THE MANY DIMENSIONS OF MAP USE

James R. Carter

Geography-Geology Department, Illinois State University, Normal, IL 61790 USA
jrcarter@ilstu.edu

ABSTRACT

Building on two terms as Chair of the ICA Map Use Commission, the author offers a typology of six dimensions of map use. The first dimension focuses on the users, ranging from experts with full functionality to youth with no experiences and skills to those with physical and visual disabilities. Many producers and distributors of maps are also included as users. The second examines the uses of maps, with uses discussed under four different headings. The third is the environment in which maps are used, be that environment an interactive computer, a television or a paper map in hand. The map itself imposes limitations on its utility and makes up the fourth dimension. Many maps, particularly those in series, are based on the standards established and maintained by map use communities, the fifth dimension. And sixth, consideration is given to the place of society in the practice of map use.

INTRODUCTION

In 1991 the author assumed the position of Chair of the Map and Spatial Data Use Commission of the ICA. That Commission was renewed in 1995 as the Map Use Commission. From the beginning, attempts were made to define the dimensions of map use through the work of the Commission. Although the Map Use Commission evolved into other commissions after 1999, I have continued to pursue this subject and today I offer a typology in which there are six dimensions to an understanding of how and why maps are used.

By examining map use in terms of these six dimensions a complexity of map use is revealed that should help direct future research and guide operational policies. The six dimensions and sub-dimensions are:

1 - the users of maps, be they consumers or producers
2 - the uses of maps examined from four different perspectives
3 - the environments in which maps are used
4 - the nature of the map or maps being used
5 - communities of map users who influence map design and use
6 - the societal aspects of map use and abuse

These ideas have been organized on a set of web pages where hyperlinks permit readers to jump between topics (http://www.ilstu.edu/~jrcarter/mapuse/) but this paper is organized in a linear progression.

MAP USERS

We can assume that any person who uses a map does so voluntarily--that is no one is forcing the person to use a map with the possible exception of that child in school who examines the map only to satisfy the teacher. If map users are persons who turn to maps by choice, then we know there are other persons who do not choose to use maps either because they do not know about maps, are not able to find an appropriate map when needed, or feel that maps do not give information worthy of their time. There are many reasons why someone turns to a map while another never thinks of looking at a map, or makes an overt decision to not use a map. Motivation is an important factor explaining why some persons use maps and others do not.

Literacy is a measure of a person's ability to use the written word to read and write. Numeracy is a comparable measure of the ability to use numbers, while graphicacy has been employed to refer to a person's ability to use graphic displays such as charts and maps. Most maps integrate visual displays with text and numbers, so in many cases the map user has to be literate, numerate and graphicate. Obviously, there is great variation in the skills and experience individuals bring to the use of maps. We cannot expect young persons to be effective map users if they are not literate, numerate and graphicate. On the other hand, learning to use maps is one way individuals become literate, numerate and graphicate.

The traditional map employs color and text as symbols are arrayed across space. The persons who can use such maps are likely to have no physical limitations on their ability to view and focus on the visual display. Maps can be quite detailed and complex and therefore can be difficult for some persons to use fully. Many persons have one or more disabilities which may affect their ability to use maps. In particular, persons with vision problems, including color blindness, need special accommodations to use maps. There is a world of tactile maps for those who must see with their fingers.

While we normally think of the map user as the person who views the map, there are many other ways a person or organization may use a map. The person who designs and produces a map may be doing it for a specific purpose, perhaps to make an argument or to explore spatial relationships. Likewise, a governmental agency produces maps to fulfill a mission and to modify behavior of a constituency. Similarly, a firm produces and markets maps as a commercial enterprise. It can be argued that all of these persons are map users for they are using maps to accomplish some end.

For many scholars the map is the end product of their work. In some cases many years of dedication have gone into researching the subject matter, development of the criteria for classifying data and the compilation of the information to make a map. There are many examples of these maps showing such things as vegetation patterns, ecological zones, classes of landforms, climatic regions, language groups, population migrations, and religious concentrations. The map is the instrument the author uses to codify and display his or her thoughts and findings and in many cases the public knows the map by the name of the author, i.e., the Koeppen/Geiger maps of world climate.

In a similar vein many maps are produced systematically by government agencies, private firms and universities. Such maps are the product of the organization and the success of the organization is measured in part by the production of the maps. This applies to the series of topographic maps, geologic maps, soil surveys, census maps, sailing charts, weather maps, road maps, cadastral maps, and national, regional and topical atlases to name a few such items. The organizations and the map producers within the organizations use these maps as the media to record and display their work. Most cartographers can recognize the look of the maps of many commercial firms and government agencies because their maps reflect the image they seek to convey.

Weather maps are used in many ways before they are seen by the final end user. Meteorologists plot data on maps to analyze patterns and help make forecasts. The forecasts are then plotted as maps and distributed to regional and local centers, where additional data may be integrated to revise forecasts and the maps. Television weathercasters then take the basic map data and fashion it into maps for presentation on television. In those presentations the on-camera person interacts with the map display to help present maps to the end users. In getting those maps to the end user many persons and organizations were users of maps.

While the conformal map projection of Mercator has distinct advantages for some applications and is employed in many different configurations, many persons think only of the equator-centered configuration when they hear this name. “Bucky” Fuller and Arno Peters have gotten great publicity by using the equator-centered Mercator world projection as an object of scorn while they have promoted their solutions to the ‘Mercator Problem.’

In summary, there are many users of maps in addition to the ultimate consumer of the map. The persons and organizations which conceive of, research, compile, edit, produce, catalog, and distribute maps are also users of maps. There is no simple map user for users, and non-users, are a diverse lot.

MAP USES

In a free society where persons can get access to maps of many subjects in many forms there are unlimited ways in which maps might be used. Here the concern is on how maps are used as maps--as representations of surfaces at the range of scales that define maps. This discussion approaches uses from four complementary perspectives.

Generic Uses

Many maps are designed and produced to serve very specific uses while other maps contain so much information that they are used by a variety of users for a great variety of activities. The first perspective focuses on the generic reasons why a map is designed, produced, disseminated, stored, preserved and/or viewed. Many authors before me have identified similar classifications of generic map uses.

- General reference – When we want to know where places are many of us turn to general reference maps, be those maps in an atlas, in a magazine or book, on television or on the web.
- Navigation, control and route planning - Whether we move on land, at sea, or in the air we rely heavily on maps to plan our routes, find our way, and maintain our course.
- Communication, persuasion and propaganda - Many maps are designed, produced and presented to convey a particular image or communicate a particular idea, be that of routing victims away from potential disaster, getting more people out to vote, changing images of the shape of the world, or arguing that Australia is not always at the bottom of the earth.
- Planning - Because 'where' is important, we use maps to determine where we want to do what by identifying areas subject to potential hazards, developing plans for containing problems, organizing our living space and providing services for those in need.
- Jurisdiction, Ownership, Assessment - Maps are used as legal documents showing the ownership of land and boundaries. Today efforts are being made to document on maps implicit land records as various forces fight for resources.
- Understanding Spatial Relationships - Many maps are made in the process of trying to understand how phenomena are distributed spatially, be that cholera around a water pump in London, the presence of ridges and trenches between tectonic plates, or the movement of fronts separating air masses.
- Forecasting and Warning - The weathercaster on television is but one component of the use of maps to predict the future of events that play out over the Earth's surface and that have the potential for significant damage to systems important to humans.
- Map Compilation - The making of a map in almost all cases requires the use of maps for map compilation is an iterative process and in that process a number of maps may be made as we converge on an appropriate design.
- Decoration, Collection and Investment - Maps are collected, sold and displayed simply because they are maps and many people like the appearance of a map.
- Storage of Information - The topographic maps that are produced by most countries provide a standardized inventory of features that are deemed to be important, such as boundaries, hydrography, topography, and place names. With the move towards GIS a virtual map based on the current database is the source of information, but then there is a concern to know what we knew at different times in the past—the historical record. The existence and support of map libraries is evidence of the importance of storing spatial information from the present and the past.

Map Functions

In an ICA study examining theoretical issues facing cartography Freitag (1993) focused on Map Functions, building on the work of others and argued that there are two Invariant Functions of Maps and four Variant Functions of Maps, as:

Invariant Functions of Maps:

1. Carrying information

2. Reflecting an explanation of what is there

Variant Functions of Maps:

1. Cognitively creating and/or enhancing spatial knowledge
2. Communication of spatial knowledge to the user
3. Decision support leading to action
4. Social and behavior changes related to map use

Examining map functions is an insightful perspective on map use. All of the Map Uses discussed above have these two invariant functions and the four variant functions may be found in each use depending on what the user does with the map.

Levels of Map Use

A number of cartographers have examined the levels of complexity in the use of maps. Muehrcke, et al., (2001) do not talk about levels but in terms of map reading, map analysis and map interpretation. Quoting from their text shows three distinct levels of map use.

Map Reading: "To read a map, you translate its features into a mental image of the environment . . . identify map symbols. . . The map reader must make a creative effort to translate the world of the map into an image of the real world." (ibid, 17)

Map Analysis: The goal of map analysis ". . . is to analyze and describe spatial structure and relations . . . to reduce the muddle of information of a map to some sort of order . . ." With map analysis ". . . we can . . . get more out of a map than was put into it. . . . all sorts of things--directions, distances, densities, and so on" (ibid, 213-4)

Map Interpretation: When you interpret a map ". . . you notice unusual or interesting patterns and seek explanations for them. . . Maps are springboards for the imagination, trigger devices to set you questioning and inspire you to search for answers." ". . . interpretation requires an understanding of more than maps. You must have some knowledge of the features depicted on the map." (ibid, 431-2)

Tasks and Strategies in the Use of Maps

As discussed above there are many reasons why people use maps, there are different functions in the ways maps are used and maps are used at different levels of complexity. Researchers in cartography, education and psychology have looked at the step by step processes, or the sequential tasks, that users employ when using maps. As we come to understand the tasks users go through then we can start to understand the strategies experts apply in the use of maps.

Young children are a special class of users and many researchers focus on them. Freundschuh (1990) in a study of the map tasks children can perform presents a good overview of what we know about the ability of young children to use maps. Olson (1976) focused on adults in a study of map communication using some rather simple thematic maps employing graduated circles in one case and dot maps in another case. For her study she identified three levels of tasks. (ibid, 152)

- Level One involves comparing the characteristics of individual map symbols such as shape, relative size, etc.
- Level Two involves recognizing the patterns, if any, of the grouping of symbols on the map as a whole
- Level Three involves using the map for decision making or to gain knowledge about the subject and integrate the knowledge from the map symbols with other information

She then tested the effects of two different activities on the ability of users to accomplish each of these tasks. One activity was to train the map users. The other activity was to change the appearance of the map by design of the symbols. Her prime objective was to identify ". . . how design changes or user training on a specific task *affects performance on other tasks* both at the same level and at other levels." (ibid. 153)

Map use tasks are hierarchical in that the user has to move through a lower level task before going to the next level. In controlled studies it is fairly easy to identify specific tasks, as Olson did in this study. The identification and articulation of

map use tasks is dependent on the researcher's approach to studying the subject. There are no standard map use tasks that everyone agrees on. And some researchers go beyond looking at tasks.

Lobben in an examination of navigational map reading argues that ". . . different elements of the map (and likely, different types of maps) will invoke the use of different human cognitive processes, controlled by different sections of the human brain, and require the completion of different tasks, which are approached with different strategies." (Lobben, 2004, 270) Reflecting on a survey of literature in psychology and cartography over many years she noted " . . . while some studies provide insight into the cognitive processes and strategies associated with specific map-reading tasks, many of these tasks, strategies and processes have yet to be identified and, possibly more importantly, understood. But, this understanding must begin with identification; researchers should first identify the map-reading tasks, and then the more complex job of identifying the associated strategies, and the processes may begin. In short, we must know the object of study before it can be studied." (ibid., 270-271)

These studies demonstrate that map reading is a complex operation that we still do not understand very well. We should remember that map reading is only the least complex operation compared to map analysis and map interpretation. So, if experts are relatively ignorant of the basic processes of map reading, we are even more ignorant of the more advanced processes of analysis and interpretation.

But, there are many people who use maps effectively. Rather than contend with the processes of understanding how we read maps, Muehrcke (1996) argues that "If we are really concerned about the map user, the basis for making much bigger and quicker gains is already within our grasp. We merely need to catalogue and teach the strategies practised by expert map makers and users." (ibid, 277)

THE MAP USE ENVIRONMENT

The way a person can use a map depends on the environment in which the map can be accessed and viewed. At one extreme is the traditional map printed on paper in the possession of the user. This will be a static map with information dated to the time the map was compiled. The artwork can be of high resolution with great detail and the user can pore over the map to make measurements, magnify areas, and annotate the map. At another extreme a map is flashed on the television screen in support of a news story, and within the few seconds the map is gone and not recoverable. This may have been a very current map but it was also a very ephemeral map. By contrast, a user can tune in a television weathercast and be comfortable in knowing the time the weather maps will appear and the basic format of those maps. These maps will be very current—almost real-time and in many cases animated maps of forecasted conditions to come.

With a computer on the Internet, a user can gain access to historic and current maps. In some places maps of highway traffic accessibility are displayed minute by minute, global patterns of weather are updated every few hours, and national patterns of soil moisture are updated weekly. On some sites the user can interact with a mapping program to create one or more maps of a subject of interest. In these cases the user becomes the producer and has the capability of crafting one or more maps that give greater insight into the appearance of the map. However, the user must be aware that he or she has the power to influence the appearance of the map and that the default map is not likely to be an optimal map.

With a visualization workstation, a user can interact with the data to explore spatial relationships and craft many maps. In such use environments the user is part of the system and has a high degree of interactivity with the mapping system. We can anticipate environments in which the system knows about the user and presents maps to the user that are appropriate to the tastes, interests, and skills of the user.

Not only does the Internet provide the user with an interface to maps, it also provides users access to maps that would have been unavailable before. Now many map collections have been scanned and made available online. And, the Internet facilitates the matching of a user's desires with the large world of map resources. In a wireless environment, a user with a hand-held device can gain access to maps that provide relevant map information as needed. This is as applicable to the tourist looking for a restaurant as it is to the soldier advancing toward an enemy stronghold. And the driver can look at a map display while navigating through traffic.

Indeed, the way a person can use a map depends on the environment in which the map can be viewed and used. In addition, it should be noted that the condition of the physical environment should also be considered for sometimes maps have to be viewed in bright sunlight, dim light, rolling seas, heavy traffic, turbulent weather, rain, high winds and under fire—both in a conflagration and/or military sense.

THE MAP OR MAPS BEING USED

The ability to use a map is dependent on the nature of the map. The map must be readable and the symbols distinguishable. Maps are international and therefore we might see a great variety of languages on maps. If we work in English, then we depend on geographic names to be translated, or transliterated, from the native language into English. Thus, on older maps of China we see Peking but on newer maps we see Beijing.

My interest in map use evolved from my experience of working with a map in an article showing the concentration of an atmospheric variable. As I studied the map I found many flaws in the map. (Carter, 1972) I have employed this map in comparison to another map in my teaching for three decades and have learned by student reactions what they see and do not see on the maps. (Carter, 1979)

Later a colleague approached me to help design a map to be presented as a projected slide. Referees had rejected his original map, deeming in inappropriate for a projected presentation. Following the strict guidelines of the referees, I redesigned the map to meet their standards. It took two iterations before I produced an acceptable map, but when it was done I realized the effect of appropriate design on the way the map can be used. It changed my ways of thinking about map design and use. (Carter, 1988)

Gersmehl (1985) reflected on how one of his maps had been misused and considered what he could have done to minimize the possibility of abuse. Using a conventional mapping technique, Gersmehl used a single dot to show that there was a small amount of a particular type of soil in each of a number of large, western states of the U.S. He found that subsequent map makers interpreted those single dots to be the location of large deposits of that soil type and interpreted that soil type to be a mineable resource. This tale should be required reading for anyone looking at the effects of map design on the use of the map.

Data classification is common in maps, whether it be in the selection of the contour interval, the representation of vegetation cover, soil type, road types, income levels or hazards to navigation. The image of the map will be determined in part by the way the data are classified and symbolized. Interactive thematic mapping programs normally give the user the option to select the number of classes, the criteria for defining classes and options for symbolizing those classes. Alternatively, the user can take default settings.

Recently, a group of us worked through a series of GIS-based maps trying to evaluate which sub-watersheds in a local drainage basin should receive special attention. Persons who knew the area well were surprised that in one case some sub-watersheds had been grouped into the same category as other watersheds. We then turned to the numeric data which revealed that the author of the maps had taken default options of 5 data classes broken into quantiles. Because many of the maps in that report were based on default classifications, they were not good representations of the nature of the data and thus the maps were misleading our discussions.

Indeed, the nature of the map does have an impact on how maps can be used and/or on how they will be used. It takes an insightful map user to understand what the map shows, what that map image represents and what can be read from that image.

MAP USER COMMUNITIES

In many cases the maps that are available for users are the product of a community which has set standards for the nature of the maps. There are great varieties of maps, but the great body of maps are based on the work of producers, professional societies and government agencies to see that maps are produced according to standards. These standards have evolved over time, in part because the user communities have changed the standards based in part on feedback from users.

When we look at a surface weather map we expect to find isobars and fronts. The warm, cold and stationary fronts are always symbolized the same way because over the years the weather community set some standards and producers and users live by those standards. All of the topographic maps of the world have a common look to them. Users can turn to these maps and be comfortable knowing what degrees of generalization exist on the maps and therefore what can be gained from the use of a map at a particular scale and what cannot be seen at that scale. The communities in support of nautical and aeronautical charting have an even greater need to set standards and produce maps at those standards, for nautical charts are aides to navigation and as such many people live and die by the quality of the chart and the ability of persons to use those charts. In most cases these standards are not locked in law, but exist because of the cooperation of the communities of persons producing maps for a variety of users.

The look of the map, and thus the things shown on the map, will be dictated in part by what the user expects to see on the map. When the user looks at a printed highway travel map he/she will see a rather conventional set of symbols, no matter where they are in the world. The text language of the map will vary by country, and the selection of colors will vary by producer, but the overall image will be fairly similar. In the 1990's the bicycling community of the Netherlands developed some prototype cycling maps and tested them among cyclists. Based on the feedback from users, they refined the image of bicycle maps in their country. (Elzakker, et al, 2001) Observing and measuring the usability of an item has become a common practice in industry in recent years and we should expect to see more usability studies in terms of maps.

Matching the potential map user with appropriate maps involves another community, or other communities. Maps are a significant part of the library collections of the world and because of the unique nature of maps we have persons who focus on map librarianship. One of the tasks of these persons is to protect and preserve that historical record in such a manner that it is available to those who have cause to use the maps. Equally important is the role of these persons in working with users to match users with the map or maps that meet their demands. Perhaps the map does not exist, but it takes an authority to know what does and does not exist relative to any search. There is a distinct community of map librarians and they stay connected through their professional societies and a computer listserv. I have been a part of this listserv for more than a decade and it is interesting to see how map librarians try to match users to maps. In this same mode, mention should be made of the map dealers, those persons who scour the world for maps so that they can put maps into the hands of users who want a particular map.

As we move into the more digital environments, the roles of the map user communities have been changing. Now the task may be to help the user find the appropriate files and combine those files into a useful map on a computer. Or the task may be to write good metafiles so that the user can determine the quality and scale of the data to minimize misuse of any maps that are created.

SOCIETAL IMPACTS FROM THE USE AND ABUSE OF MAPS

In the situations discussed above, the focus is on the persons who touch, view or feel the maps and are directly related to the maps. There are larger communities that benefit from the use or misuse of maps but who may be unaware that maps exist or are being used in activities that might have an affect on them.

We hear many stories in the news that have an obvious map component to them. Time and again we hear one community complain when the water body is labeled either the Persian Gulf or the Arabian Gulf on a map. In the mid-1990's a missile launch in Yugoslavia hit the Chinese Embassy and killed three ambassadors. The fault was blamed on the use of an inappropriate map. A charge of a faulty map was made a few years earlier when a low-flying aircraft cut a ski-lift cable in Italy, but that argument soon evaporated. In these cases attention is focused on the map although in many cases the map is being used as a surrogate for larger issues.

Infrastructure is thought of as those capital investments that help us become more productive and good maps and quality spatial data are part of the infrastructure of a nation, region, and community. This thinking has led to the creation of the term National Spatial Data Infrastructure, or NSDI, to refer to the systematic organization of maps and mapping in the United States. Other nations have similar concerns and there is a Global Spatial Data Infrastructure organization. With a good SDI we should expect to see intelligent decisions made about planning and resource use, understanding of the natural and social processes that lead to better predictions, warnings appropriate to the potential hazards, and proper routing of

traffic and material. Society benefits or suffers depending on the nature of our spatial data infrastructure and how we use that infrastructure.

Just as society is concerned that we can get the proper information to the right persons at the right time, society is also concerned that the wrong people cannot get certain information at certain times. Maps and spatial data have security implications and there will always be a concern as to who can have access to maps. In many countries the topographic maps of the country are readily available to the citizens but in some countries access to such maps may be tightly restricted. Maps are information and if the controllers of the information do not want that information to be made public, then access to such maps will be restricted. Such restrictions may be considered a benefit to society or an impediment to society.

When a hurricane approaches a coast the weather forecasters and emergency management people have to decide if and where the storm is likely to come ashore, the strength of the storm on landfall, the progress of the storm over land, the potential damage from the storm, and who needs to evacuate and to where people should evacuate to. To make these decisions requires a great amount of map analysis on the part of the persons making the forecasts and directing residents to prepare, evacuate or do nothing. Then the television and radio personalities have the responsibility to communicate the decisions to the public in such a way that the residents know what they should do. Of course maps will be used, whether displayed on television or described over the radio. In cases of this nature a great burden is placed on society to get it right. It is very costly to fail to evacuate people when they should move, but it is also costly to have people move when it is not necessary. A major concern is the credibility of the persons who make these forecasts and issue the commands, and the quality of their work is based heavily on maps and spatial data. Society relies on the map communities to have good spatial data and use it properly.

These examples show that many societies are affected by the use or misuse of maps and that in most cases the public is never aware of being a party to the use of maps.

SUMMARY

This paper argues there are six aspects or dimensions to the use of maps. With six dimensions it sounds like using maps is very complex, and in some ways it is. On the other hand, people have been using maps for centuries. The potential complexity was captured when Ormeling (1997, 21) wrote: ". . . we must be concerned that not only do we get the right data to the user but that the user gets the data right." To make certain the user gets the right map at the right time and is able to use that map effectively requires the integration of these all of these dimensions of map use.

REFERENCES CITED

Carter, James R., 1972, "Commentary on Mason's 'Spatial Variability of Radioactivity in the United States," *The Professional Geographer*, Vol. 24, (Feb. 1972), 77-80.

Carter, James R., 1979, "Two Maps--Many Images," *Proceedings of the American Congress on Surveying and Mapping*, 39th Annual Meeting, 1979, 153-159.

Carter, James R., 1988, "The Map Reading Environment: A Significant Factor in Cartographic Design," *The American Cartographer*, Vol. 15, No. 4, Oct. 1988, 379-85.

Elzakker, C.P.J.M. van; A.W. Simon van Leeuwen & E. Massop, 2001, "Investigations into the use of Dutch cycling maps and their results." *The Cartographic Journal*, 38(1), pp. 41-47.

Freundschuh, Scott, 1990, "Can Young Children Use Maps to Navigate?", *Cartographica*, 27(1), pp. 54-66.

Gersmehl, Phillip, 1985, "The Data, the User and the Innocent Bystander: A Parable for Map Users," *The Professional Geographer*, 37(3), pp. 329-334.

Lobben, Amy, 2004, "Tasks and Cognitive Processes Associated with Navigational Map Reading: A Review Perspective," *The Professional Geographer*, 56(2), pp. 270-81.

Muehrcke, Phillip C., 1996, "The Logic of Map Design," in Clifford H. Wood and C. Peter Keller (eds.), *Cartographic Design: Theoretical and Practical Perspectives*. New York: John Wiley & Sons, pp. 271-278.

Muehrcke, Phillip C., Juliana O. Muehrcke, A. Jon Kimerling, 2001, *Map Use: Reading, Analysis, Interpretation.* (4th ed.) Madison: J.P. Publications.

Olson, Judy M., 1976, "A Coordinated Approach to Map Communication Improvement," *The American Cartographer*, 3(2), pp. 151-159.

Ormeling, Ferjan, 1997, "Map Use Steps and Their Data Quality Requirements" *Cartographic Perspectives*, 28, pp. 21-24.

BIOGRAPHICAL SKETCH

James R. Carter, Ph.D., is Emeritus Professor of Geography, having retired in May 2005 from Illinois State University. In his academic career he taught at the University of Tennessee for many years before moving to Illinois in 1990. In addition to teaching he worked for the U.S. Geological Survey in the 1960's and served as an administrator of academic computing services at both universities where he taught. He was the Chair of the U.S. National Committee for the ICA and Chaired the Map Use Commission of the ICA for two terms, 1991-1999.