System (GPS), cartographic methods (including multimedia cartography), and advanced GIS.

At the time of writing the grant, the goal was to equip the lab with six Sun Sparc stations in a local network to run UNIX-based ARC/INFO, plus other mapping software packages. Additional peripherals would include an e-size plotter, several smaller size digitizers, and a high-quality projector. By the time that the grant money was available, serious reconsideration was given to the choice of operating systems. UNIX was the original intent, but the cost of updating UNIX operating systems, such as Solaris or Silicon Graphics, is high. The cost of an average UNIX Sun Sparc station that will run ARC/INFO is currently around $13,000. Six such machines plus the networking cost would easily add up to an amount larger than the budget of the grant. The largest difficulty, however, is the lack of UNIX systems administrative support on campus. This deficiency turned out to be the largest deciding factor in the selection of an operating system.

In October, 1996, Windows NT 4.0 debuted, and in November ARC/INFO for Windows NT 4.0 was released. This timing basically helped make the decision to go to a powerful Pentium 200 Pro server with Windows NT 4.0 as the network server. This Pentium server is configured with 128 MB of RAM, two 4-GB harddrives, CD-ROM, and a 4mm 8-GB tape backup, costing just over $8,000. A network of fifteen more Pentium Pro client machines were networked, each one having 64 MB RAM, a 4-GB harddrive, CD-ROM, and 17-inch monitor, costing $3300. This network was ultimately a lot less expensive than the UNIX network that was earlier intended. In addition, with twelve client machines in a classroom/lab setting, our class enrollment can now increase to 24, with two students sharing one machine. Our six licenses of UNIX ARC/INFO were traded in for six licenses of ARC/INFO for Windows NT 4.0.

Other peripherals that were purchased include an INFOCUS 580 projector, an Epson 720dpi color inkjet printer for 17" x 22" output, a color scanner, a digital camera, CD writer, and a 12" x 18" digitizer (in addition to the existing 36" x 48" digitizer). For GPS equipment, the idea was to get as many hand-held receivers as possible even though the accuracy would not be as good as some expensive units. Again, the aim is to have as many students use the receivers simultaneously as possible in a class field trip. Six Garmin 45 GPS units were selected for the reasons that they were inexpensive and with eight channels they are accurate to within 5 meters. Two beacon receivers and differential software were also purchased so that students may learn how to process differential corrections.

Other software acquired with this grant include ERMapper 5.5 (for Windows NT 4.0), Digital Chart of the World, ArcView 3.0, ArcScan, ArcPress, Arc/Spatial Analyst, Adobe PhotoShop, CorelDraw 7.0, WebDesigner, and TripMate (a real-time GPS route documentation software).

This new Cartography/GIS lab has been in operation for one semester now. It has served our mapping sciences courses flawlessly. The real advantage is that the Geography Department faculty members are implementing new ideas, new exercises, and new innovative approaches to teaching their classes; these new innovations would not have been possible without the new lab and this grant. Remote sensing data can now be integrated into ARC/INFO, and GPS data are also compatible. Through the Internet, our students may also have access to the EMTC, the U.S. Geological Survey, and to the Wisconsin database managed by the State Cartographer's Office in Madison. After just one semester, this new laboratory has proven to be invaluable to our curriculum and to our department. Additionally, it also attracts a lot of interest and cross-disciplinary use from Biology, Archaeology, and Business majors and faculty.

Thanks to the NSF and to the EMTC, our mapping sciences curriculum in the Department of Geography/Earth Science at the

University of Wisconsin-La Crosse has begun building the bridge into the Twenty-first Century.

reviews

Cartographic Design: Theoretical and Practical Perspectives.
Clifford H. Wood and C. Peter Keller (eds.). Chichester: John Wiley and Sons. 1996. 306 pp. Cloth, price $110.00. (ISBN: 0-471-96587-1)

Reviewed by:
Julio Rivera
Department of Geography
University of Wisconsin—Milwaukee

What has happened to cartographic design and what is its future? These are the central questions raised through *Cartographic Design: Theoretical and Practical Perspectives.* This book is an anthology of papers from the "Symposium on Cartographic Design and Research" held at the University of Ottawa in August 1994. Each chapter is a paper presented by different cartographers at the symposium and the topics represent a wide range of thought about cartographic design.

In Chapter 1, "Design: its place in cartography," the editors voice concern over the recent neglect of design as a topic in the cartographic literature. They suggest that the quantity and focus of literature on cartographic design have fluctuated over the years, and most recently have been overshadowed by the strong and growing interest in automated cartographic methods and Geographic Information Systems (GIS). The authors suggest that there is an increasing realization among professional cartographers that many non-professionals are making maps; maps which the authors contend are often inefficient and of poor aesthetic quality. It is also suggested that the technology of map creation has changed so dramatically that the design process itself has changed and is in need of examination.

Chapter 2, "Challenges and response in cartographic design," is Taylor's conference keynote address and, as such, sets the stage for the book. The author reviews a conceptual basis for cartography-based communication, formal techniques, and cognition and analysis. Taylor suggests that cartography must broaden itself beyond a paradigm of positivism into a greater variety of philosophical approaches.

In Chapter 3, "Geography and cartographic design," Krygier provides a brief review of the history of the relationship between geography and cartographic design. By use of a case study, he suggests that cartographic design and geography are linked in thought and practice based on their processes of data synthesis, research theory and philosophy, and the use of a variety of visual forms to communicate geographic ideas.

Huffman reviews some of the 'postmodern' critiques of cartography in Chapter 4, "You can't get here from there: reconstructing the relevancy of design in postmodernism." He points out that these discourses have affected design theory both in and out of cartographic circles. He articulates the view that because cartography and surrounding technologies are not politically or socially neutral, cartographic designers should be fully engaged in social issues in their communities.

Mackaness suggests in Chapter 5, "Automated cartography and the human paradigm," that the hope of automating visualization and GIS techniques by modeling previous human cartographers has not been as fruitful as previously hoped. He does, however, encourage researchers to continue. In particular, researchers should recognize that computers have altered the design process, and that any design of a new computer system should take advantage of the human elements (e.g., knowledge, skills) of its users.

In Chapter 6, "The practitioner's view? A pilot study into empirical knowledge about cartographic design," Wood and Gilhooly report the results of a pilot study of professional cartographers. Their work suggests that not only academic cartographers contribute to thinking about design, but the practitioner who makes maps influences design as well. They also suggest that cartographic design is not always based on a systematic set of rules; rather, it depends on the feelings and emotions of the designers.

Monmonier illustrates his idea of cartographic complementarity in Chapter 7, "Cartographic complementarity: Objectives, strategies, and examples." Cartographic complementarity is the practice of using additional data, features, or graphic representations to provide the cartographic audience with a more coherent representation of geographic concepts in consistent and coherent ways.

Vasconcellos discusses her research on map design for the visually impaired in Chapter 8, "Tactile mapping design and the visually impaired user." She reviews some of the specific needs of tactile map makers and users. She modifies Bertin's variables by using elevation and texture in place of variables such as color. She also stresses that tactile map design is different from traditional design because it requires feedback between map users and makers.

Anderson examines Quebec's social studies curriculum in

Chapter 9, "What does that little black rectangle mean?: Designing maps for the young elementary school child." She suggests that the curriculum represents a belief of many educators that maps are not an important form of graphic representation in their own right; rather, they are merely a medium for understanding space. Using her research on the differences in interpretation of maps by kindergartners, she suggests that cartographers must become involved with the education of the next generation of map makers and users to remain a viable profession.

Kumler and Buttenfield offer some interesting observations about gender differences in students' sketch maps in Chapter 10, "Gender differences in map reading abilities: What do we know? What can we do?" Based on preliminary results from a study they are conducting, these authors suggest that females may prefer to illustrate maps with perspective views. They offer their plan for studying this phenomenon and suggest further research into gender differences and map reading.

Vasiliev discusses design issues regarding mapping time in Chapter 11, "Design issues to be considered when mapping time." Different types of time phenomena are discussed (time as a moment, time as a period, time as a structured object, time as distance, and space as a clock). She also provides suggestions for mapping each of these concepts as points, lines, and areas.

In Chapter 12, "Re-examining the cartographic depiction of topography," Wheate reviews earlier work which suggests that shaded relief maps provide a more imageable surface, allow faster interpretation of relief surfaces, and help the map reader to structure the information. Since shaded relief is effective and can now be produced by more sophisticated tools at lower cost, Wheate concludes cartographers should use these more modern techniques and include relief shading in their work.

In Chapter 13, "Cartographic symbolization requirements for micro-computer based geographic information systems," Mersey reviews the symbolization techniques used in traditional atlases for both quantitative maps and qualitative ones. She also examines and discusses non-map content. Mersey points out that all the design techniques found in traditional atlases have been automated; however, not all software packages perform the entire range of traditional mapping functions. She cites examples such as the need to often export GIS output to illustration software to gain the desired range of design flexibility.

McGranaghan, in Chapter 14, "An experiment with choropleth maps on a monochrome LCD panel," reports the results of his study on the display of choropleth maps on LCD panels. The results suggest that maps on lighter backgrounds were read faster than those on darker backgrounds. He also suggests that although there is a faster response time, when taken in total, the differences are unlikely to "add up to a good coffee break."

In Chapter 15, "An evaluation of multivariate, quantitative point symbols for maps," Nelson and Gilmartin report their results on multivariate point symbol research. Their study examines the effectiveness of various point symbols (Chernoff faces, circles, crosses, and boxed letters) and their results suggest that Chernoff faces may not be the best choice for cartographic representation. They suggest that traditional cartographic point symbols appear to work better than Chernoff faces and recommend further research.

Lloyd, Rostkowska-Covington, and Steinke discuss two experiments in Chapter 16, "Feature matching and the similarity of maps." The studies suggest that "maps representing categorical information are judged to be more similar if they share common features and less similar if they have distinctive features." They also suggest that "categorical information not directly related to the patterns on maps also affects how similar maps are thought to be."

In Chapter 17, "An examination of the effects of task type and map complexity on sequenced and static choropleth maps," Patton and Cammack report the results of a study which examines the effects of sequenced choropleth maps and subjects' abilities to perform memory tasks. The study evaluates the effectiveness of artificially guided 'chunking' for tasks which evaluate 'what' and 'where' tasks. They found that 'what' tasks were more accurately performed with less reaction time than 'where' tasks.

Belbin briefly reviews Gestalt theory and its contribution to graphics and cartography in Chapter 18, "Gestalt theory applied to cartographic text." He discusses such elements as figure-ground, grouping, and various Gestalt 'laws' and suggests that the whole is greater than the sum of its parts. In addition to his essay, he provides a number of visual examples of Gestalt principles applied to graphics and cartography.

Muehrcke's chapter, Chapter 19, "The logic of map design," includes a wide ranging list of comments about the preceding chapters. His comments focus on the following four points. First, maps are abstract representations of our environment. Those abstractions are not necessarily 'absolute truth;' rather, they are more 'truth to scale.' Second, he suggests that care be taken to not make GIS into a system which is more real than our maps already appear. Third, map design has a dual nature in both analytical processes and intuitive (or, 'gut') processes. Finally, he suggests better education for maps users.

The real strength of the book is also its weakness. The editors have collected a truly broad set of perspectives. Within these pages, the reader moves between some very systematic approaches (Nelson and Gilmartin, Kumler and Buttenfield, McGranaghan, etc.), to more broadly philosophical ideas (Huffman and Belbin), to very practical strategies (Mersey, Monmonier). This 'big tent' approach is good for bringing out ideas. On the other hand, the variety of foci does not allow a truly detailed exploration of cartographic design. The papers tend to not be in-depth and are not conceptually integrated with each other.

To compound the issue, the authors in this volume vary in their interpretation of cartographic design. Some put forth broad theoretical statements that define design as a process which is analytical and intuitive. Other authors focus on research questions dealing with narrowly defined design elements. There does not appear to be any organization to the order of these chapters. The result is that ideas are often juxtaposed with one another, requiring the reader move between contrasts such as postmodernism, Gestalt theory, gender differences, maps and children, and feature matching.

Another problem with the book is that some of the equipment used in the studies can now be considered 'old' (monochrome LCD panels, 486 computers). Likewise, there is little mention of the influence of the World Wide Web on cartography; a venue that was just emerging at the time these papers were presented in Ottawa in 1994.

The best use for this book would be in an advanced cartographic design class or seminar (although the book price may be prohibitive for students). The chapters are each conceptually independent and all of the readings offer a number of opportunities for discussion about design in a number of contexts: communication, cognition, philosophy, aesthetics, etc. Because the book covers such a wide range of viewpoints, most of the essays are bound to raise the ire of someone in a group discussion while simultaneously pleasing someone else.

The cartographic professional may come away with a mixed evaluation. On the one hand, no startling new breakthroughs in design theory and practice are offered here. Nor is there any consensus on cartographic theory in general. On the other hand, the reader will find the chapters igniting research questions and philosophical ideas in their own minds. By reading these diverse viewpoints, readers are prompted to re-evaluate and re-consider their own theories about cartographic design. Most of the authors make clear there are a variety of questions about design which are yet unanswered, and they provoke new ones in their writings.

It is unfortunate that this book does not include any significant interaction between the chapter authors. Given the range of beliefs expressed here, it might have been interesting to have the authors critique and respond to each other. There are a number of differing points of view, but the reader is left with the idea that there is no conflict, or controversy among them. How can we discuss cartographic design without actively discussing the areas of agreement and especially disagreement amongst ourselves?

Geographic Information Systems: A Visual Approach. Bruce E. Davis. Santa Fe, NM: Onward Press, 1996. 374 pages, about 175 diagrams. Paperback. ISBN 1-566900-098-0.

Reviewed by:
Irina Vasiliev
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In this day of proliferating Geographic Information Systems (GIS) textbooks, Bruce Davis provides an interesting departure from the norm in his book, *Geographic Information Systems: A Visual Approach.* Davis teaches at the University of the South Pacific in Fiji; English is often a second language for his students and their exposure to computer technology has not been as ubiquitous as most GIS book authors expect. With these limitations in mind, Davis has written a simple handbook of GIS technology and concepts that would satisfy the novice as well as those more technologically sophisticated.

The "visual approach" used by Davis is to present each concept on two facing pages: the left page has a graphic description of the concept, and the right page explains the concept verbally and makes reference to the graphic. This format is used for all eleven chapters of the book. The book is a quick read, two afternoons at most, and I found myself looking at the graphics first and then reading the text only if I needed more explanation of the visual presentation.

The book covers all concepts necessary to understand what a geographic information system is and how it works. Chapter 1, "GIS and the Information Age," is a brief introduction to information and the need to manipulate it. Davis articulates the importance of this by stating that "Information is the heart of GIS (pages 14-15)." It is in this chapter where he discusses the concept of visualization and explains GIS organization, infrastructure, and principles.

Chapter 2, "What Does GIS Do?" briefly describes a GIS's functions: location, measurement, attribute definition, patterns and relationships, and trends. Davis provides a definition of modeling and shows how GIS is useful in this regard.

Chapter 3, "Spatial Data," discusses databases, attributes, and their manipulations. Terms such as data, information, attributes, and spatial data are defined here. Davis also describes a typical spatial database and its uses.

Chapter 4, "Raster and Vector Data," explains these two data structures, conversions between them, and their respective advantages and disadvantages. The discussion considers maps as both input and output for spatial data and display.

Chapter 5, "Topology," explains the concept of topology and its usefulness in manipulation of data containing spatial relations.

Chapter 6, "Data Entry," describes data acquisition. Several pages are devoted to remote sensing, and there is one section on digitizing and another one on database construction. Georeferencing is defined in terms of coordinate systems and map projections. Davis also presents a brief section on Global Positioning Systems and their use in data capture.

Chapter 7, "Inventory Operations," discusses extraction of basic data and information from databases, including Boolean queries, and simple coverage editing operations. Here Davis discusses measurement applications, coverage modification, dissolving, and recoding.

Chapter 8, "Basic Analysis," moves on to overlay analysis, graphic manipulation, and buffer zones. Recoding is more fully explained and used. Overlay analysis is discussed in detail, as are map algebra and matrix operations.

Chapter 9, "Advanced Analysis," discusses proximity analysis, clustering, terrain analysis, routing, and various graphic operations. This chapter starts to tie together all the previous concepts and to synthesize them for use in concrete problems, such as routing and terrain analysis.

Chapter 10, "Site Suitability and Models," applies the concepts presented in the previous chapters to a typical GIS problem: where to locate something. Here, types of GIS models, such as time-series, environmental, statistical, sensitivity, and other models are discussed.

The concluding chapter, Chapter 11, "Data Issues and Problems," addresses the fact that, without accurate data in the first place, the resulting GIS analysis is worthless. A brief glossary and an index make up the final pages of the book.

This book's strengths are its simplicity and its independence of particular GIS software. The author does an excellent job in addressing the needs of his intended audience. He explains the concepts in such a way that computers are not even needed to understand what a GIS does. This book could be used to teach a class in which all the exercises are done on paper, where students do not have access to a 'real' GIS; yet they would still gain a strong understanding of what a GIS does and how it works. This book could also be useful for schools with GIS programs, since good basic definitions of GIS concepts and methods of analysis are always welcome. In a more technologically sophisticated setting, the book should be supplemented with material applicable to the specific computer environment.

While simplicity is one of the book's strengths, it is also one of its weaknesses. In its goal for simplicity some terms lack adequate definitions. For example, the 'G' of GIS is finally linked to 'geography' on page 21, long after GIS, the acronym, has been expected to be understood. 'WYSIWIG' is referred to but is never defined, making it more difficult to understand its impact by not understanding the acronym. There is some confusion as to whether the word "data" is singular or plural. "Data is" and "data are" are used interchangeably, although Davis does address this in Chapter 3 by writing, "Technically we say 'datum is' and 'data are,' although data is commonly used as both the singular and plural form(page 59)." We do seem to be moving in the direction of "data is" and, for folks for whom English is a second language, I would think that Davis would have chosen one use and followed through with it.

These latter points, however, are minor. This book is useful to anyone interested in the basic concepts of GIS, whether a student in a GIS class or someone who is expected to quickly develop an understanding of new technology. In most university GIS lab settings, this is a good supplement to specific software manuals. For programs just starting to teach GIS, this is a good beginning text.

Raster Imagery in Geographic Information Systems.
Stan Morain and Shirley Lopez Baros, Editors. Santa Fe, New Mexico: OnWord Press, 1996. 536 pages, bw and color maps and illustrations, list of contributors, contact points, and subject index. $59.95, paper (ISBN 1-56690-097-2).

Reviewed by:
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In this book, over one hundred academics and professionals (primarily in the field of remote sensing) have come together to produce a volume illustrative of the potential for fruitful interaction between raster imagery and vector Geographic Information Systems (GIS). To justify their efforts, the editors of this book cite the increased availability and use of raster imagery in GIS problem solving and the lack of training of many GIS developers in the spectral properties of raster data. Specific goals for the book are to illustrate that "(1) raster data, especially multispectral data, have found numerous uses in vector-based GIS; (2) these raster data contain unique information about the landscapes they portray; (3) the information content can be updated frequently and economically; and (4) the hardware, software, and modeling techniques for raster data are already available for use by the GIS community (p. xviii)." With few qualifications, the editors and authors of *Raster Imagery in Geographic Information Systems* have achieved the stated objectives.

To achieve the above stated goals, the editors have organized the book into two major sections. The first section, comprised of Chapters 1-4, is a primer on the basic concepts of raster imagery. The main topics are "Image Formation and Raster Characteristics," "Image Display and Processing for GIS," "Using Scanned Aerial Photographs," and "Data Collection Systems, Formats, and Products." The editors have assumed that the readers of this book will have a minimal background in remote sensing. Therefore, the primary goal of the first four chapters is to provide the reader with a basic vocabulary and understanding of remote sensing and raster imagery concepts so that the reader can better appreciate the application of raster imagery in GIS as presented in the remainder of the book. The second section of the book, comprised of Chapters 5-9, offers a wide array of case studies in which raster imagery is presented as a central component in GIS applications. The case studies are organized as follows: Chapter 5, "Modeling Techniques," Chapter 6, "Water, Crops and Weather," Chapter 7, "Land Use and Planning," Chapter 8, "Environment and Mineral Exploration," and Chapter 9, "Forest Management." To supplement the two main sections of the volume, the book also includes the following: a 16-leaf insert with 76 color, glossy maps and illustrations; an appendix listing all 118 contributors and their affiliations; an appendix of contact points listing complete addresses for 56 of the contributors; and a detailed subject index.

In Chapter 1, "Image Formation and Raster Characteristics," Morain, Estes, Foresman, and Separr attempt to provide "a tutorial on (1) how raster data from images are created; (2) raster data property description and identification, and (3) the primary sensors and satellite systems currently being employed (p. 3)." To this end, the authors provide a very brief history of remote sensing, some basic definitions concerning data and information as viewed within the arena of information processing, and a short overview of the basic characteristics of the electromagnetic spectrum. After explaining the difference between active and passive remote sensing systems, the reader is presented with descriptions of a variety of common passive systems (electromechanical scanners, push-broom scanners, electromechanical imaging spectrometers, and solid-state imaging spectrometers). The remainder of the chapter deals with the formation and resolution characteristics of rasters.

Chapter 2, "Image Display and Processing for GIS" (written by Baros, Neville, and Messina) and Chapter 3, "Using Scanned Aerial Photographs" (by Welch and Jordan), provide very cursory explanations of the processing and preprocessing methods used in transforming digital and analog data into raster images suitable for analysis within a GIS. In both of these chapters, the authors acknowledge that a complete explanation of image processing is not possible in these brief chapters, and they suggest several sources to which the reader should turn for a more thorough treatment of the subject.

Of the first four chapters, Chapter 4, "Data Collection Systems, Formats, and Products" (by Budge and Morain), may be the most useful to the intended audience. This chapter presents, in a very straight-forward and readable manner, an outline of the primary satellite systems "currently providing operational raster data to GIS developers and modelers (p. 72)." For example, the authors provide the following information for the *Satellite Pour l'Observation de la Terre* (SPOT) system: program objectives; system characteristics (including launch dates, orbital information, and temporal resolution); sensor information (including date of operation, detectors, swath, spatial resolution, and radiometric resolution); and World Wide Web and postal addresses for information concerning commercial data available from the program. Similar information is provided for Landsat, Television and Infrared Observation Satellite (TIROS), European Resource Satellite (ERS-1), Indian Remote Sensing Satellite (IRS), and RADARSAT. The chapter concludes by describing, in detail, specific products that are available from the various organizations operating the above-mentioned satellite systems. Of course, what makes this chapter so useful is the basic understanding of remote sensing systems that the reader obtained in Chapter 1.

The remaining five chapters consist of 53 case studies. Chapter 5, "Modeling Techniques," begins with seven case studies grouped under the subheading "Economic Applications." The cases presented include studies on franchise location, calculating least-cost paths for the siting of an oil pipeline, determining tourism potential, and monitoring timber holdings for tax purposes. One innovative study (by Jensen, Huang, Graves, and Hanning) looked at the use of digitized aerial photography in the creation of accurate, large-scale digital elevation models (DEMs). The goal of this study was to develop a method for improving intervisibility analysis within urban areas. Another study (by Byrne) incorporated raster imagery into fly-throughs with the intention of allowing the viewer to visualize the impact of a highway bypass in Australia. The remaining seven cases presented in Chapter 5 come under the subheading of "Diverse Modeling Scenarios." This sub-section seems to be a catch-all for those studies that didn't fit in any other chapter. Included in this sub-section are studies showing the benefits of raster imagery when updating vector land use files, modeling vegetation distribution, and building attribute tables for raster GIS files. Two of the studies in this sub-section are clearly cartographic in nature. These studies seek to illustrate the use of raster imagery in the creation of shaded relief images with vector overlays to produce more effective map displays.

While several of the studies in Chapter 5 represent fairly cutting-edge techniques in the use of raster imagery in GIS analysis, the majority of the studies in Chapters 6, 7, 8 and 9 consist of fairly straight-forward uses of remote sensing and GIS. The techniques presented in these chapters should be familiar to anyone with a basic understanding of remote sensing or raster imagery. These case studies, however, do represent a broad range of projects, which is entirely in keeping with the stated goals of this book. That is, these studies serve to expose the reader to a wide array of geographic problems to which raster imagery and GIS can be applied.

Chapter 6, "Water, Crops, and Weather," consists of three sub-sections. Presented under the subheading "Hydrology" are case studies on the creation and maintenance of wetlands inventories, managing water resources, mapping glaciers, and monitoring irrigated water use. In the "Agriculture" sub-section, cases are presented on the use of raster imagery and remote sensing data for the monitoring of agricultural land cover, drought patterns, irrigation water use in a desert environment, and changes in irrigated land. In the final sub-section of Chapter 6, "Meteorology," raster imagery is incorporated in GIS to monitor and analyze lightning, climate data for winter road maintenance, and global atmospheric conditions.

"Land Use and Planning," Chapter 7, begins with five case studies in the area of "Landscape Analysis." In this sub-section, raster images are utilized to monitor and map land use change, to map variations of wilderness in England, to define topographic regions in Italy, and to accurately map vegetation and land use patterns in remote areas of Chile. In "Land Use/Land Cover," the reader is presented with a detailed description of procedures for carrying out a change detection study. In addition, raster imagery is used in the updating of vector land use inventories in San Diego,California; the automation of vegetation and land use mapping in the Tijuana River Watershed; and the development of a land use/land cover map for the State of Kansas. In "Urban and Regional Planning," two studies illustrate the use of raster imagery to measure and map urban growth in Katmandu and Beirut. A third study addresses the topics of inventorying and evaluating natural resources in Tamaulipas, Mexico with the goal of developing an effective regional economic plan.

In Chapter 8, "Environmental and Mineral Exploration," and Chapter 9, "Forest Management," the editors state that "case studies are presented that illustrate the growing number of ways that raster and vector data are used to approach environmental and resource exploration issues (p. 365)." Issues addressed in these two chapters include monitoring mining operations, measuring and inventorying wetlands, managing forest reserves, modeling fire behavior, and mapping biodiversity.

In the first chapter, the authors note that GIS and remote sensing "are linked at the most fundamental levels of measurement, mapping, monitoring, modeling, and management (p. 3)." Clearly, the intended purpose of much of this book is to demonstrate the linkage between GIS and remote sensing and to promote the use of raster imagery by GIS developers. Toward these goals, the editors and authors have succeeded admirably. The extensive range of applications presented in the case study chapters are sure to stimulate ideas for new projects that will incorporate raster imagery and vector GIS. In the introduction, the editors also state that "if the book serves no other purpose than to put would-be GIS developers and users into contact with those who have contributed, at least one aim of the book will have been achieved (p. xix)." It is also highly likely that this goal will be achieved. Achieving the goal, however, is not necessarily a compliment to the book. While the book presents a large array of studies, each case study is given only approximately 3.5 pages, and there is no bibliography anywhere in the book. The brevity of the reports and the lack of references are likely to leave many readers very interested in the potential applications, but unsure as to how to proceed. Therefore, the contributors may indeed receive many calls. The intended audience may have been better served with fewer studies that would have gone into greater detail.

This book represents an interesting contribution to the fields of remote sensing and GIS, particularly the latter. It is very nicely produced and reasonably priced. The color plates are especially attractive and useful. The organization is clear and the goals of the volume are straight-forward and well defined. It seems clear that this volume is intended for people with a GIS background but little experience with raster imagery. Given the technical jargon used and the brevity of the case studies, the reader will need to have at least a beginning background in GIS. The book will probably find an audience among professional GIS developers. The book could undoubtedly be used in an advanced undergraduate course in applied GIS; however, it is doubtful that this book could be the sole text for an applied GIS course. Given its reasonable cost, it could be used to supplement such a course. This reviewer recommends this book, given the understanding that it is written and intended for a fairly specific audience.

The Mapping of New Spain: Indigenous Cartography and the Maps of the *Relaciones Geograficas*. Barbara E. Mundy. Chicago: University of Chicago Press, 1996. 281 pages, illustrated. Hardbound, $39.95. (ISBN 0-226-55096-6)

Reviewed by:
Raymond Craib and D. Graham Burnett
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Wallace Stevens begins each of the five stanzas of his mesmeric poem "Sea Surface Full of Clouds" with the same line: "In that November off Tehuantepec..." What follows each time is a rich evocation of the Pacific Coast of Mexico. But while each stanza describes precisely the same view of the coast before the town, the same clouds, the same sea, no two stanzas are alike; each view of Tehuantepec is unique, each view defies the pretense of the others to have shown Tehuantepec itself.

The late sixteenth century *Nahua* painter from Tehuantepec who was given the task of painting a map of his native town to be sent back to crown geographers in the Alcazar of Madrid might well have understood the poet's frustration. What Tehuantepec should he depict? Using what symbolic system? Trained in the elaborate graphic tradition of his indigenous forebears, the Tehuantepec painter could paint the elaborate pictograms of Nahuatl, with their toponymic meanings and associated spiritual traditions. He likely knew enough of the pre-Hispanic mapping traditions that he could use the iconography of clan and lineage to depict the human geography of his community in a spatial framework that was intimately linked to local topography. At the same time, the Tehuantepec artist had a mission education and was conversant, if not literate, in Spanish. He may well have helped paint devotional images for the friars, and he had certainly picked up a fair bit of Spanish pictorial conventions.

Not to mention spatial conventions. The Tehuantepec painter watched the tail end of a spatial revolution in his land; by the late 1580s, when he was at his artistic prime, more than 90% of the total surface area of his region had been ceded to the Spaniards. The rate had accelerated dramatically over the century. A livestock economy had transformed land use and tenure systems, displacing indigenous agriculture, and the booming market was real estate. All this he would have known well, because the Tehuantepec painter who was chosen to make the map that would become Tehuantepec's response to a geographical questionnaire sent out by Phillip II, hungry for knowledge of his 'New World,' was by trade a painter of cadastral plots, the 'base maps' on which colonial scribes would write in the names of the new Spanish landlords.

The Tehuantepec painter, the creator of the fabulously seductive and syncretistic depiction of Tehuantepec in the *Relaciones Geographicas*, is anonymous. But thanks to Barbara Mundy's recent Nebenzahl prize-winning book, *The Mapping of New Spain*, he (or she) is no longer a total enigma. Nor is the map he made. The cultural, political, and artistic context in which the painters of Tehuantepec, Xalapa, and more than fifty other regions in the Spanish dominion worked are the subject of this book, which takes on a set of rich and difficult texts and succeeds admirably in evoking the complexities of a cross-cultural encounter in geographical depiction.

The Spanish officials in charge of the mapping of New Spain, Pedro de Esquivel and Lopez de Velasco, had assumed that the primary respondents to their questionnaire would be the Spanish colonists themselves. If it had been so, the responses might have been collated and published in an attempt to make the new empire visible. However, due in part to the disdain for pictorial representations held by the colonists (itself a self-conscious response to indigenous forms of representation) the Spanish settlers devoted their attention to the written responses and doled out, with some exceptions, the pictorial, chorographic, and cartographic responsibilities to local native map makers from the *Nahua* nobility. The resulting documents, palimpsests of representational strategies, are daunting symbolic fields, traced over with iconic animals, stylized trees, and trails of footprints. Mundy deciphers their many levels, and by doing so she provides a graphic portrait of the changing conceptions of reality and space among indigenous groups.

Mundy begins with the early modern Spanish context and the imperial ideology of mapping. Her opening chapter lays out the groundwork for understanding Philip's commissioning of the *relaciones* and puts particular emphasis on state centralization and formation, giving the reader an ideological context within which to place the *Relaciones Geograficas*. But the heart of Mundy's book is concerned more with the cultural implications of the *relaciones* cartographic project than with its political ramifications. By contrasting the changing styles and iconography on the maps, Mundy attempts to reconstruct how native cartographers had a command of both the "artistic conventions of their world as well as the dominant conventions of Europe."

Their images suggest they were self-conscious about their liminal place, not only between Spain and New Spain, but also between criollo and indigenous culture. They realized they were presenting their communities to the king and at the same time creating maps for their communities, mirroring the ambiguities of post-conquest life. In fact, the mapping of the community was a crucial aspect of pre-conquest life. Native map makers, nearly always from the nobility, mapped the community rather than a city or the topography. They presented not so much how a community (*alteptl*) actually was but how they envisioned it, usually in two ways: as a history and as a social structure and settlement. As Mundy puts it, the Aztec map was an historical map; that is, not structured by geometry but by society. While European maps were geometrical and represented physical space, indigenous maps were social, representing the social and human composition of space and stressing the importance of social relationships and their endurance through time.

Spanish rule gradually undermined and transformed the social and historical basis of Aztec mapping as well as indigenous notions of space and time. Indigenous maps began to change when the understanding of space held by the indigenous peoples changed, particularly as Spanish land use programs and urbanization were imposed, forcing indigenous peoples into different relationships with their surroundings. Ultimately then, the requirements for a map forced natives to comply with Spanish cultural and ideological norms regarding property, space, and landscape. Similarly, through the replacement of logographic styles with alphabetic writing, natives' ability to both represent community or communicate ideas, as well as to understand such representations, was severely limited. The Tehuantepec painter drew the maps, but the words inscribed on the fields, the words that alienated the land, were written by others.

Mundy's work nicely weaves into a cohesive whole, one meant to analyze not only the state project of mapping New Spain but also the cultural transformation it produced. She reveals, through her analysis of the maps produced, how a state project intent upon capturing the lay of the land was doomed to failure, yet at the same time could succeed in creating the object of its attention, enabling the very cultural transformation that furthered colonial rule. In the shifting signs and glyphs, the blend of landscapes and pictographs, the historian can discern the fading lights of pre-conquest cultural conceptions of space and time. Power struggles trouble the smooth surface of such maps, in which a subject people appropriates the language and tools of their oppressors in order to maintain some semblance of political autonomy and local control.

In the end, the fate of the *relaciones* has a Borjesian twist. So polyvocal were the texts that they were readable by no one. Discouraged by the haphazard responses to the questionnaire and the highly syncretistic, eclectic, and non-arithmetic maps, Lopez de Velasco put the maps into a forgotten corner. While they may not have been useful to Spain's cosmographers and kings, in Mundy's hands they provide a memorable, and at times moving glimpse into the transformation of indigenous society and the establishment of colonial rule. Such glimpses open a narrow aperture onto the moment between contact and control, between encountering space and eventually controlling a place. In that November, off Tehuantepec...

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NACIS Board Meeting
March 22, 1997
Chicago, IL

The following members of the Board were present: Officers Mike Peterson, Keith Rice, Pat Gilmartin, Sona Andrews and Craig Remington; Board Members Jeremy Crampton, Jim Anderson, Cynthia Brewer, Kathy Thorne, Tom Patterson, Joe Stoll, Glenn Pawelski, and Barbara Buttenfield; Executive Director Chris Baruth. The meeting began at 10:03 a.m. with the approval of the minutes from the San Antonio meeting.

President's Report
Mike reviewed the positions up for election to the Board. It was the wish of the Board to encourage map librarians to run for election. Sona suggested an email campaign of the membership to solicit nominations.

Vice-President's Report
Pat reported that the Call for Papers was mailed and is arranging workshops for the Lexington meeting. Ruth Rowles reported on the need to make timely reservations at the Radisson. Rooms may become scarce. The Board reviewed possible tours of Frankfort and Lexington, as well as potential opening session and banquet speakers. A motion was offered and passed to award a $100 honorarium to both the opening session and banquet speakers.

Executive Director's Report
Chris reviewed our individual membership numbers for the last three years. A second notice of renewal for 1997 was mailed. Total membership remains around 360. Sona offered a motion to replace the "institutional membership" category with "affiliate membership". Affiliate membership dues of $72 annually will allow one designated voting member, an annual subscription to *C.P.*, and two membership rate registrations at the annual meeting. The motion passed. Affiliate members will have the opportunity to profile their organization once a year in *C.P.*, link their logos to the NACIS homepage, and to participate in the annual meeting's poster session.

Membership Development
Tom Patterson volunteered to lead a membership development committee with the aid of Glenn and Jeremy. They will focus on compiling a list of government and GIS professionals for contact.

Treasurer's Report
Sona offered a detailed analysis of our revenue and expenses from the San Antonio meeting concluding that the Society made approximately $3,500. Owing to unpaid expenses for *C.P.*, all accounts had a balance of $35,441.98. The Board called upon Sona to invest a portion of these funds into certificates of deposit at her own discretion.

Future Meetings
After discussion by the Board reviewing potential sites for future meetings, Keith made a motion for Chicago, IL in 1998, Williamsburg, VA. in 1999, and a yet to be determined site, west of the Rockies, for 2000. The motion passed.

Cartographic Perspectives
The Board reviewed the current costs associated with production of *C.P.* during the period of interim editorship. Production by Jim in Tallahassee with guest editors is proceeding smoothly. Jim agreed to payment of $1,000 per issue to cover production costs. Cynthia discussed various organizational models for a cooperative effort between NACIS and other similar societies for future journals. The Board agreed that this would be an excellent topic for a panel discussion at the annual meeting.

World Wide Web
The Board discussed the contents of the website, domain name registration procedures and the selection of a webmaster. A motion to use $100 to establish the domain name, www.nacis.org, at the University of Wisconsin-Milwaukee passed. It was agreed that the purpose of the webpage should be to promote the Society, increase membership, and outline career paths and educational opportunities.

Other Business
Sona made a motion to prepare an amendment to the bylaws establishing a student director seat on the Board. The motion passed. A motion was offered in response to a funding request from the University of Victoria concerning a map preservation project. The motion failed to generate a vote. All business being addressed the meeting was adjourned at 5:48 p.m.

Submitted,
Craig Remington
NACIS Secretary

job announcement

NEW YORK, SYRACUSE 13244-1090. Syracuse University. Full time tenure-track ASSISTANT PROFESSOR appointment. PhD required or must be completed by time of appointment.

ENVIRONMENTAL-GEOGRAPHIC INFORMATION SYSTEMS SPECIALIST AND SCHOLAR with expertise in physical geography and environmental applications. Duties will include managing our Geographic Information and Analysis Laboratory. The successful candidate will be expected to teach introductory and advanced courses in GIS and environmental analysis.

Send letter of application (including a statement of research agenda and teaching interests), vitae, email address, and three letters of reference to Professor Mark Monmonier, Chair, Faculty Search Committee, Department of Geography 144 Eggers Hall. Professor Monmonier can be reached by email at mon2ier@syr.edu; fax at (315) 443-4227; or by phone at (315) 443-2605.

FEATURED PAPERS

Each issue of *Cartographic Perspectives* includes featured papers, which are refereed articles reporting original work of interest to NACIS's diverse membership. Papers ranging from theoretical to applied topics are welcome. Prospective authors are encouraged to submit manuscripts to the Editor or to the Chairperson of the NACIS Editorial Board. Papers may also be solicited by the Editor from presenters at the annual meeting and from other sources. Ideas for special issues on a single topic are also encouraged. Papers should be prepared exclusively for publication in *CP*, with no major portion previously published elsewhere. All contributions will be reviewed by the Editorial Board, whose members will advise the Editor as to whether a manuscript is appropriate for publication. Final publication decisions rest with the Editor, who reserves the right to make editorial changes to ensure clarity and consistency of style.

REVIEWS

Book reviews, map reviews, and mapping software reviews are welcome. The Editor will solicit reviews for artifacts received from publishers. Prospective reviewers are also invited to contact the Editor directly.

TECHNICAL GUIDELINES FOR SUBMISSION

Literature cited should conform to the Chicago Manual of Style, 14th ed., University of Chicago Press, Chapter 16, style "B." Examples of the correct citation form appear in the feature articles of this issue. Authors of Featured Papers should submit four printed copies of their manuscript for review directly to Dr. Michael Peterson, Chair of the *CP* Editorial Board, Department of Geography, University of Nebraska - Omaha, Omaha, Nebraska 68182. Manuscripts are reviewed by a minimum of two referees. The recommendations of the reviewers and the Chair of the *CP* Editorial Board are sent to the Editor of *CP*. The Editor will contact all authors to notify them if their paper has been accepted for publication and if revisions are necessary prior to publication. The following technical guidelines should be followed for all accepted manuscripts (these guidelines also apply to book, map, and software reviews).

Material should be submitted in digital form on 3.5" diskettes. Please send a paper copy along with the disk. Text documents processed with Macintosh software such as *WriteNow*, *WordPerfect*, *MS Word*, and *MacWrite* are preferred, as well as documents generated on IBM PCs and compatibles using *WordPerfect* or *MS Word*. ASCII text files are also acceptable.

PostScript graphics generated with *Adobe Illustrator* or *Aldus FreeHand* for the Macintosh or *Corel Draw* for DOS computers are preferred, but generic PICT or TIFF format graphics files are usually compatible as well. Manually produced graphics should be no larger than 11 by 17 inches, designed for scanning at 600 dpi resolution (avoid fine-grained tint screens). Continuous-tone photographs will also be scanned.

Materials should be sent to: Mr. James R. Anderson, Assistant Editor- *Cartographic Perspectives*, Florida Resources and Environmental Analysis Center, UCC 2200, Florida State University, Tallahassee, FL 32306-2641; (850) 644-2883, fax: (850) 644-7360; email: janderso@mailer.fsu.edu

COLOPHON

This document was desktop-published at the Florida Resources and Environmental Analysis Center, Florida State University, using Apple Macintosh computers. Word processing was accomplished primarily with *Microsoft Word 6.0* ; page layout with *PageMaker 6.0*. Graphics not rendered with *Aldus FreeHand* , *Adobe Illustrator, Corel Draw, or ATLAS*GIS* were scanned from paper originals using a desktop scanner. The *PageMaker* document was output at 2400 dpi. The bulletin was printed by offset lithography on Warren Patina 70# text stock. Text type is set in Palatino, a face designed by Herman Zapf.

The North American Cartographic Information Society (NACIS) was founded in 1980 in response to the need for a multidisciplinary organization to facilitate communication in the map information community. Principal objectives of NACIS are:

§ to promote communication, coordination, and cooperation among the producers, disseminators, curators, and users of cartographic information;

§ to support and coordinate activities with other professional organizations and institutions involved with cartographic information;

§ to improve the use of cartographic materials through education and to promote graphicacy;

§ to promote and coordinate the acquisition, preservation, and automated retrieval of all types of cartographic material;

§ to influence government policy on cartographic information.

NACIS is a professional society open to specialists from private, academic, and government organizations throughout North America. The society provides an opportunity for Map Makers, Map Keepers, Map Users, Map Educators, and Map Distributors to exchange ideas, coordinate activities, and improve map materials and map use. *Cartographic Perspectives*, the organization's Bulletin, provides a mechanism to facilitate timely dissemination of cartographic information to this diverse constituency. It includes solicited feature articles, synopses of articles appearing in obscure or non-cartographic publications, software reviews, news features, reports (conferences, map exhibits, new map series, government policy, new degree programs, etc.), and listings of published maps and atlases, new computer software, and software reviews.

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