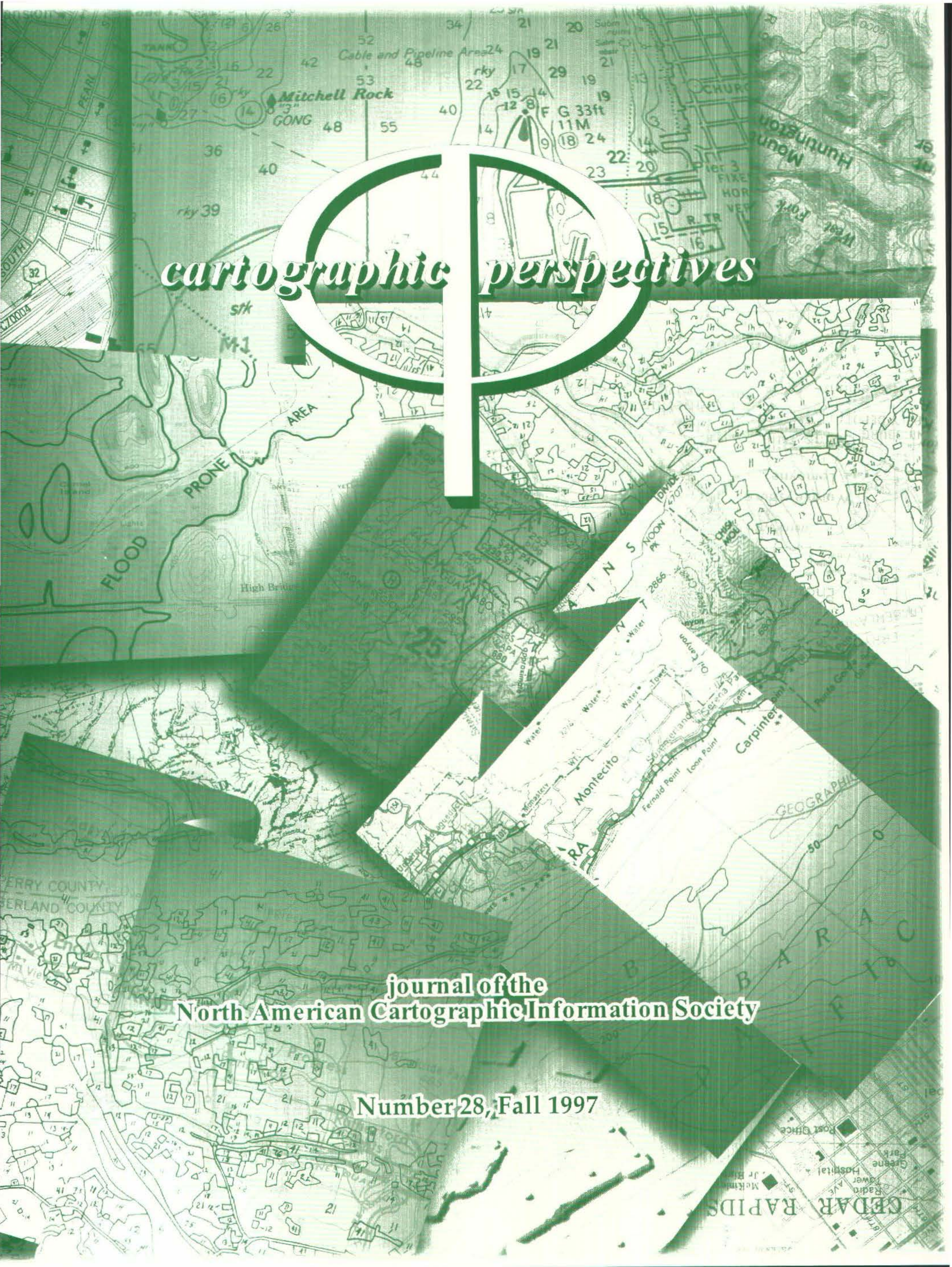

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messages

FROM THE GUEST EDITORS

Introducing the Special Issue on Map Use

In a personal conversation at the Symposium on Cartographic Design and Research in Ottawa in 1994, Muehrcke opined that 'it just gets down to a question of map use.' In his formal paper from that Symposium, Muehrcke (1996) cited map use many times in "The Logic of Map Design." Some examples from the paper include: "Much of the discussion in this book focuses on the importance of the map user. I would go further to state that changes in the way maps are used in the electronic age are probably far more significant than changes in how they are made." (272-3) "The cartographic literature, including our textbooks, does not seem to be as much at fault here as the cartographic literacy of those who use maps." (273) "Some of our critics seem to have missed the point here—the issue of user responsibility. . . users must learn to handle mapping tools responsibility." (275) "If we are really

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concerned about the map user, the basis for making much bigger and quicker gains is already within our grasp. We only need to catalogue and teach the strategies practised by expert map makers and users" (277) "Unfortunately, . . . the level of user sophistication is dismal." (277)

This concern with the map user is consistent with the work of the authors of the papers collected here. In meetings of the Map Use Commission at the International Cartographic Association General Assembly in Barcelona in 1995, there were many discussions about collecting our thinking on map use. We decided to organize one or more sessions on map use at the Annual Meeting of the Association of American Geographers in Charlotte in 1996. Here are some of the papers presented in two sessions at that meeting.

The Web pages of the Map Use Commission (1997) spell out the terms of reference and directions of the Commission. Included there are the organizing themes of the study of map use. These themes focus on what are considered to be the four major dimensions of map use: the individual map user, a map user community, the map use environment, and the map use task. Monmonier (1996) has suggested the addition of a societal dimension of map use.

Individuals bring various skills, competencies, experiences, abilities or disabilities to the act of map use. Some of the papers here focus on different types of individuals. Ungar, et.al., report on two studies of blind and visually impaired users. One study involves blind adults who are experienced in navigation with tactile maps. Another study examines children, where a group of blind children is compared to a group of sighted children in performing given tasks. Board attempts to catalog the expertise of a group of educated geographers who bring considerable knowledge to the higher level task assigned to them. Thompson pleas for guidance in working with college students who have little or no knowledge of maps and mapping but who are called upon to make and study maps to learn about cities.

Carter (Map Use Commission, 1997) contends that in many cases map user communities determine what maps will be produced, at which scales, and in which forms. The experts in these communities set standards for acceptable uses of their maps, although in many cases these standards are implicit rather than spelled out. In the papers in this issue, Board carries out his study using topographic maps from many different nations. The nature of the community that specifies small scale topographic standards has been so effective that the same tasks can be performed with maps from many different sources. It can be said that the other authors are seeking some standards that may lead to better map use in the future.

For centuries we have thought of maps as ink on paper, being the result of some printing process. While these paper maps are static and fixed in time, a user can linger over a paper map, make measurements, magnify segments of the map, and annotate the map. Of course, these paper products may not be convenient to use under some environmental conditions. As we move into an electronic age, the environments in which maps are being used is changing radically. We have dynamic maps that may be very current. Users have unique tools that allow them to interact with the maps in ways not

in this issue (continued)

possible with the paper maps. While all of the papers in this issue feature some aspects of the map use environment, Torguson most strongly focuses on the map use environment where users can interact with maps in electronic formats. Ormeling hypothesizes ways that maps will evolve in response to user actions. He emphasizes that it is equally important to 'get the user the right information as it is to make certain the user gets it right.'

There are many ways to classify map uses, or tasks. Each of these papers have a component relating to one or more uses. In the papers by Ungar, et.al., the tasks are assigned by the researchers. In one case, persons are required to use tactile maps to navigate a specific route. In another case, children are required to learn a geographic arrangement and to recreate that pattern in a given time. Thompson wants his students to use maps to gain an understanding of a complex urban world. Board reports on a higher level task, where users are asked to integrate map details to find complex regions. Ormeling is concerned about the design of maps appropriate to the many tasks involved in using maps.

These papers do not tell us all that we need to know about map use, but they represent a good illustration of the many dimensions of this important area of study. As such, they give us a perspective on cartography, and thus deserve to be published in *Cartographic Perspectives*.

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Use of Tactile Maps by Blind and Visually Impaired People

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Most research on tactile maps has focused on aspects of map design and methods of construction. Relatively little attention has been paid to the way in which blind and visually impaired people actually use tactile maps for everyday way finding tasks. This paper reports on studies carried out in Madrid and Sheffield which consider how people gain spatial knowledge from tactile maps. In the Madrid study, participants were introduced to an urban area by one of three instructional methods: direct experience, tactile map or verbal description. Those who learned the area with the map were considerably more proficient in following the route unguided than were participants who received the other two instructional methods. However the different methods had little effect on the participants' overall representation of the space. It is possible that the map reading strategies used by the participants were effective for gaining practical route-based knowledge but did not give the participants an overall spatial representation of the area. To explore this possibility further, the Sheffield study considered the effect of individual differences in map reading strategies on the type of mental representation which visually impaired people acquire from a tactile map. It was found that those participants who acquired an accurate and full representation of the map used different map learning strategies from those who performed less well. We suggest implications of these studies for the education and rehabilitation of blind and visually impaired people.

INTRODUCTION

Most research on tactile maps has focused on design aspects, such as discriminability of symbols and relative suitability of various tactile media (e.g. Thermoform vs. Microcapsule). Comparatively little attention has been paid to how tactile maps are used by blind and visually impaired people. Psychologists have long been interested in the way in which people form and manipulate mental representations of the spatial environment. Within this research area, a small number of studies has considered the way in which blind and visually impaired people form mental representations of space from direct experience and from tactile maps (Carreiras and Codina, 1992; Dodds, Howarth and Carter, 1982; Herman, Herman and Chatman, 1983; Ungar, Blades, Spencer and Morsley, 1994).

"Comparatively little attention has been paid to how tactile maps are used by blind and visually impaired people."

It has been shown in a number of studies that blind and visually impaired people have difficulty in constructing an accurate and spatially integrated mental representation of their environment from direct locomotion alone (Rosa and Ochaíta, 1993; Spencer, Blades and Morsley, 1989). Maps, which provide the spatial structure of the environment at a scale accessible to touch and without the disorienting effects associated with travel in the real world, can overcome this difficulty (Ungar, Blades and Spencer, 1996; Espinosa and Ochaíta, in press). Unfortunately tactile maps are still not widely used, and we feel that this is partly due to a lack of understanding of tactile map use.

"It has been shown in a number of studies that blind and visually impaired people have difficulty in constructing an accurate and spatially integrated mental representation of their environment from direct locomotion alone. . ."

This paper reports on two studies, each of which focuses on a different aspect of using tactile maps. The Madrid study compared the effectiveness of different instructional methods to provide visually impaired adults with the practical spatial knowledge necessary to navigate in a complex urban environment, and with configurational knowledge of the spatial structure of the environment. The Sheffield study looks at the strategies used by blind and visually impaired children to learn a tactile map, focusing on the acquisition of an overall representation of an urban layout.

LEARNING A COMPLEX URBAN AREA BY THREE INSTRUCTIONAL METHODS

Researchers working with sighted adults have found that learning about space is highly related to the instructional method used (Espinosa and Ochaíta, 1997; Hirtle and Hudson, 1991; Lindberg and Gärling, 1983). For example, when people learn a space using a map or a panoramic verbal description, the resulting spatial schemas are better co-ordinated than when the space is learned through direct interaction with the environment or from a sequential verbal description (Thorndyke and Hayes-Roth, 1982). The Madrid study examined the effects of different instructional methods on way finding performance and mental representations of space in blind and visually impaired adults.

Participants

The participants were 30[1] visually impaired adults who were blind from birth or before six years of age. The participants ages ranged from 22 to 40 years (mean = 29 years, 3 months). All the participants were employed by ONCE (Spanish Organization for the Blind) in a variety of posts. All had the equivalent of secondary school (high school) education. None of the participants had any residual vision which could be effectively used during the experiment. None of the participants had received any formal training in the use of tactile maps for navigation. Participants were randomly assigned to one of the three methods of instruction designed for this study.

Procedure

Participants were required to walk and learn a complex route of 2,050 meters in an unknown environment over four sessions (see Figure 1). The route consisted of eight landmarks, all of which could be recognized by kinesthetic, auditory and tactile cues. There were three different methods of instruction during the first session:

"The route consisted of eight landmarks, all of which could be recognized by kinesthetic, auditory and tactile cues."

Direct Experience: the participants, accompanied by the instructor, walked freely along the route. The experimenter guided the participant but did not provide any descriptive information about the route.

Tactile Map: the participants carried a tactile map of the area with the route marked on it while they walked the route accompanied by the experimenter. Again, the experimenter did not provide any details of the route.

Verbal Description: as the participants walked the route the instructor provided a detailed verbal description of the route.

In the subsequent three sessions, the participant was asked to walk the route unguided. When the participant got lost, the experimenter allowed him/her to walk to the next intersection between streets. Then, we asked him or her the right way to reach the next landmark. If the participant knew the correct direction, he/she was allowed to continue along the route, otherwise he/she was guided by the instructor to the next point of the route.

"...the participants carried a tactile map of the area with the route marked on it while they walked the route accompanied by the experimenter."

[1]Although relatively small, the sample size is necessitated by the relatively low incidence of visual impairments in the general population.

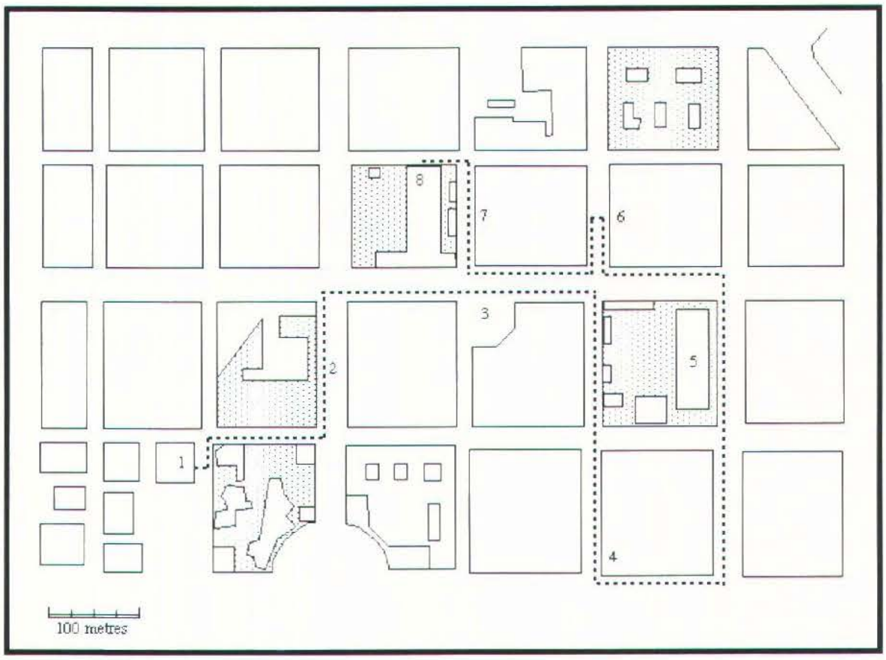

Figure 1.

"The participant's behavior was video-recorded on all sessions. The information from these recordings was combined with behavioral maps. . ."

The participants' behavior was video-recorded on all sessions. The information from these recordings was combined with behavioral maps (which were drawn by the instructor as she accompanied the participants) and were analyzed using a number of different measures of practical spatial knowledge, some of which had proved effective in previous studies by the Madrid research team (Ochaíta, Huertas and Espinosa, 1991). During the second and fourth sessions, the participants were also asked to make direction and distance estimates between all the landmarks, which yielded three measures of configurational knowledge. Thus the following six measures were used in the analysis:

Measures of Practical Spatial Knowledge

Meters: the number of meters by which the participant deviated from the specified route, measured as the difference between the total number of meters walked by a participant and the total length of the specified route, or 2,050 meters.

Stops: the number of times the participant paused while navigating the route for any reason.

"A participant was considered to be lost when he or she did not know the way to the next landmark."

Lost: the number of times the participant lost his/her way. A participant was considered to be lost when he or she did not know the way to the next landmark. In this situation, the experimenter allowed the participant to walk to the next intersection, and then asked him or her the way to the next landmark. If the participant was not able to give the correct directions, he or she was led by the experimenter to the next point on the route.

Measures of Configurational Knowledge

Direction Error: the deviation in degrees between the participant's estimate of direction and the actual direction.

Euclidean Distance Error: difference between the participant's estimate and the true Euclidean (i.e. Crow-flight) distance.

Functional Distance Error: difference between the participant's estimate and the true functional (i.e. City-block) distance.

Results

Analyses of variance (ANOVA) were carried out for each of the six measures on the data from the fourth session to determine the effect of the instructional conditions on the practical and representational spatial knowledge of the participants.

Practical Spatial Knowledge: The results showed a significant effect of the different conditions on practical spatial knowledge in two of the measurements (see Table 1): meters ($F = 5.987$, $p < 0.05$) and lost ($F = 7.324$, $p < 0.05$). The participants who learned the route with a tactile map lost their way less often and walked fewer meters off the specified route than the other two groups. Performance was poorest when participants received a verbal description of the route while walking, resulting in higher scores on 'meters' and 'lost'. The number of stops was not significantly affected by the type of information which the participants received.

"The participants who learned the route with a tactile map lost their way less often and walked fewer meters off the specified route than the other two groups."

Condition	Meters	Stops	Lost
DE	275	5.00	2.00
DE+Map	50	1.60	0.00
DE+Verbal	462.5	2.00	2.25

Table 1. Effect of instructional condition on practical spatial knowledge average values

Spatial Representation: The results showed a significant effect of instructional condition on functional distance errors ($F= 3.716$, $p< 0.05$). The subjects who learned the route with direct experience + tactile map have higher error scores on functional distances estimation than the participants who learned the route with by direct experience alone (see Table 2).

Condition	Direction Error	Euclidean Distance Error	Functional Distance Error
DE	35°	61.56	40.74
DE+Map	38°	61.44	60.00
DE+Verbal	34°	56.11	57.70

Table 2. Effect of instructional condition on spatial representation

Discussion

These results suggest that the combination of direct experience and a tactile map is a very good method for giving visually impaired people practical knowledge of the environment; although participants in this condition did walk some distance off the taught route, they never became completely lost. However, the map seemed not to provide them with a coordinated spatial representation of the area. In this respect, it should be noted that blind and visually impaired people are generally taught to orient themselves on the basis of route knowledge of the environment (i.e., Knowledge based on landmarks linked in sequence), and thus may not have had experience of forming overall representations of their environ-

"However, the map seemed not to provide them with a coordinated spatial representation of the area."

ment. So they may require training in the use of effective strategies for coding the spatial information contained in tactile maps.

"This suggests that visually impaired people would benefit with training in the use of effective strategies for coding the spatial information contained in tactile maps."

The results clearly differ between practical and the representational measures. While the use of a tactile map in conjunction with a direct experience is a good method for giving visually impaired people practical knowledge of the environment, it is not clear that the map allowed them to acquire a coordinated spatial representation of the area. It should be noted that the participants had several years of experience of route-based way finding, and may not have had experience in forming overall representations of their environment. This suggests that visually impaired people would benefit with training in the use of effective strategies for coding the spatial information contained in tactile maps.

STRATEGIES FOR ACQUIRING INFORMATION FROM TACTILE MAPS

The Madrid study showed that, while maps are clearly effective for introducing visually impaired people to a route, they were found to be no more effective than the other instructional methods for providing a global representation of the mapped space. However, as the Madrid study focused on group differences in way-finding ability, the Sheffield study was carried out to consider the possibility that the group scores may have concealed individual differences in strategies used by visually impaired people to acquire information from a tactile map. It has previously been found with sighted people that differences in strategies can account for differences in the resulting mental representation of the map (Thorndyke and Stasz, 1980).

When a print map is viewed by a sighted person, a great deal of information such as the relative and absolute positions of locations, the relative orientations of roads and the divisions between regions is instantly available. But the visually impaired map reader must discover this information by constructing it from sequential scanning of the map, forming reference frameworks and gradually establishing an overall, integrated impression of the map. For this reason it is important that a visually impaired map user has effective strategies for learning information from a tactile map. In previous studies we found a close relationship between the tactile scanning strategies spontaneously used by visually impaired children and their performance in spatial tasks (Ungar, Blades and Spencer, 1995; Ungar, Blades and Spencer, 1996a; Ungar, Blades and Spencer, 1996b). We examined the relationship between map reading strategies and the ability of map readers to acquire information from a tactile map.

"But the visually impaired map reader must discover this information by constructing it from sequential scanning of the map, forming reference frameworks and gradually establishing an overall, integrated impression of the map."

Participants

Nineteen children with visual impairments (VI group) took part in the study; of these children seven were totally blind and twelve had limited residual vision. All usually read Braille. Twenty-two sighted children also took part in the study so that comparisons could be made between the performance of the children with visual impairments and the performance of children with sight. The children were divided into three age groups: a young group (6 and 7 year olds), a middle group (8 and 9 year olds) and an older group (10 to 13 year olds).

Materials

A map of an imaginary town center (30cm x 42cm) was constructed in tactile and print forms (see Figure 2). It included thirteen named roads, nine labeled places and a river. The materials also included a metal board (30 cm x 42 cm) and a box of magnetic pieces used for map reconstruction.

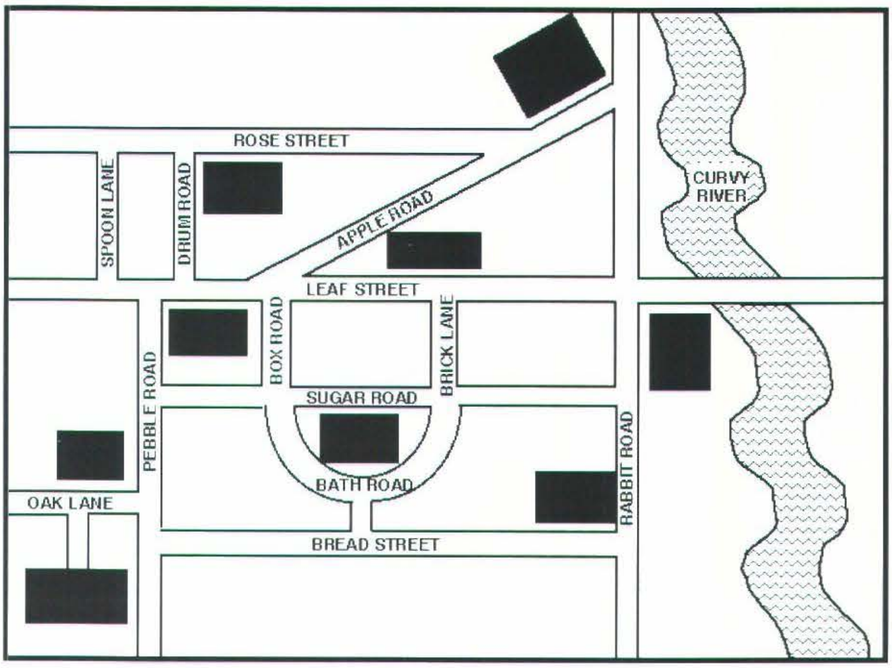

Figure 2.

Pieces were provided to represent roads, places and the river - there were more than three times the number of magnetic pieces required to reconstruct the map.

Procedure

The sighted children were given the print map and the visually impaired children were given tactile maps. All children were initially asked to learn the map for seven minutes. During this learning period they were asked to talk aloud about everything they noticed on the map and everything they thought about while they were trying to learn it (cf. Gilhooly, et.al., 1988; Thorndyke and Stasz, 1980). At the end of the learning period the map was removed, participants were given the metal board and magnetic pieces and were asked to reconstruct the map from memory. As the participant placed each piece on the board and named it, it was labeled by the experimenter with either a Braille or a print label. The reconstruction was photographed and the magnetic pieces were removed.

This procedure was repeated twice. Thus, in all, the participants learned the map three times and made three reconstructions. All three learning and reconstruction periods were videotaped to provide a complete record of the participants' commentaries and performance.

"The sighted children were given the print map and the visually impaired children were given tactile maps. All children were initially asked to learn the map for seven minutes."

"Thus, in all, the participants learned the map three times and made three reconstructions."

Analysis

The participants' commentaries were analyzed for statements which referred to: map objects; methods of learning the map; intentions to use particular techniques; and comments about their own performance. The strategy types were derived from previous pilot studies on learning tactile maps. For each child's transcript we calculated number of statements of each strategy type expressed as a proportion of the total number of statements by that child. Man Whitney U tests were used to test for any differences between the experimental groups in the mean proportion of use of each strategy type.

"The children's reconstructed maps from the third trial were scored on two criteria - one objective and one subjective."

The children's reconstructed maps from the third trial were scored on two criteria - one objective and one subjective. For the objective criterion, the children scored one point for every map element placed within 4 cm of its original position on the map. Thus each child could score a maximum of 23 (13 roads + 9 locations + the river). For the subjective criterion, each map was rated by one of the experimenters and an independent rater. The children's maps were ranked blind according to how well they resembled the original map, in particular, how well they preserved the spatial relationships between locations and the interconnections between roads of the original. There was 95% agreement between two independent judges who rated the maps.

Results

In this section, we will report only those results which were significant at the 0.05 level.

An analysis of the accuracy of the maps revealed no differences between totally blind and residual vision groups. However, both these groups were significantly less accurate in reconstructing the map than the children with sight (by both criteria). There were no significant differences by age. There was great individual variation in performance within and across groups.

"...children with visual impairments spent more time reading out names or tracing routes around the map..."

A comparison of the learning strategies used by the visually impaired children and the children with sight revealed that the children with visual impairments spent more time reading out names or tracing routes around the map, they also tended to describe features on the map without interpreting them as symbols, and they were more likely to bring in general knowledge which was not directly relevant (e.g. By making comments like "there should be a roundabout in the park"). In contrast, the children with sight more frequently mentioned the position of features on the map with reference to the frame of the map or relative to the position of other features, and they made more frequent comments about patterns formed by groups of roads or features on the map.

A second analysis focused on the children with visual impairments. A comparison was made between the strategies used by the seven visually impaired children who produced the most accurate maps and the strategies of the seven visually impaired children who produced the poorest maps. There were two significant differences in the way that these two groups of children learned the map - the more accurate children more frequently related features to the frame of the maps and more frequently mentioned the relationships between features.

Discussion

"...successful learning of the map was associated with the use of a specific set of strategies;"

In the Sheffield experiment, successful learning of the map was associated with the use of a specific set of strategies; children who focused on the relative and absolute locations of objects on the map as well as on patterns formed by groups of map objects, tended to perform better than other children. This accounts for the better performance of the sighted children who more often reported using such strategies than did the blind children and distinguishes between the good learners and the poor learners within both sight groups.

GENERAL DISCUSSION AND CONCLUSIONS

Both of these studies show that people with visual impairments can use tactile maps effectively. In the Madrid study, a tactile map used in conjunction with direct experience was shown to be more effective than direct experience alone or than direct experience plus verbal description for familiarizing visually impaired adults with a long and complex route through an urban area. The fact that they did not gain a faithful global representation of the mapped area may be due to the strategies they used to acquire and organize the information from the map.

The Sheffield study showed that individual differences in the ability to learn a tactile map of an urban area were closely related to the strategies which the young people used while learning the map. Good map learners tended to focus on the spatial relationships between items on the map, local and global patterns formed by map elements and the locations of places and structures in relation to the external framework of the map.

"Good map learners tended to focus on the spatial relationships between items on the map, local and global patterns formed by map elements and the locations of places and structures in relation to the external framework of the map."

Future work will look at ways of introducing people with visual impairments to the overall layout of environments through tactile maps and at ways of training tactile map users to employ more effective strategies which may allow them to extract a richer representation of the environment from a tactile map.

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Regional Recognition and Delimitation from Topographic Maps: User Strategies

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This is a report from a pilot study conducted with nine geographers to delimit regions on a map they were not familiar with. The participants varied greatly in age and experience. Making notes as the users talked through their thinking provided insight into how such complex maps are read. Experienced geographers with larger geographical vocabularies sought to distinguish salient patterns. No simple relationship could be established between experience and region-dividing strategies. Suggestions are made for expanding such studies.

THE GEOGRAPHICAL CONTEXT

This paper will concentrate on "map use in its classic form, a percipient interacting visually and mentally ... with a single map" (Wood, 1993a, 112) and the process of reading, analysis and interpretation. It will also focus on level 3 (Olson, 1976) or higher order tasks (Board, 1984), summarized as the application of deep-structure information to decision-making and content-knowledge-building for problem solving.

Geographical education from the turn of the century seized the opportunity of studying landscapes on relatively large-scale topographic maps which were increasingly available (Herbertson, 1902; Geikie, 1901). By the 1920s and 1930s texts on map reading and interpretation were commonplace, compulsory map interpretation questions were typical of British public examinations in geography, encouraged no doubt by the flowering of the regional paradigm. This situation continued well into the 1960s, although the textbooks often separated physical and human landscapes. Candidates were expected to integrate these into regional recognition and division. As a student who was brought up to employ this form of map use, I was expected to undertake this geographical task using the evidence provided on the map and not information I might have acquired directly in the field or from reading.

In his formidable geographical study of Germany, Dickinson (1953, 416) "sought to recognize a limited number of clearly recognizable landscape types that could be consistently and legibly mapped over the whole of Germany on a scale of 1:200,000". These landscape types were essentially based on physical characteristics, but their recognition was in part related to human occupance. This approach to environmental understanding based on a topographic map series has probably not been surpassed. It represents a high-water mark in regional map analysis. Such map use became rarer after the Quantitative Revolution. Muehrcke has documented the decline of geographical map use and the rise of statistical geography alongside a more professionalized cartography with a heavy emphasis on thematic, statistical map design (Muehrcke, 1982).

"This approach to environmental understanding based on a topographic map series has probably not been surpassed. It represents a high-water mark in regional map analysis."

THE CARTOGRAPHIC CONTEXT

Research into the cognitive aspects of map use, related to changing paradigms in psychology, has developed apace in the last quarter century. Despite pioneering work such as that by DeLucia (1976) and many others reviewed by MacEachren (1995) and Wood (1993b) and the renewed interest in visualization, our understanding of how maps are read is still incomplete. However evidence is accumulating that levels of experience

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of map use and geographical study are associated with more successful map reading and map learning. But, surprisingly, comparatively few accounts of research using complex general-purpose or topographic maps have been published, although MacEachren cites Geoffrey Edwards (1991) who contends that the "ability to take the landscape analysis approach depends on being able to access labels for the features from memory. Experienced map readers are said to have 'a whole dictionary of names' for grouped entities which he or she carries around her head, allowing her to read and understand maps more quickly and effectively.' . . . For the experienced map reader, an extensive vocabulary exists that defines and labels complex entities." (MacEachren, 1995, 394). In parenthesis it should be acknowledged that the chunking process referred to by Edwards (1991) was described by Head in his 1984 work.

Michael Wood and his associates recognized that a deeper understanding of map interpretation needed a study of the knowledge structures and map reading strategies of users. They employed protocol analysis (Gilhooly et al., 1988; Kinnear and Wood, 1987) with both experienced and inexperienced map readers as did Thorndyke and Stasz (1980) but in contrast to the latter, their research used complex maps of the real world. Similarly Kulhavy and others (1992) have also used protocol analysis on a complex, general map in the *National Geographic Magazine*. Both of these studies emphasize memory and learning.

As far as I am aware there has been no modern study of experts' geographical interpretation of complex topographical maps in the mold of that once so popular in geographical education. Gilhooly et al. (1988) concentrate on contour patterns while Edwards (1991) deals principally with remotely sensed images. We must remember nevertheless that topographic maps select features and present them with varying degrees of emphasis according to national or regional styles and specifications. What applies to remotely sensed images may not apply to map reading.

"This is . . . to argue for a looser, more anecdotal account which I believe can be captured by note taking during a session when the user is thinking out loud while map reading."

In a pilot study some map interpretation protocols were informally recorded in a small seminar I organized in the mid 1980s. Four participants in turn described the patterns seen on maps of areas with which we were not familiar. Each chose a map for others to describe. Transcribing the rather rambling accounts after an interval of a decade reveals that they may not be an adequate guide to map reading strategies and that word counts of our murmurings may convey spurious precision. This is not to denigrate the research methodology of Kulhavy et al. (1992) but to argue for a looser, more anecdotal account which I believe can be captured by note taking during a session when the user is thinking out loud while map reading. Informed by this exercise I devised a new one in which geographers were asked to describe regional patterns on maps. Because the aim of my study was to discover what different strategies were adopted by map readers for one task, there was no need for a formal experimental design demanding quantitative data on accuracy or time of recall. It is recognized that further study and analysis of map-reading strategies will require a more formal design.

THE PRESENT STUDY

Building on the pilot study, the aim of this study was to examine the strategies by which skilled map readers approached the task of regional division on topographic maps. This higher-order task is what was expected of educated geographers.* Nine experienced map-using geographers were invited to divide the area on the map into regions of distinctive landscape type. The objective was to record the essence of the strategies adopted by each geographer to undertake this task. All had degrees in geography. Their ages ranged from 25 to 77. Four were female and four had been trained recently. Different maps were presented to each individual, all but one on the scale of 1:50,000. All the maps chosen had fairly clear regional patterns. Most participants had seen examples of the map series, but none had studied the particular sheet in question. Nevertheless all but two of the geographers were familiar with the geography of the country whose maps they were reading: giving them a better chance of describing geographically significant patterns. To have asked individuals to delineate regions from graphic patterns, and also to deprive them of the benefit of readable place-names would have reduced the study to one of recognizing pattern without necessarily seeing what it meant. That would have been another study with a different aim.

". . . all but two of the geographers were familiar with the geography of the country whose maps they were reading . . ."

Subjects were interviewed on their own but their comments were not recorded verbatim. Although detailed notes were kept of the thinking-aloud sessions, it must be acknowledged that these may be partial and selective. In one case a map reader offered a sketch map of the regions he had devised, but in other cases it has proved possible to reconstruct such a map. In retrospect, perhaps it would have been wiser to ask all respondents to reconstruct their regional division on a piece of tracing paper or film of exactly the same size, to avoid any suspicion that inability to create freehand copies might distort the conclusions. This delineation of regions should be done with the topographic map at hand, so that memorization can be eliminated as a factor. This act of interpreting regions to reveal unknowns tends to be at the intensive "private" interaction node between map user and map (MacEachren, 1995, Fig. P.III.1, p.358).**

"This act of interpreting regions to reveal unknowns tends to be at the intensive "private" interaction node between map user and map."

RESULTS

1. All nine map readers scanned their maps several times making several trials of a regional division. Two of them missed some significant detail. One, a cartographic researcher and map librarian, strayed into cartographic technicalities and details of the specification rather than concentrating on the landscape. The one who was least experienced spent much more time looking at some detail, missing others.

2. All nine used terms from the geographical vocabularies they commanded. Some features were given names from type localities, e.g. fjord, fells, garden city. All used a rich list of adjectives to qualify features: two dimensional shape and three-dimensional morphological qualifiers being the most common. Some terms were very specific to landscape description, e.g. accidented relief, mature valley (a Davisian term), organized networks. Relatively complex concepts such as relief, enclosure, clearance, and settlement were typically employed. Others such as good walking country are personal, idiosyncratic or private, meaning much to the individual concerned. A varied selection of terms were employed to describe location, distribution and arrangement from the relatively simple clustered and evenly distributed to focused, radiating and interdigitated.

"Relatively complex concepts such as relief, enclosure, clearance, and settlement were typically employed."

3. All map readers linked small features such as those appearing in the legends of maps into larger chunks often relating land use to physical features. These include valley bush on the Kidd's Beach map, for the prevalence of a type of forest surviving along valleys in a repeating pattern over wide areas. Another more complex example was the recognition of areas around villages where the forest had been cut back, noticed on the Belgian map, although in this case there appears no English term for this. Another recognized what he thought was a drumlin field on the Bavarian map.

Map Readers	DR	PD	RJ	WD	TA	LC	WM	GK	LP
Traditionally or recently trained	T	R	R	R	T	T	T	R	T
Map number in list	8	3	7	1	4	6	5	9	2
Procedures adopted by map readers									
Wide Scan	+	+	+	+	+	+	+	+	+
Repetition	+	+	+	+	+	+	+	o	+
Have Geographical Vocabulary	Y	-	+	Y	+	+	Y	-	+
Chunks (small, large)	L	L	L	L	L	L	L	L	L
Concepts external to the map	Y	+	+	+	+	-	Y	+	Y
Gave attention to small detail	+	+	+	Y	+	+	o	o	+
Revealed knowledge of the area	o	+	+	o	o	+	o	o	+
Searched for detail in the area	o	+	+	o	o	+	o	o	+
Strategies employed by map readers									
Main regions identified, then subdivided	+	+	+	+	+				
Distinctive regions, then others						+	+	+	
Physical regions, then human regions									+

Notes: Y = Yes very much, + = yes, - = not much, o = not

Table 1. Summary of Results of Regional Division on Maps

"Three out of nine geographers made extensive use of concepts external to the map."

4. Three out of nine geographers made extensive use of concepts external to the map. These were the individuals with the longest experience of map use. They frequently speculated on explanations for patterns and associations observed on the map. For example, industrial history was invoked to differentiate the dense valley-bottom settlement on the

Lancashire / Yorkshire border with water-power sites for 18th century textile production. The same very experienced map user pointed out the routeways through the Pennine hillcountry diminished the sharp distinction between Lancashire and Yorkshire by permitting movement along lines of communication. The very experienced geographer reading the Kidd's Beach map saw evidence of White planning for Blacks in the imposition of a planned landscape, wiping out a traditional economic/ cultural landscape of no significance for the White dominated political economy.

5. All of the nine map users were from time to time attracted to unusual or curious details on their sheets. Examples range from two or three very small, but obviously locally important hills rising from the otherwise flat alluvial plain intersected by the Waimakariri, to the outlier of the steel industry separated from the main industrial region on the Belgian frontier with France, to the deep and narrow waterless channel across the alluvial fan on the Bavarian map which suggested sub-glacial water flow.

"All of the nine map users were from time to time attracted to unusual or curious details on their sheets."

6. Only four out of the nine acknowledged and displayed knowledge of the area on the maps they were reading. They also spent some time searching for features they expected to encounter. Of these four, one knew the city of Johannesburg but had not looked at this map, but rather like the air traveler arriving at a familiar place expected to be able to see the site of Sophiatown, a Black township demolished under apartheid. Another who had just visited Barcelona for the second time in three months looked for the Parc Guâll designed by Gaudi, the five motorway rings around the city and the area "where the bourgeoisie live" on the hills above the Autonomous University, which she had visited. The third had visited the region by bicycle in her childhood and could obviously recall those journeys and landscapes. The last expected to find an escarpment but was frustrated by the industrialization which obscured the rather discontinuous feature.

7. Three strategies can be discerned among the nine when their approach to regionalization is examined:

"Three strategies can be discerned among the nine when their approach to regionalization is examined . . ."

(a) Decide main regional divisions at the outset and then fill in the detail, subdividing some of their main regions when distinct subdivisions were perceived. The process tended to be iterative, beginning with a rough division which was sometimes modified in detail. Tracing the boundaries of regions by hand was often a component of the map-reading exercise. One subject drew a sketch map to conclude his account. This group included both very experienced and less experienced map users. (5 subjects.)

(b) Look for physical regions first and then switch to other criteria on which to base the regional division. The sole subject to use this method (preferred by Garnett, 1935) arrived at the same conclusion as the author of this paper, who was observing and prompting.

(c) Isolate the most distinctive area, which was generally rather smaller and certainly less typical of the map as a whole. Then return to the apparently more typical and homogeneous area to find that it could be subdivided, and sometimes subdivided again. Those who employed this strategy included the most and the least experienced. The most experienced map user began by identifying the region he happened to have studied on the ground, being drawn straight away to it before noticing what was depicted elsewhere. (3 subjects)

CONCLUSIONS

1. Experienced map users sought to "see the wood from the trees" or distinguish the salient patterns.
2. Experienced map users who continued to use a rich geographical vocabulary for features at different scale levels appear to get more from the map.
3. Experienced map users made more use of larger, more complex chunks. This is in line with the suggestion of Gilhooly et al (1988) that the underlying schemas of more highly skilled map users were richer and more complex.
4. The most experienced map users employed concepts external to the map itself, which deepened their understanding of the landscapes represented on the maps. See Kulhavy et al (1992).
5. Any map user, whether experienced or not, can be distracted by unusual, exceptional details.
6. A direct knowledge of the ground may prove helpful, but too much may be a handicap.
7. No simple relationship between experience and region-dividing strategy was seen. This may reflect differences between the landscapes on the maps used.

"A direct knowledge of the ground may prove helpful, but too much may be a handicap."

IMPLICATIONS

This qualitative survey generally bears out how important expertness is in map reading and vindicates the views expressed in military map-reading manuals (see Board, 1984 references to War Office). Further research is required to disaggregate the effects of expertise and ground knowledge. It would be wise to restrict the test maps to those of one series in one country. This would make it easier to control the type of map-using training and experience. It must be admitted that some areas are more easily divided into regions than others, providing another argument for further testing on the same map. This would allow one to see whether there were still different strategies in regional division.

Given that one were able to distinguish between the more experienced and the less experienced map users, degree of knowledge of the area on the map might be another factor to take into account in a further study. While establishing the degree of map-using experience would require some in-depth interviewing, knowledge of the area is probably simpler to determine. However, such knowledge may be from direct field experience, or solely second-hand from documentary sources. This could be a further factor to take into account in selecting map users. It might also be valuable to establish whether subjects in a future study had previously undertaken such a regional division on maps. Cartographic knowledge as such needs to be defined more clearly and may be less relevant than geographical knowledge to success in map reading. By this is meant a knowledge of mapping beyond the understanding of what symbols and lettering styles signify. That those who are expert have acquired considerable cartographic knowledge may have no bearing on reading and interpreting maps.

"Cartographic knowledge as such needs to be defined more clearly and may be less relevant than geographical knowledge to success in map reading."

If the division of areas into landscape regions is regarded as helpful (e.g. to provide strata for surveys at a more detailed level) it is worth examining more closely the overall strategies adopted by map users in regionalization. If it could be shown that one strategy of regional division was more common than another, one might with greater confidence advise those who wish to generate visualizations from GIS's millions of complex combinations to begin with an examination of a detailed topographic map as a precursor to the selection of variables from a data base. One could rely on a formula such as those formerly used by textbooks on map interpretation, e.g. Garnett (1935, pp. 9 & 25) dealing with the physical features first, then the human responses to them followed by the regional synthesis. Research might show that an another approach would suggest a more effective way of selecting significant variables.

"One could rely on a formula . . dealing with the physical features first, then the human responses to them followed by the regional synthesis."

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*See for example Birch, 1968, Map and Photo Reading, pp. 59-60, which urges that the description of a map area should start with the physical landscape relating human settlement to it, and, "if the area subdivides into distinct types, deal with one at a time and give each a suitable name . . . ."

** A classic instance of this process, albeit carried out under wartime pressures, is the interpretation of Germany's secret V weapon sites (Smith, 1957).

What Do We Want to Know About Map Use, Users and Use Environments

The editors organized a panel on Map Use for the Association of American Geographers Annual Meeting in 1996. The persons appearing on the panel were selected because they represent diversity in terms of interests in the broad realm of cartography and map use. Each panelist was asked to prepare a 10 minute presentation addressing: "What is it we want to know about map use, users, and use environments?" And, "what insights can you contribute to these questions based on your research and observations?"

". . . what insights can you contribute to these questions based on your research and observations?"

It was assumed that there would be a great amount of overlap in the panel presentations. Rather, each author brought a unique and insightful perspective. Because the papers were refreshingly unique and of such quality we decided each paper should stand by itself rather than be blended together in a summary of a panel discussion. These three papers grew out of that panel discussion.

James R. Carter and Ute J. Dymon, Editors

Map Use Steps and Their Data Quality Requirements

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We want to better understand geo-information production lines so that we can represent data quality concerns on our maps. And, we must be concerned that not only do we get the right data to the user but that the user gets the data right. We need research to find optimal geo-information production lines, to assess data quality, to link quality to intended uses, and to visualize the results in effective ways. This may involve using fuzzy and crisp symbols, or employing possibility and probability values.

INTRODUCTION

Map reading is not an isolated activity. It is part of a query and answer process that can be termed a geo-information production line (figure 1). When we want to solve some problem with spatial implications we collect spatial information, present it in a visualized form and by using the resulting map we hope to get an answer to a problem. The foundation of this production line is formed by a number of concepts such as a spherical earth, generalization, abstraction, etc.

"Map reading is . . . part of a query and answer process that can be termed a geo-information production line."

Map designers should have an integrated view of the whole geo-information production line, because their maps should accommodate users' need to correctly weigh and interpret the quality of the visualized data (figure 2). As noted in this model, cartographers should be aware of the nature of the data capture process as it affects data quality, and they should convey the nature of the data quality. This might be done by employing some objective quantifier like the number of samples or the distance between sample sites. The same can be said for the data analysis process - when we combine data sets or transform them, aggregate them or whatever - and here again we should indicate what happened to the data quality. The users should not only be informed about the quality of

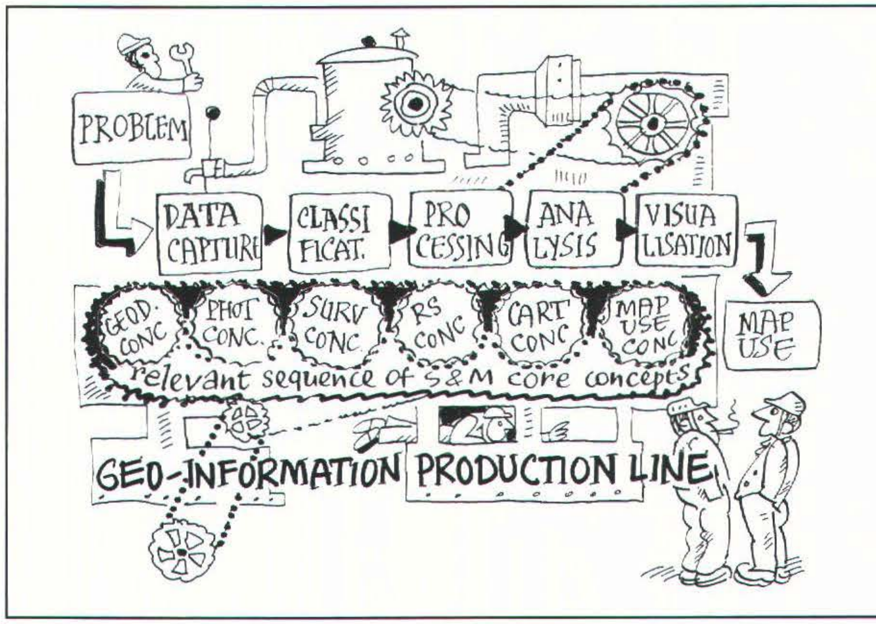

Figure 1. Geo-Information production line (by A. Lurvink, unpublished)

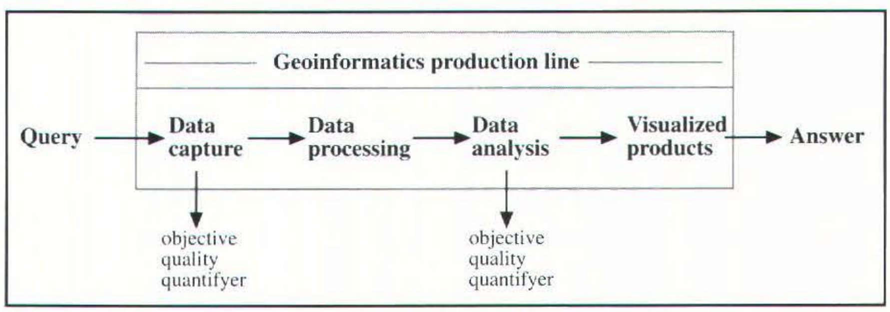

Figure 2. Formalized Geo-Information production line

the dataset as a whole, but also about local or regional anomalies in data quality, because they may want to select locations, corridors or regions that address specific requirements. To represent data quality, cartographers might classify map items as fuzzy or crisp, or employ possibility or probability values. Various techniques for visualizing data quality information have been developed by cartographers (see Van der Wel, et. al., 1994).

To visualize accuracy of ratio-scale attribute data it is possible, for instance, to use differences in size; in order to show the accuracy of nominal data both color hue, orientation, texture or pattern would be suitable. These variables can either be rendered in a separate map presented next to the main map, or can be integrated with the main map - thus combining variables showing the contents - such as color hue - and variables showing the accuracy of the contents. It will make a difference whether these variables indicating data quality are used in a static or in a dynamic environment (Hootsmans, 1996). What is still missing in the research results cartographers have come up with is a concordance between specific quality visualization methods and types of spatial information use.

"What is still missing . . . is a concordance between specific quality visualization methods and types of spatial information use."

This concern with the visualization of data quality is just part of the more general issues: "how to get the user the right information", as well as "how to make sure the user gets the information right". Few persons in geo-information, including cartographers, seem to realize that both of these tasks are equally important. It can be modeled with the modified geo-information production line in figure 3.

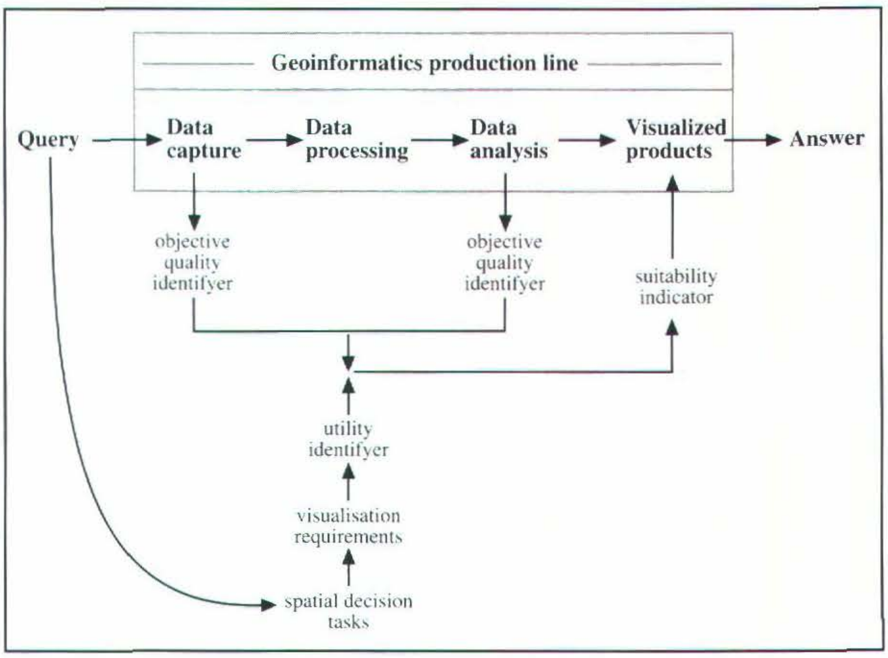

Figure 3. Modified formalized Geo-Information production line (taking account of visualization requirements of spatial decision making tasks)

Whether the information on the map is right should not only be decided by objective quality identifiers, but also by the kind of task to be performed with the information. This task will call for a specific visualization method, and the kind of use of the resulting image will determine the utility of the information with a specific objective quality. So the question would be, for example, how important is it, for a specific application, that the data are only 97% correct or that more than a third of the data points on the map are more than 5 m from their actual position in the field?

To ascertain these utility or suitability values we need to research all types of uses of visualized spatial information: what do people actually do with the visualized spatial information when they need to make decisions? If they want to know the situation at a specific point, their visualization requirements would be different from when they wish to see overall trends; when they want to compare themes, requirements will be different from when they want to use the map for orientation.

". . . what do people actually do with the visualized spatial information when they need to make decisions?"

If data quality is defined as fitness for use, then objective quality measures, like probability (for crisp classes) or possibility (for fuzzy classes) are not enough, but should be linked to some utility measure, showing or evaluating the desirability that data are up to standards for a specific use of the data. Spatial data uses may be identified in broad categories such as management, reference, navigation, etc. Each of these broad uses can be broken down into single actions or steps, such as locate, compare, count, estimate, etc. Each step will have its own requirements; for each map use step a specific image quality will have a specific utility. For a specific step a map with a regional probability value of 0.8 might be desirable for reading off suitable point locations. A land cover map with an overall possibility value of 0.7 might still be adequate to serve as a basis for land use planning. Whether it actually is suitable would depend on the accuracy or data quality requirements for the individual map use steps.

"Whether it actually is suitable would depend on the accuracy or data quality requirements for the individual map use steps."

A map use task like navigating will consist of steps like: orient map, locate position, identify destination, determine route requirements, find optimal route, mark route, select landmarks, check landmarks, and verify destination. High absolute accuracy will be important for both finding the position and the destination on the map. For optimal route finding or for checking landmarks only relative accuracy is relevant.

The relevance of this subdivision into map use steps would be to adapt the visualized information to the task at hand. An interactive map use environment might enable us to change the map image as soon as tasks requiring specific data quality have been performed. This could have important implications for guided interactive map use exercises - as soon as correct answers have been given to specific questions, the data quality is adapted to the next question. Even when browsing, the data quality could be set to specific use modes, and the relevant quality concerns for that specific map use mode would be visualized.

Aspects of data quality other than fuzziness (similarity to the core of a fuzzy set) can be ambiguity (a measure of the difference between most likely and the second possibility), credibility (indicates the stability of boundaries of fuzzy spatial sets) or boundary certainty. When I want to locate boundaries between phenomena, I would like to use a quality map showing boundary certainty, probably represented with achromatic variables. When I would be more interested in identifying core areas then I would opt for visualization of fuzziness or ambiguity. In many cases I would expect to get a better opportunity for identifying core areas in an interactive display environment by using animated techniques - by manipulating fuzziness dispersion values with a slide bar for instance.

"If we can make certain the user or customer gets the right information, and gets this information right as well . . ."

So it is not only the type of information and its quality which will influence possibilities for use, but also the nature of the steps in the use of the map. If we can make certain the user or customer gets the right information, and gets this information right as well, then we have provided not only the map as our final product, but the whole geo-information production line with added value.

The types of research called for here consists of finding the optimal geo-information production lines, assessing data quality, linking these to the intended uses, and visualizing the results. Whether data quality visualization methods will ever be applied depends on the desire and willingness of map users to consider information on differences in data quality. For users, it is a question of perceived relevance. For those of us in the geo-information production process it is a matter of demonstrating the relevancy of data quality indicators as well as determining how to represent those differences in data quality.

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Map Use - Perspectives in Geographic Undergraduate Education

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The author introduces junior-level students with no background to various tasks involving maps, computer mapping and GIS as part of a project called UrbanWorld. A concern is how to evaluate the student's learning as well as the products the students produce, whether on paper or electronically. Three challenges are posed to the cartographic community. What can we offer in terms of map reading strategies? Do we have guidelines for good cartographic practice and helpful hints about map design? What research has there been on the complexities of the individualistic analysis and decision-making that are major elements of the spatial reasoning process?

INTRODUCTION

I address the question of 'what do we want to know about map use, map users, map use environments' in only one context, that of geography undergraduate education. The particular context for me is an upper division course in urban geography. It is a course undergoing major revision from a lecture format to an active, authentic learning environment. (1) This course has no prerequisites and therefore students may have had no exposure to cartography nor geography.

Focusing on this one situation makes the discussion more tangible and focused, especially by putting the discussion in the context of real uses of maps and spatial data, and facilitates the identification of issues and particular needs. I assume that some of the characteristics of this context will be found in other use environments such that my remarks can be seen to be general as well as specific to the pedagogic application.

A PROFILE OF THE MAP USE ENVIRONMENT

The population of users are students undertaking several different kinds of tasks involving maps as part of an assignment that guides them towards an improved understanding of a geography topic, in my case, the characteristics of metropolises. The students are cartographically naive junior-level students (from several different disciplines), having no prior work with maps, nor use of computer mapping nor GIS software.

"The students are cartographically naive junior-level students . . ."

The students are required to do four main kinds of cartographic tasks:

- interpret maps already made for topics such as demographic characteristics and land use,
- make thematic maps as part of a process of analyzing geographic patterns of demographics, housing, or other conditions,
- make thematic maps representing quite specific requirements for an assignment, for example factors influencing transit use for the catchment area of a rail station, and
- express ideas about mapped geographic distributions as schematic mental maps, for example the spatial patterns in a metropolis of different social groups.

As part of their work students encounter many kinds of maps and types of spatial data. Some tasks involve count data, such as the number of elderly (who may be regarded as one element of the transit dependent population), and sometimes norming to percentages or densities, especially where the spatial units, be they blocks, block-groups, or tracts, are quite varied in size. An appreciation for the spatial variations in land use is facilitated by visualization of land value surfaces or other devices to reveal gradients of change. Flow and network maps are important for showing transit facilities, and for gravity model predictions. Choropleth maps resulting from the calculation of composite indicators are important for conveying the geographic distribution of transit captives.

"... students have to quickly appreciate what types and scales of maps are appropriate for given situations ..."

The map use tasks are quite varied; students have to quickly appreciate what types and scales of maps are appropriate for given situations as well as elements of bias, perception, alternative representations, data quality, and so on. But the user environment has additional important characteristics: the likelihood that many maps will be made in a short period in the digital environment; that the intent of making maps is to facilitate map data analysis; and that all activities are part of a spatial reasoning process. Students are asked to make conclusions or present evidence for solving a problem. Map interpretation and data analysis are of higher priority than map creation as an end-product, although students are required to create maps to represent some aspects of data and those which are expressions of their own ideas.

AN ADDITIONAL DIMENSION OF EVALUATION

There is, though, a complication. The map use is undertaken in a setting which requires evaluation of student learning. For the pedagogic context the instructor must:

1. evaluate the specific products created by the student, either hard-copy maps or electronic versions;
2. evaluate the student progress in learning the geographic content, but because this involves use and creation of maps and working with spatial data, then it becomes necessary to
3. assess the contamination of the learning progress by any inability on the part of the student to acquire the necessary practical cartographic skills.

For the first of these a practical need is a set of guidelines, or even standards, to assess map design in a context. For the second of these there is no explicit cartographic concern, but for the last it is necessary to evaluate progress with the acquisition of map use and map creation skills.

"Urban World ... is a project to create an active learning environment, engaging students in map data analysis ..."

This general concern is motivated by the requirements of a real project, funded by the United States Department of Education, called UrbanWorld. (2) It is a project to create an active learning environment, engaging students in map data analysis as they learn urban geography with the aid of digital resources. Given that the funding is from the Education Department, through the Fund for the Improvement of Post-Secondary Education, there is a requirement to do formative and summative evaluations.

There is, therefore, consideration of how to undertake student performance assessment. It is quite interesting and intriguing to note to an audience of cartographers, who will readily appreciate the vocational value of a record of cartographic products kept in a folder, that the idea of a portfolio is increasingly favored by educational assessors as a vehicle for performance assessment. (3) A portfolio is a purposeful assembly of student work that tells the story of student achievement or growth. Not all work is saved or evaluated, but enough, perhaps chosen to meet different purposes, that reveals the level of attainment with specific skills, and the progress through the semester between the entry and exit skill levels. The portfolio is more than an aid to revealing skills to prospective employers; it is used as an integral part of the instruction and evaluation process. As such it is believed to be a novelty for most geography classes; a literature search has not revealed any other instances of the use of portfolios.

SOME REAL NEEDS

As I move into the implementation of my different learning environment, UrbanWorld, I see three areas where I say to cartographers that I need help. First of all, how do I establish initial levels of visualization and spatial reasoning skills, and monitor progress in building these skills? Is there any standard battery of tests that I can use? What research is there that might help, for example research on map reading strategies, as well as research about the receptivity of students to interactive mapping. My own searches have not revealed any authenticated sets of test questions for visualization and spatial skills for a geography context. Therefore, for my own immediate purposes I have begun the creation of an on-line instrument to collect background information via a series of maps and connected questions, evaluating simple skills like measuring distance, identifying steep gradients, or comparing maps.

"I see three areas where I say to cartographers that I need help."

Second, the project will create a knowledge base that students can draw on as a resource, either under specific directions or using their own initiative, to obtain guidance as to what kind of map to make, what data preparation might be necessary, or which operational procedures, e.g. software tools, are needed. As part of this I seek guidance as to the existence of a collection of examples of good cartographic practice, and helpful hints about map design. Perhaps the on-line system will in time have intelligent assistants, or resources can be tapped via the World Wide Web.

Third, I see the need for a record-keeping process, a way to capture some of the "back-of-the-head" rules used in the process of working with the maps, whether with an element of formality associated with hypothesis testing or more intuitive learning by trial and error. Such metadata are important contextual information at different stages of the spatial reasoning process. What research has there been on the complexities of the individualistic analysis and decision-making that are major elements of the spatial reasoning process?

". . . a way to capture some of the "back-of-the-head" rules used in the process of working with the maps . . ."

SUMMARY

My remarks about what we want to know about map use, map users, and map use environments have emphasized the particulars of what may be a somewhat specialized use domain. Yet this context has led me to raise a number of issues and issue some challenges which in time may lead to interesting research avenues. There are both practical and intellectual matters. For the practical, for my UrbanWorld project this means ascertaining what exists today regarding standard tests for assessing map use skills and the creation of portfolios. From an intellectual viewpoint it means striving to understand the complexities of map use as part of a spatial reasoning process supported by a digital environment where the geographic content is the critical element, but for which the practical cartographic skills must be adequate for the task at hand.

ACKNOWLEDGMENTS

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FOOTNOTES

[1]Among many publications on active learning, I refer to only a bibliography by James Eison, Ellen Stevens, and Charles Bonwell, The Center for Teaching Enhancement, University of South Florida, Tampa, FL, February 1994, "Involving College and University Students Through Active Learning."

[2]Details about UrbanWorld can be found in Derek Thompson et.al., "Towards a framework for learning with geographical information systems: the case for UrbanWorld, a hypermap learning environment based on GIS," forthcoming in *Transactions in GIS*, 1997, 2(2).

[3]Two short articles oriented to the practice of portfolio-based performance assessment are: Judith A. Aster, Vikki Spandel, and Ruth Culham, "Portfolios for Assessment and Instruction," *ERIC Digest* (EDO-CG-95-10), 1995; and Richard J. Stiggins, "Design and Development of Performance Assessments," an instructional module from the National Council on Measurement in Education, Fall 1987, pp. 33-40.

User Interface Studies in the Virtual Map Environment

With the acceleration of interactive virtual map use and the proliferation of such mapmaking software, we need to learn much more about how interactive electronic media and animated map environments influence the communication of cartographic information. When assessing the communicative value of maps in any given environment where animation and other virtual maps are used, I argue that the interface itself becomes a significant factor in the use of the map, or map sequences. We need a revitalized and expanded role for a user-oriented or a user-interface form of research, not too dissimilar to the shifts in research emphasis undertaken by cartographers with the first wave of automation.

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INTRODUCTION

To cartographers, geographers, and others promoting the map as a primary vehicle of communicating spatial information and analysis, the question of how to contend with and best utilize the increasingly more powerful information technology and associated distribution techniques is ever persistent. Observing the impact of the computer technology on the mapping process during the 1960's and 1970's led Morrison (1974) to conclude that the technological expansion was a major catalyst forcing cartographers to be introspective about how maps communicate information. Now with the current proliferation of increasingly powerful microcomputers in education, government, business, and industry, much of the spatial information is portrayed and distributed in some form of virtual map, as defined by Moellering (1980). Once again we need to become introspective about map communication issues relative to the newer mapping environments.

The current "hot venues" for these virtual maps include electronic atlases, electronic encyclopedias, and the World Wide Web. These venues often incorporate map animation sequences and other multimedia components, and are increasingly including features which allow for the map reader to control many animation functions and interact with the map/atlas environment to exert some control over the display. When assessing the communicative value of maps in any given environment where animation and other virtual maps are used, I would argue that the interface itself (i.e., how to "operate" the map) becomes a significant factor in the use of the map, or map sequences. Thus, in terms of what we would like to know, I contend that we need a revitalized and expanded role for the user-oriented or a user-interface form of research as one appropriate avenue of inquiry given the literal explosion of virtual map use, particularly with increasingly interactive map animation.

"... the interface itself becomes a significant factor in the use of the map, or map sequences."

The 'user-oriented approach' is used by Gilmartin (1992) and others as a catch-all phrase to incorporate all aspects of cognitive and perception based research. In traditional user-oriented research, map components and/or whole maps are used as stimuli to test the map viewer's (the percipient's) reactions or perceptions. The mental and psychophysical responses are measured by the researcher, and ultimately the maps' communicative power is assessed and hopefully enhanced by this line of inquiry. Most past perception studies are appropriately specific in isolating a single variable, such as simple circle size in a proportional symbol map, with other map elements held as neutral and constant as possible. The question is, can we now apply a more broad based user-oriented test in these new environments, where the means to control or interpret an animated map, for example, is so dependent on the integrated relationship between many of the map elements (e.g., the static and temporal legends, the means to pause, slow down, speed up, reverse direction, etc.)?

In a research project I wanted to measure the degree of viability or impact that the animated map would have on the electronic atlas environment, particularly when the electronic atlas would be used in an educational setting. I developed a series of map animation sequences using a constant base map, consistent map element placements, but varied the themes and thematic map types. I animated choropleth, isoline, flow, and moving symbol maps across a wide variety of human and physical geography topics in order to emulate some of the breadth of a thematic atlas. I then tested the user reactions using a semantic differential test to quantify their subjective reactions to the maps, and also gave them a brief geography quiz to ascertain what kind of geographic information was being communicated. During the testing, I also monitored the interactive control functions as to the number of starts, stops, pauses, animation speed, and number of viewing times for each of the sequences, which were used as a measure of perceived map complexity. In all, I was able to test nearly 500 map-to-map user communications and interactions (Torguson, 1993).

"I animated choropleth, isoline, flow, and moving symbol maps across a wide variety of human and physical geography topics . . ."

Originally, I set out to examine the relationship between the subjective reactions of the map users and the amount of geographic information that was communicated from these animated maps while emulating an educational "laboratory" setting. In the process, among other things, it was found that there was no statistically significant relationship between subjective impressions of the maps and how well students were able to glean geographic information from the map. This fact is good news for those using maps in educational settings, where student enthusiasm for maps, even animated ones, and geography in general varies considerably. Unintentionally, I also found that in this study I was testing and qualitatively evaluating the viability of the entire user interface of the animated atlas system. For example, the relatively high scores that resulted on questions that required viewing and interacting with both the static and temporal legends, as well as use of the interactive control functions, suggested that the functional and positional configuration of the controls and legends was accomplished in a practicable manner.

Because most animated map environments (animation software packages, atlases, and media players) have similar control functions, broader user interface studies should translate to any user-environment that employs the animated map. Further, other microcomputer environments that use "interactive" map domains, such as query based encyclopedias and World Wide Web/Internet applications (Peterson, 1996), as well as many scripted or directed software packages (Monmonier, 1992), could benefit from such study. ArcView, which contains both menu and scripted interfaces, is a good example of an application that is being used more frequently by both cartographers and non-cartographers. This increased use can be seen (for example) in the adoption of ArcView as the state standard for "presentation GIS" in Wisconsin (Koch, 1996).

". . . broader user interface studies should translate to any user-environment that employs the animated map."

Many cartographers develop map-related packages such as atlas and encyclopedia shells using programming languages which facilitate graphics user interface design and development, such as Visual Basic. For example, I recently released a beta version of a Cartogram Generation Program for Windows. In this program, the user interactively creates contiguous value-by-area cartograms. To address the interface issues, I may opt not only to test the viability of the software interface, but also to utilize a user-oriented study to compare manual and computer generated cartograms in regards to cartogram accuracy, the time it takes to complete a cartogram, and perhaps even cartogram aesthetics. Note that Visual Basic is becoming an increasingly popular programming language in both commercial mapping and educational environments (Slocum and Yoder, 1996). Cartographers and software developers using Visual Basic could benefit from user interface studies, because there are scores of possible menu, icon, and interactive/dynamic map display combinations which can lead to a potentially non-intuitive user interface.

DiBiase et. al. (1992) have suggested that with a quarter century of experience with perception testing, cartographers may now be more prepared than ever to study map animation communication. And with the acceleration of interactive virtual map use and the proliferation of such mapmaking software, user-oriented testing can also apply to electronic atlases and encyclopedias, scripted and menu driven software packages that are increasingly being used by non-cartographers, and new software programs that are being developed by the cartographic community. Obviously, we need to know much more about how interactive electronic media and animated map environments influence the communication of cartographic information.

"... we need to know much more about how interactive electronic media and animated map environments influence the communication of cartographic information."

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reviews

Exploring Geographic Information Systems, Nicholas Chrisman. New York, John Wiley & Sons, Inc., 1997. 298 pages, maps, diagrams, equations, 12 page index. $49.95, softcover. ISBN 0-471-10842-1.
by Eric Fowler
Johnson Controls Inc.
Milwaukee, WI

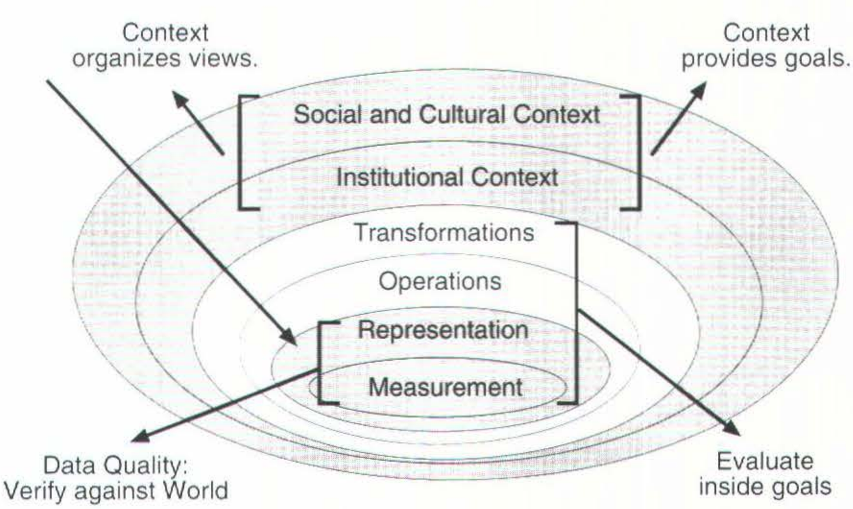
The organizing framework for Exploring Geographic Information Systems by Nicholas Chrisman looks at the subject in five ways simultaneously: as a technical problem, an empowering application, a scientific endeavor, an academic pursuit, and as a social necessity. Chrisman suggests that a GIS can be approached from any one of these, but one by itself is not adequate. He presents the diversity of GIS with a nested scheme of 6 rings, grouped into 3 parts of the book. Part 1 covers Measurement (chapters 1 and 2), and Representation (chapter 3). Part 2 covers Operations (chapters 4 through 8) and Transformations (chapter 9). Part 3 looks at the broader context of GIS, from the Institutional (chapter 10) and the Social and Cultural Context (chapter 11). As mentioned in the preface, the author has over 12 years of teaching experience in the subject area and believes it is important to focus on critical thinking in his courses, "confronting real dilemmas, not simplified examples or abstract theories." This is definitely the case in this book. The examples, and the technical descriptions, are both very thorough. The book has many references to prior methods of cartography, as well as suggestions for the user about conversions, databases, and cartographic representation of data.

Part 1: Building Blocks of Geographic Information

In Part 1 the author covers measurement and representation. He suggests that the process of geographic measurement (the first ring) requires choices that can be organized as measurement frameworks. The measurement framework differences best explain, he says, the technical choices of representation (the second ring). Measurement and representation strongly influence operations (third ring). Transformations, the fourth ring, is the conversion from one measurement framework to another. With this hierarchy of rings, Chrisman shows that each ring builds on decisions made at the lower or "simpler" levels. He also shows that GIS is more than just vectors, rasters, and linkages to attributes and promotes the critical details of Stevens' scheme of nominal, ordinal, interval and ratio measurements. Chrisman points to gaps in Stevens' scheme when applied to GIS and provides three reference systems as examples: Temporal (has an origin-time to call zero), Spatial (the brief introduction brings out the complexity of this level of measurement), and attribute (includes Stevens' plus several more).

Chapter 1 starts with the innermost ring in the 6-ring diagram of GIS-Measurement. Chrisman defines geographic information (Chrisman rarely uses GIS, rather the reference "geographic information"), reviews the conventional approach to measurement, and introduces reference systems for measurements of time, space, and attributes. He starts the chapter with a good description of map use including: civil engineering, cartography, surveying and the introduction of global positioning systems (GPS). An important point is made about the tendency to cling to the printed map as a model for digital development. This, Chrisman points out, has been a large barrier to GIS progress. He goes on to provide a definition for GIS and cites the general definition widely accepted by Dueker and Kjerne 1989. However, he adopts the following definition for the perspective of this book: GIS-The organized activity by which people: measure, represent, operate, and transform geographic phenomena. Each of these activities is expanded upon in the book. The conventional view of measurement is also detailed.

Chapter 2 deals extensively with Measurement Frameworks, which are the set of rules for measure-



ment. An example, taken from the book, is that of the geographical matrix. Basically a geographic object such as a city or state, has attributes. Chrisman then goes on to examine the three components of geographic information: time, space and attribute. He describes each as they serve as control, while one of the others (e.g. space) can be measured. Additionally, he suggests that, in geographic relationships, there are composites, indirect measurements, choropleth, and temporal that are all measurements frameworks for geographic information.

Chapter 3 describes the translation of measurement schemes into practical systems of representation. Substantial treatment of the conversion from paper maps to digital form (e.g. hardcopy maps into the computer-digitizing / scanning) is given. Chrisman discusses the details of representations of geographic information. Not just vector and raster differences and digitizing, but also computer storage explained with bits, bytes, integers, floating point, and double precision representation. However technical this may be to the reader, it provides a very good understanding of data representation. For example, a remotely sensed image, which is a continuous measurement, may be rescaled into a range from 0 to 255 to be coded as an integer, thus possibly losing data. Chrisman gives a very good description for vector and reintroduces the notion that the geographic information and decisions regarding the system should be tailored to the purpose of the project or enterprise. The chapter includes an in-depth discussion on digitizing including the pitfalls especially with accuracy variations. To help avert this, quality control and data checks are explained in regard to topology and digitizing.

Part 2: Operations and Transformations

Part 2 tackles the next two rings, operations and transformations, which comprise the majority of the book. Chrisman defines an operation, the third ring, as "the procedures that manipulate the information to construct new relationships or to make new measurements" the analytical basis of GIS. When an operation converts the information into a new measurement framework, it is called a transformation, the fourth ring. The final chapter of this section presents transformations as the culmination of the operations from chapters 4 through 8. The first two rings, measurement and representation, occur in a specific order. However, in operations and transformations, there is not as clear of a boundary. The 3rd ring, operations, takes 5 chapters discussing groups of tools in increasing complexity. Operations are the procedures that manipulate the information to construct new relationships or to make new measurements. Special operations convert the information into a new measurement framework, so they are termed transformations. The reader must get the measurement framework reference that Chrisman is making, since it is referred to throughout the book, starting with chapter 2. The definition given for measurement frameworks is "rules for control of other components of a phenomenon that permit measurement of one component - GIS has 3 components: time, space and attribute. "

Chapter 4 starts with the manipulation of attributes within one geographic entity (i.e. cities). For example. reducing and increasing information content. Chrisman points out the different affects, and possibly additional data needed, between decreasing and increasing information content. Chapter 4 ends with a discussion of the interaction between attributes and spatial components. An example is given in converting detailed land use categories to more generalized urban / rural categories. From this simple example Chrisman sheds light on the uses of aggregation and isolation and how certain categories can cause problems by not falling neatly into two categories.

Chapter 5 discusses overlay of different geographic data sets, in contrast to chapter 4, which deals with analysis within a geographic theme. The origins of the map overlay procedure are described in detail and the actual overlay operation is explained for both raster and vector mapping. Some history on the debate between vector and raster is also provided. Various uses of overlay are presented such as detecting differences in land use change over time. Chapter 5 details taxonomy of overlay combinations, which are broken into three groups: dominance rules, contributory rules, and interaction rules. This is a good description of the process and the rules used to accomplish various overlays. Several very good examples are given to help the reader tackle overlay problems.

Chapter 6 covers distance relationships such as vector buffers, and distance fields for rasters. The processes of how the buffers and distance fields are created are explained and comparisons are given for both. Voronoi diagrams, or as many geographers are familiar with-Thiessen polygons, are introduced at the end of the chapter. This method is introduced as a form of control through relationships, rather than control by attribute or space as in vectors and rasters respectively.

Chapter 7 describes neighborhood construction and the topology of surfaces. A challenge for the student of geographic information is given to ensure they understand what and how to use the term: topology of the topography. In this chapter Chrisman provides a description of how to compute relationships on a surface. Also, neighborhood operations are described and compared to overlay procedures. The complexity of neighborhood operations is discussed leading to the construction of neighborhoods. This is followed by a comparison of vector and raster neighbors, and finally we get taxonomy of neighborhood operations.

Chapter 8 deals with the last set of operations: comprehensive operations. This includes neighborhoods, location-allocation methods, and statistical analysis and GIS. This chapter deals with the complex operations a GIS undertakes, taking into account not only the surroundings, but also what is going on elsewhere. The author covers this complexity in three parts in this chapter: first with iterative operations, where the result at one place can propagate to influence the results elsewhere. The second group deals with location-allocation models, where the strategy is to find the most practical solution, possibly not the optimal one. The chapter concludes with a summary of the whole distribution with statistical models.

Chapter 9, covers the 4th ring, transformations of information from one form to another. This chapter looks at past approaches to transformations in analytical cartography, operations to transform surface information, and develops taxonomy for transformations. Chrisman admits that many of the operations presented in the book to this point could be considered transformations, but this chapter focuses on conversions between measurement. Chrisman calculates there are 144 transformations for the operations introduced in his book. Because of the large number, and mostly to make a point, he only deals with surface transformations in this chapter-a total of 16 transformations. A few good examples of transformations are given at the end of the chapter to help the reader understand the utility.

Part 3: The Broader Context

Part 3 suggests evaluating a GIS not only on technical merit but also how it meets the goals for the project. This section covers the measures of evaluation and the procedures to implement a GIS. Part 3 tries to focus on the purpose behind doing a GIS in the first place. The final 2 rings are explained to the reader by covering the broader context of institutional, social and cultural issues with regard to geographic information. First, in Chapter 10 the author looks at the process of evaluating the operation of a system and its implementation. Measures that are used to evaluate geographic information systems are reviewed, and a description of database design procedures in implementing geographic information systems is given.

The goal of Chapter 11 - Social and Institutional Context is to examine how the social and institutional context shapes and constrains the use of geographic information. Chrisman starts the chapter with a discussion on mapmaking throughout history, followed by a section on the "geography of geographic information". A discussion of how the needs for geographic information arose is covered. Basic political problems are covered in this chapter since GIS often affect many departments. Information equity, access and balance of competing concerns are addressed from this social context with references to GIS.

The author's goal is to have the reader examine, and explore GIS based on a nested scheme of 6 rings. These progress from measurement, to representation to operations & transformations, to an institutional, social & cultural context. He definitely covers these rings and how they interrelate. He shows their importance and uses their hierarchical structure for the book's foundation. The technical aspects of GIS are covered very well, in order for the reader to "master this powerful new technology". However, the book does not give as much depth to the final two rings, Institutional, Social and Cultural Context, which is misleading when viewing the these two large rings in the nested scheme of rings diagram. Chrisman does inform the reader in the preface that the organizational views are missing from most technical literature on GIS, and that view is needed since a GIS is developed and maintained for a reason. So to that end, even though it is sparse, it is at least included. To the author's credit, the brevity does not take away from the content; Chrisman packs a lot of information in the last part of the book.

Chrisman does a good job of covering the breadth of GIS while also providing the user with plenty of references and technical descriptions of GIS. The author does admit early on that this is a book to begin exploration of GIS, not to cover all aspects. However, this book is not meant for users starting out with new desktop GIS software. Even though the suggestions in it are very useful, the level of technical knowledge is well beyond a business executive, or a crime analyst who may be using GIS occasionally to answer spatial questions. This book would better serve a GIS analyst, student of geographic information, or anyone charged with implementing or maintaining a GIS.

This book is unlike many other GIS books that focus on the people, data, software, hardware, and processes, or those that discuss the potential uses of GIS. This book starts with a detailed description of measurements. The author gives a very good description of the vector model as it relates to GIS. He also, again, contrasts with cartography as well as drafting or illustration software. The book does a very good job at discussing measurements, and operations on data sets (the first 4 rings), but just a small portion of the book is spent on people, and the social context required for a GIS. Chrisman wants to get across the notion of exploring GIS in his nested 6-ring context. The concept seems very valid, however, the book seemed a little off balance with the highly technical sections on surfaces, and levels of measurement, and then the very light touch on the institutional, social and cultural context. I agree with the author that many GIS books are very technically slanted. However, I doubt this book will be read, if not only understood, by those other than technically literate GIS / computer / geography users.

As I have mentioned, there are extensive references to the cartographic processes, as well as several references to surfaces, which help to make several key points in the book. However, again the level of detail and amount of information on the technical side seems to make the final two chapters out of place. For example, Chrisman spends a lot of space, relative to other topics, on compression for raster images such as the TIFF standard and quadtrees.

The order of the material was also presented slightly different than other GIS books. The very technical topics first and than the broad approach of GIS, where it fits, evaluation, etc. are at the end. Even in chapter 10: which covers evaluation and implementation, Chrisman has a list of steps to implement a GIS, and construction is of course last, with assessment and analysis for a system listed first.

I think the GIS terminology is very well explained and many examples are given. In addition, the comparison to cartography is helpful to many geographers and cartographers. However, the connection to the decision-makers interested in the "broader context" may not be appropriate. This book is heavily focused on surfaces, cartographic background, which may not be suitable for many desktop GIS users. However, I don't think Chrisman intended it for the masses of GIS users. It is a wonderful book for someone involved with GIS, or intends on learning more about geographic information.

The author has a web site encouraging continued exploration. The web site is http: / / www.wiley.com / college / chrisman. It is a great site full of content. It includes the book's table of contents, a definition of GIS, the book's index, and more.

Overall Chrisman meets his goal of starting the reader on an exploration of GIS. Very good examples are given as well as problems to look for during the implementation and technical phases of a GIS. In addition, he makes connection from GIS to other fields, or past processes to help the user understand a concept. Some examples of how he does this are provided here. A simple example, a reminder is given to the reader regarding "standardizing" a ranking from say 1 to 9. An assignment of numbers, Chrisman reminds the reader, does not automatically construct valid arithmetical relationships. Pitfalls with digitizing are highlighted. For example, taking the digitizing tablet's resolution as a measure of accuracy. Projections and classification reductions are other examples Chrisman uses to get the reader on this exploration. Many links are made to other technologies, or just older methods of doing the same thing. Such as the overlay method taken from photomechanical reproduction, seeing through multiple layers. In addition to uses and specific technological tools, the author also gave specific examples from real-world projects such as the Pennsylvania project to site a disposal for radioactive waste. He used this project in the example of overlay. Other operations are detailed, such as raster overlays to get a cost surface. A good example is given in the transformation section of the book. Chrisman explains the process of Dasymetric mapping of population density. Showing population density after taking out uninhabited areas from the predefined set boundaries, in this case the census tracts-also called controlled guesswork. The importance of a good cultural context is explained with the backdrop of systems that chose the hardware and software on technical merit, not the purpose of the organization.

I think current "power" users of GIS will learn interesting details and further their understanding of GIS. One of Chrisman's underlying goals, I believe, is to have the reader question some of the data or processes currently in place in a GIS department.

Shapes of Ireland: Maps and Their Makers, 1564-1839, J. H. Andrews Geography Publications, Dublin, 1997 346 p. Illus.
by Sharon Hill, AGS Collection, Univ. of Wisconsin-Milwaukee

" Shapes of Ireland: maps and their makers, 1564-1839", by J. H. Andrews, successfully presents and evaluates the cartographic impacts of the mapping history of Ireland. The early cartographic styles, with both their shortcomings and genius, juxtapose with the territorial and political struggles of the lands of Ireland and Britain that differ culturally and socially. Ireland owes most of its cartographic representation to English mappers, many never having set foot on its green and hilly shore. The story is poignant and true and told with erudition. It is only by reading between the lines that one sees the reasons for its late-blooming cartographic production. From present day evidence, most of Irish cartographic history, owing to circumstance, style, and need is rooted in the English school. The need for the English to map Ireland finds reason in military and economic causes. The fact that the data was located in Dublin and the cartographer usually in London substantiates the theory that this was often long-distance work. Traditionally, the Irish themselves were a word-of-mouth people, apparently seeing no need to extensively record mapping data on paper, evidenced by a complete lack of extant provincial maps today. Andrews characterizes them as perhaps neither ambitious enough or too ambitious to be satisfied with the simple objective of presenting an early completed map. The conflict between linguistic representation, love of land, and knowledge of place, makes for some dramatic accounts of English / Irish mapmaking during this tumultuous time of the union of Ireland and Great Britain.

Andrews draws a magnificent picture of the historical cartographic development of Ireland, for all of its frailties. The apparent lack of Irish-made maps is evident. This is attributed to the causalities of time and human carelessness. The last stage of conquest of Ireland, 1603, nearly coincides with the present evidence of the early English / Irish mapping. At this time, travel to the once-Gaelic Ireland, now under the influx of the English, was easier, what with the network of towns, the spread of the English language, and the extension of agriculture to feed the mainland. It actually was a wealthy and developed land, for some. There was no reason why it should not be mapped extensively. But it's mapping was flawed. The English cartographers in the 18th-early 19th century found the current wave of triangulation to be more relevant to commercial interests than the mathematical details of latitude and longitude of this small island. Vast areas were missed out, whole counties were found wanting for evenly surveyed representation, and place-names were Anglicized. The Irish were not found on the map of Ireland.

Andrews relates the details of fieldwork, compilation, production, and distribution of the nine key maps of Mercator, Boazio, Speed, Petty, Pratt, Jeffreys, Beaufort, Arrowsmith, and Larcom. The genealogical history is traced with specificity of what is currently known. The characteristics of the cartographer and the maps themselves are closely examined. Examples of the salient contributions to this cartographic history are shown and described. The maps are viewed as specimens of cartography, not as examples of iconography, propaganda, or art. They are examined by Andrews to the scholarly standards of the present day. As a further disclaimer, the manuscript map is silenced out, pre-empted by the printed map, which, according to Andrews, has more intrinsic precedence through his identification of merit and influence as determiners of successful historic mapping. He evaluates such criteria as legibility, comprehensiveness, aesthetic appeal, relationship to other maps, and its inherent noteworthiness as a means to identify merit. To assess the range of influence, Andrews specifies the derivations of the map, and its use. Using this as a guideline, he concludes that the printed map complies with more of the characteristics of merit and influence than the manuscript map, bringing the early phase of Irish mapping to about 1590. As mapping history progresses, Andrews carries onward the importance of the maps derived rather than the those which are the cause. The key maps he identifies throughout the text are evaluated for the degree of new information brought forth from them. It is the key map that is the foundation map, the cause, giving rise to the derivative map, the effect. In the ultimate effort to map Ireland, it is now the derivative map that is most complete and useful and representative of accuracy. How accurate it was assessed at the time is unsure, for those in the map workshop were often not those who had done the fieldwork. He nevertheless acknowledges 'the place of new mistakes on new maps,' ' that the cartographer only tells the truth as he sees it,' ' and that reputations already won often contributed to the recognition of a map.' We have the evidence of its size and relative detail upon it. Occasionally, we have the documented explanations of cartographic procedures described by the mapper himself. Often the cartographic influence itself was illusory, a place across the rough sea described and mapped by a colonizer safely at home in London. Having said all this, he defines the 16th century as marking the take-off period of map accuracy. The period reviewed by Andrews falls within this prescribed time. We can therefore be relatively certain that his examples are the definitive maps congruent with the mapping history of Ireland.

Following the 'later is best' theory, Andrews traces the cartographic representation of Ireland to the 20th century. Along the way, he reviews the progress of the Ordnance Survey, including the eventual need for the O.S. to seek the advice of commercial cartographer John Bartholomew of Edinburgh in the 1890s. Contending with the complexities of color, relief, and scale, the Ordnance Survey was pressured by both the military occupations of late-Victorian imperialism and increased tourism following the famine of the 1840s. Commercial competition forced the Survey to bring their work up to date in keeping with the technologies of the day. The non-geographical concerns such as color schemes, decoration, marginal text-matter, or specialized thematic material, make for competitive cartographic work. The accuracy of the map declines as information accumulates or over-simplification ensues in keeping with customer demands or business concerns. Andrews contends that "maps become as correct as paper and ink will allow, or for that matter, as the users desire." He tells of the scale issue in which 'improvement lies henceforth in selectiveness rather than completeness.' The simple problem of placing all that needs to be mapped with the constraint of a single sheet of paper made for some difficult decisions.

Within the time-span of two and a half centuries, Andrews cites the key-map concept as integral to the appreciation of Irish map history. As time progresses, the key-map concept 'the evolutionary flow (of information) may divide instead of converging, and one powerful family may be challenged by another of the same generation. The solution is then to treat both contenders as key maps.' This solution definitely has a limit, that the unique distinction of key map not be widely applied and cartographic history become redundant. The mapping of Ireland now is at the behest of the computer. Geographical information systems have made the change of scale and point coverage a matter of mathematical adjustment. Map history of Ireland is still in the making, as is the mapping of this green and beautiful land.

In conclusion, J. H. Andrews has compiled and written a comprehensive account of the mapping history of Ireland. It is also a story of colonization and conquest of a country by an imperial power. This is a world-wide tale in history. The story has more than one ending. There could be other characters. The issues of the history of cartography are relevant to other places and times. Andrews has shown the relevance of cartography to history and place and the people who make the maps. Those who inhabit this land may have less interest in the story. The conquered not only have less voice, but perhaps less interest in the conquered land, as they struggle for their daily needs. Remembering it was for militarism and tourism, following the Irish famine that maps reached a zenith of popularity. The cartographic history here is seemingly as complete as it could be, short of a wonderful discovery that would fill in some early gaps. It probably would be Andrews himself who would be the scholarly discoverer of such missing links in the map history of Ireland. I wish him well, that he never completely closes the book on his research in this most interesting area.

Counties USA 1997: A Directory of United States Counties. Kay Gill and Darren L. Smith, eds. Detroit: Omnigraphics, Inc., 1997. 573 pp., Index, Maps. $85.00 hardcover (ISBN 0-7808-0094-X).

Reviewed by Scott R. McEathron
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Milwaukee, WI 53211

This basic reference book provides limited descriptive statistical data for each county in the United States. The counties are arranged alphabetically by chapters for each state, making the book very easy to use. Each state chapter is proceeded by a Bureau of the Census base map showing the boundaries and names for each of the counties in that state. Basic contact information for state officials (telephone and fax numbers, and Internet addresses) are then provided. Contact information is also given for each county and includes the county seat mailing address, telephone and fax numbers, and Internet address when available.

The descriptive statistical data provided for each county includes both 1990 and 1995 population, population density (1995), and land and water area in square miles. Brief descriptions of the county's location and name origin are also given.

The book has limited utility since all of this information it contains can be found in other sources. The 1990 population, population density, land and water area in square miles, and the brief descriptions of the county's location and name origin is the same as what can be found in American Places Dictionary (Omnigraphics, Inc., 1994). The 1996 County and City Extra: Annual Metro, City and County Data Book (Bernan Press, 1996) is a much more comprehensive source for statistical data. Carroll's Municipal/County Directory: 1996 Annual (Carroll Publishing, 1996) has much more comprehensive contact information at the county level. Similarly, Carroll's State Directory: 1997 Library Edition (Carroll Publishing, 1997) provides more comprehensive contact information at the state level.

The most disturbing thing about Counties USA 1997 is the large number of errors evident in the land in square miles data. A possible printing or data entry problem caused all counties with land or water areas of four or more digits to be incorrect. For example, the land area for Bayfield County, Wisconsin is listed as 1 square mile! In reality it is 1,476 square miles. This problem results in an unacceptable number of errors of fact thoughout the book. In western states such as Wyoming, where all counties have land areas greater than 1,000 square miles, the number listed for the area in square miles is always wrong. Because all of the information in Counties USA 1997 is found in other sources and the many obvious errors, it is difficult to recommend its purchase to any individual or institution.

cartographic techniques

A Desktop Approach to Shaded Relief Production

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A companion Web site at www.nacis.org/cp/cp28/relief_tp.html contains sample files, links to software and data sources, and additional techniques, including a map projection method.

Cartographers often have mixed opinions about shaded relief. Although shaded relief is valued as a design option for presenting understandable and aesthetic terrain on maps, it is frustratingly difficult to produce. Heretofore, the prerequisites for creating shaded relief have been artistic talent and/or the mastery of complex and expensive software. Today, however, relief shading is undergoing democratization thanks to the accessible tools of desktop publishing. In this article I discuss shaded relief production and presentation techniques using Adobe Photoshop 4.0, the popular graphics program in which many cartographers have dabbled.

Photoshop offers practical advantages to cartographers for producing shaded relief. Many cartographers already own this desktop program. It is relatively easy to use, and can (by digital standards) generate reasonably attractive shaded relief. Photoshop offers powerful interactive tools to manipulate the rendered shading for final presentation. Many output options are available, including print-ready PostScript files and JPEG files for the Web.

Using a graphics application such as Photoshop for cartographic production is not without problems. One problem is the importation of Digital Elevation Models (DEMs), the data upon which digitally-generated shaded relief are based. Photoshop does not import raw DEM files. Third-party utilities are needed to convert raw DEM's (text files of elevation values) to 8-bit raster images that Photoshop will recognize. The converted DEM's will be 256-level grayscale images that show highlands with light values and lowlands with dark values (figure 1). Each pixel in the grayscale image corresponds to a sampled elevation point on the original DEM. A list of freeware and shareware DEM conversion utilities is provided on the Web site. They are well documented and easy to use.

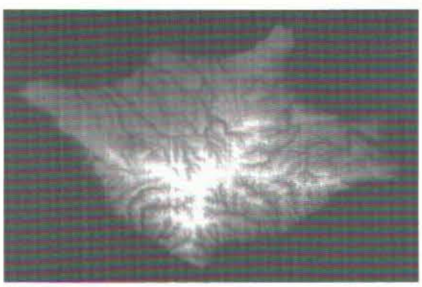


Figure 1. USGS DEM of Santa Rosa Island, California in grayscale format.

The procedure for creating shaded relief in Photoshop is straightforward: Open a Photoshop RGB file with a white background, insert a grayscale DEM into an alpha channel, and apply a lighting filter that interacts with the DEM to generate a "bump map" texture that simulates shaded relief. If this process sounds unfamiliar, relax. Shaded relief can be created without difficulty by following the recipe below. To execute the recipe you will need a grayscale DEM. A sample DEM is posted on the Web site for you to use.

Recipe for quick and easy shaded relief

Ingredients:
* Photoshop 4.0
* Grayscale DEM data
* Ample RAM (at least 16 MB is needed to work on the sample DEM)

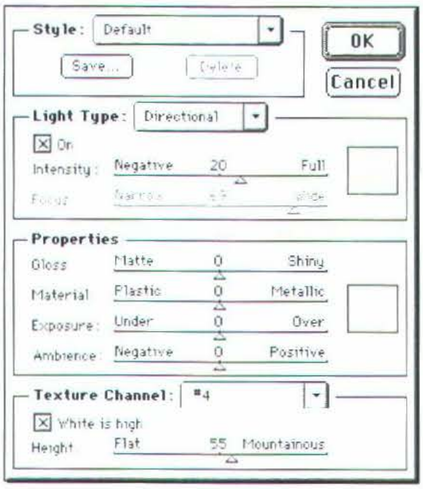
Serving Size:
Shaded relief in square or rectangular shapes at any size up to the 30,000 x 30,000 pixel limit of Photoshop.

Preparation:
Note: Keyboard shortcuts are shown for the Mac OS. For Windows use simply substitute the Control key for the Command key.

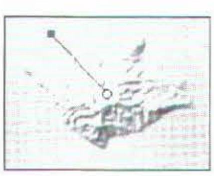
1) Launch Photoshop and open a grayscale DEM. Make sure the background color at the bottom of the toolbar is set to white.

2) With the DEM visible as the Background layer, choose "select all" (Command A), and then "cut" (Command X). The Background layer should become white.
3) Change the color mode from grayscale to RGB by choosing "Image/Mode/RGB Color" from the pull down menu.
4) Open the channels palette from the pull down menu (Window/Show Channels). Create a new alpha channel by clicking the "Create new channel" button at the bottom of the palette. An alpha channel (#4) will appear at the bottom. Paste (Command V) the grayscale DEM into the activated alpha channel.
5) Click the top "RGB" channel to make it active. The DEM disappears, and the background becomes white. The eye icon should be visible in all channels except #4. Acti-

vate the layers palette by clicking the "Layers" tab.
6) From the pull down menu choose "Filter / Render / Lighting Effects." Enter:



7) On the left side of the dialog box is a graphical device for setting light direction and altitude. Select the small square at the end of the tethered line and drag toward the upper left to set northwest illumination. Dragging away from the center circle lowers the light source altitude, turning the preview black. Drag too close to the center and the preview turns white. Place the square about two thirds of the way between the center and upper left corner of the preview box for best results. Experiment.



8) Now for the moment of truth. Click "okay" to render the shaded relief. Notice that the rendered relief looks much better than it did in the dialog box preview. If the relief doesn't look right, use "undo" (Command Z) and return to the lighting effects dialog. Try adjusting the intensity, flat / mountainous setting, and the light direction and altitude until the results are pleasing.

Presentation Techniques

Photoshop offers almost unlimited ways to manipulate shaded relief graphically. The following is an overview of techniques preferred by the author.

Reproducible results: Settings in the Lighting Effects dialog box can be saved for applying identical properties to other reliefs. The saved settings appear in the "Style" pop-up menu. Also, the Actions Palette allows the cartographer to record and save most graphical manipulations performed on a relief. The saved "action" can be replayed at a later time for replicating a presentation style.

Sharpening: Relief generation is an interpolative process that can give relief an unfocused look. Applying a moderate amount of Unsharp Mask (Filter / Sharpen / Unsharp Mask) will make shaded relief look crisper (figure 2). Try these settings on a 72 dpi relief: Amount 150%, and Radius 0.5 pixel. Nudging the threshold up from zero levels removes sharpening from flat areas with less contrast.

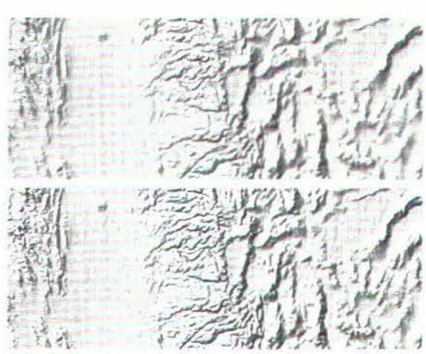


Figure 2. Shaded relief before unsharp masking (top) and after (bottom).

Layers: Before editing, always duplicate the relief to an extra layer as an insurance copy in case something goes wrong. Layers are indispensable for applying localized modifications to a landscape. For example, to sharpen an area of high mountains on an otherwise gentle landscape, duplicate the relief layer, place the duplicated layer beneath the original, and apply sharpening to the entire duplicated layer. The next step is to add a layer mask to the original relief layer. Finally, use a soft-edged paint brush gradually to open windows in the mask. This last step allows the sharpened peaks to emerge through the gentle original relief.

Painting: The quality of many DEM's is sub-optimal, which translates into unwanted visual artifacts on the final shaded relief. Common problems are: systematic banding, edge matching, elevation spikes and holes, and terracing (figure 3). These problems can be disguised, up to a point, with the standard arsenal of painting tools—especially the rubber stamp, dodge, burn, blur, and airbrush tools. Be careful when using painting tools to beautify shaded relief; overuse can decrease accuracy.

Illumination: Cultural and historical influences have made northwest illumination the convention for relief shading. Sometimes, however, strict adherence to northwest lighting fails to portray all parts of a landscape. A common problem is the flattening of northwest-trending

Figure 3. Terracing is a flaw found in some DEM's. It is most pronounced in flat areas.

topography, which lacks illumination and shadow contrast. This problem can be alleviated by rotating the light source up to 30 degrees in either direction from northwest. In the most troublesome cases, it may be necessary to generate two or more shaded reliefs that use slightly different light sources. Place the shaded reliefs on separate layers and use the layer mask technique to call out localized illumination.

Lowland tones: Gray value in flat areas is necessary for shaded relief to appear as a continual landscape. However, too much value in lowland areas can interfere with the presentation of thematic map data. To solve this problem, adjust settings in the Lighting Effects dialog box to lighten lowland values without unduly diminishing mountainous areas. Elevating the light source and increasing ambience serve to lighten the entire relief. Simultaneously increasing the mountainous setting will replace lost contrast in rugged areas. Also, lowland tones can be lightened after a shaded relief has been generated. Use the Brightness / Contrast controls (Image / Adjust / Brightness / Contrast...) to make global adjustments and the dodge tool—selecting a soft-edged brush—for localized touch-ups.

Resampling: Photoshop renders shaded relief at the same resolution as the grayscale DEM, typically 72 dpi. If a higher resolution is needed for print production, two methods are available: 1) Increase the resolution of the original grayscale DEM and then render, or, 2) increase the resolution of the shaded relief after it is rendered. Neither technique yields additional terrain detail but, only larger file sizes. In the opposite situation, excess detail can obscure larger, more important, topographic features. This problem can be remedied by downsampling (generalizing) the grayscale DEM before generating shaded relief (figure 4).

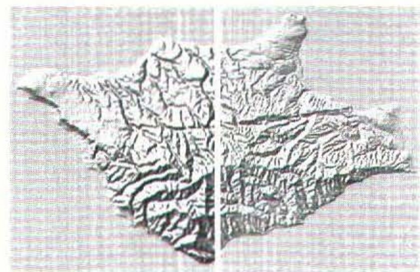


Figure 4. Shaded relief generated from low resolution (left) and high resolution (right) versions of the same DEM.

Elevation color: The 3D look of a landscape can be enhanced by blending shaded relief with continuous-tone elevation colors derived from the grayscale DEM. Accomplish this by pasting the DEM on a new layer beneath the shaded relief, then colorizing the DEM using HSB controls (Image / Adjust / Hue, Saturation...). After colorizing the DEM, set the overprinting shaded relief to "multiply" blend mode (in the layers palette) and adjust the opacity of the relief and DEM layers until the right look is achieved. Multiply blend mode emulates traditional screen printing by adding the color of upper layers to those beneath.

Hypsometric tints: Accurate hypsometric tints can be produced by applying the threshold command (Image / Adjust / Threshold) to a grayscale DEM. The threshold command creates area masks that can define each of the 256 grayscale levels (elevations) in a DEM (figure 5).

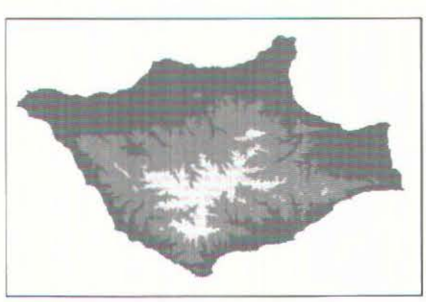


Figure 5. Hypsometric tint layers shown at 500 foot intervals.

To calculate the elevation of a single grayscale level, in feet or meters, divide the elevation range of the DEM (DEM conversion utilities report this) by 256.

Needed Photoshop Capabilities

Additional cartographic functionality could be brought to Photoshop via plug-in filters, in the same way Avenza MAPublisher has brought Geographic Information Systems (GIS) functionality to Adobe Illustrator and Macromedia Freehand. Such cartographic plug-in filters would help to bridge the gap between the PostScript-centric world of presentation cartography and GIS.

Conclusion

With the steps covered in this article, cartographers now have an avenue to easily produce shaded relief to enhance the geographic quality of the maps they produce. Further exploration by cartographers using Photoshop should yield additional useful techniques.

NACIS news

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minutes

NACIS Board Meeting
October 1, 1997
Lexington, KY

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, Susan Peschel, Valerie Krejcie, Glenn Pawelski, and Barbara Buttenfield; Executive Director Chris Baruth. The meeting began at 3:20 p.m. with the approval of the minutes from the Chicago meeting.

NACIS '97

Susan Peschel reported 103 preliminary registrants for the Lexington meeting. Chris felt comfortable with the hotel room nights. Sona reported on the preliminary costs of the Lexington meeting and will offer a final report in the spring. It was agreed that future "Calls for Papers" will mention the requirement that participants pay the registration fee. Presenters will also be asked to note any audio/visual needs.

Elections

Chris reported the election results as follows: new Officers, Cynthia Brewer, Vice President and Jim Minton, Secretary and new Board Members, Greg Chu, Elizabeth

Nelson, Jeremy Crampton, and James Meacham.

Treasurer's Report
Sona reported a balance of $27,414.76. She offered a detailed accounting of expenses and revenues for the 1996-97 year, which offered new guidance toward fu ture budgetary requirements.

Web Page
A private service provider has been retained for the maintenance of the NACIS Web Page. Jeremy reported the costs involved with the company and his satisfaction thus far with their service. This company will be used for the next two years on a trial basis. The Board expressed the desire to establish page content which promotes the organization. This would include membership requirements, Call for Papers, meeting announcements, C.P. News, and links to other cartographic sites of interest. Chris agreed to handle the day-to-day site updates. A motion was made to establish a 3-member committee, appointed by the President, to solicit the membership for contributions to the web site's content. The President will serve as an Ex Officio member of the committee. The motion passed. Jeremy Crampton and Tom Patterson were selected to serve.

Membership
Tom Patterson distributed a flyer to promote new memberships for the Society. Comments and changes on the flyer would be addressed at the second board meeting.

NACIS XVIII
Owing to a failure to find suitable accommodations in Chicago, NACIS XVIII will be held in Milwaukee, Wisconsin at the Hyatt on October 7-10, 1998. Room rates are $99. A pre-conference symposium on "The History of Cartography in Education" has been proposed by Jim Ackerman. The Board agreed to help facilitate registration and encourage the membership to attend.

NACIS XIX
Jim Anderson reported that a contract has been signed with the McGruder Inn in Williamsburg, Virginia for the 1999 meeting. Room rates are $98/night. Don Zeigler has offered to help with local arrangements.

NACIS XX
The Board suggested the following cities for future investigation for the meeting in 2000: Kansas City, Omaha, Las Vegas, Cleveland and San Diego.

Cartographic Perspectives
Jim Anderson reported that the production process at FSU was working smoothly. The Board expressed their desire to find a permanent editor as soon as possible.

Other Business
Chris pointed out that the membership must be polled to amend the by-laws in order for a student to sit on the Board. Ballots will be forthcoming. Mike closed the meeting by thanking the retiring Board Members and the Local Arrangements Committee for the Lexington meeting. Adjourned 6:20 p.m.

Submitted,
Craig Remington
NACIS Secretary

NACIS Business Meeting
October 2, 1997
Lexington, KY

Mike Peterson welcomed the membership and recognized participants from Australia, Russia and Austria. He announced the forthcoming vote on the change in the by-laws to allow a student member to the Board. Mike thanked Jeremy Crampton and Chris Baruth for their development of the web site and asked the membership for comments and suggestions on its content. He recognized and thanked Jim Anderson on his work with *Cartographic Perspectives* and asked the membership for aid in selecting a permanent editor. Mike also announced next year's Milwaukee meeting site and dates, as well as the 1999 meeting in Williamsburg. Sona Andrews circulated a Treasurer's Report and spoke on the general highlights of its contents. She also reminded the members to pay their dues in a timely manner. Chris Baruth announced the results of the election for the Board. Chris thanked Mike for his work as President and wished Pat Gilmartin much success for her term. He also made the membership aware of the symposium prior to the Milwaukee meeting on "The History of Cartography in Education" by Jim Ackerman. Mike closed the Business Meeting at 1:40 p.m. by asking the members to consider running for positions on the Board in the future.

Submitted,
Craig Remington
NACIS Secretary

announcements

CONFERENCE ANNOUNCEMENT

Canadian Cartographic Association and the Association of Canadian Map Libraries and Archives - A Joint Conference
May 27-30, 1998
The University of Western Ontario, London, Ontario CANADA

Web Page Bookmark:
WWW.geog.uwo.ca/
1998_map_conference/
overview.html
Preliminary program details will be available early in 1998 at this URL address.

A WORLD PREMIERE! You are invited to visit The University of Western Ontario campus in the forest city - London, Ontario - to participate in the first joint conference of the Canadian Cartographic Association and the Association of Canadian Map Libraries and Archives.

CONFERENCE WILL ADDRESS CARTOGRAPHIC THEMES SHARED BY EACH ASSOCIATION AS WELL AS THOSE UNIQUE TO EACH. To encourage a co-operative learning experience the conference format will include a mix of joint as well as concurrent sessions, workshops and special theme sessions. An added bonus -
the ICA 1997 Canadian Map Exhibit from Stockholm will be on display at the University art gallery in conjunction with other artists' works influenced by cartography.

Forward inquiries to either
CCA Co-Chair Patricia Chalk (chalk@sscl.uwo.ca) or
ACMLA Co-Chair Cheryl Woods (Woods@sscl.uwo.ca)

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submissions

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

NACIS membership form

North American Cartographic Information Society
Sociedad de Información Cartográfica Norte Americana

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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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